SCIENTIFIC COMMITTEE WORKING GROUP ON ABUNDANCE ESTIMATES

18 November 2025

Online

REPORT

Presented to the 32nd meeting of the Scientific Committee as NAMMCO/SC/32/06b

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All reports of the AEWG are available at https://nammco.no/abundance_estimates_reports/

Chair

Daniel Pike

Rapporteur

Maria Garagouni

Authors

Martin Biuw, Geneviève Desportes, Maria Garagouni, Anita Gilles, Philip S. Hammond, Mads Peter Heide-Jørgensen, Bjarni Mikkelsen, Daniel Pike, Stine Petersen, Gudjón Már Sigurdsson

North Atlantic Marine Mammal Commission

Postbox 6400, N-9294; Visitors: Sykehusveien 21-23, N-9294; Tromsø, Norway

nammco-sec@nammco.org | www.nammco.org

http://www.instagram.com/nammco_org/

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REPORT

The Working Group on Abundance Estimates (AEWG) met online on 18 November 2025, chaired by Daniel Pike. At a previous meeting of the AEWG in September, abundance estimates of pilot whales generated from the North Atlantic Sightings Survey (NASS) 2024 project had been presented for East and West Greenland, as well as preliminary analyses for the Faroe Islands and Iceland. As the estimates presented were not endorsed at the time, the aim of this meeting was to review the additional analyses and, if possible, endorse the estimates of abundance for this species, to facilitate a stock assessment.

1 GREENLAND AERIAL SURVEYS

At the previous meeting of the AEWG, the group recommended investigating the effect of two analysis alternatives on the Greenlandic aerial survey abundance estimates, namely: i) the effect of diving synchronicity for groups larger than two and groups larger than four animals and ii) the effect of using a strip census analysis for groups larger than 20 animals. Mads Peter Heide-Jørgensen prepared a working document incorporating these elements prior to this meeting.

Summary
Estimates were developed for a uniform detection to 300 m for groups larger than 20 and 600 m for groups with fewer than 20 animals. Only front observer detections were included and no correction for perception bias was attempted. Based on the mean group size estimates the availability bias (â') is calculated from

$$\hat{a}'_g(\text{Pilot whale groups} > T) = 1 - (1 - \hat{a}'(\text{Pilot whale}))^{\text{GroupSize}}$$

where T is the threshold for the group sizes and â for T=0 is 0.40. Availability bias estimates for T=2 and T=4 were calculated and applied to the abundance estimates for groups larger than two or four. Abundance estimates were calculated separately and then summed for three categories: i) groups larger than 20 pilot whales, not adjusted for availability, ii) groups larger than T adjusted for $\hat{a}'_g$, and iii) groups smaller than T adjusted for $\hat{a}$. Using T=2, the estimate for East Greenland was 518 (CV = 0.57) and for West Greenland 5367 (CV = 0.61). Using T=4, the respective estimates were 608 (CV = 0.61) and 5773 (CV = 0.57) for East and West Greenland (see Table 1).

Discussion
The WG thanked Heide-Jørgensen for conducting the additional analyses in a timely manner.

Lacking the appropriate data to develop a full availability bias for pilot whales, and given that availability likelihood approaches 1 as group size increases, the estimates presented here could be used as an upper and lower bound of the actual number. However, for management purposes and trend analyses, a single point estimate is desired. Although applying the base availability bias value to all groups, as in the original analysis, results in the "upper bound" estimates, there was consensus that this approach was likely the least biased and was compatible with the previous estimate from 2015. It was recognised that this approach will have a positive bias because the time-in-view of the sightings to observers could not be taken into account, but this bias is likely small. Additionally, it was noted that applying the strip census method to larger groups resulted in two sightings alone contributing well over half of the overall abundance for West Greenland, indicating that the abundance estimate is very sensitive to this alternative.

Conclusion
The AEWG took note of the alternative estimates presented. In the absence of necessary information to determine appropriate time in view and availability bias values, and because the use of a strip transect for larger groups resulted in an abundance estimate strongly dependent on only two sightings, the WG **endorsed** the original abundance estimates for pilot whales in East (2,025; 95% CI: 585–7,012) and West (7,595; 95% CI: 3,084–18,707) Greenland, noting that they may be positively biased.

Table 1. Revised abundance estimates of pilot whales from the Greenland aerial surveys.

<table>
<tr><th>Data selection</th><th>Availability bias</th><th>Mean group size</th><th>Stratum</th><th>n</th><th>At surface abundance per stratum</th><th>cv</th><th>Abundance per area</th><th>cv</th><th>Corrected abundance</th><th>cv</th><th>East Greenland Groups split at 2</th><th>East Greenland Groups split at 4</th><th>West Greenland Groups split at 2</th><th>West Greenland Groups split at 4</th></tr>
<tr><td rowspan="2">Groups>20</td><td rowspan="2">Not included</td><td rowspan="2">54,5</td><td>5W</td><td>1</td><td>1878</td><td>1,11</td><td rowspan="2">3662</td><td rowspan="2">0,87</td><td rowspan="2">3662</td><td rowspan="2">0,87</td><td></td><td></td><td rowspan="2">3662</td><td rowspan="2">3662</td></tr>
<tr><td>6W</td><td>1</td><td>1774</td><td>1,11</td><td></td><td></td></tr>
<tr><td rowspan="3">Groups<3</td><td rowspan="3">0,40</td><td rowspan="3">1,25</td><td>6E</td><td>1</td><td>20</td><td>1,02</td><td>20</td><td>1,02</td><td>50</td><td>1,03</td><td>50</td><td></td><td></td><td></td></tr>
<tr><td>5W</td><td>2</td><td>43</td><td>0,73</td><td rowspan="2">76</td><td rowspan="2">0,60</td><td rowspan="2">190</td><td rowspan="2">0,62</td><td></td><td></td><td rowspan="2">190</td><td></td></tr>
<tr><td>7W</td><td>1</td><td>33</td><td>1,01</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Groups between 2 and 20</td><td rowspan="5">0,96</td><td rowspan="5">6,5</td><td>5E</td><td>2</td><td>246</td><td>0,70</td><td rowspan="2">449</td><td rowspan="2">0,60</td><td rowspan="2">468</td><td rowspan="2">0,62</td><td rowspan="2">468</td><td></td><td></td><td></td></tr>
<tr><td>6E</td><td>2</td><td>203</td><td>1,01</td><td></td><td></td><td></td></tr>
<tr><td>5W</td><td>8</td><td>896</td><td>0,55</td><td rowspan="3">1454</td><td rowspan="3">0,44</td><td rowspan="3">1515</td><td rowspan="3">0,47</td><td></td><td></td><td rowspan="3">1515</td><td></td></tr>
<tr><td>6W</td><td>3</td><td>212</td><td>1,02</td><td></td><td></td><td></td></tr>
<tr><td>7W</td><td>2</td><td>346</td><td>1,02</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Groups <5</td><td rowspan="4">0,40</td><td rowspan="4">2,4</td><td>6E</td><td>3</td><td>113</td><td>1,01</td><td>113</td><td>1,01</td><td>283</td><td>1,02</td><td></td><td>283</td><td></td><td></td></tr>
<tr><td>5W</td><td>5</td><td>207</td><td>0,48</td><td rowspan="3">310</td><td rowspan="3">0,40</td><td rowspan="3">775</td><td rowspan="3">0,43</td><td></td><td></td><td></td><td rowspan="3">775</td></tr>
<tr><td>6W</td><td>1</td><td>39</td><td>1,02</td><td></td><td></td><td></td></tr>
<tr><td>7W</td><td>1</td><td>64</td><td>1,01</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Groups between 4 and 20</td><td rowspan="4">0,99</td><td rowspan="4">8,5</td><td>5E</td><td>2</td><td>322</td><td>0,69</td><td>322</td><td>0,69</td><td>325</td><td>0,71</td><td></td><td>325</td><td></td><td></td></tr>
<tr><td>5W</td><td>5</td><td>732</td><td>0,65</td><td rowspan="3">1323</td><td rowspan="3">0,51</td><td rowspan="3">1336</td><td rowspan="3">0,53</td><td></td><td></td><td></td><td rowspan="3">1336</td></tr>
<tr><td>6W</td><td>1</td><td>138</td><td>1,02</td><td></td><td></td><td></td></tr>
<tr><td>7W</td><td>2</td><td>453</td><td>1,02</td><td></td><td></td><td></td></tr>
<tr><td colspan="11">Abundance for each area</td><td>518</td><td>608</td><td>5367</td><td>5773</td></tr>
<tr><td colspan="11">cv of abundance estimates</td><td>0,57</td><td>0,61</td><td>0,61</td><td>0,57</td></tr>
</table>

