**NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ABUNDANCE ESTIMATES**

**Kerteminde, 13-15 March, 2002**

## 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.

At its 1999 meeting, the NAMMCO Council recommended that the Scientific Committee continue its efforts to co-ordinate future sighting surveys and analyses of the results from such surveys in the North Atlantic. In response, the Scientific Committee convened a meeting of this Working Group in November 2000, for the dual purpose of continuing analyses from previous NASS surveys, and planning a NASS survey for 2001. The Working Group developed a survey plan which incorporated vessel surveys by the Faroe Islands, Iceland and Norway, and an aerial survey around coastal Iceland, as in previous NASS surveys. This plan was further developed and modified by correspondence among Working Group members and at an additional training/planning meeting held immediately before the survey. The NASS-2001 survey was conducted in June - July 2001.

The main purpose of the meeting was to review survey reports and abundance estimates from the survey, particularly for the target species minke and fin whales. Many of these estimates were only partially complete, so the Working Group was to recommend additional analyses to be conducted. A secondary objective was to evaluate the survey design and procedures used, and make recommendations for future surveys. Finally, the Working Group was asked to plan and schedule the publication of the results from NASS-2001, and those from previous surveys that had not already been published.

## 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. Document SC/10/AE/4, Abundance of minke whales from NASS-2001 ship surveys, had not been completed in time for the meeting. An additional document describing the Faroese ship survey was accepted as SC/10/AE/15. In addition, working papers from previous meetings of the Working Group, and other published documents, were also available as needed.

## 5. SURVEY REPORTS

Working papers describing the general methodology and results from the 2001 ship and aerial surveys were briefly reviewed by the Working Group. Target species of the surveys were minke and fin whales for the Faroes and Iceland, and minke whales for Norway. For the first time the Faroese and Icelandic vessels used identical methodology, a Buckland-Turnock (BT) mode using 2 independent observer platforms. This involves one platform (the "tracking" platform), searching further ahead to set up "trials" from which the detection function of the other platform (the "primary" platform) is estimated. It requires the primary platform to operate independently of the tracker platform, but not vice-versa.

The Norwegian survey methodology was somewhat different as the Norwegian component of the NASS survey was also a part of their national 6 year rotational survey program.

After the survey had begun, permission to enter UK territorial waters was withdrawn for the Norwegian vessel and refused for the Faroese vessel. This necessitated a last-minute re-allocation of survey effort by the Norwegian vessel from the North Sea to the Norwegian Sea, and the abandonment of part of the planned Faroese survey block. The Working Group noted that because of this important areas were not surveyed, reducing the overall value of the survey results.

The final survey plan is shown in Fig. 1, and realised effort and sightings are shown in Fig. 2 - #.

**Faroese ship survey**
The refusal of admittance to UK waters significantly reduced the size of the Faroese block. Consequently there was higher coverage in this reduced area. The primary north-south tracks were completed, and part of the secondary east-west tracks were completed as well. Weather was relatively good throughout the survey and most lines were completed in Beaufort sea state of 4 or less. A total of about 2,500 nautical miles was covered on effort, and 459 groups of cetaceans comprising twelve species and 1,798 individuals were sighted. The most common species were by rank pilot whales, sperm whales, bottlenose whales, white-sided dolphins, harbour porpoises, minke whales and fin whales.

**Icelandic ship survey**
Subsequent to the November 2000 Working Group meeting, it was decided in Iceland to share survey effort on an international redfish survey being conducted by Icelandic survey vessels participating in the survey. This necessitated a change in the survey area, block structure and effort allocation. The northern and eastern parts of the Icelandic area were still surveyed by a dedicated survey vessel.

Planned transects had to be adjusted because of prevailing weather and ice conditions, particularly in the northern and northwestern areas covered by the dedicated vessel. The primary target species of the survey were minke and fin whales but an emphasis was made to identify as many sightings to species as possible in particular to distinguish fin and blue whales. Cetaceans of 14 species were identified in the survey. These were in addition: sei, humpback, sperm, northern bottlenosed, pilot, and killer whales, a beaked whale, white beaked, Atlantic white sided, likely bottlenosed dolphins and harbour porpoises. The most common large whales were fin whales (890 animals in 556 sightings) and humpback whales (441 animals in 282 sightings).

**Icelandic aerial survey**
The survey design was identical to that used in 1995 and 1987, except that Blocks 5, 7 and 9 were extended eastward from 11° to 10° W. This was done to achieve better coverage of a major concentration of humpback whales in the area. A greater emphasis was placed on observer training in an effort to avoid some of the problems experienced in earlier surveys. Double platform effort was maintained throughout the survey with the cruise leader, and partially the pilot acting as secondary observers. Realised effort was greater than that achieved in 1987, but less than that achieved in 1995. At least partial coverage was achieved in every block. In all 537 primary sightings of 1,354 animals comprising at least 9 species were made, including 200 sightings of minke whales, 161 of humpback whales and 118 of dolphins.

**Norwegian ship survey**
The last-minute shift from the North Sea to the Norwegian Sea resulted in problems in co-ordinating the activities of the Norwegian survey vessel. Due to miscommunication very little of the planned effort was realised. Poor weather affected the second half of the survey. As a result this survey block was not covered. The vessel did however collect surfacing data for minke whales that will be of use in future surveys.

## 6. MINKE WHALES

**i. Ship survey**

***NASS-2001***

No abundance estimate was available for minke whales from the Faroese and Icelandic ship surveys. However the Working Group noted that the coverage and distribution of sightings in the Icelandic survey area may necessitate some non-standard analyses. Because of weather and ice related revisions to the survey plan in the northern and northwestern blocks, the coverage probabilities were substantially higher in some parts of strata than in others. Sightings of minke whales were highly clustered close to the northern and western edges of the western and northwestern blocks, presumably in association with the pack ice edge. This corresponds to an area of high coverage probability. Very few sightings of minke whales were made in the western block, which was mostly surveyed in unfavourable conditions for detecting minke whales (high Beaufort sea state and fog). For these reasons, the Working Group recommended that a spatial analysis be pursued for minke whales and possibly other highly clustered species such as humpback whales. In such an analysis the random placement of transect lines in relation to geographical features is unnecessary. Such an analysis can produce an estimate of greater precision than a line transect analysis, and can provide a better understanding of the underlying distributional patterns of the animals. As a simpler alternative to a spatial analysis, some post-stratification of the original blocks could be pursued.

***NASS-95***

In 1997 the NAMMCO Scientific Committee Working Group on Abundance Estimates derived an estimate of the abundance of minke whales in the Icelandic survey area of NASS-95 (NAMMCO 1998a). This estimate had 2 components: one from coastal waters covered by the aerial survey, and the other from offshore waters covered by the shipboard survey. However the shipboard estimate was apparently calculated at the meeting and was never properly documented. SC/10/AE/6 presented a recalculation of this estimate for archival purposes.

The analysis used standard line transect methods. No double platform data was available to correct for whales missed by the observers. The estimate was calculated using both the original block structure and a post-stratification of block 9 between Iceland and E Greenland to a smaller block that included all the sightings. This post-stratification had been used in the original reported estimate. The total estimates for the survey area and for the survey area outside the aerial survey block were almost the same as those reported in NAMMCO (1998a), irrespective of post-stratification, although there were some minor differences in the individual block estimates and variances. These estimates are negatively biased by both perception and availability biases.

In discussion the Working Group considered that the post-stratification of block 9 was acceptable because it was not based on observed minke whale distribution, but was done in an effort to achieve equal coverage probability in the area close to the pack ice edge. This area is more sheltered that the rest of the block and less effort was discarded due to high Beaufort conditions. The derived estimate will be useful for comparison with similarly calculated estimates from earlier surveys.

**ii. Aerial survey**

SC/10/AE/5 described an estimate of minke whales from the aerial cue counting survey around Iceland. The survey, conducted in June-July, was the fourth large-scale aerial survey covering Icelandic coastal waters since 1986. Stratified cue counting methods were used to calculate a preliminary estimate of the abundance of minke whales in the survey area. Because of differences in the viewing patterns and sighting efficiencies of the primary observers, 2 estimates were calculated, one using only the better observer, the other using data from both observers. The best estimate of minke whale abundance in the survey area was derived using only the data of the best observer and a cueing rate of 53 cues per hour (no variance estimate), 40,115 whales (95% CI 24,660 to 65,257) for the entire area. This was about 1.4 times the estimate using both observers, with a slightly higher variance. Double platform effort was maintained throughout the survey, and it appears that the proportion of cues seen close to the survey platform approached 1 for this observer. This estimate may be positively biased by failure to account for error in measuring radial distances. However it appears

that distances were measured relatively precisely (CV 8%) so this bias is probably slight. The estimate is higher than that obtained in 1987 and lower than that from 1995. However the lack of data on distance estimation error in 1995 preclude comparison of the 1995 estimate with other years.

The Working Group agreed that the estimate using data from the best observer only was less biased than the estimate using both observers. There is still a need to account for bias due to random error in radial distance measurement, but it was considered that the bias due to this factor is unlikely to be large, given that the observed measurements have an estimated CV of only 8%. A more important factor is likely the cue rate used. Data collected from tagging of minke whales off Norway indicates that the cueing rate there is somewhat lower than the cueing rate of 53 cues per hour used here. This would increase the estimate by proportion. In addition, variance in cueing rate should be incorporated into the estimate.

The Working Group therefore concluded that completion of this estimate will require:

i. accounting for bias due to error in measuring radial distance, and;
ii. use of the best available cueing rate for minke whales during daylight hours, and incorporation of variance in cueing rate in the estimate, and;
iii. using double platform data to correct for perception bias. This may involve analysing the data with respect to where effort appears most concentrated.

It was anticipated that these tasks could be completed within 6 months.

The Working Group agreed that the 1987 and 2001 data should be analysed using consistent methodology that takes account of distance estimation errors.

**iii. Combined estimates**

As the ship survey estimate had not been completed, no combined estimate could be derived. The Working Group recommended that this be done in a timely fashion.

**iv. Trends in abundance**

SC/10/AE/7 presented an analysis of trends in distribution and abundance of minke whales from aerial surveys conducted in the coastal waters of Iceland in 1986, 1987, 1995 and 2001. The 1986 survey was conducted as a line transect survey, while the later surveys were conducted as cue counting surveys. The distribution of minke whales was very stable from year to year, with highest densities in the SW, N and SE waters of Iceland. Line transect density was used as an index of relative abundance, and all datasets were treated in an identical manner so that any trend signal would not be masked by analytical differences. Relative abundance showed a significant increase in the area to the N of Iceland, and moderate but non-significant increases in the high-density area in SW Iceland (Faxaflói), NW Iceland and in the survey area as a whole, over the period. The apparent increases in the N and NW of Iceland may be partially due to the cessation of minke whaling, which was concentrated in these areas up to 1985.

