Annex 4

Report of the Working Group on Acoustic Survey and Analysis Methods 2024 (WG-ASAM-2024)
(Cambridge, United Kingdom, 20 to 24 May 2024)

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Report of the Working Group on Acoustic Survey and Analysis Methods 2024 (WG-ASAM-2024)
(Cambridge, United Kingdom, 20 to 24 May 2024)

Introduction

1.1 The 2024 meeting of the Working Group on Acoustic Survey and Analysis Methods (WG-ASAM) was held at the British Antarctic Survey (BAS) from 20 to 24 May 2024 in Cambridge, UK.

Opening of the meeting

1.2 The Convener, Dr S. Fielding (United Kingdom), welcomed the participants (Appendix A), noting that the Co-convener, Dr X. Wang (China), was unable to participate in this meeting.

1.3 Prof. D. Hodgson, Director of Science at the British Antarctic Survey (BAS) welcomed all participants. He encouraged the participants to enjoy their stay in Cambridge and wished them a fruitful meeting.

Adoption of the agenda

1.4 The meeting's provisional agenda was discussed, and the Working Group adopted the agenda (Appendix B).

1.5 Documents submitted to the meeting are listed in Appendix C. The Working Group thanked the authors of papers and presentations for their valuable contributions to the work of the meeting. Acronyms used in this report are provided on the CCAMLR website.

1.6 This report was prepared by S. Chung (Republic of Korea), M. Cox (Australia), D. De Pooter (Secretariat), T. Dornan (United Kingdom (UK)), H. Murase (Japan), N. Nickells and R. Saunders (UK) and G. Zhang (Norway). Sections of the report detailing advice to the Scientific Committee and other working groups are highlighted in grey and summarised under 'Advice to the Scientific Committee'.

Review terms of reference and workplan

2.1 The Working Group reviewed the terms of reference agreed by the Scientific Committee in 2022 (SC-CAMLR-41, Annex 11) and noted that they are available on the CCAMLR website.

2.2 The Working Group reviewed the workplan set out in Annex 15 of SC-CAMLR-42 and agreed that the Working Group would discuss additional modifications to the workplan under 'Future Work' (paragraph 8.1)

Standardised procedures for the collection of acoustic data for the implementation of the revised krill fishery management approach

Methods for calibrating echosounders on fishing vessels

3.1 No papers were submitted to this agenda item, however, the Working Group recalled the table of WG-ASAM research priorities (SC-CAMLR-41, Table 9) including that:

(i) the Working Group will recommend appropriate methods, procedures, and reporting requirements for calibration of echosounders on fishing vessels used for acoustic data collection,

(ii) the Working Group will develop guidelines for collection of relevant data to assess acoustic calibration methods which make use of seafloor backscattering.

3.2 The Working Group recalled that there were two potential methods of calibration, the standard sphere (Demer et al., 2015) and seabed (WG-ASAM-2023/08).

3.3 Dr Zhang reported recent experiences Norway had encountered with tests of seabed calibration in the North Sea sand eel surveys. They had found the seabed returned highly variable S_v (volume backscattering coefficient) even though all vessels were calibrated using the standard sphere. It was suggested that the seafloor substrate in the North Sea may have shifting sediment that could affect S_v.

3.4 The Working Group recalled that WG-ASAM-2023/08 identified that one of the sites used for seafloor calibration was more reliable than the other. Dr J. Arata (Invited Expert) noted that vessels have been collecting seabed calibration data from location no. 2 as identified in WG-ASAM-2023/08. The Working Group encouraged the authors of WG-ASAM-2023/08 to analyse these data.

3.5 The Working Group recognised that seafloor calibration should be treated with caution. It noted that the location that had returned more stable S_v in WG-ASAM-2023/08 should be investigated for substrate qualities to recommend other candidate sites that could be tested using calibrated echosounders in the future.

3.6 The Working Group discussed the challenges of calibrating echosounders. It noted that recent Member experiences included high Root Mean Square (RMS) error values, erroneous beam angle estimates, non-sphere targets entering the calibration region, and the time required to calibrate. It discussed whether facets of the EK80 calibration wizard were responsible for the erroneous values and the requirement to engage with Simrad/Kongsberg to resolve this.

3.7 The Working Group identified that erroneous calibration results could be associated with too many data points, and engagement with Simrad had identified methods to reduce these in calibration data sets (see Appendix D).

3.8 The Working Group recommended that the Scientific Committee note that ideally a calibration would be undertaken prior to a survey to ensure the echosounder was performing correctly. However, this may not always be feasible, and the Working Group recommended that echosounders should at least be calibrated during, or at the end of, the survey period. The Working Group further recommended that Battery Impedance Tests (BITE tests) should be conducted prior to a survey to ensure all sectors of the transducers were performing appropriately. Following WG-ASAM-2024/15, an impedance of 75Ω ± 40%, would indicate that echosounders are operating correctly.

3.9 The Working Group discussed whether a calibration undertaken in one Subarea could be used for another. It recognised that the temperature effect on transducers (Demer and Renfree, 2008) meant that calibrations completed in Subarea 48.1 may not be applicable to surveys in Subarea 48.3 with different ambient conditions. The Working Group also noted that it was not possible to insert a temperature of <0° C into Simrad EK80 and that a TS profile is required for <0° C. It was noted that fishing vessels have CTDs on trawls that could be used to assess changing environmental conditions.

3.10 The Working Group developed a simplified calibration protocol for fishing vessels from the Demer et al. (2015) ICES cooperative research report, highlighting calibration wizard settings and routes to deal with poor calibration, and calibration frequency and sites (Appendix D, Echosounder Calibration Protocol). The Working Group agreed that .xml calibration files should be submitted to the Secretariat alongside raw survey data and metadata. The Working Group agreed that an Acoustic Survey Metadata Form (ASMF) should be developed, analogous to the C1 form, and that this should include vessel details, sampling net details and sampling data, CTD instrument details and sample metadata, echosounder details and acoustic transect metadata.

3.11 The Working Group thanked Dr Dornan for leading a sub-group to develop an Echosounder Calibration Protocol.

3.12 The Working Group recommended that the Echosounder Calibration Protocol (Appendix D) should be used by fishing vessels if conducting acoustic surveys with EK80 software and further recommended intersessional work in the WG-ASAM e-group (https://groups.ccamlr.org/group/3) to include simplified protocols for other transceiver and software versions for consideration by WG-ASAM-2025.

Acoustic transect design and data collection

3.13 WG-ASAM-2024/10 presented the development of a workplan for conducting krill surveys in Subarea 48.1, which collated the protocols outlined in SC-CAMLR-42 Annex 13. The paper considered the list of nominated transects and equipment required for conducting the surveys, as well as the protocols for conducting acoustic calibration, acoustic transects, trawl sampling and CTD casts. The paper noted that not all fishing vessel echosounders are scientific. It identified that krill sampling could use either a 7 mm mesh macroplankton net or a ≤4 mm mesh RMT8 net to trawl for krill at predetermined locations along survey grids, spaced approximately 20 – 25 n miles apart. It suggested provision for three scientists onboard for calibration and surveys and that the surveys would follow predefined transects.

3.14 The Working Group welcomed the paper and used it to frame discussions around transect design, CTD and krill biological sampling that led to the development of protocols and reporting templates during the meeting.

3.15 The Working Group commended the concept of the fishery working in concert to provide krill area biomass estimates and recommended that the Scientific Committee consider how this could be implemented.

3.16 WG-ASAM-2024/14 presented a study of Antarctic krill diurnal vertical movements using acoustic moorings deployed near the South Orkney Island. The paper noted significant intra-annual variability, which could be relevant to deciding when to undertake an acoustic survey for krill. The paper further discussed the potential for calculating a correction factor to account for the acoustic "blind" zone caused by the vertical migration of krill to the upper 15 m depth layer of the water column.

3.17 The Working Group noted the high degree of variability of acoustic backscatter with no clear patterns and that considering survey timing is important for capturing biomass variability. It also noted that swarms were highly variable in size and depth (possibly in response to predation) and suggested that seasonal patterns in the data might emerge by separating the data into day and night subsets.

3.18 The Working Group discussed the depth interval over which acoustic data could be integrated, noting the current method of integrating between a surface exclusion line (nominally 20 m deep in the 'swarms algorithm' template) and a maximum depth of 250 m. The Working Group noted that the lower integration limit was based on the range of the 200 kHz frequency used as part of the three-frequency dB difference target identification algorithm, and that there is the possibility of extending the swarms algorithm using solely the 120 kHz frequency to depths deeper than 250 m. The Working Group further noted that the majority of krill detected in WG-ASAM-2024/14 were identified in the upper 250 m and the signal-to-noise ratio for some vessels may prevent data collection at deeper depths.

3.19 WG-ASAM-2024/15 presented the preliminary results from the acoustic surveys of Antarctic krill conducted by the Chinese fishing vessels in Subarea 48.1 during austral winter 2023 and summer 2024. The survey used Echoview and RapidKrill to process acoustic data using the single 120 kHz frequency swarms algorithm approach for target identification. The survey extended current nominated transects closer to the shore and revealed that in winter krill were observed in these areas, whilst in summer, krill were more widely dispersed. This highlighted the variability in seasonal krill distribution, and the need to survey nearshore.

3.20 The Working Group noted that two different krill processing software were used in paper WG-ASAM-2024/15 and recognised that using different methods for processing acoustic data to derive krill biomass should be encouraged, noting the need for test data sets and comparative assessments to evaluate the performance of the different software (e.g. Echoview LSSS, RapidKrill, and Krillscan). The Working Group recalled previous recommendations to submit test datasets to the CCAMLR Secretariat and welcomed the offer by Dr Cox to provide a test dataset including raw data and the results from the Echoview Swarms template processing.

3.21 The Working Group noted that acoustic transects could be extended further inshore, but that many seabed areas of the Southern Ocean are poorly surveyed, and that ice could also restrict access to nearshore areas.

3.22 The Working Group commended the survey as an example of several krill fishing vessels collaborating to produce one survey of several candidate krill fishery management units in Subarea 48.1. It noted that calibration of the vessel echosounders was required for a krill density estimate.

3.23 WG-ASAM-2024/04 presented a proposal for ensuring a sustainable strategy for the long-term monitoring of krill populations, by allocating a quota-based compensation scheme for vessels undertaking surveys.

3.24 The Working Group noted that the area proposed for the compensation quota would likely be the Bransfield Strait and estimated that it would take 30 days to complete the current survey transects in Subarea 48.1. Dr Arata indicated that approximately half of the fleet would consider undertaking the surveys if the new krill fishery management quotas are increased. However, it was noted that there is a limited number of acousticians available to support surveys.

3.25 The Working Group discussed whether the fishing vessels would gain an advantage from undertaking the surveys by knowing where high krill densities could be found as a result of the surveys. Dr Arata identified that the quota compensation area would be identified during a Scientific Committee submission prior to the survey being undertaken.

3.26 The Working Group noted the request of the Scientific Committee to provide advice on transects covering the whole of Subarea 48.1 and used the submitted papers to frame a discussion on the length and spacing of transects, and how best to survey areas which are not covered by current transects within the sampling capacity of the fishing fleet. It was noted that the CCAMLR 2019 survey had a higher density of transects 'on-shelf' than 'off-shelf'. The continental shelf break was recognised as the highest density krill areas in the spatial overlap analysis and from previous surveys.

3.27 The Working Group discussed the mismatch between survey areas, strata areas and candidate fishery management units and highlighted that the use of the Jolly and Hampton (1990) survey design-based estimator required *a priori* definition of a survey area and that the method may not be statistically robust if a survey was then used in a *post-hoc* re-stratification to a new area (e.g. a new management area). The Working Group noted that a model-based estimator approach could be more valid to enable *post-hoc* re-stratification of biomass estimates should future management boundaries change.