2 FAROE ISLANDS AND ICELAND SHIPBOARD SURVEYS

Stine Petersen and Philip Hammond presented the updated analysis of pilot whale data from the Faroese and Icelandic shipboard surveys (see Appendix), noting that some issues with duplicate and resighting identification had delayed the process somewhat.

Summary
Data from the NASS 2024 Icelandic and Faroese ship surveys were analysed to estimate pilot whale abundance. Surveys were carried out in double platform mode (IO configuration). The available data required some processing before analysis, which was done in collaboration with the data providers from the Faroes and Iceland. The survey effort included designed transects and some additional transects. All on-effort data, including 123 sightings of groups, were used to estimate detection probability. Only the data from designed transects were used to estimate abundance; these included 7,091 km of effort and sightings of 42 groups with mean group size of 17.8. The data were first analysed to estimate abundance uncorrected for animals missed on the transect line using a single platform approach by combining data from both platforms on each ship. The top-ranking detection function included vessel as a covariate and fitted the data well. Within the nominal survey strip defined by the largest perpendicular distance of 1,686m, average detection probability was estimated as 0.207 (CV = 0.241). Total uncorrected abundance was estimated as 174,246 individuals (CV = 0.302; 95% CI = 95,569–317,696). The data were then analysed to estimate abundance corrected for perception bias using a double platform approach. The top-ranking conditional detection function included Beaufort as a covariate and fitted the data well. Average conditional detection probability was estimated as 0.688 for both platforms combined, giving an overall average detection probability of 0.207 * 0.688 = 0.142 (CV = 0.244). Total corrected abundance was estimated as 262,387 individuals (CV = 0.339; 95% CI = 134,027–513,681). Two survey blocks in areas that in previous surveys had had relatively high abundance, block IR_N to the west of Iceland (no effort) and block FM around the Faroe Islands (effort but no sightings on designed transects), had no estimate of abundance.

In response to a request from the AEWG, alternative analyses were undertaken to investigate the sensitivity of the estimates to different choices of which data to use for duplicate sighting pairs for the two Faroese vessels. The original analysis chose to use the data from the platform that had the highest overall mean group size for all sightings. The alternative analyses used (a) data from the platform that had the lowest overall mean group size for all sightings or (b) the mean of both platforms for both group size and perpendicular distance (as done for aerial survey). Results showed that total uncorrected and corrected abundance varied by <1% from the original analysis but that estimates for block FDE decreased while estimates for block FDW increased, reflecting differences in mean group size in these two blocks when the alternative data were used for duplicate sighting pairs.

Discussion
The WG thanked Petersen and Hammond for taking on this task and completing it at such short notice, as well as Biuw for the preliminary analysis and R code.

The selected detection functions were closely examined by the group and deemed appropriate.

In analysis, the *mrds* software uses the data from Platform 1 for duplicate pairs. The designation of Platform 1 on the Faroese vessels based on a larger overall mean group size was discussed at length. While in aerial surveys it may be appropriate to use the average group size and perpendicular distance between observers in duplicate sightings, on (slower-moving) shipboard surveys it is quite possible that one platform may have a better view of than the other of any given sighting, and therefore record a more accurate group size. If so, designating platform 1 based on a higher mean group size could provide more accurate data. However, it is also possible that observers on one platform might be positively biased in estimating group size, which would result in the overall estimate being upwardly biased. By the same token, certain observers may regularly underestimate group size, and thus selecting the platform with the lowest average would negatively bias the abundance estimate.

However, as neither the total number of sightings nor perpendicular distances differed much between the two platforms, the choice was made based on group size. It was noted, moreover, that this choice only affected a fraction of the total sightings, since it only applies to duplicates. To determine how much of an effect on the total estimate this choice might have, the WG requested that the analysis be repeated with two alternatives for selecting data for Platform 1: one using mean group size and mean perpendicular distance from both platforms (as typically done in aerial surveys); and the other using data from the platform with lowest mean group size. For the purposes of a stock assessment, these alternative values could provide an additional level of uncertainty around the abundance estimate. For future surveys, it was suggested that Platform 1 be designated *a priori*.

The alternative analyses (see Addendum) showed that, as expected, estimates for the blocks surveyed by Icelandic vessels were almost unchanged (smaller by a maximum difference of <1%) when using different data for Platform 1. The uncorrected estimates for Faroes block FDE decreased by approximately 10% if Platform 1 was designated as the platform with the lowest mean group size and by around 5% if mean group size and mean perpendicular distance were used for Platform 1. For corrected abundance, these decreases were approximately 8% and 4%, respectively. In contrast, the uncorrected estimates for Faroes block FDW increased by around 17% and around 8%, respectively and by around 16% and 8%, respectively for corrected abundance. These differences in blocks FDE and FDW primarily reflect differences in estimated mean group size (Table A9c). Total corrected and uncorrected abundance was <1% different from the original analysis in both alternative analyses.

It was reiterated that duplicate identification should be done more in a more rigorous manner, preferably using an algorithm, to reduce uncertainty and prevent delays. Ideally, duplicate matching should be done during the survey itself when observers have the maximum amount of information to work with and memories are fresh.

The lack of sightings in large parts of the survey design was also noted as an issue. Most of the fishery vessels sighted very few pilot whale groups while on effort, which necessitates a further discussion on whether these platforms are suited for cetacean surveys. The Faroese mackerel vessel, in particular, sighted no pilot whales in block FM except during effort that was not part of the original transect design. As such, that entire block was excluded from the design-based estimate, despite it being an area of high pilot whale density in 2015—as was block IR, the northern half of which had no survey coverage in 2024. A model-based estimate could be calculated for the off-transect sightings in block FM. At present, however, the total estimate is likely considerably lower than the actual abundance of pilot whales in the original survey area.

The overall estimate of 262,387 pilot whales is comparable to the estimate from NASS 2015, of 344,148 (95% CI: 162,795–727,527) pilot whales, considering that the latter survey provided better coverage of expected high density areas. This lends an additional level of confidence in the analysis of the NASS 2024 data as presented.