In discussion the Working Group noted that an analysis of simple encounter rate would likely give similar results (SC/10/AE/14). The Working Group concluded that the abundance of minke whales around Iceland has been stable or shown a moderate increase over the period. The apparent increase in relative abundance in block 4 is consistent with population growth after cessation of catching, however other factors, such as immigration from other areas, may also be involved. There are also indications of better feeding conditions off northern Iceland in 2001 than in previous surveys.

## 7. FIN WHALES

**i. 2001 ship survey**

SC/10/AE/8 described the abundance estimate for fin whales from the Icelandic and Faroese ship surveys. The distribution of sightings of fin whales (see Fig. X) was more even than in earlier surveys, particularly in the blocks west of Iceland, where the distribution in previous surveys was more concentrated around the continental slopes. Double platform data collected indicated that the

proportion of whales seen by the primary observers close to the trackline was close to 1 for this species, and that a correction for whales missed would not increase the estimate substantially while increasing the variance. Estimates by block and for the total area are given in Table 1. The estimate for the total area of 25,352 is higher and has a lower CV than estimates from equivalent areas from past NASS surveys. While some of this increase may be related to increases in survey efficiency, this factor alone likely cannot explain the observed increase since 1987. Stock increase, immigration from other areas, and/or variation in distribution between years may also be involved.

The Working Group concluded that this estimate is likely to be only slightly negatively biased by perception and availability biases, and accepted that correcting for perception bias was not likely to be worthwhile. The four NASS ship surveys carried out since 1987 provide an excellent time series of abundance for this species. It was therefore recommended that a more complete analysis of changes in abundance over all the NASS surveys be conducted. This may require some re-analysis of past survey data as the coverage has changed between surveys.

The Working Group noted that sharing of survey platforms with the redfish survey had apparently been successful. International redfish surveys will be carried out over similar areas on a 3 year rotation, and cover a larger area to the south and west of the NASS-2001 survey area. The Working Group recommended that the possibility of extending the cetacean survey by sharing platforms with the other participating vessels in the redfish survey be further investigated.

| Block | Area (nm) | *n* | *L* (nm) | *N* | CV (%) | 95% CI | |
|---|---|---|---|---|---|---|---|
| **Icel.SW** | 190,577 | 31 | 1,169 | 2,723 | 27.87 | 1,480 | -5,009 |
| **Icel.W** | 154,692 | 271 | 2,424 | 10,800 | 15.20 | 7,862 | -14,836 |
| **Icel.NW** | 28,154 | 144 | 616 | 5,513 | 38.81 | 2,274 | -13,370 |
| **Icel.N** | 31,781 | 38 | 556 | 1,522 | 53.13 | 449 | -5,155 |
| **JanMayen** | 145,847 | 47 | 1,791 | 2,719 | 38.13 | 1,196 | -6,180 |
| **Faroe Isl.** | 117,500 | 62 | 2,457 | 2,074 | 27.39 | 1,139 | -3,777 |
| **Combined** | 668,551 | 593 | 9,013 | 25,352 | 12.71 | 19,576 | -32,831 |

Table 1. Abundance of fin whales in Icelandic and Faroese ship survey blocks from NASS-2001. *n* - number of fin whale groups sighted; *L* - survey effort; *N* - abundance.

## 8. OTHER SPECIES

### i. Humpback whale

SC/10/AE/9 reported a line transect estimate for humpback whales from the 2001 Icelandic aerial survey. Sightings of humpback whales were highly concentrated off northeastern Iceland and to a lesser extent off southwestern and northern Iceland. A relatively high proportion of sightings close to the trackline by the secondary observers were duplicated by the primary observers, indicating that perception bias is low but not absent for this species. The total number of humpback whales in the search area was estimated to be 3,057 (95% CI 1,727 - 5,410), with NE Iceland accounting for over half of this number. However this estimate has a negative bias because of perception bias and, probably more importantly, animals missed because they were diving when the plane passed. The estimate from this survey is substantially (but not significantly) lower than that produced from the NASS-95 ship survey (Pike *et al.* MS 2001), however this may be due to the above mentioned biases and the fact that the ship survey covered a larger area.

Sightings from the NASS-2001 ship survey were also highly clustered around NE and W Iceland within the aerial survey block, but substantial numbers were also seen in areas farther offshore. More sightings were made in the Faroese block than in previous surveys. No estimate has been derived from these sightings as yet.

In discussion the Working Group noted that the contagious distribution of humpback whales seen in both the aerial and ship surveys may make spatial modelling a suitable analytical approach. It is likely that a spatial model would provide a more precise estimate and might enable some ecological interpretation of the observed distribution. The overlap between the shipboard and aerial surveys may also provide a means of correcting the aerial survey for availability bias, using the ratio of observed shipboard/aerial survey density in the overlap area. However such a correction factor is likely to have a high variance. Another approach might be to use diving data from other areas to correct for availability bias in the aerial survey.

SC/10/AE/14 analysed trend in the relative abundance of humpback whales over the course of the 4 Icelandic aerial surveys carried out since 1986. Encounter rate increased by an average of 11.4% (SE 2.1%) per year over the period in the survey area. Encounter rates for other species did not change much over the period, so it seems unlikely that the increase for humpback whales can be attributed to changes in survey efficiency. This rate of increase is in accordance with that of 11.6% over the period 1970 - 1988 in recorded sightings humpback whales by whalers operating west of Iceland reported Sigurjónsson and Gunnlaugsson (1990).

The Working Group noted that humpback whale sightings have also increased over the course of the NASS ship surveys conducted since 1987, and that much of this increase appeared to have occurred off E Iceland. It was considered useful to break down the trend in the aerial surveys by E and W Iceland to see if the rates of increase differed. It is unlikely that a shift in distribution from offshore to inshore areas can account for this trend as the ship surveys indicate no such shift. Indeed, more offshore sightings of humpbacks were made in 2001 than in earlier surveys.

There has been almost no catch of humpback whales around Iceland since the first stage of Icelandic whaling came to an end in 1915 (Sigurjónsson and Gunnlaugsson 1990). Therefore, stock recovery is one plausible explanation for the trend, however the observed rate is on the edge of biological plausibility. Immigration from other areas may also be playing a role. The Yonah study (Palsbøll *et al*. 2001) has shown that there are at least 2 breeding populations of humpbacks in the North Atlantic, and that the whales around Iceland and Norway are a mixture of the 2 groups. It is possible that the stocks are growing at different rates, accounting for the apparent recent high growth rate around Eastern Iceland.

There has been very little sampling of humpback whales from E Iceland. Víkingsson noted that genetic and photographic sampling was planned for summer 2002, and would be continued if successful.

In summary the Working Group recommended the following with regard to humpback whales:

1. apply spatial modelling techniques to the 2001 aerial and shipboard surveys, and possibly to earlier surveys as well if this proves useful;
2. correct the aerial survey for perception bias using the double platform data;
3. attempt to correct the aerial survey for availability bias using the ratio of observed densities from the shipboard and aerial surveys in areas of overlap, or using diving data from the literature;
4. estimate trends separately in E and W Iceland.

**ii. *Lagenorhynchus* dolphins**

SC/10/AE/9 reported a line transect estimate for dolphins from the 2001 Icelandic aerial survey. Species identification was uncertain but 96% of the sightings were identified as white-beaked dolphins, with the rest being of unknown species identity. The high proportion of white-beaked dolphins is consistent earlier surveys and other information from the area. The distribution of dolphins was consistent with earlier surveys, with animals being concentrated in N central, SW and SE Iceland, however dolphins were found almost everywhere in the survey area. Group size estimation was somewhat uncertain but there was no apparent bias in group size estimation with perpendicular distance. The total number of dolphins in the search area was estimated to be 20,444 (95% CI 12,714 -

32,874). This estimate is biased downwards both by perception and availability biases. There are duplicate data that can be used to correct for perception bias, but this has not been done yet.

The Working Group recommended that further analyses that incorporate the duplicate data be completed. It was also recommended that the other aerial surveys be analysed in a similar manner to look for temporal trends.

There were large numbers of dolphin sightings in both the Faroese and Icelandic ship surveys. Virtually all sightings in the Faroese block were confirmed as white-sided dolphins. Some of these sightings were in an area in which *Lagenorhynchus* were also seen on the aerial survey. This should be investigated further. Most sightings from the Icelandic vessels were of white-beaked dolphins, but many sightings were not identified to species and it was considered that species identification was uncertain even for those that were identified. Tracking of dolphin groups by the secondary observers was not very successful in either the Faroese or Icelandic surveys, so there is insufficient information to correct for availability bias or responsive movement.

The Working Group reiterated its conclusions from 2000, that while an analysis of the shipboard dolphin data from this 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 Icelandic members agreed to inspect the data for these species to determine if further analyses are likely to be useful. If so, an analysis that assigned species identification probability using relevant explanatory variables should be considered.

**iii. Pilot whales**

A total of 55 sightings of 622 pilot whales was made in the Faroese block, more than in 1995. Sightings were concentrated in the western part of the survey block. The 32 sightings of 563 animals made by the Icelandic vessels were concentrated in the W and SW blocks. Unlike in the 1995 survey when pilot whales were a target species, no closing experiments were conducted to calibrate group size estimation.

The Working Group considered that, given the relatively high number of pilot whale sightings in the 2001 survey, and abundance estimation was worthwhile and should be conducted. Pike agreed to carry out the analysis. It was also noted that a recent successful application of satellite tags in the Faroe Islands will provide data with which to correct for availability bias for this species.

**iv. Sperm whales**

SC/10/AE/13 presented a calculation of sperm whale abundance from the 2001 Icelandic and Faroese shipboard surveys. For the first time data was collected in such a way that a cue count, using terminal dives as a cue, was feasible. The vessel to stopped or slowed down if it was heading to within 0.5 nm of a sperm whale to avoid triggering responsive cues, and the position of the cue relative to where the vessel would have been had it continued was used in the analysis. In addition to the cue count, which included only those animals that displayed a cue, a line transect estimate that included those animals that were visible on the surface as the vessel passed abeam was calculated. It was assumed that sperm whales cued twice per hour, and line transect estimate was corrected by assuming that sperm whales spent 20% of the time visible at the surface. For the Icelandic area, the weighted average of the two estimates was 9,477 (CV 0.406). A cue count estimate was not possible for the Faroese area because the positions of terminal dives were not recorded consistently. The ratio between the combined estimate for the Icelandic area, and a line transect estimate that included all sightings (1.41), was used to correct the Faroese line transect estimate to 1,708 whales. The combined estimate for the entire area was 11,185 (CV 0.34). Data from past Icelandic harvests has shown that only male sperm whales are found in these waters.