3.28 The Working Group reiterated that the Jolly and Hampton (1990) estimator was relevant for a predefined survey area and that biomass estimates extrapolated into areas that had not been surveyed should be treated with caution.

3.29 The Working Group developed an additional survey strategy to sample areas not yet surveyed in Subarea 48.1 and concluded that when developing these:

(i) there is insufficient consistency (seasonal and inter-annual) in krill density distribution to make a distinction between nearshore and offshore, so agreed to extend the existing transects offshore

(ii) where possible it should use the Jolly and Hampton (1990) design-based estimator. Otherwise, where sufficient data exists, it could use a model-based estimator as this yields greater flexibility to change strata areas in the future. The latter would require agreement to use

(iii) it should not extrapolate out of the data collected and it is suggested to bound the data using a convex hull

(iv) it should extend existing transects out to the edge of the spatial overlap analysis boundary and it should extend every n^{th} transect further off-shore to the boundary of the 48.1 Subarea. The Working group agreed that n could be 2.

3.30 The Working Group proposed additional transects to cover the whole area of Subarea 48.1. Noting the criteria for transects to be orientated orthogonally to the prevailing currents, it rotated transects in the Weddell Sea by 90 degrees (Figure 1).

3.31 The Working Group noted that if the spatial overlap analysis and associated management units were to change in the future, WG-ASAM may need to change the transect density to reflect this. The Working Group also recognised that new acoustic transects needed to be accompanied by CTD and trawl stations. The protocols were developed and discussed in paragraphs 3.45 to 3.63.

3.32 The Working Group discussed a sampling protocol for proposed transects to cover all of Subarea 48.1. Following WG-ASAM-2024/15 and historic AMLR surveys, the Working Group recommended that sampling stations were spaced 20 n miles apart on each transect. The group recognised that it was often not possible for the science team onboard to process catches obtained every 20 n miles. The Working Group suggested that there was an aim to sample at each 20 n mile station but that it would be acceptable to sample 2–3 stations per any 60 n miles of transect, with a between-sample station distance on any transect of 20 – 60 n miles. The Working Group agreed that stations sampled should be distributed across transects and depths. In addition, if one station had no krill catch, the next station should be sampled.

3.33 The Working Group considered three examples of sample station positioning along transects, which are shown in Figure 1. The Working Group provided estimates in Table 1 of the time it would take to complete the Subarea 48.1 survey as described in Figure 1. An example route was presented to the Working Group noting that there was no definitive route.

3.34 The Working Group also noted that the transects, start and end locations and nominated sampling stations could be refined later, when there was clarity around the boundaries of the agreed management units. All elements used in the production of Figure 1 are available in the CCAMLR geospatial operations GitHub repository at: https://github.com/ccamlr/geospatial_operations (WG-ASAM-2024/01).

3.35 The Working Group thanked Dr Cox for guiding the process and the Secretariat for the remote work they had put into preparing the maps.

Krill biological data collection

3.36 WG-ASAM-2024/12 presented the utility of automated, machine-learning approaches for determining krill length frequencies, shape and maturity stage.

3.37 The Working Group noted the potential benefits of the model for obtaining standardised data in a more timely and efficient manner, particularly for observers at sea. The Working Group noted that the approach could provide important information on krill shape for informing future developments of Target Strength (TS) models (SDWBA), as well as potentially important information of krill colour that may provide information on feeding condition. The

Working Group noted that modern cameras can integrate geolocation data into image capture and that this could be useful for this kind of data and analysis.

3.38 The Working Group encouraged the authors to present the paper for consideration by WG-EMM-2024 and further develop the pilot method, noting the potential for future commercial development from professional/specialist software developers.

3.39 WG-ASAM-2024/05 presented a comparison of different length frequency biases associated with different samplers (nets, predator diet-based and observer) and their impact on TS (or Conversion Factor) estimation, and the consequences for survey biomass estimation. The paper noted that despite significant differences in length frequency, the Conversion Factor estimates seem to be relatively similar, and this could be a product of the relationship between TS and krill length within the range of 18 – 42 mm.

3.40 The Working Group noted that small variations in Conversion Factors could lead to relatively large variations in survey biomass, highlighting the need for future consideration of length frequency biases and further analyses to compare size selectivity across different net types and predator-based samplers. In particular, the Working Group noted that the RMT1 used in paper WG-ASAM-2024/05 was biased towards sampling smaller krill and that a comparison with the standard RMT8 was recommended.

3.41 WG-ASAM-2024/P01 examined the effects of sampling and measurement variation on krill biomass estimates. The paper highlighted that variation in krill shape and orientation may need to be used in TS models for more robust future biomass estimates. The paper further highlighted the utility of image-based methods for measurements of krill size and shape.

3.42 The Working Group noted that the study was a useful sensitivity analysis and that there should be future consideration of shape and orientation parameterisation in TS calculations.

3.43 WG-ASAM-2024/02 presented a draft version of the revised C1 form for krill fisheries and requested feedback regarding its potential to be used by krill fishing vessels in combination with the observer logbook to report krill length frequency data collected during acoustic surveys.

3.44 The Working Group noted that the C1 form and the ‘Krill Biological’ sheet from the observer logbook for krill trawl fisheries can be used as a template for the development of an Acoustic Survey Metadata Form (paragraph 3.71).

3.45 The Working Group considered the development of an acoustic survey trawl sampling protocol (paragraph 3.53) and recalled that the RMT8 and macroplankton nets have been deployed to depths of 200 m as standard gear during the 2019 large scale survey.

3.46 The Working Group recommended that the Acoustic Survey Trawl Sampling Protocol specifies that both RMT8 nets and macroplankton nets can be used as standard sampling gear for sampling depths between 0 and 200 m (or 10 m from seabed). The Working Group recommended that details of such samplers be fully documented in the Acoustic Survey Metadata Form (paragraph 3.71).

3.47 The Working Group recognised that other net gear/samplers can be used in surveys (e.g. RMT1, predator diet, fishery observer), but were subject to biases, and encouraged further research to understand the impact of these biases on acoustic estimates of krill.

3.48 The Working Group discussed optimal fixed net sampling locations (or distances) and noted the spacing between stations of 20 n miles used by the acoustic surveys conducted by Chinese fishing vessels in Subarea 48.1 (WG-ASAM-2024/15). Correspondence with the authors of WG-ASAM-2024/15 identified that a trawl station every 20 n miles frequently exceeded the capacity of the vessel and scientists to process the krill data and trawls every 20 n miles was an aspiration. The Working Group noted that a sampling rate of one net haul every 40 n miles may be more achievable, with a separation no greater than a net every 60 n miles (paragraph 3.32).

3.49 The Working Group recommended that the Acoustic Survey Trawl Sampling Protocol specifies an aim to undertake standardised trawl sampling at each 20 n miles station, but it would be acceptable to sample 2–3 stations per 60 n miles of transect. It noted that where a trawl did not retrieve Antarctic krill, ideally the next station 20 n miles away should be conducted. It also noted where transects included onshore and offshore regions, at least one trawl should be conducted in each region.

3.50 The Working Group recommended that the Acoustic Survey Trawl Sampling Protocol include guidance for additional targeted net haul sampling on acoustically detected swarms once per day where possible.

3.51 The Working Group discussed the number of krill to be sampled per net haul and noted that the CCAMLR 2000 Survey protocol recommended sampling 100 individuals. The Working Group considered the time needed to process the sample and recommended that the acoustic trawl sampling protocol specifies a requirement for sampling 100 individuals.

3.52 The Working Group developed an Acoustic Survey Trawl Sampling Protocol (Appendix E) for biological sampling on acoustics surveys. The protocol was devised for the purpose of determining krill length frequency. However, the Working Group recognised the requirement to revise the protocol to give guidance on sampling other biological organisms and recommends further review by WG-ASAM-2025.

3.53 The Working Group thanked Dr Liszka for leading a sub-group to develop the Acoustic Survey Trawl Sampling Protocol.

3.54 The Working Group recommended the Acoustic Survey Trawl Sampling Protocol (Appendix E) be used by fishing vessels conducting acoustic surveys and that they complete the corresponding set of metadata within the Acoustic Survey Metadata Form (paragraph 3.71).

Oceanographic data protocols

3.55 The Working Group recalled the request by the Scientific Committee to develop protocols for the collection of CTD data, including metadata requirements (SC-CAMLR-42, Annex 13).

3.56 The Working Group recommended that CTDs be deployed ideally at stations spaced 20 n miles along acoustic survey transects, but that it would be acceptable to sample 2–3 stations per 60 n miles of transect, with an interim sample station on any transect of between 20–60 n miles. The Working Group noted that some nets can be equipped with oceanographic sensors, or a CTD could be mounted to the trawl and this could save survey time if combined.

3.57 The Working Group recommended that nets be fitted with time-depth recorders (TDRs) to collect additional oceanographic data to complement those from CTDs. The Working Group recommended that net-based oceanographic data should be accompanied by geolocation data.

3.58 The Working Group noted that factory calibrations of CTD instruments are costly and time consuming, particularly when factory calibration can only be carried out by a small number of companies.

3.59 The Working Group recommended that where possible, CTDs be calibrated annually, and Members also develop options to intercalibrate sensors where factory calibrations are not possible. The Working Group recommended that the CTD data sampling rate is set to achieve a minimum vertical resolution of 1 sample per metre, noting that the sample rate of the instrument would vary depending on the deployment method.

3.60 The Working Group identified the utility of an inventory of different CTD systems and specifications used across Members for comparisons. This would help inform a determination of the best gear and settings to recommend for acoustic surveys in the Acoustic Survey CTD Sampling Protocol. The Working Group encouraged Members to compile this table for review by WG-ASAM-2025.

3.61 The Working Group discussed ways to record metadata for CTD data collection during acoustic surveys and recommended the Acoustic Survey Metadata Form (paragraph 3.71) includes CTD metadata fields based on BODC submission guidelines (https://www.bodc.ac.uk/submit_data/submission_guidelines/ctd_data/).

3.62 The Working Group thanked Dr Zhang for leading a sub-group to develop an Acoustic Survey CTD Sampling Protocol.

3.63 The Working Group recommended that the Acoustic Survey CTD Sampling Protocol (Appendix F) be used by fishing vessels conducting acoustic surveys.

Submission and storage of acoustic data

3.64 WG-ASAM-2024/03 presented recent developments on the CCAMLR Acoustic Data Repository. The paper provided an overview of acoustic data and metadata submitted since WG-ASAM-2023 and presented the data visualisation tool requested by WG-ASAM-2023. The paper also described progress in testing the python package *Krillscan* and discussed options for future data submissions, including the results of tests of a cloud-based platform to exchange raw acoustic data between the Secretariat and Members.

3.65 The Working Group endorsed the use of the cloud-based system massive.io for exchanging raw acoustic data between the Secretariat and Members, noting that for very large amounts of data (over 1 terabyte) exchanging data using hard drive is still efficient and cost effective.

3.66 The Working Group considered the cost associated with maintaining the acoustic data repository and noted that the acoustic data file size depends on the number of frequencies recorded, the depths the data are logged to, the ping rates and the file formats. The Working Group further noted that the total volume of the data which would be submitted annually will depend on the sampling effort. The Working Group provided estimates of the volume of acoustic data generated per survey day, considering four different acoustic data storage formats (Table 2).

3.67 The Working Group requested that the Secretariat estimate the annual cost of maintaining the acoustic data repository based on the expected volume of data exchange, for consideration by the Scientific Committee.

3.68 The Working Group noted the value of processed data products for the CCAMLR community and recommended the submission and storage of processed data products (NASC and Areal densities) from surveys at the Secretariat. The Working Group noted that additional work is required to develop standards for the submission of processed data products, including shapefiles.

3.69 The Working Group noted difficulties in connecting via the CCAMLR authentication systems and tasked the Secretariat with scoping options and costs to develop it to authenticate users on RShiny applications.