<u>Conclusion</u>
The AEWG **endorsed** the presented abundance estimate for pilot whales, noting that the choice of how to use perpendicular distance and group size data for duplicate pairs had almost no effect on estimates of total abundance, but did result in different estimates for blocks FDE and FDW surveyed by one of the Faroese vessels.

3 PLANS FOR NEXT MEETING OF THE AEWG

In light of the upcoming meeting of the WG on Large Whale Assessments (LWAWG), the AEWG will need to review the abundance estimates of fin and minke whales from the Faroese and Icelandic surveys. Analysis is currently in progress and will be reviewed by the AEWG in mid-December. Minke whale estimates from the latest Norwegian mosaic survey will be presented to the LWAWG for feedback, and fin and minke whale estimates from the area surveyed in 2024 will also be shared to inform the stock assessment for the Central North Atlantic.

It was noted that concrete guidelines on how survey data are to be prepared and formatted for analysis are necessary before the next survey is undertaken. This topic should be on the agenda of a future in-person meeting of the AEWG and/or the planned workshop on alternative survey methods for cetaceans.

4 REPORT ADOPTION AND MEETING CLOSE

The Chair thanked participants for their contributions, especially for the updated analyses, and looked forward to the next meeting. Garagouni was thanked for rapporteuring, and Pike was commended for his able chairing.

The report was adopted by correspondence on 21 November.

Abundance of pilot whales from NASS-24 Icelandic and Faroes ship surveys

Stine Petersen & Philip Hammond

Sea Mammal Research Unit, University of St Andrews, Scotland, UK

2025-11-25

Introduction

This Working Paper describes the data processing and analysis undertaken since the AEWG meeting 23-26 September 2025 to estimate the abundance of pilot whales in the Northeast Atlantic from NASS 2024 Icelandic and Faroese ship surveys.

Biuw et al. (SC/32/AEWG/06b) undertook preliminary analyses of these data, which were discussed at the AEWG meeting 23-26 September 2025. During the meeting, it was noted that there were substantial parts of two survey blocks (IR and IDS) that were unsurveyed, resulting in agreement to split these blocks into two parts: a surveyed part and an unsurveyed part (described in SC/32/AEWG/06b). It was also noted that some effort had erroneously been included in the wrong block and that this should be removed.

The data included several transects that were additional to the approximately equal coverage survey design (zig-zags on dedicated vessels; parallel lines on fisheries survey vessels). These additional transects and associated sightings cannot be included when calculating abundance, but on-effort sightings from these additional transects can be used in estimation of detection probability (fitting detection functions).

Surveys were carried out in double platform mode (IO configuration) but the preliminary analyses described in SC/32/AEWG/06b were limited to a single platform approach (by combining data from both platforms on each ship). The preliminary estimates were thus uncorrected for animals missed on the transect line.

The main objectives of the work described here, therefore, were to ensure that the correct data were used in analysis and to estimate both uncorrected (single platform) and corrected (double platform) abundance.

Data

Preparation of data for analysis from available effort and sightings files was based on R code developed by Biuw et al. (SC/32/AEWG/06b), subsequently modified to select data appropriate for analysis. All off-effort sightings were excluded. The remaining inclusive data (all transects and associated sightings) are shown in Figure 1.

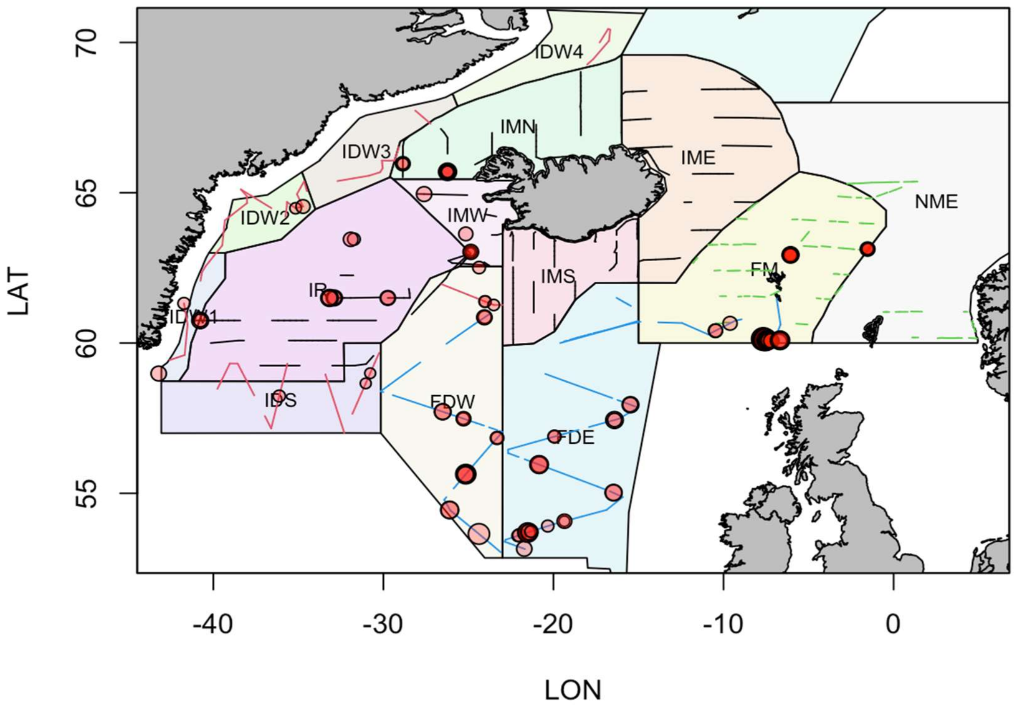

Figure 1. Original survey blocks and all transects (designed and additional) with associated pilot whale sightings from NASS 2024. Point size indicates relative group size.

Splitting survey blocks IR and IDS into two parts, one surveyed and the other not surveyed, led to sub-blocks IR_N and IR_S, and IDS_W and IDS_E. The revised survey blocks, all on-effort transects in these blocks, and on-effort sightings used in the estimation of detection probability are shown in Figure 2.

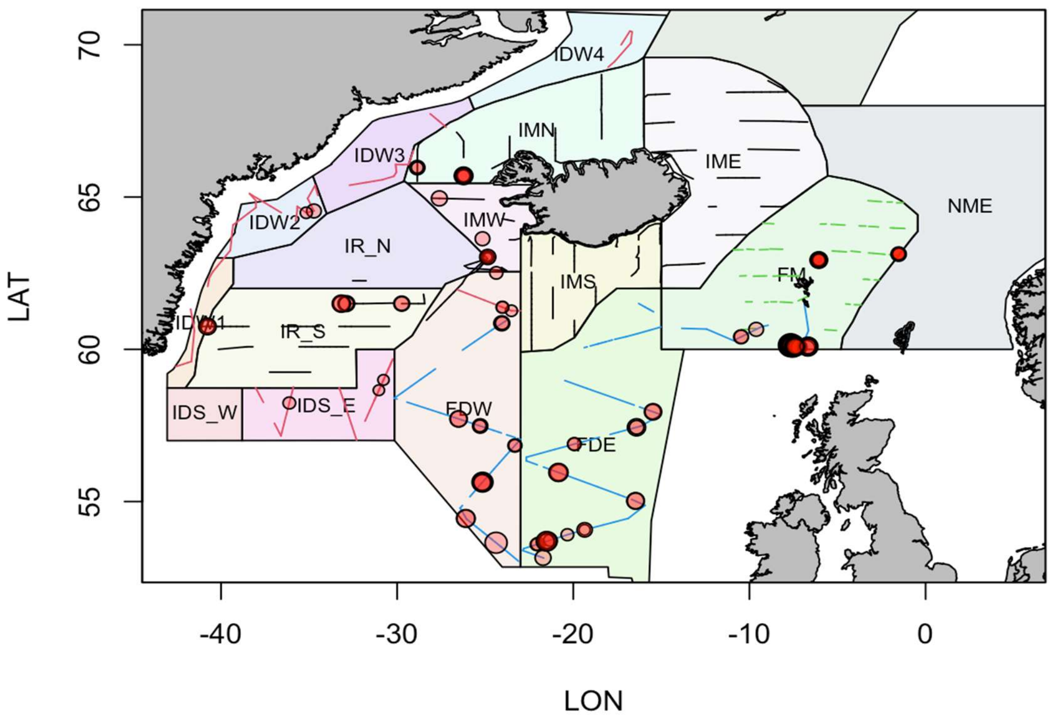

Figure 2. Revised survey blocks and transects, and sightings used in estimation of detection probability.