In discussion the Working Group agreed that the methodology used was theoretically and practically valid. The cue rate and proportion of time spent on the surface used to calculate the estimate are of course crucial. While no data has been collected from this area, data collected from other areas could

be applied to provide a better estimate of these parameters. Radio tagging studies in North Atlantic waters will however be required to provide more reliable estimates.

**v. Bottlenose whales**

More bottlenose whales were were sighted in both the Icelandic and Faroese surveys than in previous surveys. Sightings of bottlenose whales were highly concentrated in the northern Icelandic block, but were well distributed throughout the Faroese block. As NAMMCO has used a line transect estimate from previous NASS surveys in an assessment of this species, it was considered worthwhile to proceed with a line transect estimate for this species, while recognising that it will have a substantial negative bias due to availability bias with this deep-diving species. In this regard the availability of dive data from Canadian waters was noted. Pike agreed to carry out the analytical work.

**vi. Killer whales**

There were 36 sightings of killer whales in the Icelandic shipboard survey, and 8 in the Faroese block. Most Icelandic sightings were concentrated on one leg in the northern block. It was noted that the animals there appeared to be travelling with the vessel, which may have led to multiple sightings of the same animals. The Working Group considered that an abundance estimate derived from these sightings was unlikely to be of use. However the distribution should be compared with that seen in earlier surveys.

**vii. Blue whales**

The Icelandic ship survey produced 29 sightings of blue whales, while 9 sightings were made in the aerial survey. While this is likely too few to derive a meaningful abundance estimate, it might be useful to compare encounter rate between surveys to determine if there is any evidence of a trend in relative abundance. However it was noted that such a trend might be confounded by between-survey differences in the effort dedicated to differentiating blue and fin whales. More effort was made to discriminate the species in 2001 than in earlier surveys.

## 9. EVALUATION OF SURVEY METHODOLOGY

**i. Ship surveys**

Working papers SC/10/AE/10 and 11 provided evaluations the platforms, equipment, training and methodologies used on the Icelandic and Faroese ship surveys. A major problem with the setup on the Faroese vessel was that the tracker platform was lower than the primary platform. Problems were also experienced with vibration on the tracker platform, making it difficult and uncomfortable to use the binoculars. The primary observers were instructed to search for both the primary species, minke and fin whales, which required them to search at greater distances from the platform than they would have if only minke whales had been targeted. BT design requires the tracker to search substantially further than the primary observers. This requirement was compromised on both the Faroese and Icelandic vessels. Few trackings of minke whales were made on the Icelandic vessels, probably because weather conditions prevented the trackers from seeing small whales at large distances, and possibly also because the observers tended to focus their search on the target fin whale. The application of the BT method was therefore not successful in terms of correcting for responsive movement and availability bias, although the duplicate data will still be useful in correcting for perception bias, and was felt to be useful in keeping observers alert.

Other more minor problems with the data forms and procedures are summarised in Appendix 4.

In discussion the Working Group considered that the application of the BT methodology was problematic in a combined survey for large and small whales, which did not restrict primary search effort to be substantially closer to the vessel than tracker search effort On these surveys, the BT method was compromised, and few trackings were made. Nevertheless the methodology might have been effective on the Faroese vessel had the tracking platform been higher than the primary platform, and if the problems with vibration had been less severe. It was also noted that tracking small whales at

great distances requires experienced and motivated observers, so it is best to ensure that those observers best able to track areused on the tracking platform.

If the BT method was applied as intended, with the primary platform searching close to the platform and the tracker platform searching farther away, it is still likely that sufficient sightings of large whales would have been made.

Another possibility would be to use symmetric platforms, with all observers tracking whales and recording cues and tracking whales, as in the Norwegian minke whale surveys. Duplicate matching would be done after the survey rather than in the field. Initial sightings could be classified by distance to derive corrections for responsive movement and availability bias using the method of Palka and Hammond (2001). Such a methodology would benefit from automated timing of cues, as is done in the Norwegian surveys.. The effort put into tracking might also reduce the total number of sightings, but this might not be problematic as the effort applied is increased by fully utilising the data from both platforms.

The Working Group concluded that the combination of multispecies surveys and BT methodology as implemented in this survey was problematic. However it was emphasised that the double platform methodology in general was successful and will prove useful particularly in refining the estimates for minke whales and other smaller species. Further effort should be devoted to the automation of data recording and entry so that observers can be better monitored by the cruise leader in the field. Finally, special attention must be paid to the design of platforms to reduce vibration, improve visibility and increase observer comfort.

There were problems in conducting distance experiments in these surveys and the Working Group reiterated its previous recommendations that such experiments be conducted during and after the survey.

**ii. Aerial surveys**

SC/10/AE/12 presented an evaluation of the methodology used in the Icelandic aerial survey, including considerations of survey platform, equipment, personnel, design and strategy, and procedures. A summary of the recommendations for future surveys is contained in Appendix 5.

A more fundamental consideration was whether cue counting from an airplane was the best approach to estimate minke whale abundance in Icelandic nearshore waters. The methodology is very demanding of observers, sensitive to distance estimation error and differences in sighting patterns between observers, although these factors can be accounted for in the analysis.. There have been problems with the conduct (1995, 2001) and analysis of data (all years) from the surveys that make comparisons of absolute abundance between surveys difficult.

In discussion the Working Group noted that cue counting from an airplane should be an effective methodology for minke whales. Correcting line transect estimates for availability bias is more difficult than for doing so for cue counting. The Working Group concluded that with the practical recommendations for improvements in equipment and procedures contained in Appendix 5, cue counting was still the best available methodology for minke whale surveys in this area. Of particular importance will be effective training of observers, and further automation and simplification of the process of data collection, entry and display. It is very important that the cruise leader have the capacity to monitor the performance of observers while the survey is in progress, so that problems can be corrected.

The Working Group agreed that the possibility of using an aerial digital photographic survey should be considered. This technique will be tested in Iceland in the coming year.

## 10. PUBLICATION OF SURVEY RESULTS

The Scientific Committee had directed the Working Group to devise a plan for the publication of results from NASS-2001 and earlier surveys. It was noted in this regard that none of the results from NASS-95 from the Icelandic and Faroese areas had yet been published. It had been originally planned to publish these results in a volume of NAMMCO Scientific Publications, but that plan had been abandoned.

It was agreed that a special volume on the NASS surveys in general would be of great interest to many researchers. Four NASS surveys have been conducted, over a long enough time frame that temporal trends in distribution and abundance may be detectable. The volume therefore should not merely report abundance estimates from the later surveys, but should synthesise results from all the NASS surveys to elucidate temporal and spatial patterns. It was considered that the volume could best be organised by species, with contributors using information from all the NASS surveys regardless of national affiliation.

Nils Øien and Daniel Pike agreed to take responsibility for organising and editing the volume, to be published as a future issue of NAMMCO Scientific Publications.

## 11. OTHER BUSINESS

The Working Group will likely need to meet again in winter 2003, once various identified analyses have been completed.

The Working Group expressed their sincere appreciation for the hospitality they had enjoyed at the Fjord and Bælt Centre, and thanked Genevieve Desportes and the Director of the Centre, Heinrich Lehman Andersen, for hosting the meeting.

## 12. ADOPTION OF REPORT

The Report was adopted on March 15, 2002.

## REFERENCES


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note on occurrence of other cetacean species. *Rep. Int. Whal. Commn* 40:537-551.

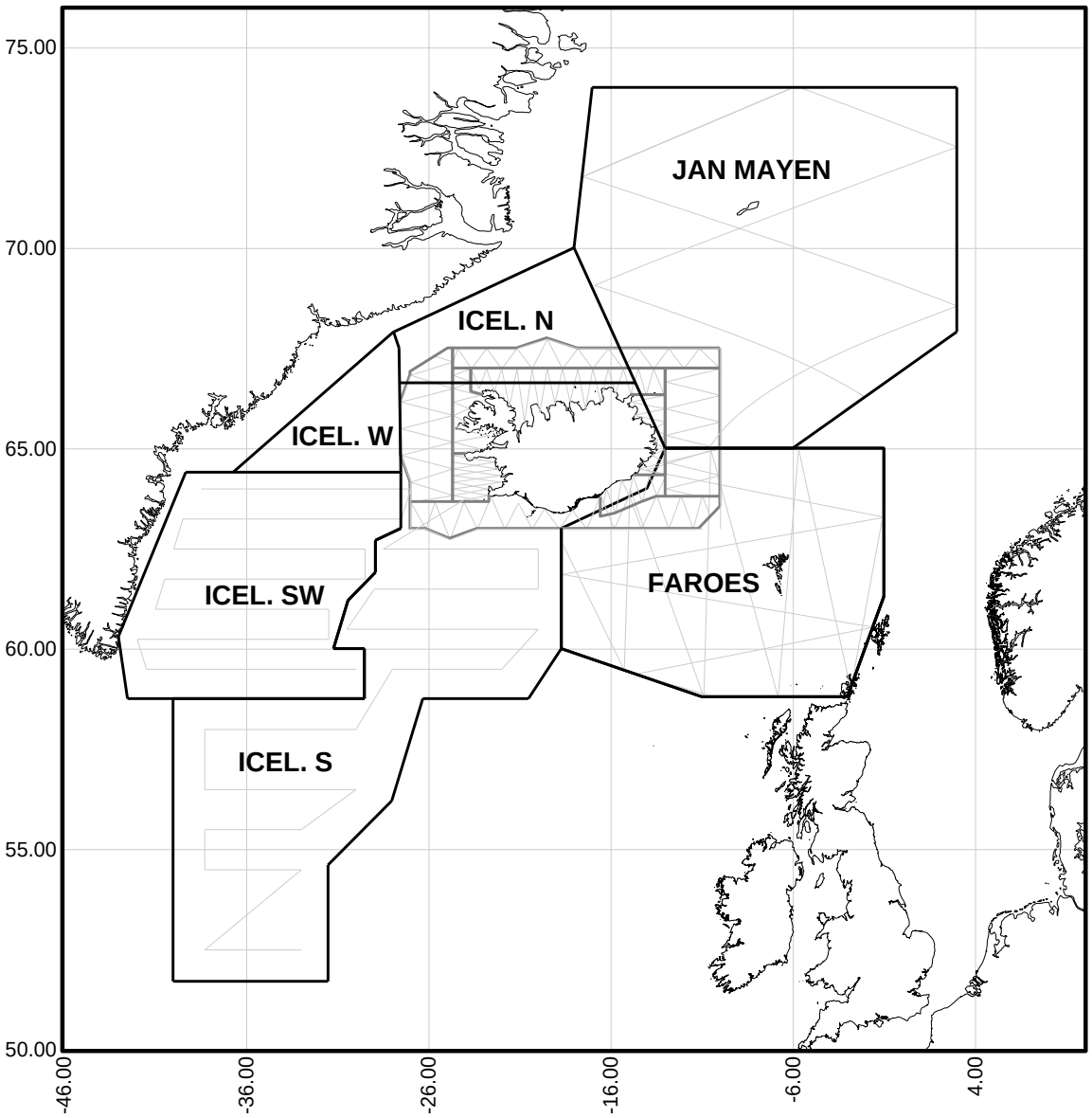


Fig. 1. Planned survey blocks and tracklines for NASS-2001.