3.70 The Working Group considered the possibility of making a simplified version of the acoustic data visualisation tool publicly available. The Working Group noted that the data are subject to the Rules for Access and Use of CCAMLR data and considered the utility of making metadata available when the data themselves are not. The Working Group requested the Secretariat engage with the Data Services Advisory Group (DSAG) to discuss the matter for consideration by the Scientific Committee.

3.71 The Working Group thanked Dr Arata and the Secretariat for leading the subgroup to develop a draft version of the Acoustic Survey Metadata Form.

3.72 The Working Group requested the Acoustic Survey Metadata Form be made available through the WG-ASAM e-group (https://groups.ccamlr.org/node/683) and encouraged Members to further develop the form during the intersessional period for consideration by WG-ASAM-2025. The Working Group requested the Secretariat engage with Members to test the Acoustic Survey Metadata Form using historic acoustic data, including the 2019 large scale survey data, and make the form available to any vessel using the protocols developed during WG-ASAM-2024.

Standardised procedures for analysis and development of krill biomass estimates

Standardised management units for krill biomass estimates

4.1 WG-ASAM-2024/11 proposed updates to the candidate management units (MUs) based on the spatial overlap analysis (SOA). The SOA can be used to split the catch in such a way as to minimise the risk to the ecosystem. It outputs a measure of regional risk which can be used to compare different management scenarios, and a value of alpha for each candidate MU, which is the proportion of the total catch that is allocated to each candidate MU. The paper proposed revising MUs, addressing some of the issues of spatial mismatch, highlighted in WG-FSA-2023/54. These updates include incorporating the coastline recommended by WG-ASAM-2024/01, using the ESPG 6932 map projection.

4.2 The Working Group noted that the outer two proposed MUs DP2 and PB2 do not have all of the required data to run the spatial overlap analysis and recognised that the approach can only be applied in the SOA footprint (WG-ASAM-2024/11).

4.3 The Working Group noted that some of the proposed MU areas are irregularly shaped. The Working Group also recognised that the proposed MU DP2 covers both oceanic and coastal waters, encompassing a large area that is not currently used by the fishing industry and is outside the footprint of the SOA.

4.4 The Working Group discussed the survey strata created by the 2019 large-scale acoustic survey for krill and the use of the Jolly and Hampton (1990) estimator. It noted that the primary sampling units of the Jolly and Hampton (1990) estimator are parallel transects randomly spaced within strata. The Working Group noted that *post-hoc* re-stratification of the 2019 survey data to new management units may not meet the method's criteria, and that in such cases a model-based estimator may be more appropriate.

4.5 The Working Group noted that some of the irregularly shaped proposed MUs in paper WG-ASAM-2024/11 were not completely covered by the surveyed transects undertaken during the 2019 large scale acoustic survey. The Working Group populated Table 3 providing an approximation of the overlap between available transect data (from the 2019 survey, previous AMLR surveys and the 2020 survey by Russia utilised by SC-CAMLR-40/11) and the proposed MUs presented in paper WG-ASAM-2024/11 (Figure 2). The Working Group also provided a qualitative assessment of whether those candidate transects were considered representative of the wider proposed MU areas.

4.6 The Working Group recalled that CCAMLR has proposed to use the lower bound of the one-sided 95% confidence interval of the biomass assessment to provide a precautionary estimate of krill biomass for management units resulting from a single survey.

4.7 The Working Group recommended that the authors of WG-ASAM-2024/11 consider some changes to the proposed MUs (such as pushing the boundary of the Gerlache Strait strata and South Shetland Island West to the edge of the SOA footprint) and that these may provide more regular shaped management units better aligned with existing acoustic transects.

4.8 The Working Group noted that there are competing priorities for the current design of MUs: 1) the design and execution of acoustic sampling to derive krill biomass estimates, and 2) the footprint of available data to parameterise the SOA to allocate catch. The Working Group noted that it might not be possible to completely reconcile these two competing priorities based on existing acoustic transects. Recognising that additional transects and some minor adjustments to existing transects might help to resolve this, the Working Group included this consideration when developing an idealised set of transects for Subarea 48.1 (Figure 1).

4.9 Dr Arata expressed concern that the proposed subdivision of PB into PB1 and PB2 left an area of significant importance for krill spawning (as identified in the Krill Stock Hypothesis) outside the current SOA and as such, it would disincentivise its future surveying.

4.10 The Working Group agreed that there may be little incentive for fishing vessels to survey the proposed MU PB2 (WG-ASAM-24/11) within the proposed sustainable strategy for the long-term monitoring of krill populations (WG-ASAM-2024/04).

4.11 The Working Group welcomed the efforts of the Secretariat and its continued work on developing standard operations for Geographic Information Systems (WG-ASAM-2024/01), including a set of R scripts to build the MUs and an update to coastlines. The CCAMLRGIS R package (version 4.1.0) has also been updated to include a function to add hashed line fill inside mapped polygons.

4.12 The Working Group considered whether the krill biomass estimates of WG-EMM-2021/05 Rev. 1 should be updated to reflect the changes in the MUs referenced in WG-ASAM-2024/01 compared to the proposed management unit used previously (WG-EMM-2022/17). The Working Group noted that the changes reported in WG-ASAM-2024/01 represented minor coastal line shifts and clarification of isolated areas of water. They agreed the biomass estimates be updated and requested that the Secretariat recalculate the krill biomass estimates in line with the revised stratum area (WG-ASAM-2024/01).

4.13 The Working Group thanked the Secretariat for the paper.

4.14 The Working Group recommended that any future changes to strata boundaries affecting biomass estimates be likewise submitted to WG-ASAM for consideration before krill biomass is recalculated.

Standardised processing and reporting of acoustic data

4.15 WG-ASAM-2024/06 presented the results of a study to determine the potential influence of sea ice cover on the krill biomass estimates of the BROKE-WEST (2006) and TEMPO (2021) surveys in Division 58.4.2.

4.16 The Working Group noted that sea ice can present significant difficulties in achieving full coverage of krill biomass survey strata, preventing sampling in southern or nearshore areas of strata. The Working Group agreed that the analysis presented in WG-ASAM-2024/06 of the effect of sea ice coverage on krill biomass estimates was appropriate but recognised that surveys should avoid presenting biomass estimates for non-sampled areas.

4.17 The Working Group endorsed the findings of WG-ASAM-2024/06 that the reduction in estimated krill biomass observed during the 2021 survey of Division 58.4.2-East was caused by a true reduction in krill biomass, rather than a change in sampling, due to sea ice coverage. The Working Group agreed that WG-ASAM-2024/06 fulfilled the examination of the effect of sea ice on krill biomass estimates as requested by the Scientific Committee (SC-CAMLR-42, paragraph 2.93).

4.18 The Working Group recommended that for future surveys, the percentage of a stratum covered by sea ice should be reported along with krill biomass estimates and considered this as future work for WG-ASAM-2025.

4.19 The Working Group noted that the simulations of sea ice effect presented by Dr Cox, utilised a krill density dataset collected in 2006. The Working Group agreed that because the 2006 data were the only data with overlap of Division 58.4.2-East, the 2006 data were the best-available data for comparison with the 2021 data.

4.20 The Working Group thanked Japan and Australia for submitting standardised metadata for the krill biomass surveys of Division 58.4.1 and Division 58.4.2-East respectively. Following the request from SC-CAMLR-42, paragraph 2.95, the Working Group reviewed the submitted metadata. The Working Group agreed that the standardised metadata from both surveys fulfilled the requirements described in Tables 2 to 8 of WG-ASAM-2022 as requested by Scientific Committee.

4.21 The Working Group recalled previous discussions regarding the submission of an Acoustic Survey Metadata Form (paragraph 3.10) and recognised that this may result in future updates to the standardised metadata reporting requirements for biomass surveys to CCAMLR (WG-ASAM-2022, Tables 2 to 8).

4.22 The Working Group suggested the Secretariat develop a method to version-control the standardised metadata reporting requirements for biomass surveys to CCAMLR (WG-ASAM-2022, Tables 2 to 8) and suggested the CCAMLR GitHub repository could be used (https://github.com/CCAMLR-Science/Krill-Biomass-Estimates).

Analysis of acoustic data collected along nominated transects

4.23 The Working Group noted WG-ASAM-2024/15 which presented an overview of the results from the acoustic surveys conducted by the Chinese fishing vessels in Subarea 48.1 during austral winter 2023 and summer 2024 and commended the collaboration between different vessels to cover a greater survey area. The Working Group encouraged the Chinese vessels to calibrate their echosounders whenever possible. (paragraphs 3.8 and 3.12)

Krill biomass estimates

Area 48 biomass estimates

5.1 WG-ASAM-2024/07 presented spatial-temporal variation of krill abundance along the northern shelf-break of the South Orkney Islands in January-February 2016. The results showed the substantial variation in the spatial distribution and the abundance between different scaled surveys (~500, 3 000, 8 500 and 28 000 km^2) even in approximately the same timeframe (within ~10 d). The study highlighted the difficulty in monitoring such a dynamic krill population effectively within reasonable logistical and practical survey constraints.

5.2 The Working Group noted the importance of conducting fine-scale (i.e., meso) surveys along the northern shelf-break of the South Orkneys considering the significant spatial-temporal variation of krill abundance.

5.3 The Working Group noted that it is worthwhile to investigate swarm sizes and composition of maturity stages of krill in relation to oceanographic conditions, and the difference between krill biomass estimates derived from the 'swarm-based' and 'dB-difference-based' target identification methods.

5.4 WG-ASAM-2024/09 presented preliminary results of krill swarm metrics from fine-scale surveys (approximately 6.5 n miles transect length with 1.1 n mile spacing between transects) at the South Shetland Islands and canyon locations off the Antarctic Peninsula conducted from the small tourist boat, the Hans Hansson (23 m in length). The main purpose of this survey was to collect data for modelling spatial overlap between the krill fishery and baleen whales.

5.5 The Working Group encouraged the authors to investigate the fine-scale interaction between krill and baleen whales using the echosounder data and the whale sighting data recorded during the survey, noting that whale tagging data was not obtained during the survey because of logistical constraints.

5.6 The Working Group highlighted the importance of understanding any bias in length frequency distribution of sampled krill from different net types noting that only the 1 m^2 mid-water trawl krill net (K-net) was used in this survey.

5.7 WG-ASAM-2024/13 presented the results of krill acoustic surveys by MV *Pharos SG* on the northern shelf of South Georgia (eastern and western core boxes) during the winters of 2022 and 2023, noting an RMT1 was used to obtain krill length data. Krill length frequency from krill fishery observer data were also used in the analysis. Conversion factors were similar between RMT1 and observer data, although the length frequencies were divergent between them. Krill biomass decreased over the season and was lower in 2023 than in 2022. Daytime acoustic surveys were repeated at night and identified that winter krill densities and biomass in nighttime were generally higher than in daytime. Distribution of krill in 2023 was deeper and further offshore than in 2022.

5.8 The Working Group noted that the RMT1 stations were typically undertaken near shore, and this may have also contributed to the differing krill length frequency between the RMT1 and fishery observers.

5.9 The Working Group discussed the effect of integration depth used in this study (surface to 250 m) on biomass estimates. The Working Group noted that some krill could distribute deeper than 250 m in winter and recalled that other frequencies (e.g. 70 kHz) may sample over a greater depth range and encouraged investigations around their use.

5.10 The Working Group noted it has been assumed that krill biomass during night is lower than during day during summer because krill move vertically into surface blind zones as the result of diurnal vertical migration (DVM) and with this assumption, the CCAMLR 2000 biomass survey was estimated using only daytime data. However, the result of this paper indicated that krill could show different patterns of vertical distribution in winter.

5.11 The Working Group encouraged the continuation of winter surveys as they provide important information for krill fishery management.

Area 58 biomass estimates

5.12 No new information was provided under this item.

Survey design and using other platforms

6.1 The Working Group noted that both papers presented for this agenda item (WG-ASAM-2024/09, in paragraph 5.4 to 5.6 and WG-ASAM-2024/05, in paragraphs 3.39 to 3.40) had been previously discussed during other parts of the meeting. They are addressed here only in as far as they relate to this agenda item.