Sightings data

An important part of sightings data preparation for analysis is to be sure which were first sightings, which were resightings and which were duplicates. This affects uncorrected (single-platform) and corrected (double-platform) analysis.

In the Faroes data, there were no resightings in the available sightings data. Mikkelsen determined duplicates after completion of the survey based on whether two sightings were made from different platforms, at the same or very similar time, on the same side of the vessel, and at positions (from angle and radial distance) consistent with being duplicates.

In the Iceland data, resightings were included in the available data. Which sightings were first sightings, resightings and duplicates was determined by Sigurðsson (in consultation with Hammond and confirmed by Petersen) based on comments recorded by observers in the field and the above criteria.

Table 1 shows the number of pilot whale groups sighted and the number of individuals associated with those sightings in each survey block, after removal of duplicates. Data for these sightings were used to estimate detection probability for single-platform analysis.

Table 1. Summary of the number of sightings of groups and individual pilot whales in each block, with mean and standard deviation of estimated group size.

Block	No. groups	No. individuals	Mean group size	SD group size
NASS2024_FDE	22	410	18.6	14.6
NASS2024_FDW	19	428	22.5	24.8
NASS2024_FM	56	1,756	31.4	38.6
NASS2024_IDS_E	3	11	3.7	1.2
NASS2024_IDW2	2	14	7.0	4.2
NASS2024_IMN	7	88	12.6	10.8
NASS2024_IMW	6	51	8.5	6.2
NASS2024_IR_S	8	133	16.6	7.8
Total	123	2,891	23.5	29.6

The distribution of all on-effort pilot whale sightings in relation to the trackline of the vessel, as determined by recorded angles and radial distances, used in estimation of detection probability is shown in Figure 3.

The distribution of perpendicular distances of these sightings used in estimation of detection probability is shown in Figure 4.

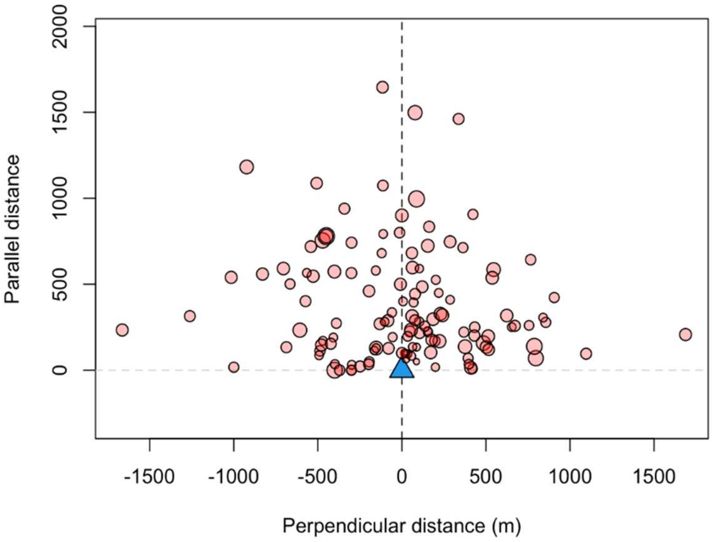

Figure 3. Relative position (in meters) of sightings in relation to the trackline of the vessel. Point size indicates relative group size (on a log scale).

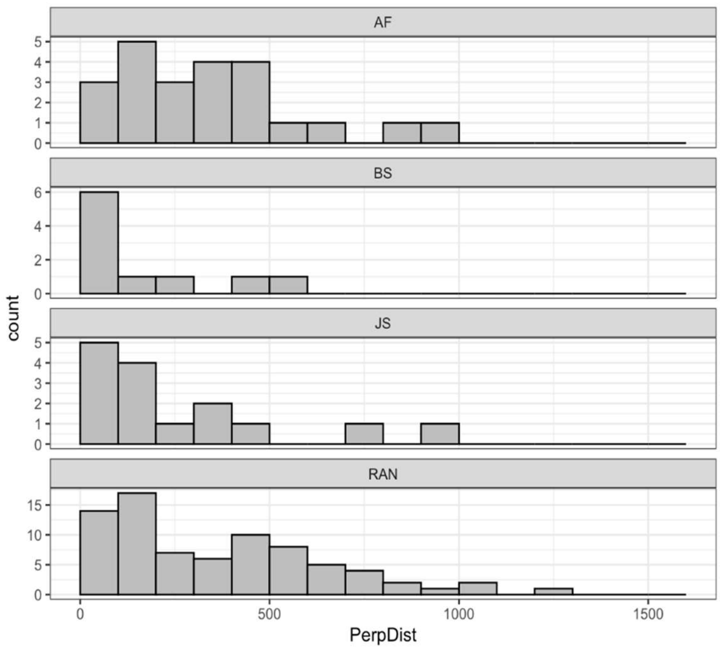

Figure 4. Distribution of perpendicular distances of sightings from the four vessels used in the estimation of detection probability.

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To calculate abundance, all non-designed transects and associated sightings were removed (Figure 5).

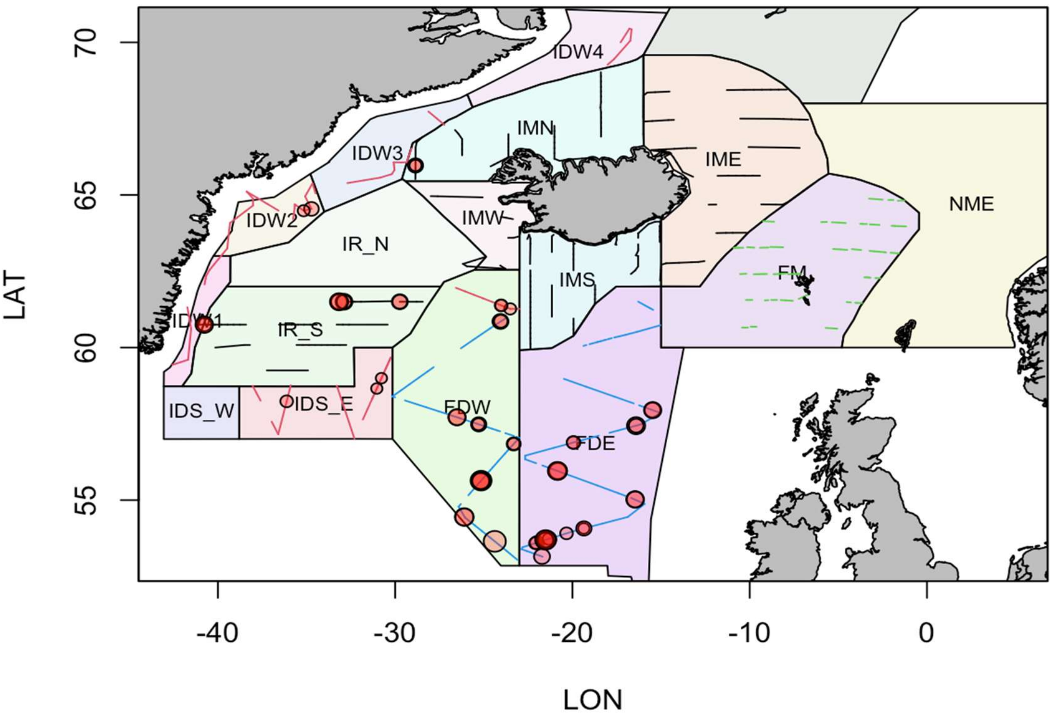

Figure 5. Revised survey blocks and designed transects with associated pilot whale sightings from NASS 2024 used in the calculation of abundance.