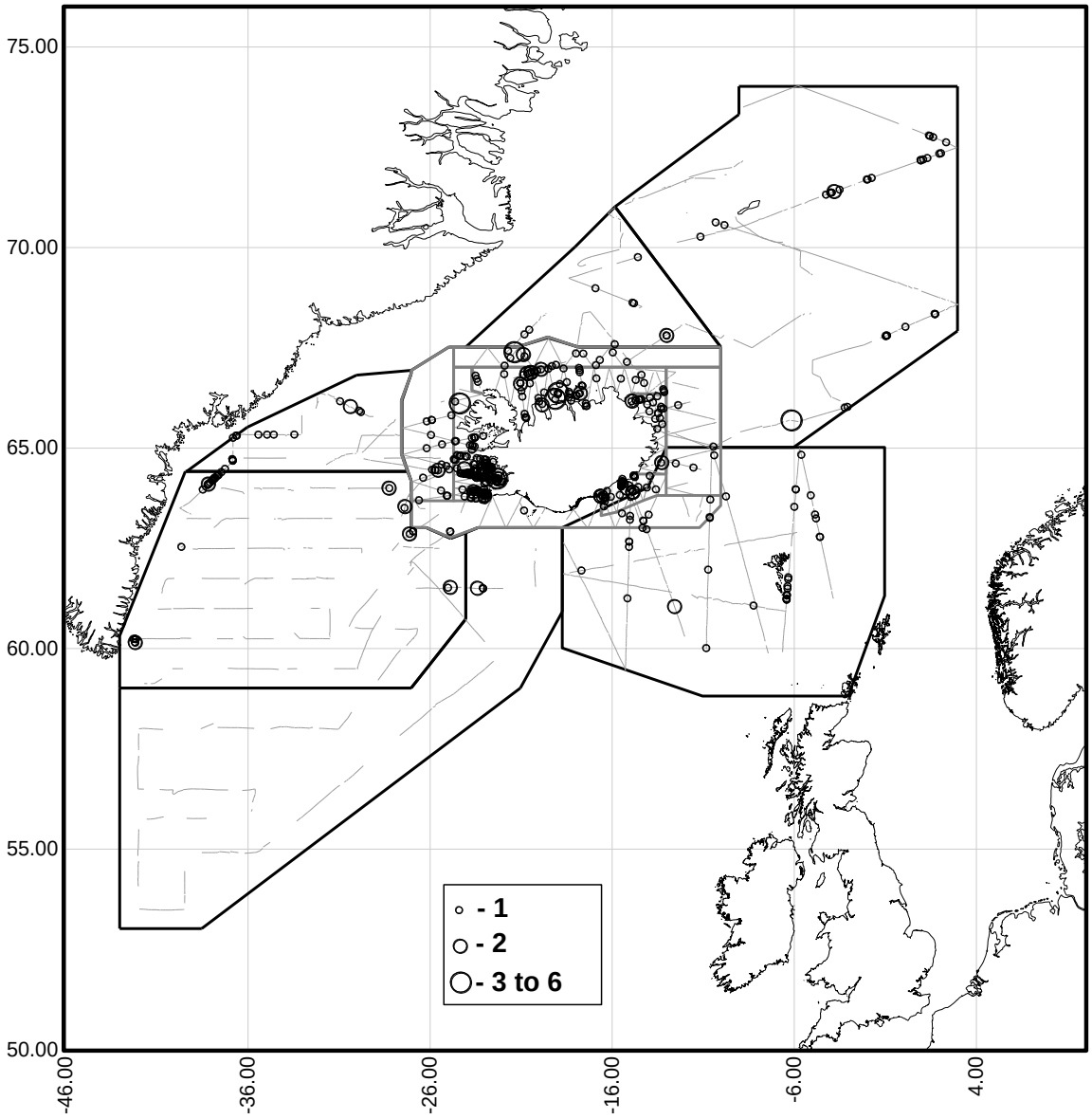


Fig. 2. Distribution sightings of minke whales from NASS-2001.

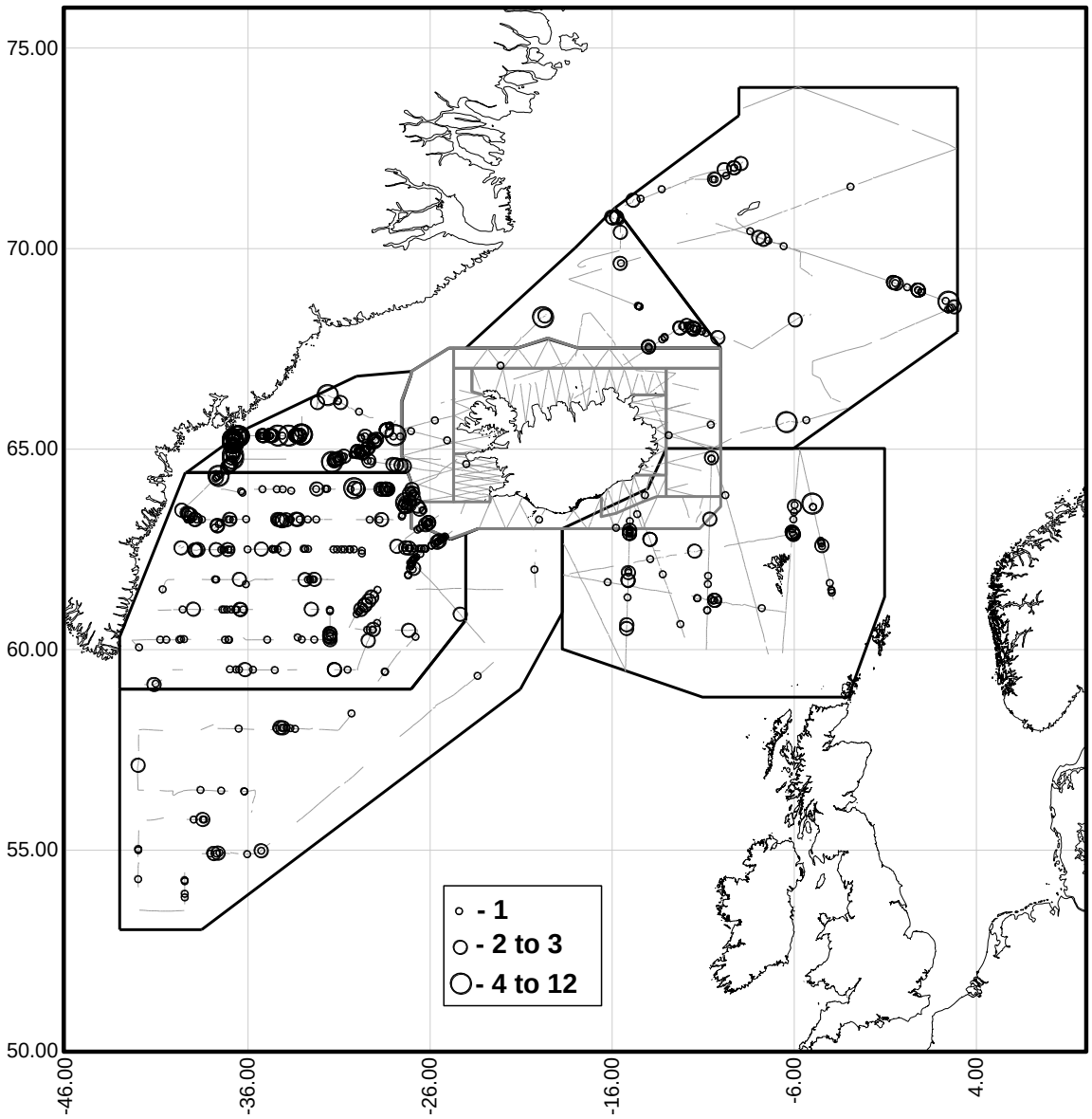


Fig. 3. Distribution sightings of fin whales from NASS-2001.

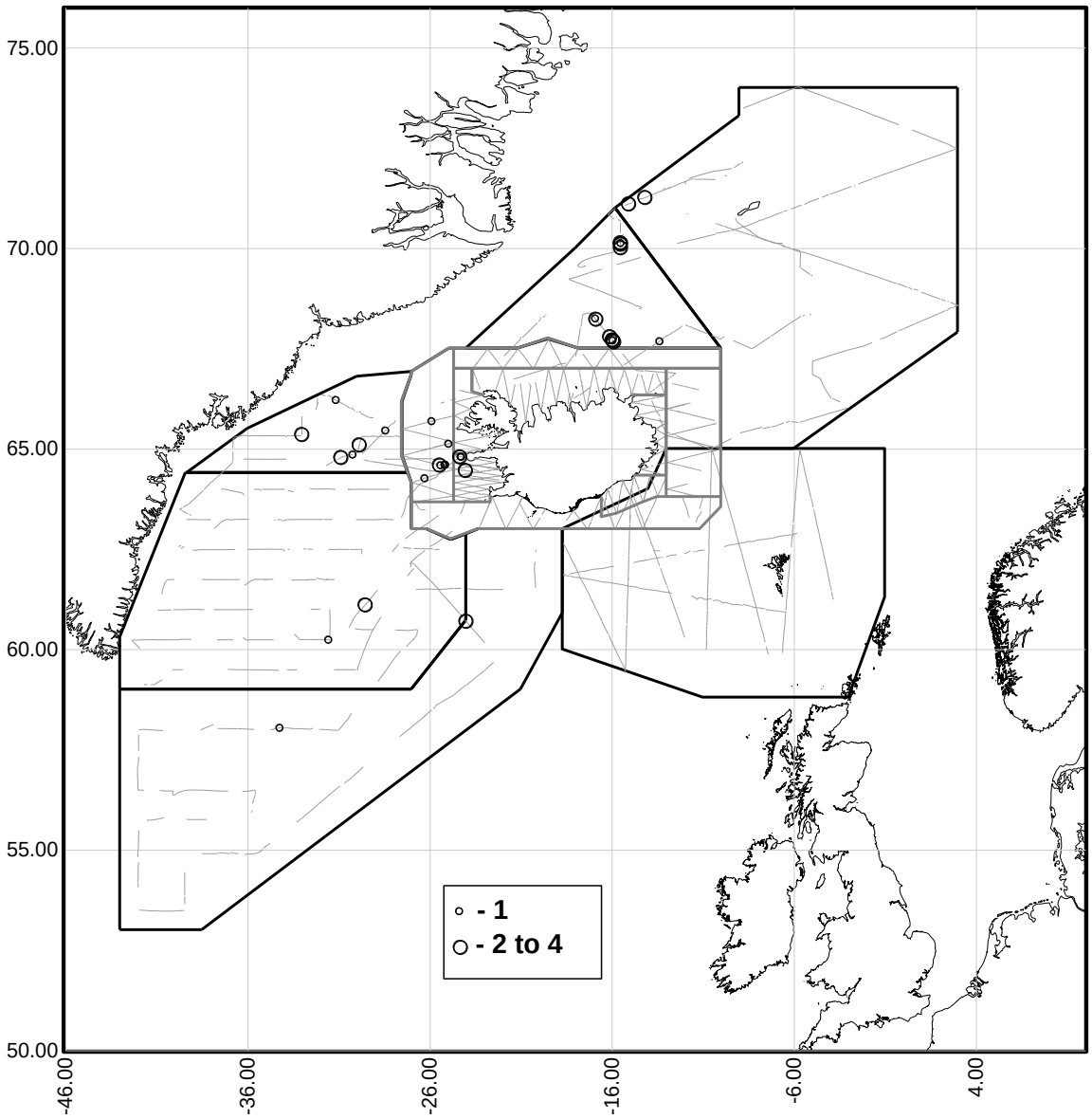


Fig. 4. Distribution sightings of blue whales from NASS-2001.