6.2 The Working Group noted the utility of using new acoustic observation platforms and the importance of considering how these platforms can be adapted to monitor the ecosystem over finer temporal and spatial scales than is possible using fishing and research vessels. An example of adaptation of a non-standard platform was given in WG-ASAM-2024/09, where a tourist vessel was adapted for acoustic surveying using a pole-mounted echosounder.

6.3 The Working Group also noted the use of fixed seafloor mooring data to elaborate on seasonal patterns in krill distribution presented in paper WG-ASAM-2024/14.

6.4 The Working Group discussed the requirement for krill length frequency data to parameterise the target-strength model and the challenge this presents for platforms which cannot collect trawl data. It noted that paper WG-ASAM-2024/05 identified differences in krill-length frequency distributions from different samplers (RMT1 and RMT8 nets, fisheries observers, and predator diet data from regurgitates or scats).

6.5 The Working Group acknowledged the need to collect unbiased krill length frequency distributions using methods outlined throughout agenda item 3. However, where this is not possible, for example with autonomous vehicles or on alternative platforms, the Working Group highlighted the need to develop methods for utilising different sources of krill length frequency accounting for differing biases.

6.6 The Working Group noted the importance and utility of alternative survey methods and platforms as a source of additional spatial and temporal information. This was recognised as being of increasing importance for considering the carbon footprint of vessel-based surveys. The Working Group encouraged the community to continue to explore these methods and submit their data to allow comparison between methods and to test new and emerging technologies.

6.7 Dr Cox offered to work with the authors of the paper to apply a statistical approach to combine krill length frequency from different sources to make these sources comparable. The Working Group welcomed this expertise and thanked Dr Cox.

Develop methods to estimate biomass of finfish using acoustic techniques

7.1 WG-ASAM-2024/08 presented a new research plan for the acoustic trawl survey under CM 24-01 for *Champsocephalus gunnari* in Subarea 48.2 by Ukraine for the 2024/25 to 2026/27 seasons. The Working Group recalled the discussion from WG-FSA-2023 (paragraphs 4.80 to 4.83) regarding the recommendation to provide advice on any modifications to the survey that may facilitate the collected acoustic data being used in the Subarea 48.2 krill fishery management strategy.

7.2 The authors noted that this proposal was developed with key objectives, including the distribution and abundance of *C. gunnari*, stock structure with Subarea 48.1, catchability of fishing gear, data collection on bycatch species, biological parameters of *C. gunnari*, plankton and oceanographic research, and ensure the achievement of the objectives of the South Orkney Islands southern shelf marine protected area.

7.3 The authors also noted some changes to the design of survey transects and stations based on the previous survey experience, including the removal of survey transect in the southwestern part and the addition of two stations in the northern part of the survey area. They also noted a plan to install a 38 kHz transceiver and perform calibration for the echosounder before the survey.

7.4 Dr Cox offered further assistance on installing the 38 kHz transceiver for the acoustic survey.

7.5 The Working Group discussed the appropriate TS estimates or marks to identify *C. gunnari* in the survey and advised the proponent to refer to SG-ASAM-09/06 on target strength of *C. gunnari* from a scattering model.

7.6 The Working Group noted that the survey design was perpendicular to the annual large-scale survey carried out by Norway. They noted that the proposed acoustic survey transects were located in an area identified by WG-ASAM-2024/07 as containing significant fluctuations in krill biomass.

7.7 The Working Group discussed the considerable complex oceanographic features in the survey area and considered that the survey design would be appropriate to also analyse for Antarctic krill biomass. The Working Group noted it would be complementary to the Norwegian large-scale survey. The Working Group requested the Secretariat to summarise this discussion for consideration by WG-FSA-2024.

7.8 The Working Group encouraged the authors to provide a krill biomass estimate for the acoustic survey outlined in WG-ASAM-2024/08 and to consider submitting an application to the CCAMLR Scientific Scholarship Scheme to facilitate the work.

Future work

8.1 The Working Group recognised that significant progress has been made in the following parts of the workplan (SC-CAMLR-42, Annex 15; reference Theme 1 Target Species (a) Develop methods to estimate biomass for krill):

(i) Survey design standards for regional and synoptic surveys (e.g. Figure 1)

(ii) Task 1: Methods for calibrating echosounders on fishing vessels

Task 2: Survey design for fishing fleets

Task 3: Develop the use of krill length frequency data in the estimation of target strength and krill weight for biomass estimates and additionally

(iii) Data collection – SISO, vessels and CEMP Specification for sample size and the use of krill length frequency data

(iv) Acoustic data storage and processing

(1) (A) Identify metadata

(B) Acoustic raw data storage requirements and processing

(4) Develop the use of krill length frequency data in the estimation of target strength and krill weight for biomass estimates, including seasonal and regional effects of developmental stage

(6) Develop statistical approaches to acoustic data emerging from new acoustic observation platforms

8.2 The Working Group encouraged Members to submit work investigating sampling biases in krill length frequency distribution and acoustic data arising from different sampling platforms.

8.3 The Working Group encouraged Members to submit work investigating alternative statistical estimators (other than the Jolly and Hampton 1990 method), particularly those that are relevant to data collected from other sampling platforms.

8.4 The Working Group recognised that further work is required to design surveys for other areas, particularly Subareas 48.2 and 48.3.

8.5 The Working Group noted that there appears to be a seasonal component to the vertical distribution of krill in the water column. The Working Group encouraged future work to investigate seasonal and geographic variability in the vertical distribution of krill and how this may impact biomass assessments.

8.6 The Working Group recommended that for future surveys, the percentage of a stratum covered by sea ice should be reported along with krill biomass estimates and considered this as future work for WG-ASAM-2025.

Other business

9.1 Dr Arata thanked the Working Group for the invitation and the constructive discussions.

9.2 The Working Group thanked Dr Arata for his active participation in the meeting, bringing the perspective of fishing fleet operations and contributing to developing the protocols for acoustic surveys from fishing vessels. The Working Group reiterated the benefit of being able to invite experts to the meeting.

Advice to the Scientific Committee

10.1 The Working Group's advice to the Scientific Committee is summarised below. These advice paragraphs should be considered along with the body of the report leading to the advice:

(i) echosounders be calibrated at least during or at the end of the acoustic survey period (paragraph 3.8) and fishing vessels with EK80 software use the Echosounder Calibration Protocol provided in Appendix D (paragraph 3.12).

(ii) consider how to implement the concept of the fishery working in concert to conduct acoustic surveys (paragraph 3.15)

(iii) proposed survey transects and sampling stations (Figure 1)

(iv) fishing vessels conducting acoustic surveys take samples using both RMT-8 nets and macroplankton nets for sampling depths between 0 and 200 m (or 10 m from seabed) (paragraph 3.46).

(v) fishing vessels conducting acoustic surveys use the Acoustic Survey Trawl Sampling Protocol provided in Appendix E (paragraph 3.54)

(vi) fishing vessels conducting acoustic surveys use the Acoustic Survey CTD Sampling Protocol provided in Appendix F (paragraph 3.63)

(vii) changes to strata boundaries affecting biomass estimates be submitted for consideration by WG-ASAM before krill biomass is recalculated (paragraph 4.14).

Adoption of report and close of meeting

11.1 The process to adopt the report took approximately 3 hours and concluded on Friday 24 May 2024 at 14:51. The report of the meeting was adopted.

11.2 At the close of the meeting, Dr Fielding thanked all the participants for their hard work both before and during the meeting, noting that the small group had contributed greatly to successful outcomes of the Working Group. She encouraged Members to consider how greater engagement could be fostered in future. She thanked Mr De Pooter for his support and work throughout the meeting, noting that he had successfully juggled many roles. She also thanked the Secretariat for their remote support during the meeting.

11.3 On behalf of the meeting participants, Dr Cox and Mr De Pooter thanked Dr Fielding for her excellent leadership and guidance throughout the meeting.

References

Demer, D.A. and J.S. Renfree. 2008. Variations in echosounder–transducer performance with water temperature. *ICES J. Mar Sci.*, 65(6): 1021–1035.

Demer et al. 2015. Calibration of acoustic instruments. *ICES Cooperative Research Report (CRR)*, 326, 136 pp., doi: 10.17895/ices.pub.5494

Jolly, G.M. and I. Hampton. 1990. A stratified random transect design for acoustic surveys of fish stocks. *Can. J. Fish. Aquat. Sci.*, 47(7): 1282-1291.

Table 1. Estimated number of days required to complete proposed transects and sampling in Subarea 48.1. Stations are placed every 20 or 40 n miles. Each sample or target fishing station is assumed to take 1 hour. Target fishing is assumed to happen once per day. Transit is between transect travel.

	Time (days)	
Distance between sampling stations	**20 n miles**	**40 n miles**
1) Transects only	26.5	26.5
2) Transects + stations	40.4	34.3
3) Transects + stations + transit	52.5	46.5
4) Transects + stations + transit + target fishing	54.7	48.4

Table 2 Summarising file creation sizes for several EK80 echosounders, collecting data from a different number of frequencies, to a different range and with different complexities of save format.

Data Platform	No. frequencies	Ping rate (ms)	Range (m)	Pulse type	File Creation Size (GB/day)	Source	Data save format	30 day survey file size estimate (TB)
EK80	6	2000	550	CW	3.6	Martin Cox	Small	0.1
EK80	2	2000	1200	CW	11,9	Cecilia Liszka	Medium	0.4
EK80	6	2000	1200	CW	350	Sophie Fielding	Large	10.5
EK80	6	2000	1200	CW	48	Sophie Fielding	Medium	1.4

Table 3 Table summarising the approximate area surveyed and qualitative assessment of data representation for proposed Candidate MUs by WG-ASAM-2024/11.

Candidate MU	Sufficient predator data for SOA (taken from WG-ASAM-2024/11)	Approximate area surveyed (%)	Current data representative of the whole Candidate MU area (Y = Yes, N = No)
Elephant Island	Y	100	Y
SSIW	Y	100	Y
Gerlache Strait	Y	100	Y
Bransfield Strait	Y	100	Y
Joinville	Y	100	Y
DP1	Y	35	N
DP2	N	46	N
PB1	Y	100	Y
PB2	N	28	N