Data analysis

Uncorrected abundance

Uncorrected abundance estimates (not taking account of animals missed on the trackline) are obtained by conducting a single-platform analysis in which unique sightings are combined across the two observation platforms and a single detection function, known as the ds function, is fitted to estimate average detection probability.

For duplicate sightings, we used the data for the sighting made from platform 1 (the higher platform on the Icelandic vessels and the port platform on the Faroese vessels). We fitted a series of candidate ds detection functions to the data, including all combinations of four covariates: vessel, platform height, Beaufort and group size. Data on Beaufort were included from the effort data because these were more consistent than some values recorded in the sightings data.

Table 2 shows model descriptions and diagnostics for the top-ranking ds models as determined by AIC.

Table 2. Top ranking single platform detection functions (ds) fitted to the pilot whale sightings data. Models are ordered by AIC, in descending order of model support from the data. Under Model: vess = vessel; beauf = Beaufort; height = Platform height; size = group size; hn = half-Normal key function; hr = hazard rate key function. AIC = Akaike Information Criterion and ΔAIC = the difference between AIC of the given model and the top-ranking model. Only models with ΔAIC <5 are shown.

Model	Key function	Formula	AIC	ΔAIC
ds.hr.vess	Hazard-rate	~Vessel	1.23	0
ds.hn.beauf.height	Half-normal	~Beaufort + PlatformHeight	1.36	0.13
ds.hr.size.vess	Hazard-rate	~size + Vessel	1.76	0.53
ds.hr.beauf.vess	Hazard-rate	~Beaufort + Vessel	2.85	1.62
ds.hn.beauf.height.size	Half-normal	~Beaufort + PlatformHeight + size	3.10	1.87
ds.hr.beauf.size.vess	Hazard-rate	~Beaufort + size + Vessel	3.53	2.30
ds.hn.beauf	Half-normal	~Beaufort	3.70	2.48
ds.hr.height.size	Hazard-rate	~PlatformHeight + size	3.72	2.50
ds.hn.beauf.vess	Half-normal	~Beaufort + Vessel	4.27	3.04
ds.hr.beauf.height.size	Hazard-rate	~Beaufort + PlatformHeight + size	4.84	3.61
ds.hr.size	Hazard-rate	~size	5.52	4.29
ds.hn.beauf.size	Half-normal	~Beaufort + size	5.61	4.38
ds.hn.beauf.size.vess	Half-normal	~Beaufort + size + Vessel	6.20	4.97

The ds detection function selected was the top model with a hazard-rate key function and vessel as the only covariate term.

This model fitted the data well. The QQ plot is shown in Figure 6 and the Cramer-von Mises test (unweighted) test statistic = 0.0457, p-value = 0.902.

The average detection probability was estimated as p = 0.207, SE = 0.0500, CV = 0.241.

The fitted detection function is shown in Figure 7.

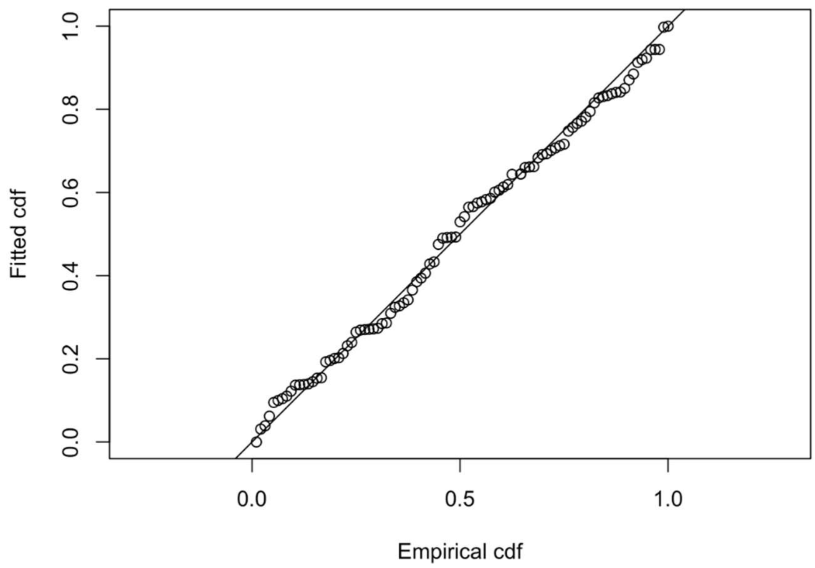

Figure 6. QQ plot for the top-ranking detection function: hazard-rate key function with vessel as the only covariate.

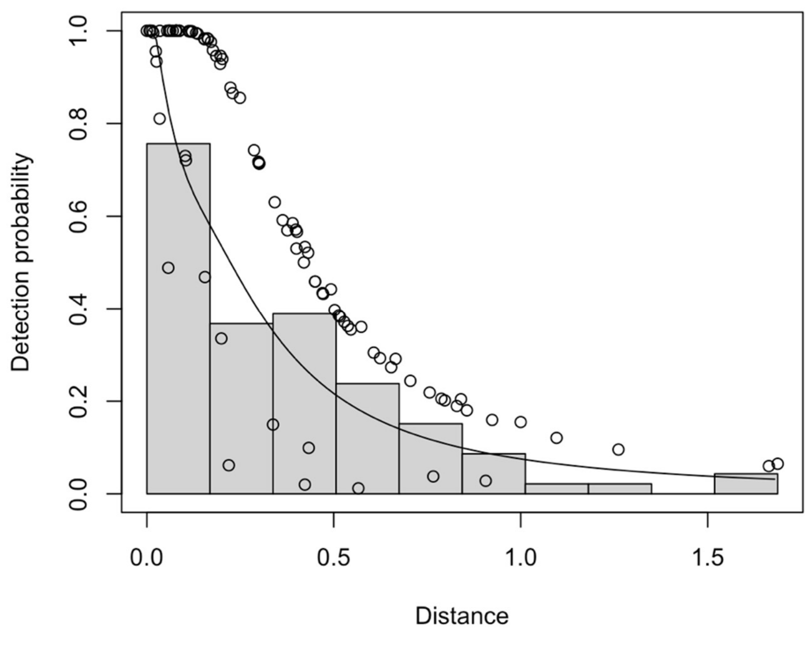

Figure 7. Fitted ds detection function: hazard-rate key function with vessel as the only covariate.