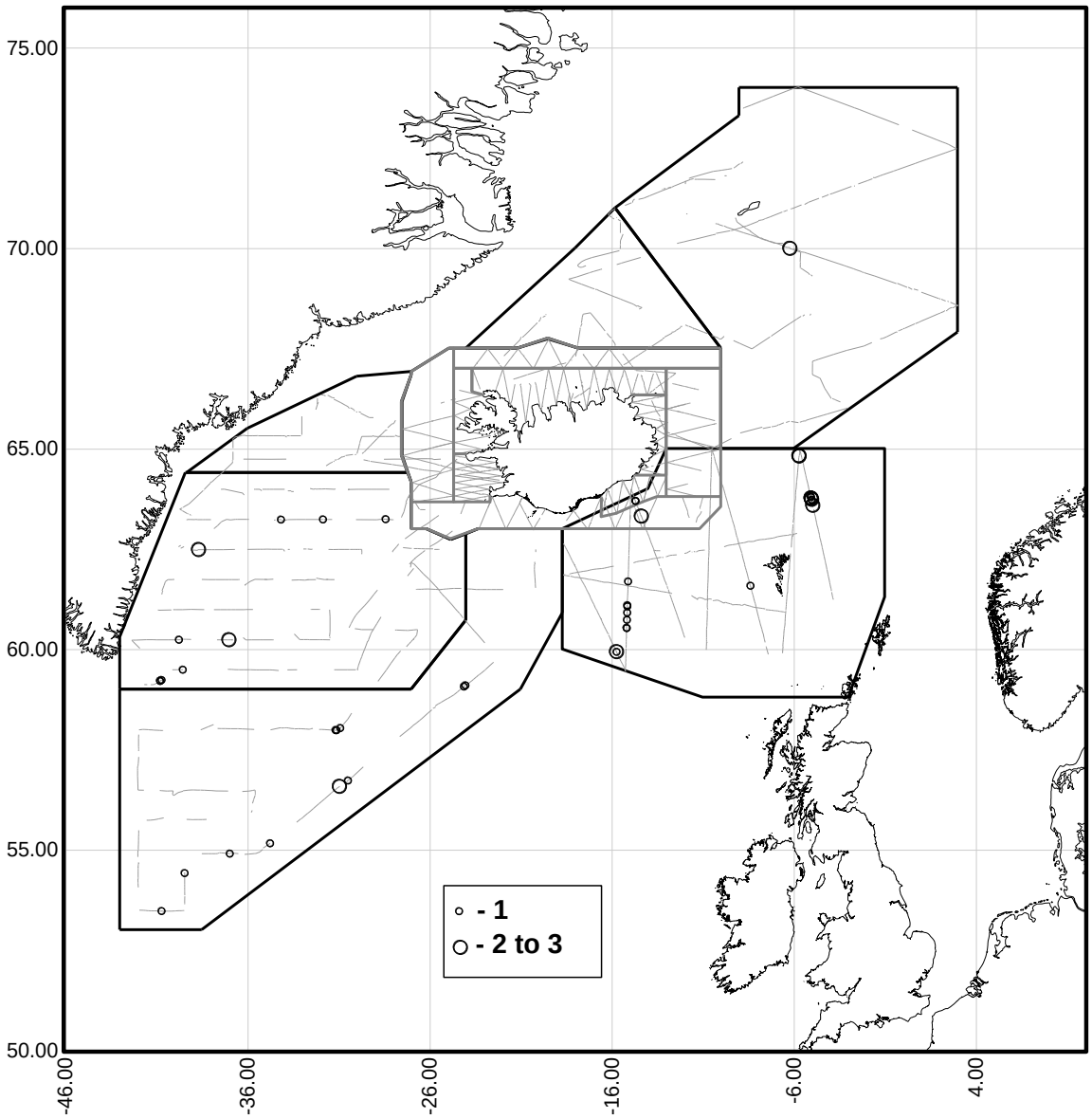


Fig. 5. Distribution sightings of sei whales from NASS-2001.

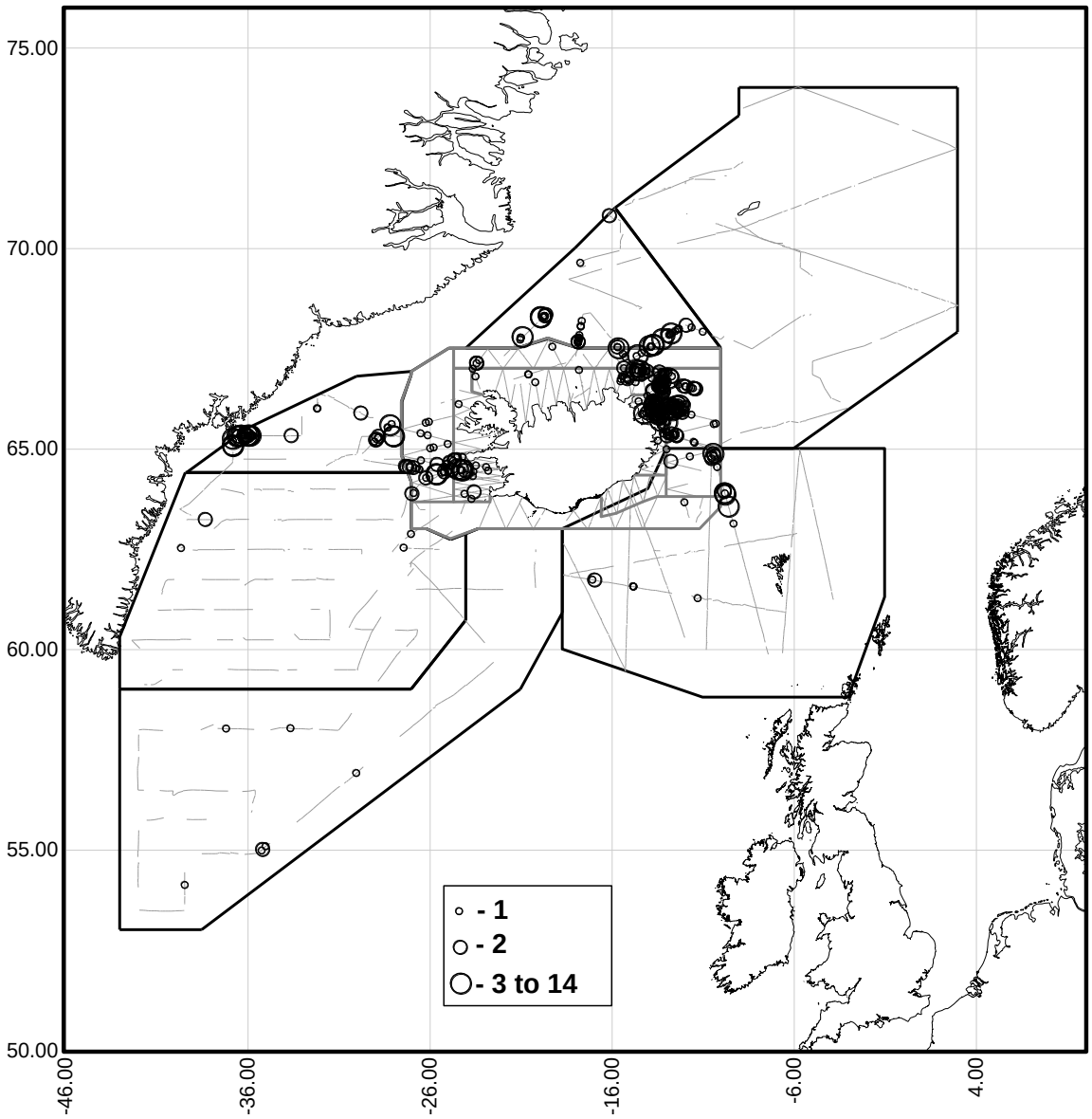


Fig. 6. Distribution of sightings of humpback whales from NASS-2001.