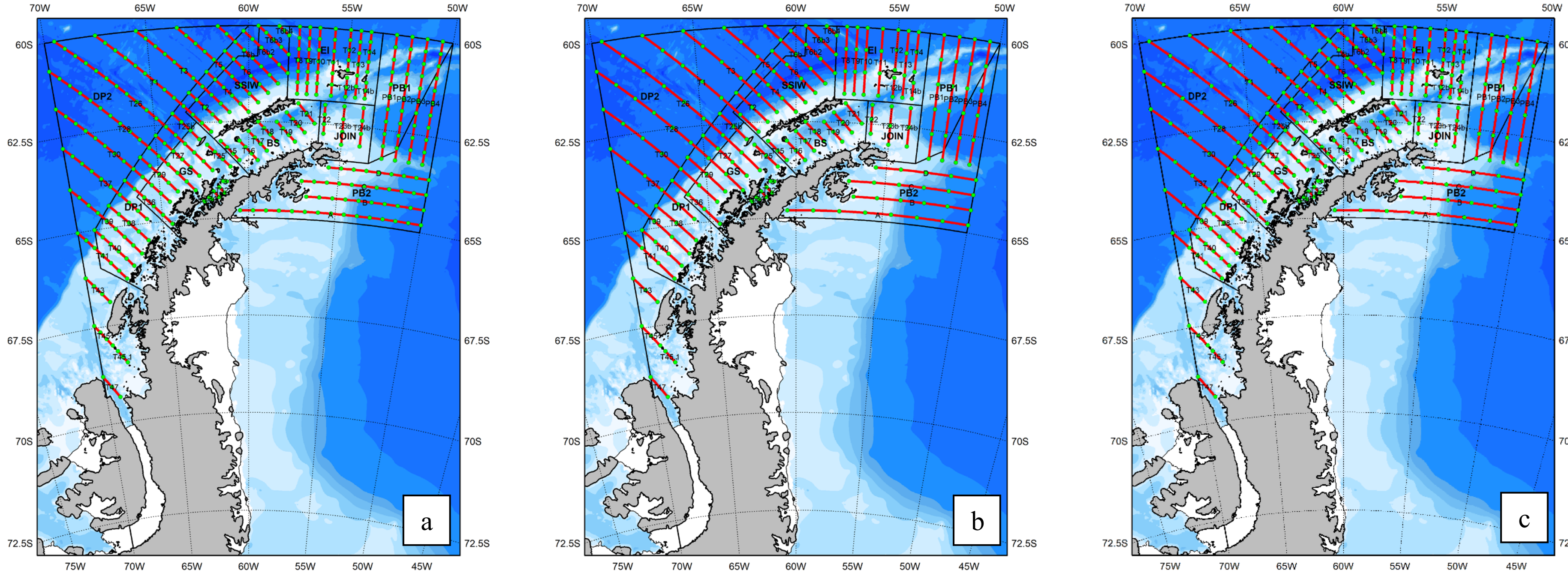
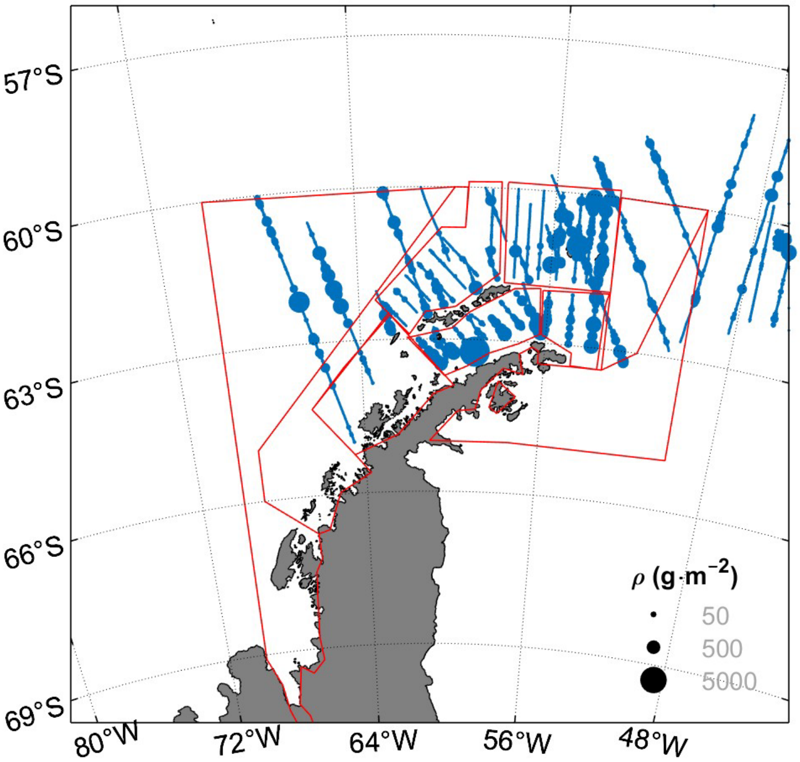
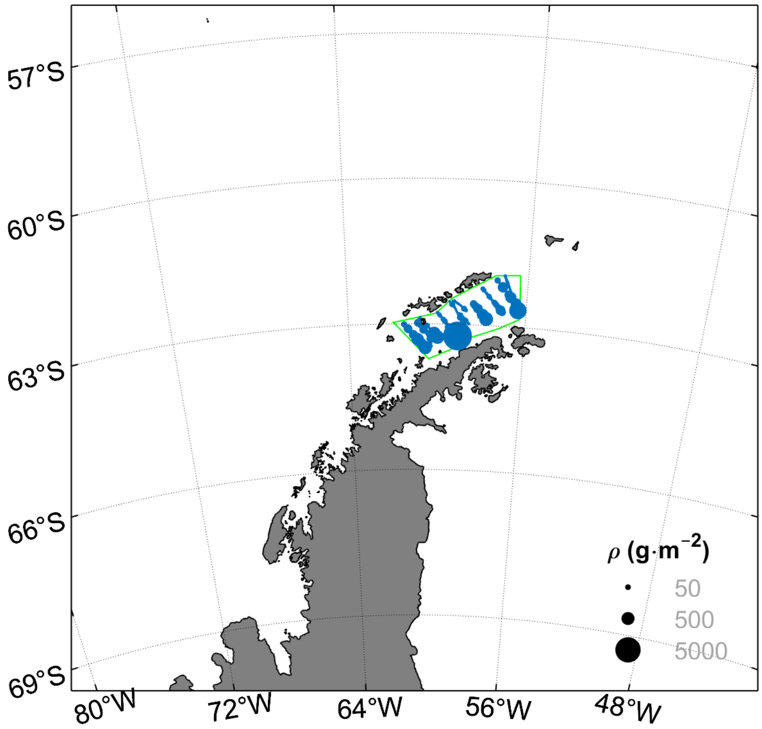


Figure 1 Proposed transects (red) and sampling stations (green) with a maximum station spacing of a) 20 n miles, b) 40 n miles, or c) 20 n miles within the spatial overlap analysis footprint (SOA; WG-ASAM-2024/11) and of 40 n miles outside of the SOA footprint. The transects are identical across all 3 maps. The proposed updated candidate management units (WG-ASAM-2024/11) are shown in black. Sources: GEBCO/CCAMLR/UK Polar Data Centre/BAS and Natural Earth. Projection: EPSG 6932 (rotated).


57°S
60°S
63°S
66°S
69°S
80°W
72°W
64°W
56°W
48°W
ρ (g·m⁻²)
50
500
5000

BS


57°S
60°S
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80°W
72°W
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56°W
48°W
ρ (g·m⁻²)
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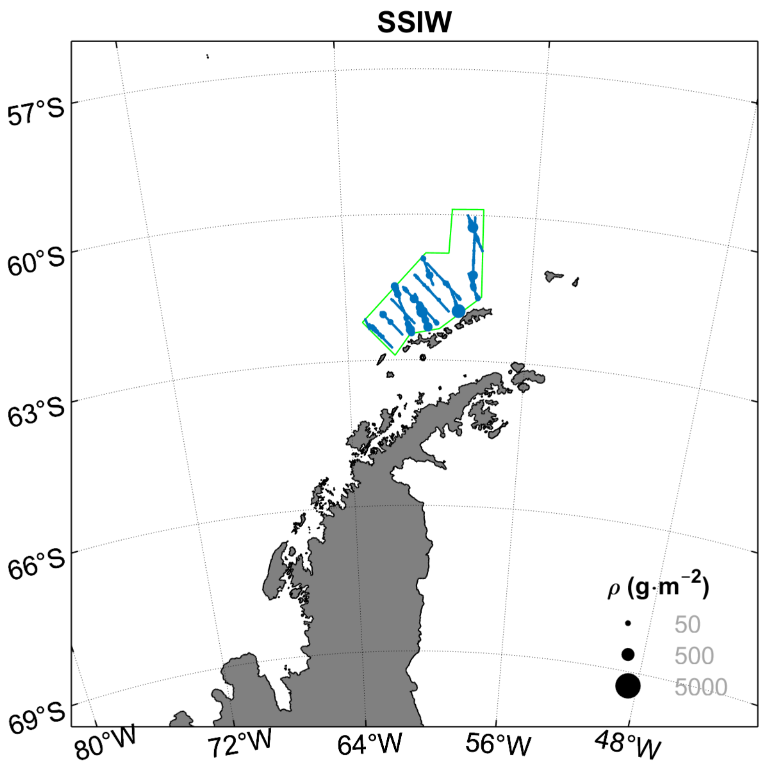
SSIW
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ρ (g·m⁻²)
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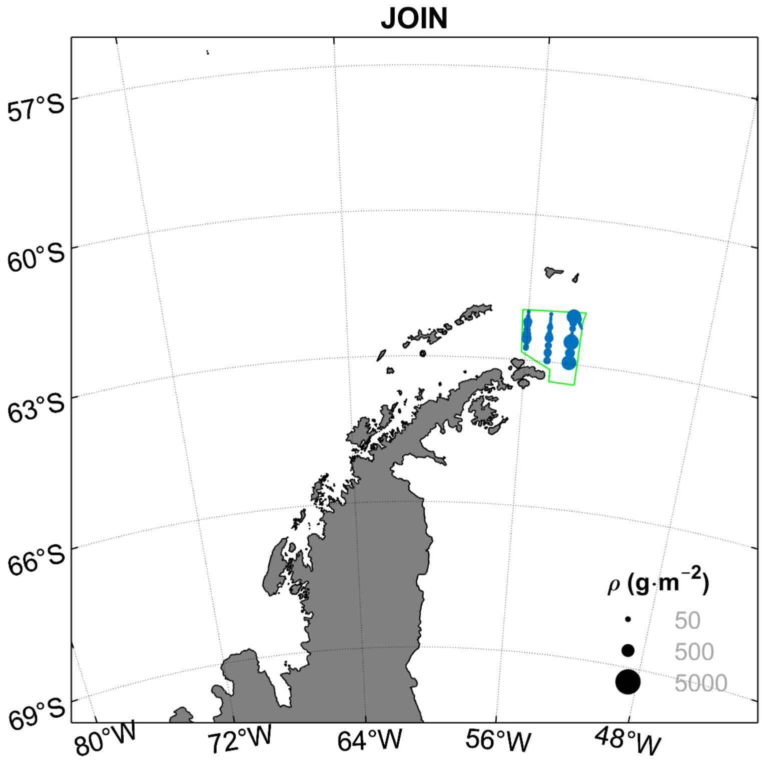
JOIN
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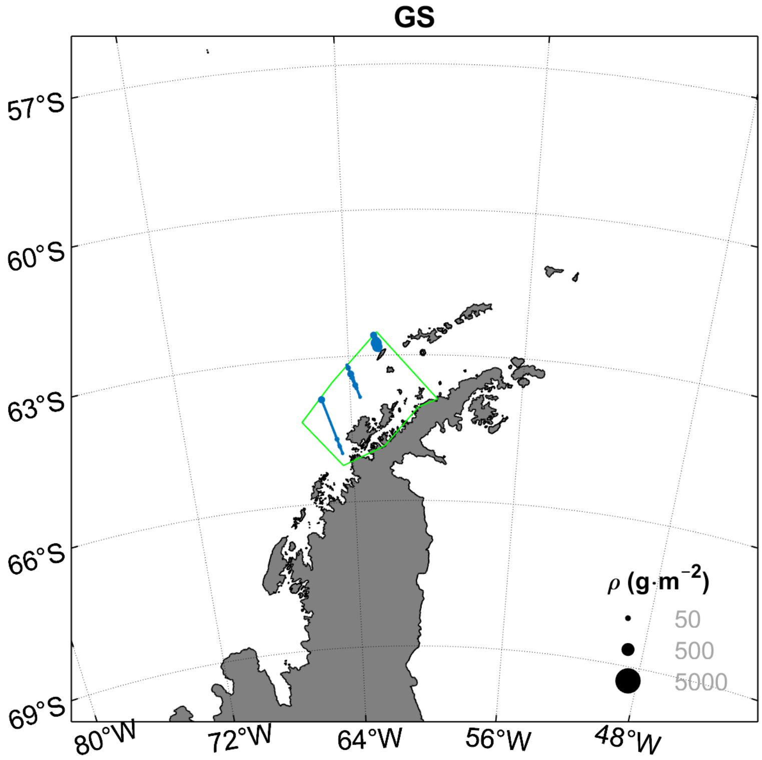
GS
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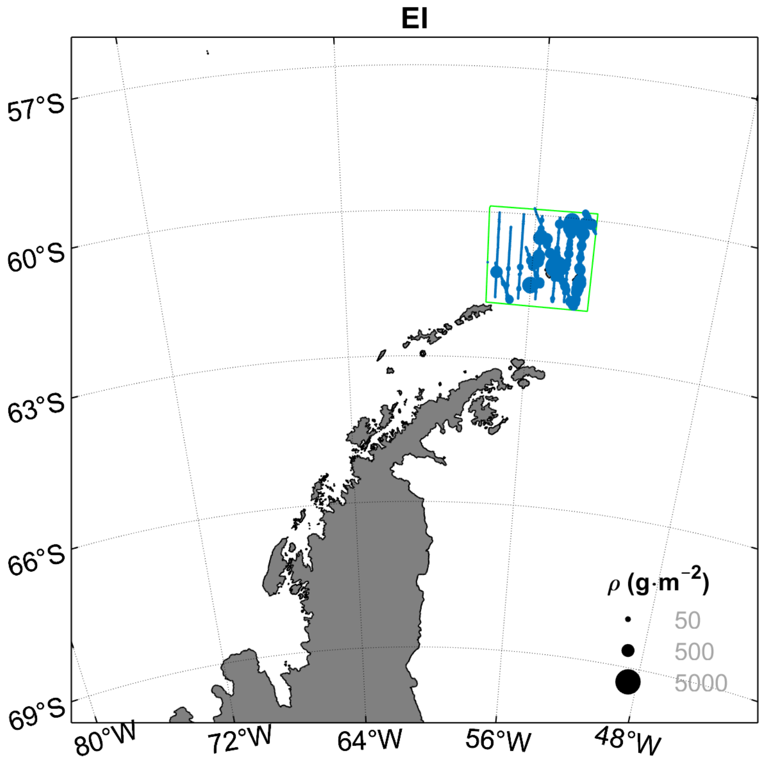
EI
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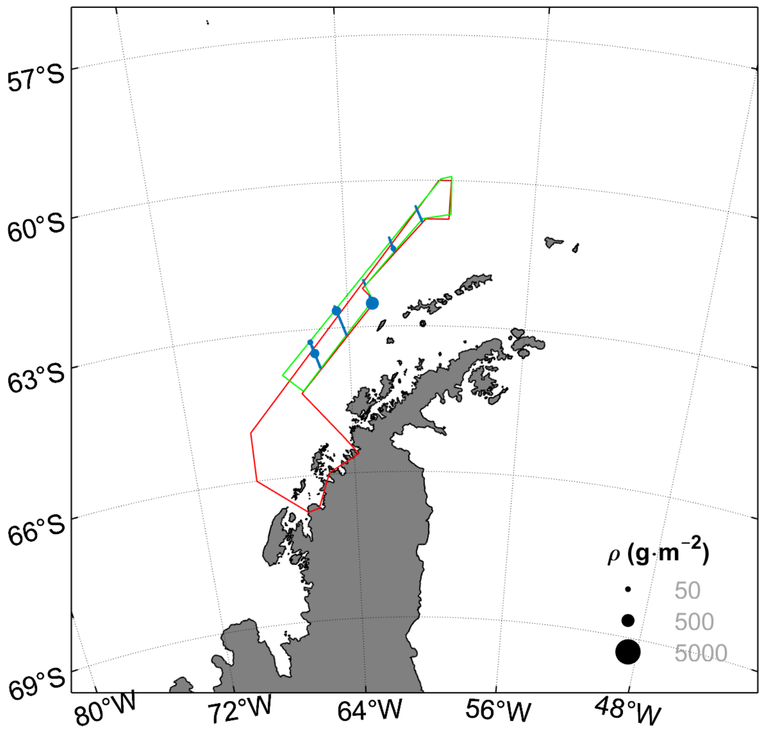
500
5000