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Uncorrected abundance estimates using the selected ds detection function are presented in Table 3 by survey block.

Table 3. (a) Estimated pilot whale uncorrected abundance by survey block, based on the best supported ds model based on AIC. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	64,969	28,843	0.444	24,649	171,246	8.445
FDW	12	63,807	29,751	0.4663	21,543	188,988	5.988
IDS_E	3	9,108	6,919	0.760	2,131	38,924	13.52
IDW2	2	19,327	11,671	0.604	6,222	60,035	33.81
IMN	2	1,833	2,035	1.110	202	16,669	5.84
IR_S	7	15,202	13,064	0.859	1,894	121,994	3.915
Total	42	174,246	52,550	0.3016	95,569	317,696	32.49

(b) Data used to estimate abundance. Area is survey block size in km^2. Effort is total transect length in km. n is number of individuals in each region. k is the number of transects. ER is the encounter rate of individuals = n / Effort.

Block	Area	Effort	n	k	ER	Mean group size	SE mean group size
FDE	457,216.0	1,987.69	321	7	0.161	20.06	3.94
FDW	335,955.0	1,533.56	262	5	0.171	21.83	7.75
IDS_E	115,107.6	771.76	11	4	0.014	3.67	0.67
IDW2	45,607.0	183.40	14	2	0.076	7.00	3.00
IMN	154,513.0	1,128.57	16	6	0.014	8.00	4.00
IR_S	219,397.7	1,485.57	123	4	0.083	17.57	3.00
Total	1,327,796.2	7,090.55	747	28	0.115	17.79	2.79

Corrected abundance

To calculate abundance corrected for animals missed on the trackline due to perception bias, a partial independence double-platform analysis was conducted. In this analysis, in addition to the ds detection function described above, a conditional detection function, known as the mr detection function, is fitted to the duplicate sightings data to estimate the conditional probability of making a sighting on the trackline (Laake and Borchers 2004; Borchers et al. 2006; Burt et al. 2014).

A series of candidate conditional mr detection functions were fitted to the duplicate data. The mr model is a binomial glm and we included all combinations of five candidate covariates: perpendicular distance, vessel, platform height, Beaufort and group size. All mr models including vessel as a covariate did not fit because there were no duplicates recorded on one vessel (BS).

Table 4 shows model descriptions and diagnostics for the top-ranking models, as determined by AIC.

Table 4. Top ranking conditional detection functions (mr) fitted to the pilot whale duplicate sightings data. Models are ordered by AIC, in descending order of model support from the data. Under Model: null = no covariates; dist = perpendicular distance; height = platform height; beauf = Beaufort; size = group size. AIC = Akaike Information Criterion and ΔAIC = the difference between AIC of the given model and the top-ranking model. Only models with ΔAIC <5 are shown.

Model	mr model formula	AIC	ΔAIC
mr.beauf	~Beaufort	212.48	0
mr.null	~1	212.95	0.48
mr.beauf.height	~Beaufort + PlatformHeight	213.38	0.91
mr.beauf.size	~Beaufort + size	213.58	1.10
mr.beauf.dist	~Beaufort + distance	213.83	1.36
mr.dist	~distance	213.87	1.38
mr.height	~PlatformHeight	214.08	1.60
mr.beauf.height.size	~Beaufort + PlatformHeight + size	214.48	2.01
mr.size	~size	214.58	2.10
mr.beauf.height.dist	~Beaufort + PlatformHeight + distance	214.72	2.24
mr.beauf.size.dist	~Beaufort + size + distance	214.79	2.32
mr.height.dist	~PlatformHeight + distance	214.96	2.49
mr.size.dist	~size + distance	215.34	2.86
mr.beauf.height.size.dist	~Beaufort + PlatformHeight + size + distance	215.67	3.19
mr.height.size	~PlatformHeight + size	215.72	3.24

Model	mr model formula	AIC	ΔAIC
mr.height.size.dist	~PlatformHeight + size + distance	216.45	3.97

The conditional mr detection function selected was the top model with Beaufort as the only covariate term. This mr model fitted the data well chi-squared = 7.61, 8 d of f, p = 0.4722.

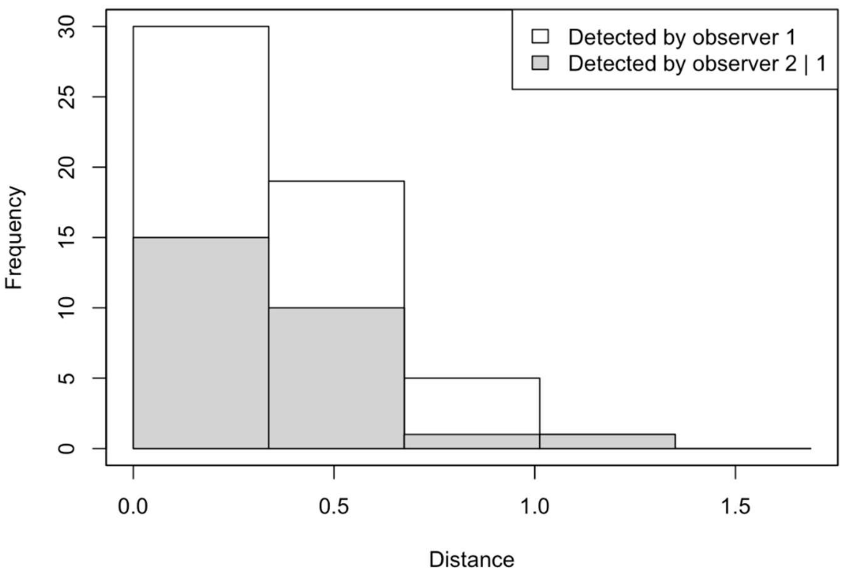
The average detection probability for the ds model (see above under uncorrected abundance) was p = 0.207, SE = 0.0500, CV = 0.241.

The average conditional detection probabilities were p(0) = 0.448 for platform 1, p(0) = 0.448 for platform 2, and p(0) = 0.688 for both platforms combined. The value for both platforms combined is used in estimation of corrected abundance.

The overall average detection probability was thus p = 0.207 * 0.688 = 0.142, SE = 0. 0348, CV = 0. 244.

Distributions of perpendicular distance of sightings and duplicate sightings from each platform are shown in Figure 8.

The fitted mr detection function is shown in Figure 9.



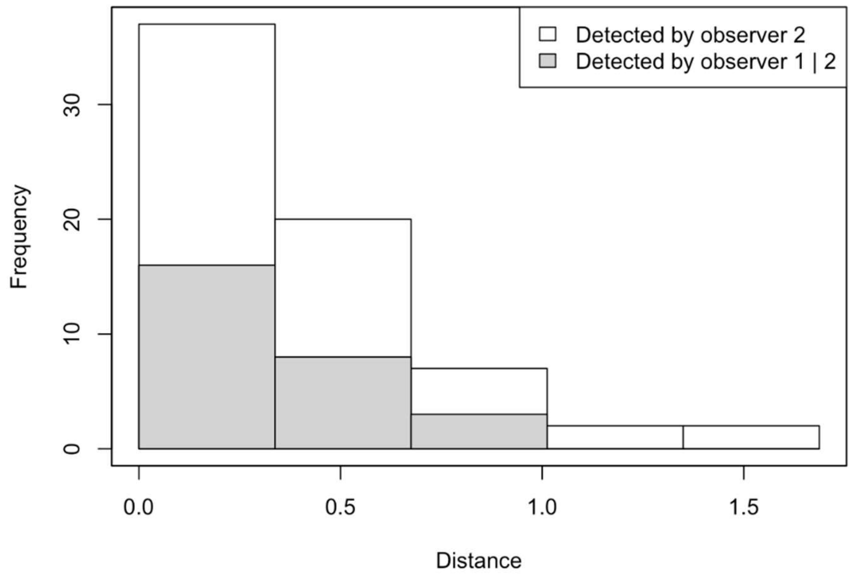


Figure 8. Histograms of perpendicular distance showing sightings (a) detected from platform 1 and detected from platform 2 conditional on being detected by platform 1, and (b) detected from platform 2 and detected from platform 1 conditional on being detected by platform 2.