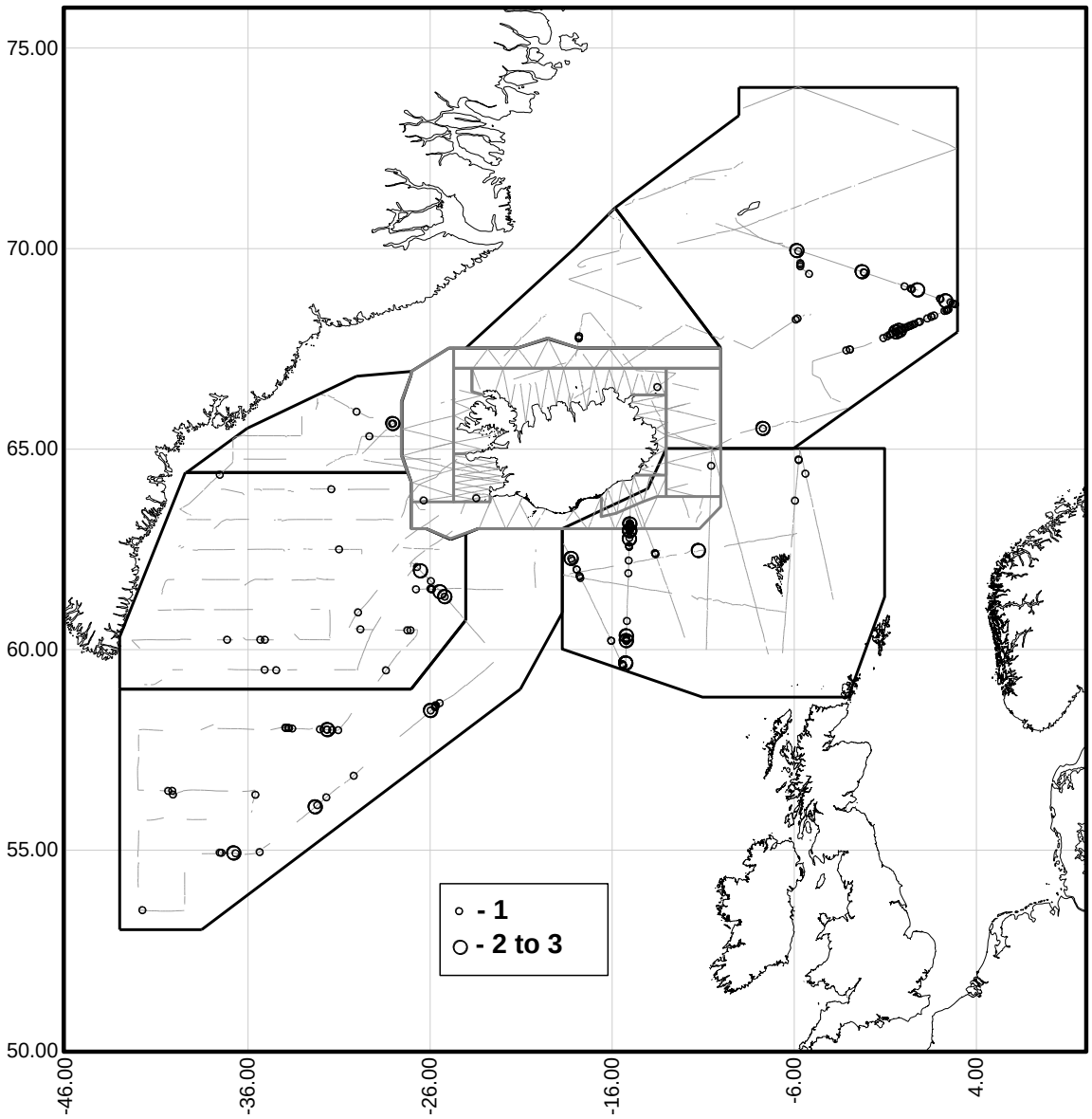


Fig. 7. Distribution of sightings of sperm whales from NASS-2001.

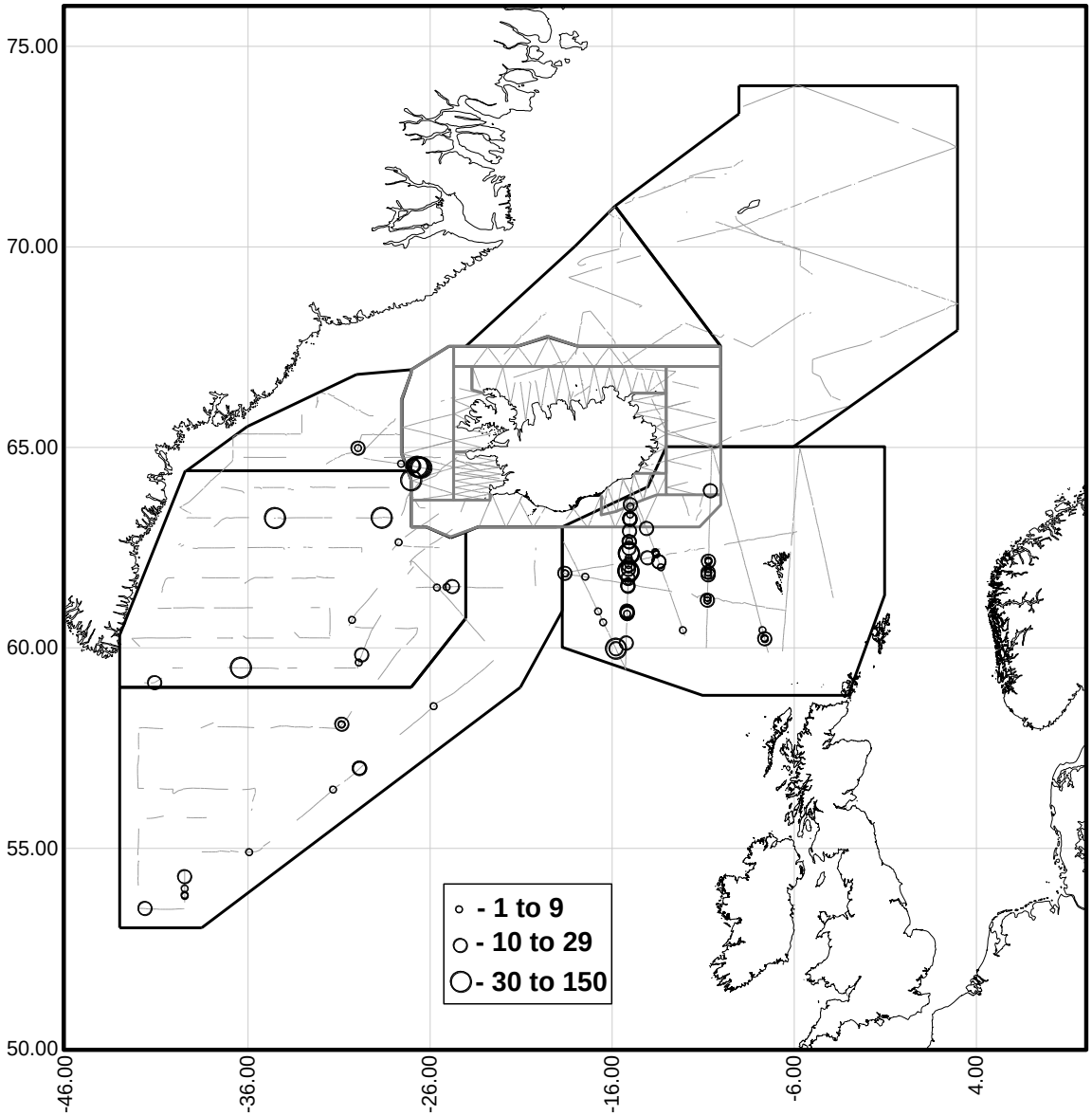


Fig. 8. Distribution of sightings of long-finned pilot whales from NASS-2001.

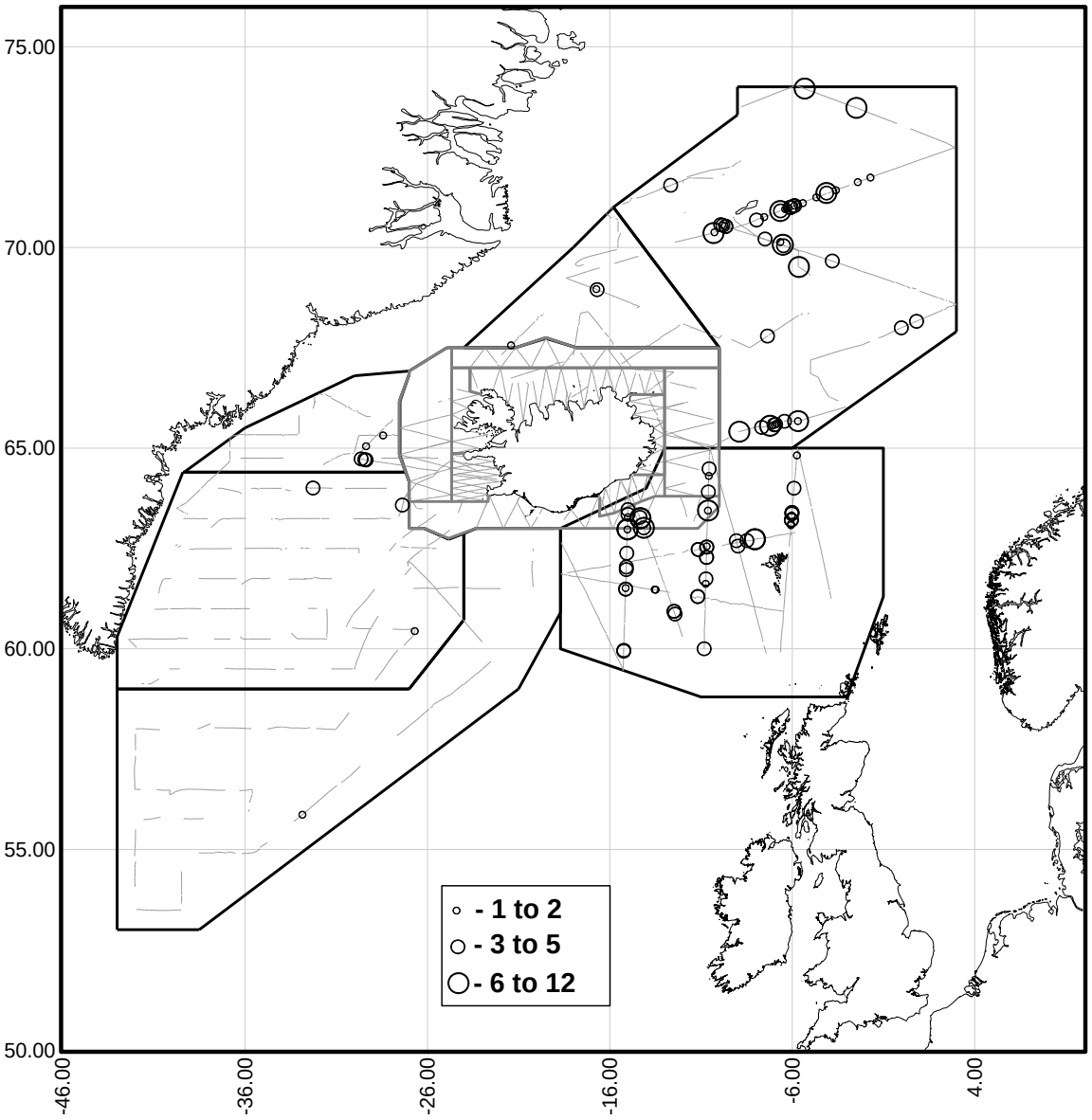


Fig. 9. Distribution of sightings of northern bottlenose whales from NASS-2001.