DP1


57°S
60°S
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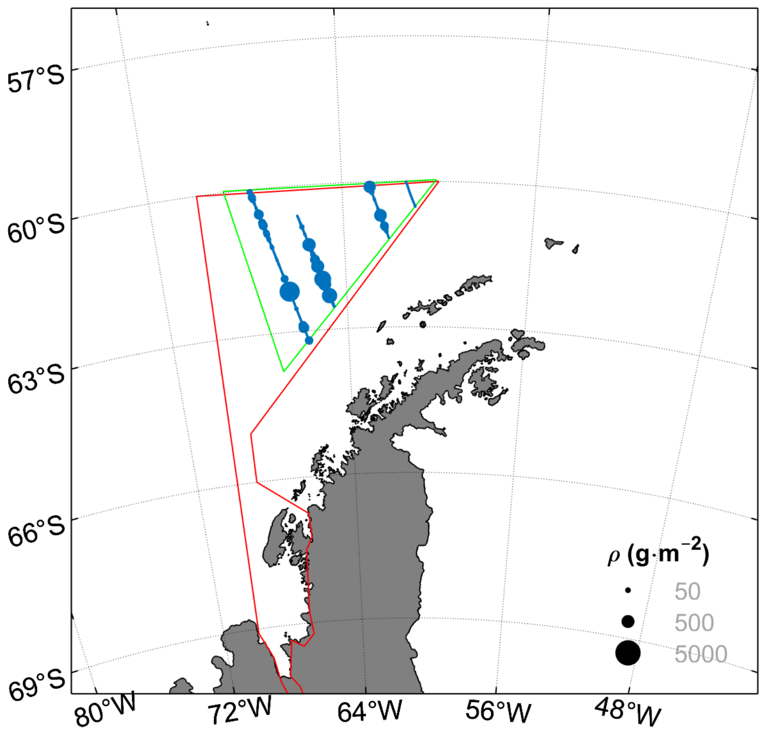
69°S
80°W
72°W
64°W
56°W
48°W
ρ (g·m−2)
50
500
5000

DP2


57°S
60°S
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66°S
69°S
80°W
72°W
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56°W
48°W
ρ (g·m−2)
50
500
5000

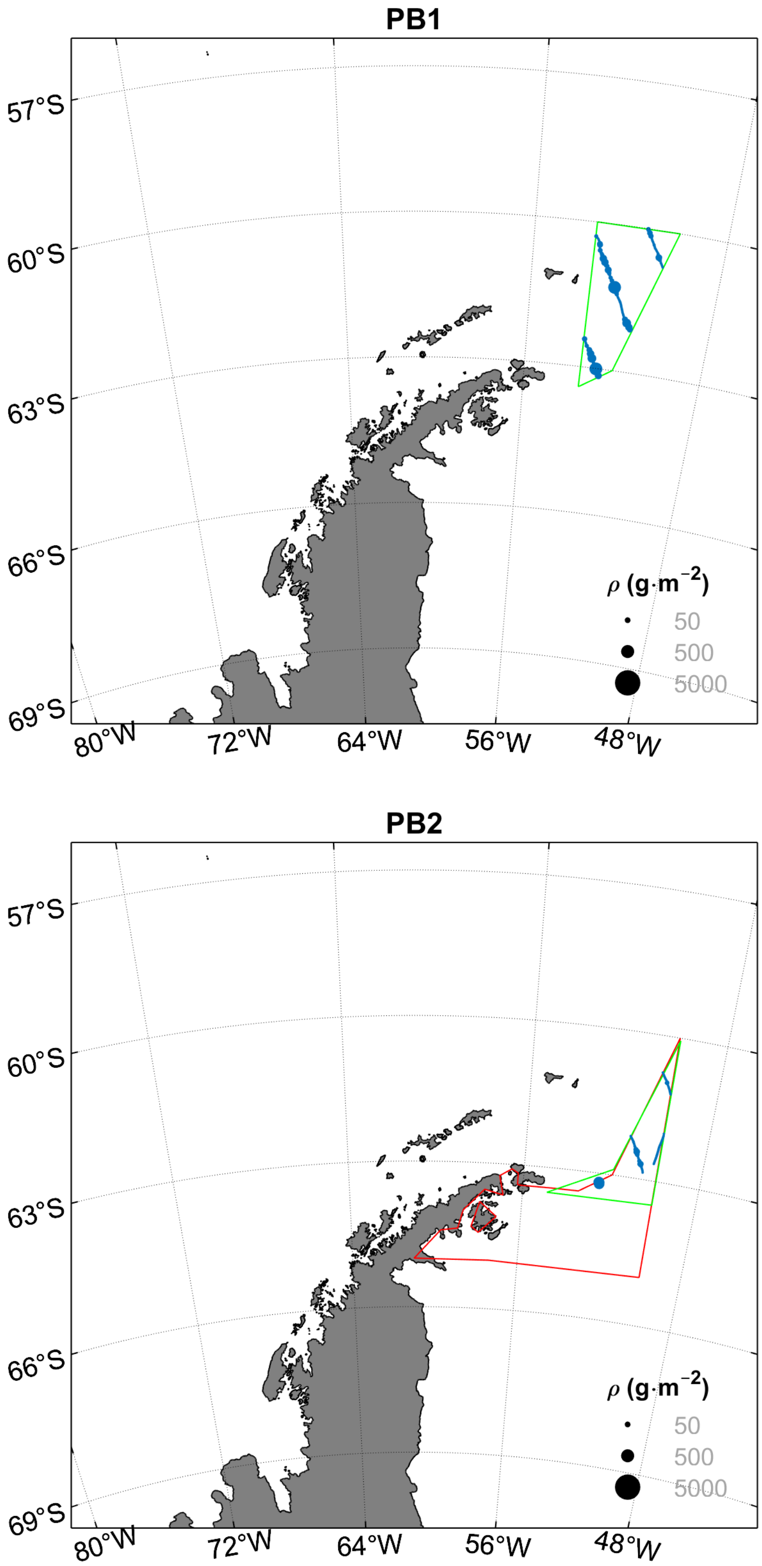


Figure 2 CCAMLR 2019 acoustic survey krill density estimates (circles) along transects for proposed MU areas (red outlines, shapefiles from WG-ASAM-2024-11) and bounding boxes around surveyed transects within any proposed MU area (green outlines). The approximate area surveyed in Table 3 is calculated from the ratio of bounding boxes around surveyed transects within any proposed MU area (green outlines) to the area of the proposed MU area (red outlines).

Appendix A

List of Participants

Working Group on Acoustic Survey
and Analysis Methods 2024 (WG-ASAM-2024)
(Cambridge, United Kingdom, 20 to 24 May 2024)

Co-convener	Dr Sophie Fielding British Antarctic Survey
Invited Expert	Dr Javier Arata Association of Responsible Krill harvesting companies (ARK)
Australia	Dr Martin Cox Australian Antarctic Division, Department of Climate Change, Energy, the Environment and Water
Japan	Dr Hiroto Murase Tokyo University of Marine Science and Technology
	Dr Tomohiko Matsuura Japan Fisheries Research and education agency
Korea, Republic of	Dr Sangdeok Chung National Institute of Fisheries Science (NIFS)
	Mr Sang Gyu Shin National Institute of Fisheries Science (NIFS)
Norway	Dr Guosong Zhang Institute of Marine Research
Ukraine	Mr Illia Slypko SSI "Institute of Fisheries, Marine Ecology and Oceanography" (IFMEO)
United Kingdom	Dr Cecilia Liszka British Antarctic Survey
	Dr Tracey Dornan British Antarctic Survey
	Dr Simeon Hill British Antarctic Survey

	Ms Natalie Nickells British Antarctic Survey
	Dr Ryan Saunders British Antarctic Survey
	Dr Vicky Warwick-Evans British Antarctic Survey
CCAMLR Secretariat	Daphnis De Pooter Science Data Officer

Appendix B

Agenda

Working Group on Acoustic Survey
and Analysis Methods 2024 (WG-ASAM-2024)
(Cambridge, United Kingdom, 20 to 24 May 2024)

1. Introduction

   1.1 Opening of the meeting
   1.2 Adoption of the Agenda

2. Review Terms of Reference and workplan

3. Standardised procedures for the collection of acoustic data for the implementation of the revised krill fishery management approach

   3.1 Methods for calibrating echosounders on fishing vessels
   3.2 Acoustic transect design and data collection
   3.3 Krill biological data collection
   3.4 Oceanographic data protocols
   3.5 Submission and storage of acoustic data

4. Standardised procedures for analysis and development of krill biomass estimates

   4.1 Standardised management units for krill biomass estimates.
   4.2 Standardised processing and reporting of acoustic data.
   4.3 Analysis of acoustic data collected along nominated transects.