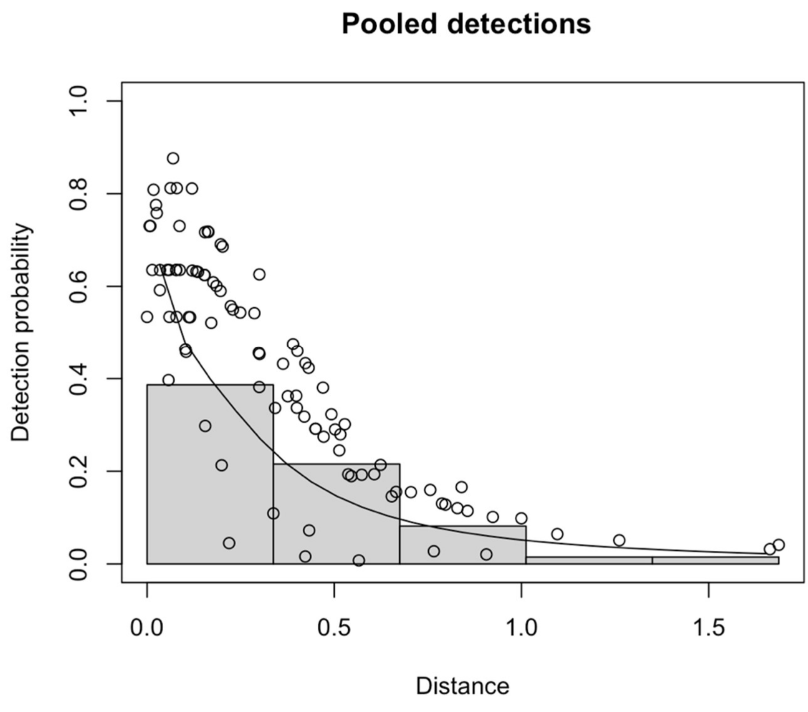


Figure 9. Fitted mr detection function for combined observers 1 and 2.

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Corrected abundance estimates using the selected ds and mr detection functions are presented in Table 5 by survey block.

Table 5. Estimated pilot whale corrected abundance by survey block and combined, based on the best supported ds and mr models based on AIC. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	105,977	56,107	0.529	34,531	325,250	9.166
FDW	12	90,761	45,336	0.500	28,582	288,210	5.987
IDS_E	3	12,636	9,539	0.755	3,009	53,066	14.59
IDW2	2	23,805	14,578	0.612	7,570	74,863	34.89
IMN	2	2,510	2,796	1.114	277	22,779	5.913
IR_S	7	26,698	24,325	0.911	3,201	222,684	4.186
Total	42	262,387	88,900	0.3388	134,027	513,681	31.64

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Addendum

2025-11-25

Introduction

At the online meeting of the AEWG on 18 November 2025, the group discussed the choice to designate the platform with the highest mean group size as Platform 1 for the two Faroese vessels. The mrds software uses the data from Platform 1 for duplicate pairs when fitting detection functions to estimate detection probability and when estimating abundance. On the Icelandic vessels, the platforms were at different heights, and the highest platform was designated as Platform 1.

The group agreed that for the Faroese vessels, while this choice was acceptable, it would be informative to investigate the sensitivity of the abundance estimates to two alternative choices: (a) designating the platform with the lowest mean group size as Platform 1 (switching platforms 1 and 2) on the Faroese vessels, and (b) using mean perpendicular distance and mean group size for duplicate pairs (all vessels).

The following sections describe the results of these alternative analyses.

(a) Using the platform with the lowest mean group size as Platform 1

Uncorrected abundance

The single platform (ds) detection function was refitted resulting in the top two models switching place in ranking according to AIC (Table A1).

The second-ranking ds model, hazard rate key function with vessel as the only covariate, was the same as that in the original analysis and was selected for consistency. This model had a delta-AIC of less than 1 and thus had almost equivalent weight to the top-ranking model.

Table A1. The two top ranking single platform detection functions (ds) fitted to the pilot whale sightings data with Platform 1 designated as the platform with the lowest mean group size for the two Faroese vessels. Under Model: vess = vessel; beauf = Beaufort; height = Platform height; hn = half-Normal key function; hr = hazard rate key function.

Model	Key function	Model formula	AIC	ΔAIC
ds.hn.beauf.height	Half-normal	~Beaufort + PlatformHeight	1.22	0
ds.hr.vess	Hazard-rate	~Vessel	2.10	0.87

Uncorrected estimates of abundance using the selected ds detection function are given in Table A2.

Table A2. (a) Estimated pilot whale uncorrected abundance by survey block, based on the ds model with hazard rate key function and vessel as the only covariate. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	58,164	28,411	0.4885	19,888	170,107	7.732
FDW	12	74,555	30,764	0.4126	28,312	196,329	6.052
IDS_E	3	9,071	6,617	0.7294	2,175	37,838	11.63
IDW2	2	19,249	10,885	0.5655	6,544	56,621	28.02
IMN	2	1,818	2,010	1.106	199	16,573	5.751
IR_S	7	15,074	12,871	0.8539	1,857	122,381	3.816
Total	42	177,932	51,937	0.2919	99,142	319,338	28.97

(b) Data used to estimate abundance. Area is survey block size in km^2. Effort is total transect length in km. n is number of individuals in each region. k is the number of transects. ER is the encounter rate of individuals = n / Effort.

Block	Area	Effort	n	k	ER	Mean group size	SE mean group size
FDE	457,216.0	1,987.69	292	7	0.147	18.25	4.13
FDW	335,955.0	1,533.56	323	5	0.211	26.92	8.58
IDS_E	115,107.6	771.76	11	4	0.014	3.67	0.67
IDW2	45,607.0	183.40	14	2	0.076	7.00	3.00
IMN	154,513.0	1,128.57	16	6	0.014	8.00	4.00
IR_S	219,397.7	1,485.57	123	4	0.083	17.57	3.00
Total	1,327,796.2	7,090.55	779	28	0.117	18.55	3.07

Corrected abundance

The double platform (mr) detection function was refitted resulting in the same top model as in the original analysis, according to AIC (Table A3), which included only Beaufort as a covariate; this model was selected.

Table A3. The two top ranking conditional detection functions (mr) fitted to the pilot whale duplicate sightings data with Platform 1 designated as the platform with the lowest mean group size for the two Faroese vessels. Models are ordered by AIC, in descending order of model support from the data. Under Model: null = no covariates; beauf = Beaufort.

Model	Model formula	AIC	ΔAIC
mr.beauf	~Beaufort	213.35	0
mr.null	~1	213.83	0.48

Corrected estimates of abundance using the selected ds and mr detection functions are given in Table A4.