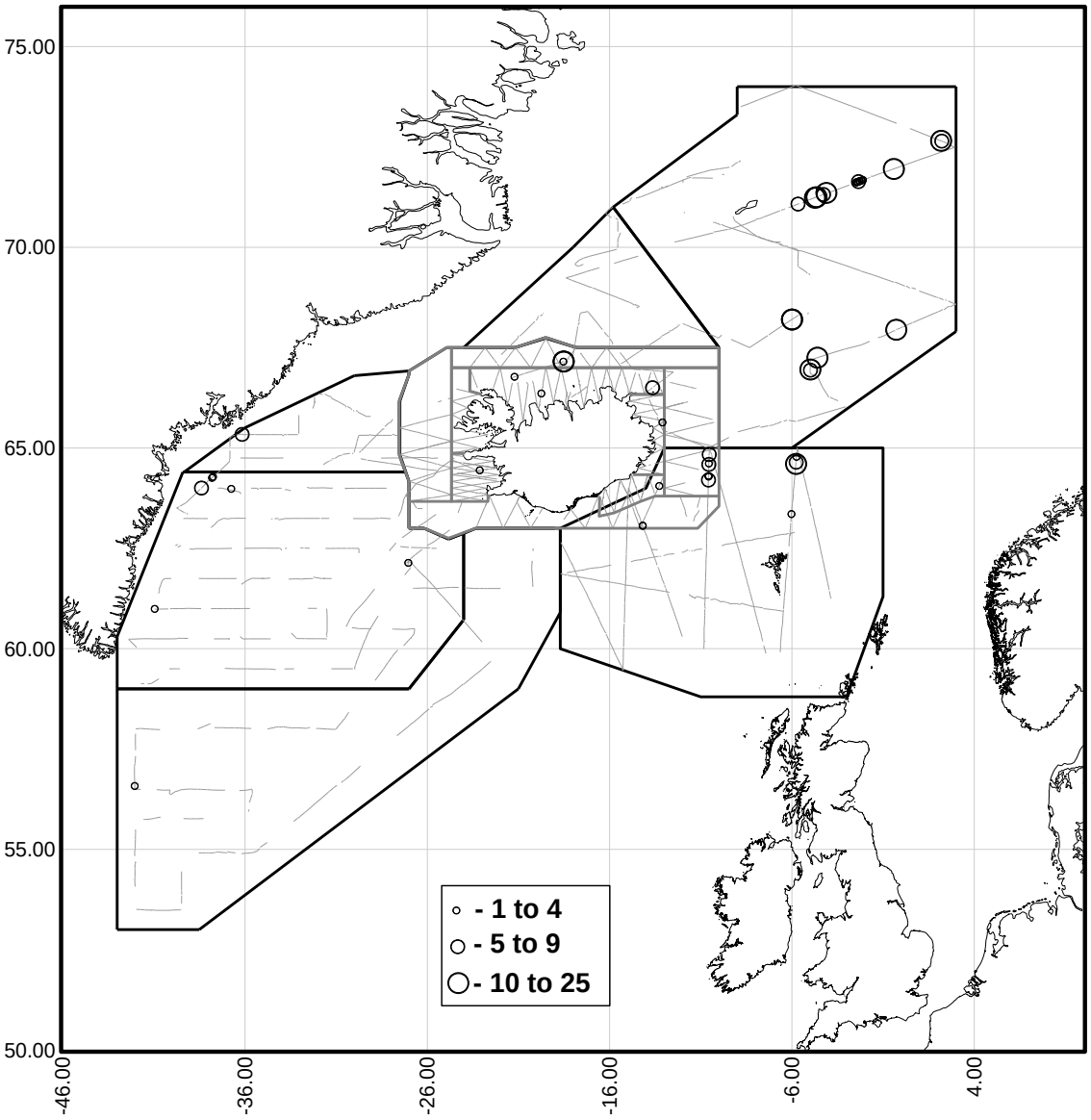


Fig. 10. Distribution of sightings of killer whales from NASS-2001.

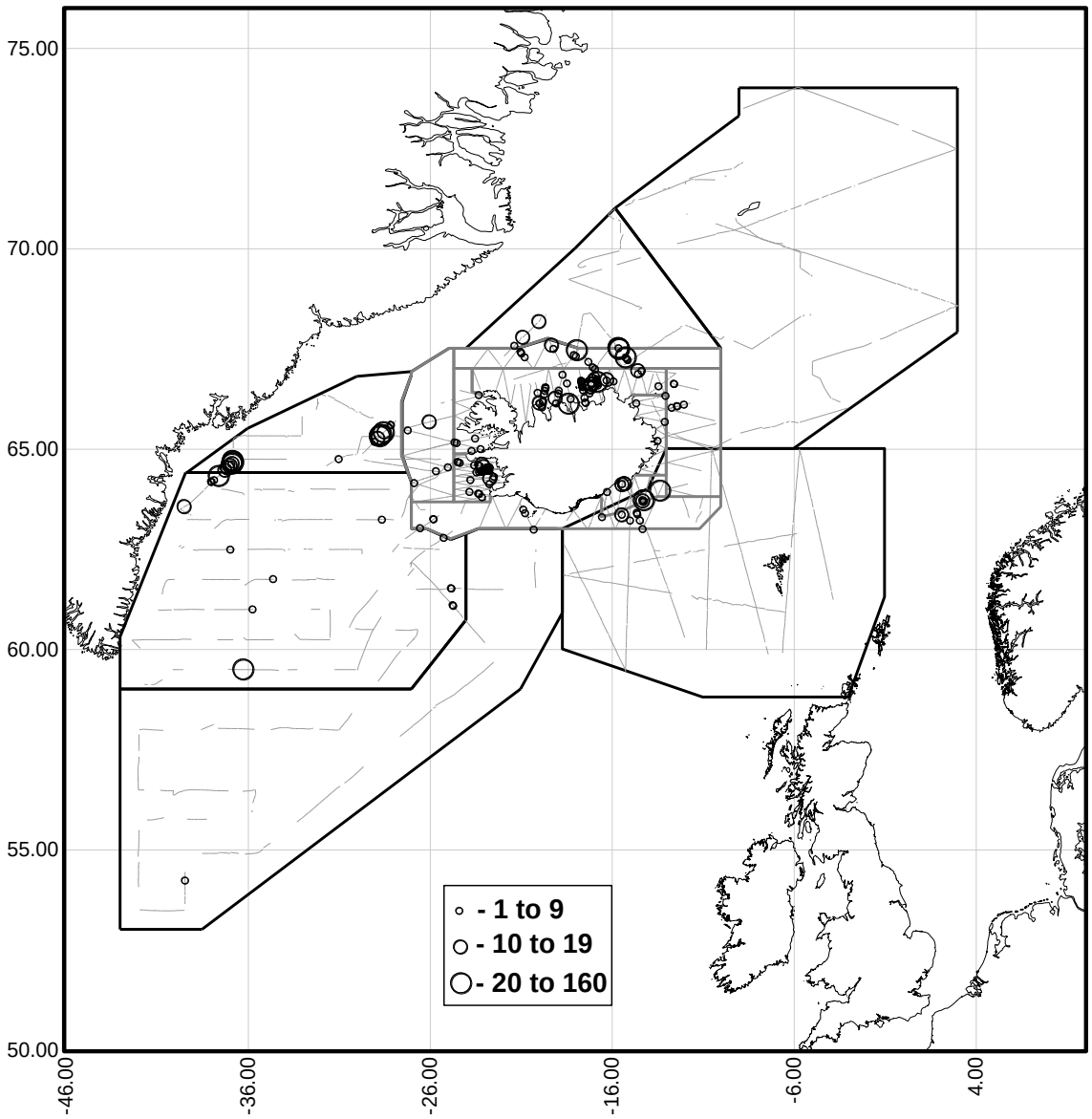


Fig. 11. Distribution of sightings of white-beaked dolphins from NASS-2001.

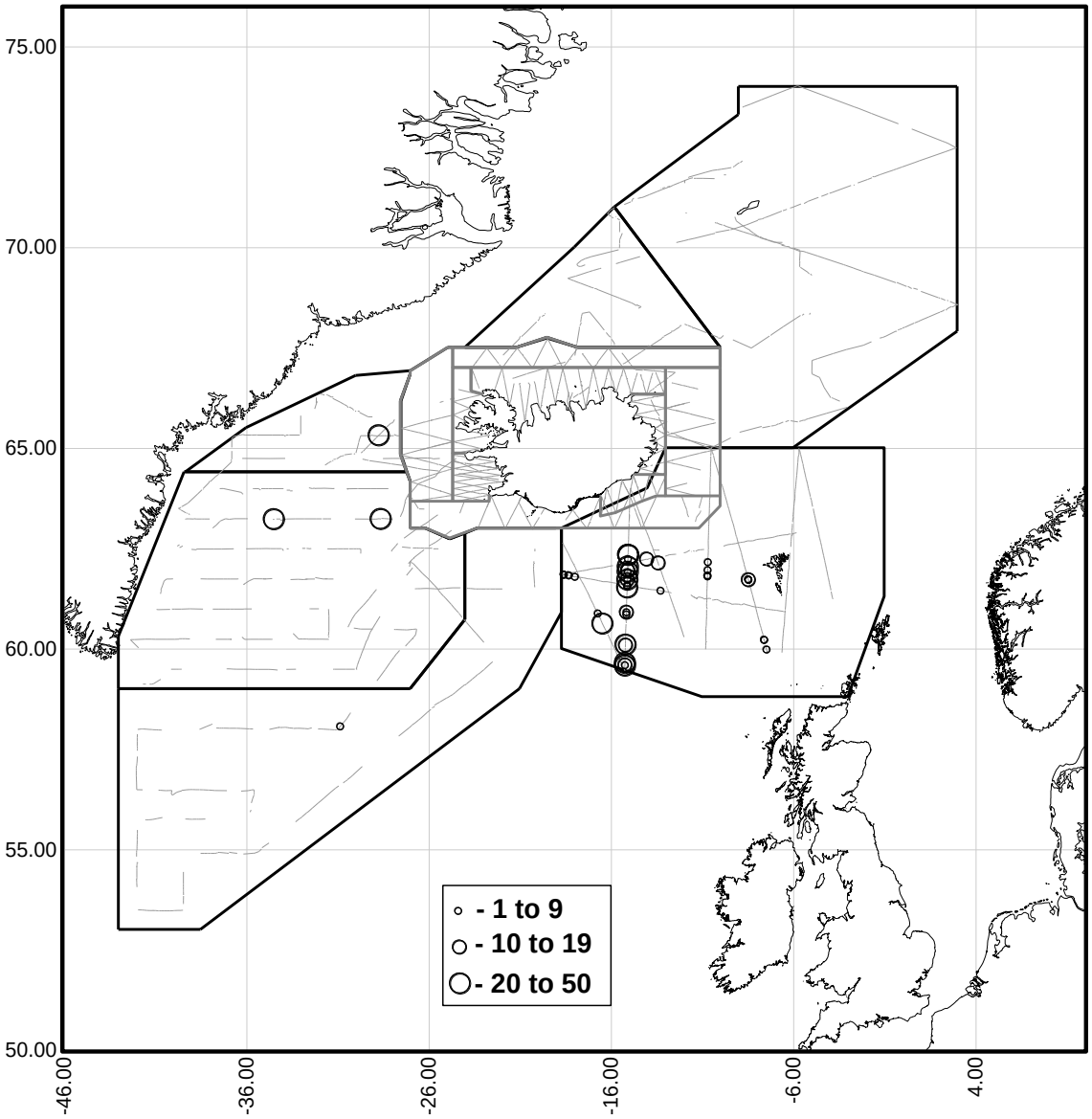


Fig. 12. Distribution of sightings of white-sided dolphins from NASS-2001.