5. Krill biomass estimates

   5.1 Area 48 biomass estimates
   5.2 Area 58 biomass estimates

6. Survey design using other platforms

7. Develop methods to estimate biomass of finfish using acoustic techniques

8. Future work

9. Other business

10. Advice to the Scientific Committee

11. Adoption of report and close of meeting

Appendix C

List of Documents

Working Group on Acoustic Survey
and Analysis Methods 2024 (WG-ASAM-2024)
(Cambridge, United Kingdom, 20 to 24 May 2024)

WG-ASAM-2024/01	2024 GIS projects update CCAMLR Secretariat
WG-ASAM-2024/02	Development of a new C1 form for Krill Fisheries, and its potential use for vessels when collecting acoustic transect data CCAMLR Secretariat
WG-ASAM-2024/03	Updates to the CCAMLR Acoustic Data Repository CCAMLR Secretariat
WG-ASAM-2024/04	A sustainable strategy for the long-term monitoring of krill populations Arata, J.A.
WG-ASAM-2024/05	Using different sources of krill length frequency to convert acoustic backscatter to estimates of krill biomass in Subarea 48.3 Dornan, T., C. Liszka and S. Fielding
WG-ASAM-2024/06	True biomass change, not sea ice mediated survey coverage, drive differences between krill biomass estimates from surveys in 2006 and 2021 in Division 58.4.2-East Cox, M.J., N. Kelly, D. Maschette, S. Kawaguchi and P. Ziegler
WG-ASAM-2024/07	Scale of variation in Antarctic krill abundance at the South Orkney Islands (Subarea 48.2): insights from multi-scale acoustic surveys during summer 2016 Saunders, R.A. and S. Fielding
WG-ASAM-2024/08	New fishery research proposal plan under CM 24-01, paragraph 3, the acoustic-trawl survey *Champsocephalus gunnari* in the statistical subarea 48.2 Delegation of Ukraine

WG-ASAM-2024/09	Krill for whales – Fine-scale acoustic krill surveys in Area 48.1 Dornan, T., N. Nickells, R. Reisinger and S. Fielding
WG-ASAM-2024/10	Development of a workplan for conducting Krill surveys in Subarea 48.1 Arata, J.A., B. Krafft, X. Zhao, Y. Ying, E. Deehr Johannessen and A. Lowther
WG-ASAM-2024/11	Candidate management units for the krill fishery in subarea 48.1 Warwick-Evans, V., M.A. Collins and S. Hill
WG-ASAM-2024/12	Automating length and maturity stage measurements of Antarctic Krill (*Euphausia superba*) from high resolution image pairs Gudelis, M., M. Mackiewicz, D. Greenwood, J. Bremner and S. Fielding
WG-ASAM-2024/13	Acoustic determination of Antarctic krill biomass at South Georgia (Subarea 48.3) during winter: results from two winter seasons Liszka, C.M., T. Dornan, S. Fielding and M.A. Collins
WG-ASAM-2024/14	Acoustic blind zone when using hull mounted transducers during traditional krill biomass surveys Zhang, G. and B.A. Krafft
WG-ASAM-2024/15	Preliminary results from the acoustic surveys of Antarctic krill conducted by the Chinese fishing vessels in Subarea 48.1 during austral winter 2023 and summer 2024 Wang, X., J. Zhang, G. Fan, J. Wang, J. Zhu and X. Zhao

Other Documents

WG-ASAM-2024/P01	Krill biomass estimation: Sampling and measurement variability Bairstow, F., S. Gastauer, S. Wotherspoon, C.T.A. Brown, S. Kawaguchi, T. Edwards and M.J. Cox *Front. Mar. Sci.*, 9 (2022), doi: https://doi.org/10.3389/fmars.2022.903035

Appendix D

Echosounder Calibration Protocol

1) Background

Echosounders should ideally be calibrated prior to a survey but at least during or at the end of the survey period.

The calibration is undertaken to ensure the instrument is calibrated to the ambient (temperature / salinity) conditions of the survey and that the instrument settings have not drifted. Scientists need to use the EK80 software to calibrate, which requires an EK80 license. Once calibration is complete the resulting .xml file should be submitted alongside calibration metadata in the Acoustic Survey Metadata Form.

2) Calibration overview

(i) Stabilize the transducer, e.g. by positioning the vessel in a sheltered area using a preferred calibration site in a water depth of approximately 50-70m (see Table 1. Suggested calibration locations). Ideally calibrate during the day to avoid vertical migration of animals into the sphere location.

(ii) Measure transducer impedance (BITE test) before and after the survey to check that all sectors of the transducer are functional.

(iii) Choose an appropriate sphere for the frequency you are calibrating (Table 2).

(iv) Suspend the sphere in the transducer beam using outriggers/rods/winches and monofilament. Range from transducer face 15-20m.

(v) Measure the Temperature (T), Salinity (S) and Sound Speed (C), between the transducer and sphere. To estimate mean T, S, and C the CTD should be lowered at a rate able to collect measurements at 1m intervals.

(vi) Position the sphere in the centre of the beam, then move it throughout the beam, recording pings in the calibration wizard.

(vii) Analyse the calibration data and results.

(viii) Retrieve the sphere and stow the gear.

Table 1. Suggested calibration locations

Subarea	Calibration locations
48.1	Admiralty Bay, King George Island
48.2	Scotia Bay, Laurie Island
48.3	Stromness Bay / Rosita Harbour, South Georgia

3) Equipment required

- Monofilament line of 0.38mm (Renfree et al., 2020)
- 2 or 3 heavy, fast fishing rods or calibration winches to suspend sphere (Demer et al., 2015).
- Calibration sphere (see next)
- Solution of 25% dish washing liquid
- CTD

4) Prior to calibration

- Do a CTD to measure T, S and C.
- Calculate average T and S between 4 and 20m (or the maximum depth the sphere is likely to be) for use in calibration.
- Identify positions of transducers in relation to centre line of vessel to help guide sphere.
- Record the transducer depth.

5) Calibration spheres

- Select sphere material and diameter for your frequency and local environmental conditions. Table 1 indicates example spheres based on pulse duration of 1.024 ms, temperature = 0°C, salinity = 33.3 PSU, pressure = 25 dbar.

Check your sphere size and material for local environmental conditions at https://www.fisheries.noaa.gov/data-tools/standard-sphere-target-strength-calculator.

Table 2. Effective sphere size and materials for calibrating different frequencies of transducer, based on ambient temperature = 0°C, salinity = 33.3 PSU, pressure = 25 dbar. Green ✓ - ideal, Yellow * - use with caution as nulls within ±10 kHz, Red x – Not suitable.

Material	WC	WC	WC	WC	WC	Cu	Cu
Sphere diameter	20.0	21.0	22.0	38.1	57.2	20.0	23
38 kHz	✓	✓	✓	✓	✓	✓	✓
70 kHz	✓	✓	✓	✓	✓	✓	✓
120 kHz	✓	✓	✓	✓	*	✓	*
200 kHz	✓	✓	x	*	*	*	x

6) Procedure for getting the sphere beneath transducers

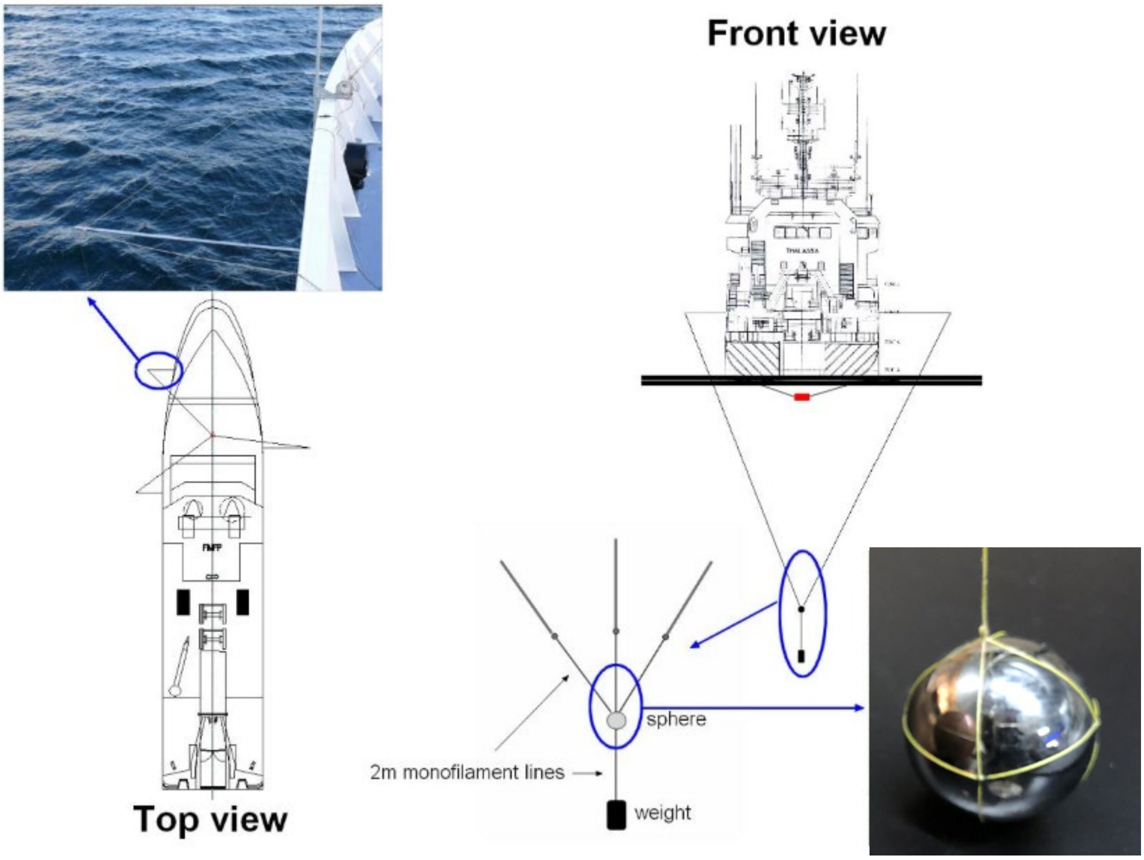


Figure 1. The three-line method for suspending a sphere below a hull-mounted transducer. The monofilament lines should be attached to the mesh bag at different locations to minimize phase noise at high frequencies (i.e. >100 kHz). Note, if the weight is too heavy, the net bag may break and the sphere could be lost. The weight should be suspended 5m below the sphere. Diagrams reproduced from Demer et al. (2015).

Steps for suspending sphere:

1. Calibration sphere should already be fitted with a monofilament mesh with an attaching loop.

2. Set up calibration winches to manoeuvre sphere under transducers. Ensure each monofilament line has a loop tied for securing the sphere.

3. Pass a small rope under the keel by either weighting the rope using shackles and walking the rope under the vessel or using a small boat. Ensure that rope will avoid protrusions on hull of vessel that may snag the rope or calibration lines.

4. Attach rope to the end of the monofilament line, fed through rod or winch. Do this on the side that only has a single rod/winch.

5. Carefully draw the monofilament under the keel to the opposite side of the vessel.

6. Place end monofilament loops from all 3 rods over hand, pass loop on sphere through 3 end loops and pass sphere through its own loop to secure all together.