Table A4. Estimated pilot whale corrected abundance by survey block and combined, based on the selected ds and mr models. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	97,261	54,648	0.5619	29,616	319,411	8.797
FDW	12	105,335	46,877	0.445	37,465	296,150	6.158
IDS_E	3	12,585	9,119	0.7246	3,077	51,474	12.54
IDW2	2	23,709	13,622	0.5745	7,956	70,655	29.22
IMN	2	2,489	2,762	1.109	274	22,645	5.824
IR_S	7	26,473	23,984	0.906	3,145	222,826	4.093
Total	42	267,852	87,841	0.328	139,477	514,383	30.21

(b) Using mean perpendicular distance and group size for duplicates

Uncorrected abundance

The single platform (ds) detection function was refitted resulting in the top three models according to AIC shown in Table A5.

The third-ranking ds model, hazard rate key function with vessel as the only covariate, was the same as that in the original analysis and was selected for consistency. This model had a delta-AIC of only 0.26 and thus had very similar weight to the top-ranking model.

Table A5. The three top ranking single platform detection functions (ds) fitted to the pilot whale sightings data using mean perpendicular distance and mean group size for duplicate pairs. Models are ordered by AIC, in descending order of model support from the data. Under Model: vess = vessel; height = Platform height; size = group size; hr = hazard rate key function.

Model	Key function	Model formula	AIC	ΔAIC
ds.hr.height.size	Hazard-rate	~PlatformHeight + size	0.66	0
ds.hr.size.vess	Hazard-rate	~size + Vessel	0.70	0.03
ds.hr.vess	Hazard-rate	~Vessel	0.92	0.26

Uncorrected estimates of abundance using the selected ds detection function are given in Table A6.

Table A6. (a) Estimated pilot whale uncorrected abundance by survey block, based on the ds model with hazard rate key function and vessel as the only covariate. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	61,513	28,419	0.462	22,297	169,702	7.977
FDW	12	69,172	29,951	0.433	24,996	191,421	5.915
IDS_E	3	9,073	6,620	0.7297	2,175	37,852	11.64
IDW2	2	19,253	10,893	0.5658	6,542	56,657	28.07
IMN	2	1,798	1,989	1.106	197	16,390	5.755
IR_S	7	14,607	12,383	0.8478	1,828	116,733	3.835
Total	42	175,415	51,296	0.2924	97,676	315,025	29.41

(b) Data used to estimate abundance. Area is survey block size in km^2. Effort is total transect length in km. n is number of individuals in each region. k is the number of transects. ER is the encounter rate of individuals = n / Effort.

Block	Area	Effort	n	k	ER	Mean group size	SE mean group size
FDE	457,216.0	1,987.69	306.5	7	0.154	19.16	3.94
FDW	335,955.0	1,533.56	292.5	5	0.191	24.38	8.01
IDS_E	115,107.6	771.76	11	4	0.014	3.67	0.67
IDW2	45,607.0	183.40	14	2	0.076	7.00	3.00
IMN	154,513.0	1,128.57	16	6	0.014	8.00	4.00
IR_S	219,397.7	1,485.57	120.5	4	0.081	17.21	3.07
Total	1,327,796.2	7,090.55	760.5	28	0.116	18.11	2.87

Corrected abundance

The double platform (mr) detection function was refitted, which resulted in the same top model as in the original analysis, according to AIC (Table A7); this model was selected.

Table A7. The top two ranking conditional detection functions (mr) fitted to the pilot whale duplicate sightings data using mean perpendicular distance and mean group size for duplicate pairs. Models are ordered by AIC, in descending order of model support from the data. Under Model: null = no covariates; beauf = Beaufort; size = group size. AIC = Akaike Information Criterion and ΔAIC = the difference between AIC of the given model and the top-ranking model.

Model	mr model formula	AIC	ΔAIC
mr.beauf	~Beaufort	212.17	0
mr.null	~1	212.65	0.48

Corrected estimates of abundance using the selected ds and mr detection functions are given in Table A8.

Table A8. Estimated pilot whale corrected abundance by survey block and combined, based on the selected ds and mr models. Estimate = point estimate of abundance, se = standard error, cv = coefficient of variation, lcl = lower 95% confidence limit, ucl = upper 95% confidence limit, and df = degrees of freedom.

Block	No. groups	Estimate	se	cv	lcl	ucl	df
FDE	16	101,540	55,108	0.5427	32,110	321,091	8.905
FDW	12	98,034	45,717	0.4663	33,093	290,412	5.987
IDS_E	3	12,587	9,123	0.7248	3,077	51,494	12.56
IDW2	2	23,713	13,631	0.5748	7,954	70,699	29.26
IMN	2	2,462	2,732	1.11	271	22,395	5.828
IR_S	7	25,708	23,172	0.9014	3,095	213,558	4.118
Total	42	264,044	87,140	0.33	136,926	509,174	29.97

Comparison

Table A9 shows a comparison of uncorrected and corrected estimated abundance and mean group size, for the original analysis and the two alternative analyses.

Table A9. Comparison of results of sensitivity analyses regarding the data used in analysis for duplicate pairs. Original = original analysis with the platform with highest mean group size designated as Platform 1 on the Faroese vessels. Switch platforms 1 & 2 = the platform with lowest mean group size designated as Platform 1 on the Faroese vessels. Mean perp dist & group size = mean perpendicular distance and mean group size used for duplicate pairs on all vessels.

(a) Uncorrected abundance

Block	Original	Switch platforms 1 & 2	Mean perp dist & group size
FDE	64,969	58,164	61,513
FDW	63,807	74,555	69,172
IDS_E	9,108	9,071	9,073
IDW2	19,327	19,249	19,253
IMN	1,833	1,818	1,798
IR_S	15,202	15,074	14,607
Total	174,246	177,932	175,415

(b) Corrected abundance

Block	Original	Switch platforms 1 & 2	Mean perp dist & group size
FDE	105,977	97,261	101,540
FDW	90,761	105,335	98,034
IDS_E	12,636	12,585	12,587
IDW2	23,805	23,709	23,713
IMN	2,510	2,489	2,462
IR_S	26,698	26,473	25,708
Total	262,387	267,852	264,044

(c) Mean group size

Block	Original	Switch platforms 1 & 2	Mean perp dist & group size
FDE	20.06	18.25	19.16
FDW	21.83	26.92	24.38
IDS_E	3.67	3.67	3.67
IDW2	7	7	7
IMN	8	8	8
IR_S	17.57	17.57	17.21
Total	17.79	18.55	18.11

As expected, in the alternative analyses, estimates for the blocks surveyed by Icelandic vessels were very similar (smaller by a maximum difference of <1% for alternative (a); smaller by a maximum difference of <4% for alternative (b)).

The uncorrected estimates for Faroes block FDE decreased by around 10% for alternative (a) and by around 5% for alternative (b). For corrected abundance, these decreases were around 8% and 4%.

In contrast, the uncorrected estimates for Faroes block FDW increased by around 17% for alternative (a) and by around 8% for alternative (b). For corrected abundance, these increases were around 16% and 8%.

These differences in blocks FDE and FDW primarily reflect differences in estimated mean group size (Table A9c).

Compared with the original analysis, total uncorrected and corrected abundance was ~2% greater in alternative (a) and <1% greater in alternative (b).

The conclusion from the results of this sensitivity analysis is that the choice of how to use perpendicular distance and group size data for duplicate pairs had almost no effect on estimates of total abundance but did result in different estimates for blocks FDE and FDW surveyed by one of the Faroese vessels.