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. Survey reports

6. Minke whales
   - ii. Ship surveys
   - iii. Aerial survey
   - iv. Combined estimates
   - v. Trends in abundance

7. Fin whales
   - i. 2001 ship survey
   - ii. Combined estimates
   - iii. Trends in abundance

8. Other species
   - i. Humpback whale
   - ii. *Lagenorhynchus* dolphins
   - iii. Pilot whales
   - iv. Sperm whales
   - v. Bottlenose whales
   - vi. Killer whales

9. Evaluation of survey methodology
   - i. Ship surveys
   - ii. Aerial surveys
   - iii. Recommendations for future surveys

10. Publication of survey results

11. Other business

12. Adoption of report.

Appendix 3

## LIST OF DOCUMENTS

| Document No. | |
|---|---|
| SC/10/AE/1 | List of participants |
| SC/10/AE/2 | Draft agenda |
| SC/10/AE/3 | Draft list of documents |
| SC/10/AE/4 | Not available |
| SC/10/AE/5 | Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. A preliminary estimate of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-2001 Icelandic aerial survey |
| SC/10/AE/6 | Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. A re-calculation of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-95 Icelandic ship survey. |
| SC/10/AE/7 | Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. Trends in the distribution and relative abundance of minke whales (*Balaenoptera acutorostrata*) from NASS Icelandic aerial surveys, 1986-2001. |
| SC/10/AE/8 | Gunnlaugsson, Th., Víkingsson, G.A., Pike, D.G., Desportes, G., Mikkelsen, B. and Bloch, D. Fin Whale Abundance in the North Atlantic, Estimated from Icelandic and Faroese NASS-2001 Vessel Surveys. |
| SC/10/AE/9 | Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. Preliminary estimates of the abundance of humpback whales (*Megaptera novaengliae*) and *Lagenorhyncus* spp. dolphins from the NASS-2001 Icelandic aerial survey. |
| SC/10/AE/10 | Gunnlaugsson, Th., Halldórsson, S.D., Ólafsdóttir, D. and Víkingsson, G.A. NASS 2001 Icelandic shipboard survey report |
| SC/10/AE/11. | Desportes, G. An evaluation of the methodology used in the NASS-2001 Faroese ship survey. |
| SC/10/AE/12 | Pike, D.G., and Víkingsson, G.A. The NASS-2001 Icelandic aerial survey: Introduction and evaluation. |
| SC/10/AE/13 | Gunnlaugsson, Th., Víkingsson, G.A., Pike, D.G., Desportes, G., Mikkelsen, B. and Bloch, D. Sperm whale abundance in the North Atlantic, estimated from Icelandic and Faeroese NASS-2001 shipboard surveys |
| SC/10/AE/14 | Trends in humpback whale (*Megaptera novaeangliae*) sightings rates from aerial surveys in Icelandic waters during 1986-2001. |
| SC/10/AE/15 | Desportes, G., Mikkelsen, B., Bloch, D., Danielsen, J., Hansen, J. and Mouritsen, R. Survey report from the Faroese shipboard survey of NASS-2001. |

Appendix 4

## RECOMMENDATIONS FOR IMPROVEMENT OF THE NASS SHIPBOARD SURVEYS

(Compiled from SC/10/AE/10, SC/10/AE/11 and comments at the meeting )

**Vessels, platforms and equipment**

1. Vessel AF2 should be fitted with an extra outdoor tracking platform around or below the present one.
2. The tracking platform should be at a higher elevation than the primary platform.
3. Every effort should be made to reduce vibration that interferes with the use of mounted reticule binoculars on the tracking platform. This should be tested before the survey begins, and modified if necessary.
4. The platforms should be placed in such a way that they do not obscure the radar. This creates problems in conducting distance experiments.

**Procedures**

1. The importance of recording re-sightings should be stressed.
2. The special protocol for sperm whales must be further elaborated. It is very important that the ultimate fate of each sighting be recorded, i.e. was it observed when abeam? Where was it last see? What effort/speed/heading changes were made prior to the last sighting?
3. Observers who prefer to use binoculars and are talented at picking up sightings at long distances should be used as trackers.

**Data forms and data recording**

1. Cloud coverage ahead should be recorded as percentage separate from weather codes for mist and rain. Cloud coverage should be categorised as high or low cloud.
2. Swell height should be recorded as 1 digit, m, and wave length as 2 digits, m.
3. Cue type should be recorded in mnemonic codes.
4. Record movement as: H, T, X = head or tail, L, R, S = side.
5. Use ISO8606 standard for date and time.
6. Missing codes: flipper as cue, wind direction, closure and confirmed sightings, code for likely duplicate between platforms, code of qualifying success of closure.
7. Use decimal points, not commas, in all records.
8. Procedures for data entry and display should be streamlined, so the observers can be better monitored by the cruise leader. Simple software should be developed for daily display of angle and distance data. More automation of data recording would be useful, for example time and angle of sighting.
9. Recording of meteorological data should be automated.
10. The recording of echosounder data periodically throughout the survey should be considered.

**Training**

1. More effort should be dedicated to observer training, and some ship time should be used. Several days of land training, followed by 1 to 2 days of training/experimental survey at sea would be ideal. The observers should understand how the data will be used, so they will understand the importance of strictly following survey procedures.

**Other**

1. Request permission to enter any other countries territorial waters at least 6 months prior to the survey.

Appendix 5

## RECOMMENDATIONS FOR IMPROVEMENT OF THE NASS ICELANDIC AERIAL CUE COUNTING SURVEY

(Compiled from SC/10/AE/12 and comments at the meeting)

**Survey design and strategy**

1. The offshore blocks are often difficult to complete because of weather. In future surveys the idea of covering these blocks by ship should be considered. It might also be possible to have some flexibility in the ship survey design, so that it could cover some of the offshore aerial blocks if necessary. This would require close communication between the aerial and ship survey teams. It could be decided beforehand that if a block had not been completed by the last week of the survey, it would be re-assigned to the ship survey.
2. The survey crew must be flexible and mobile, and able to move at short notice to areas of Iceland that have suitable survey weather.
3. Weather forecasting services should be used to choose an area where surveying might be possible. The crew should then contact the Icelandic "Coast Guard" to obtain telephone numbers of fishing vessels in the prospective survey area, then contact the vessels in the area to get an on-the-spot account of the conditions. In doing this, one must remember that a fisherman's idea of "good" weather may be quite different from that required for survey. The Captain should be asked to describe the waves he is experiencing, not just to report the Beaufort sea state.
4. A general prioritisation plan for the blocks, rated on minke whale density, would be:
   i) Blocks 1, 4 and 8;
   ii) Other inshore blocks: 2, 6 and 9;
   iii) Offshore blocks: 3, 5 and 7.

Of course this prioritisation scheme will be different if other species (e.g. humpback whales and dolphins) become more important in future surveys.

**Platform and equipment**

1. A lighter, less bulky system, that records voice and data directly on the computer hard drive, is required. It should be designed so that it is possible for more than one person to transcribe data simultaneously (using separate computers).
2. Data acquisition and entry should be further automated so that it is feasible for the cruise leader to view displays of angle and distance data on a daily basis, in order to monitor the observers properly. Alternatively, a non-flying crew member should be dedicated to data transcription and data entry during the survey.
3. Sightings close to the platform are of course most important in both cue counting and line transect methodologies. The use of an observer at a belly window should therefore be considered.
4. An electronic declinometer with a digital display should be tested and used if it performs adequately. This should be easier to read quickly than the analog models.
5. A method of directly measuring or more easily and accurately estimating angle from the nose of the airplane to the sighting should be developed.

**Procedures**

1. The use of double-platform methods should be considered an absolute necessity in these surveys. The Cruise Leader can observe full-time if he/she records all environmental observations verbally rather than using paper forms.
2. A special protocol should be developed for the pilot, which would allow him/her to record his/her sightings verbally without taking measurements, preferably with the use of a voice-activated microphone. The pilot would be instructed to describe his/her sightings as they occur, including estimations of declination and head angle.
3. The primary and secondary platforms should be visually isolated from one another. This can be easily achieved with the use of a curtain.

4. To achieve aural isolation of primary and secondary observers, the observers should be instructed to hold the recording microphone close to the mouth and to speak only as loudly as required to make an audible recording. The intercom microphone should be pushed out of the way while on effort
5. Consideration should be given to using 3 primary observers on the flights, and rotating them approximately every 30 minutes, or between survey legs, so that each observer would have a 30 minute rest after every hour of observation. This would reduce the risk of observer fatigue affecting sighting efficiency on long flights.
6. It is important for the primary observers to change seats at least every day and preferably more frequently, for variation in seating position and so that all combinations of primary - secondary observer are used.
7. The observers' data should be transcribed and entered electronically on a daily basis. This would allow the cruise leader to examine the angle, location and distance distributions of the sightings, to make sure the observers are covering their areas adequately, and not favouring certain angles or areas in the sighting field. This will require changes in equipment (see above).
8. Sitting in one position for hours on end can be extremely uncomfortable, and this increases observer fatigue and reduces the effectiveness of the observers. The observers should be encouraged to use pillows or other means to increase the comfort of their observing stations.
9. If dolphins are a priority in future surveys, closings should be made on a subsample of dolphin groups to confirm species identification and calibrate group size estimation.
10. If cue counting (as opposed to line transect) methods are realistically expected to be of use for humpback and other whales, the necessity for the observers to count blows should be emphasised. Otherwise, the protocol should be changed such that the observers are instructed simply to count groups of whales as in a line transect.

**Observer training**

1. Observer training is extremely important. At least 2 days of ground training and 5-10 hours of in-flight training are required.
2. A general training plan is as follows:
   i. Class training- survey plan, theory, data forms, etc.
   ii. Ground training. Conducted in the plane, on the ground. Observers record sightings of targets dragged under the wing of the plane. Subsequently, they go over the recordings and transcribe the data. Problems with procedures are identified and the process is repeated.
   iii. In-flight training. Conducted over Faxaflói Bay in a 2-3 hour flight. Should be done in full survey mode. Afterwards, the observers go over their recordings and transcribe their data. Problems are identified, and the process is repeated if necessary.

**Other**

1. It would be extremely useful to apply satellite tags to minke whales in the same area and simultaneous with the survey. This would give time/place specific estimates of cueing rate and surfacing times that could be of use in a cue counting or line transect survey. It could also provide an estimate of inter-block movements over the course of the survey, and could provide data with which to estimate $g(0)$ by attempting to sight tagged whales.
2. The feasibility of a digital photographic survey, as an alternative to cue counting, should be investigated.