7. Although you can calibrate using the sphere on the line on its own, you may find it easier to put a weight below. A shackle attached to a ~5 m length of monofilament to the loops in the same way as the sphere. This shackle will act as a weight for the sphere and lines but is far enough below the sphere to not interfere with calibration. Ensure that any knots securing the shackle are away from the sphere. Be sure not to overload the lines or they may snap and the sphere may be lost.

8. Dip sphere plus any monofilament knots near the sphere in 25-50% liquid soap to water ratio to break surface tension on deployment.

9. Pay out monofilament on winches to align the sphere under the transducer.

10. Keep someone monitoring the EK80 screen looking to see whether the target comes on screen (on 'Active' EK80 panel view on Sv (20 log) to more easily locate the sphere).

11. Adjust the reel lengths / locations slightly to get the sphere in the main target area on the EK80 calibration screen (see below). Often you will see either weight or sphere in a side lobe, but just not the main target area. Try paying in and out on each line a bit to see if it gets closer (i.e. intensity gets stronger) – small amounts of movement.

12. Be patient. Once you have located the sphere, it is worth marking the monofilament lines at the rod/winches so it is easier to pay out the correct amount of line and locate the sphere next time.

7) Setting up the EK80 software for calibration

1. Turn on the transceivers.

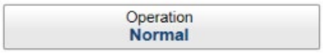
2. Turn on the EK80 display and processor unit.

3. Open EK80 software.

   a. See the Simrad EK80 manual for full details of calibrating and running the EK80.

4. Turn pinging on for all frequencies that you will be using during the survey and set to an interval of 1000ms or 500ms.

On operation tab 

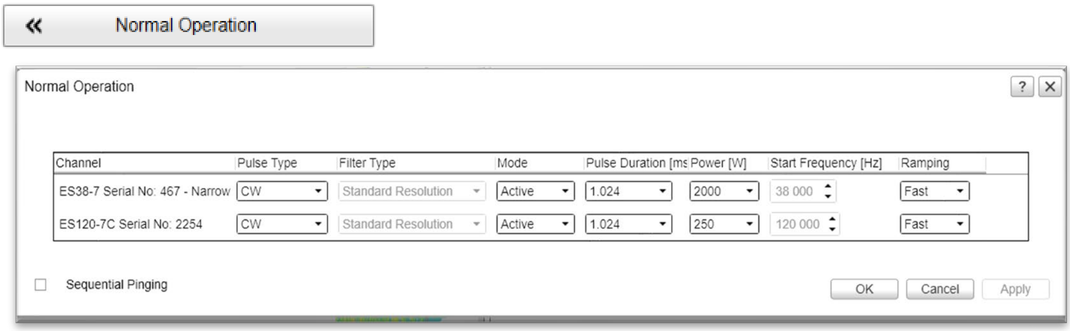


Ping function	On	
Ping Mode	Interval	
Ping Interval (ms)	1000	i.e. once per second

1. Check the parameters of the transducer ping cycles. It is essential to calibrate at the same power and pulse length settings that will be used during data collection. Following Krafft et al. 2021:

Parameter/Frequency (kHz)	38	120
Transmit power (W)	2000	250
Transmit pulse duration (ms)	1.024	1.024

On operation tab

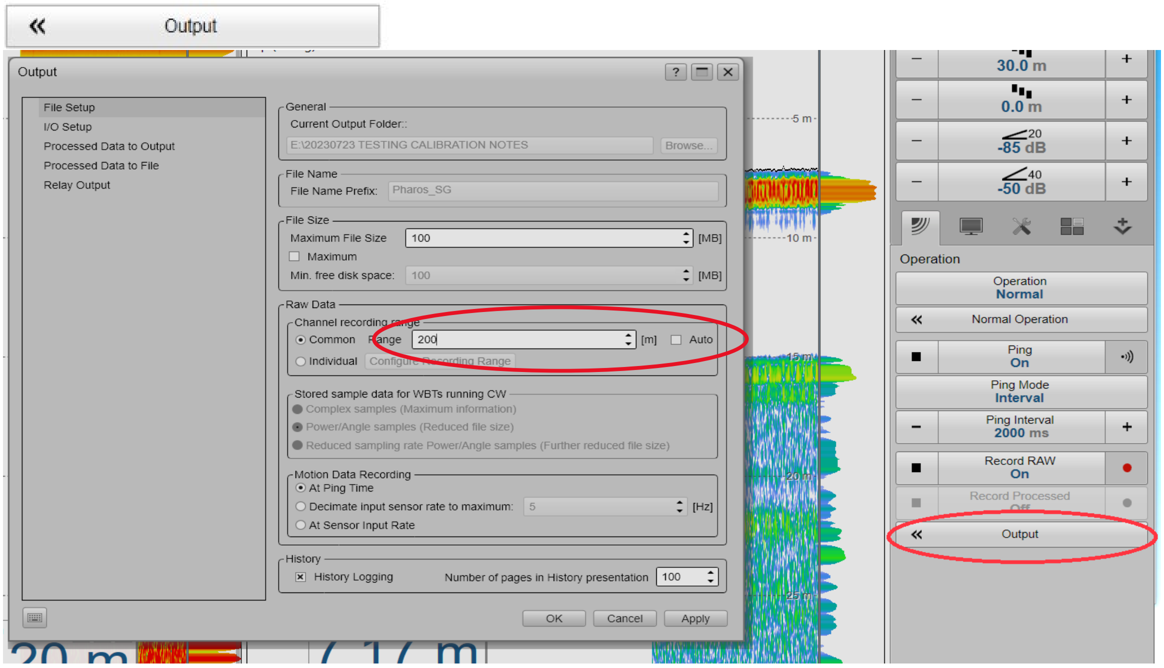


Pulse type: **CW** Mode: **Active** Ramping: **Fast**

2. Set channel recording to Common with a range of 200m (in 50-70m water depth) and make sure Auto is unchecked.

3. Ensure that Individual configuration Auto boxes are also unchecked, this is to prevent the echosounders waiting for a ping to return in empty deep water even if individual is unchecked

On operation tab

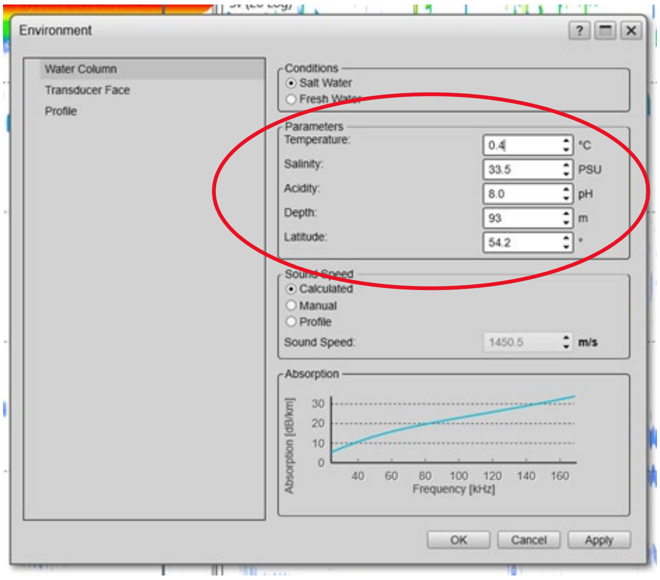


After calibration you must change channel recording Range back to 1100m and ping interval to 2000 ms for data collection

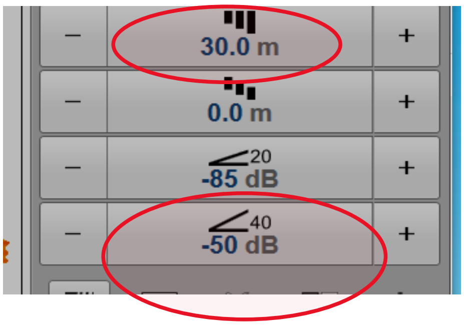
4. Enter the environmental data from the CTD deployment

On setup tab

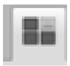
- Check: Salt water
- Enter the average Temperature and Salinity values to one decimal point, these values are taken from an average of the CTD data between transducer face and depth of sphere
- Acidity: 8.0 pH
- Latitude: this is the vessel's geographical latitude (°)
- Depth: the current depth under the keel (m)

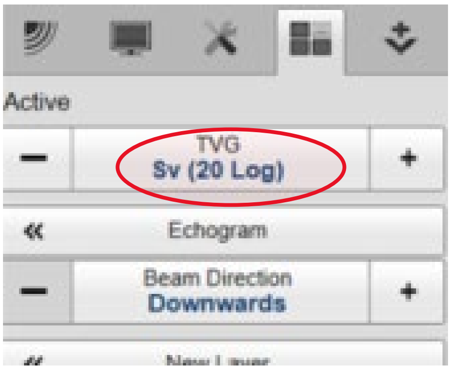


1. Set the range on the main page to be 30 m and ensure the threshold for the 20 angle is -85dB and 40 angle is -50dB.

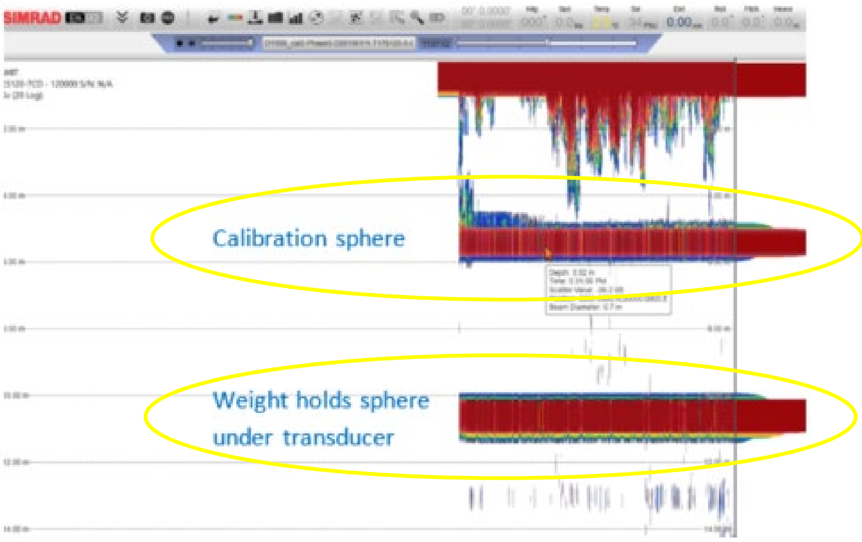


2. Set to Sv (20 log) and check Apply to All box to more easily locate the sphere. This gives a more detailed view.

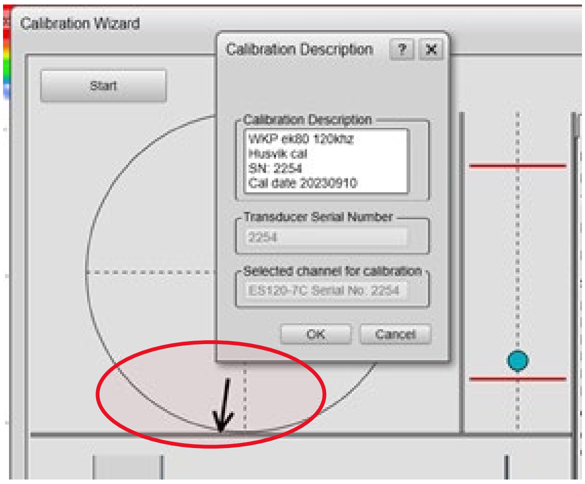
On Active tab 



3. Looking in the window for the transducer you are calibrating, adjust monofilament line (sphere) by hauling in, paying out, in small increments until sphere is underneath the transducer.
The sphere should be 15-20 m from the transducer face.



If you are struggling to find the sphere, it could be worth starting the calibration wizard window (instructions in the following pages) as there is an arrow pointing in the circle showing which way the sphere is from the echosounder beam.

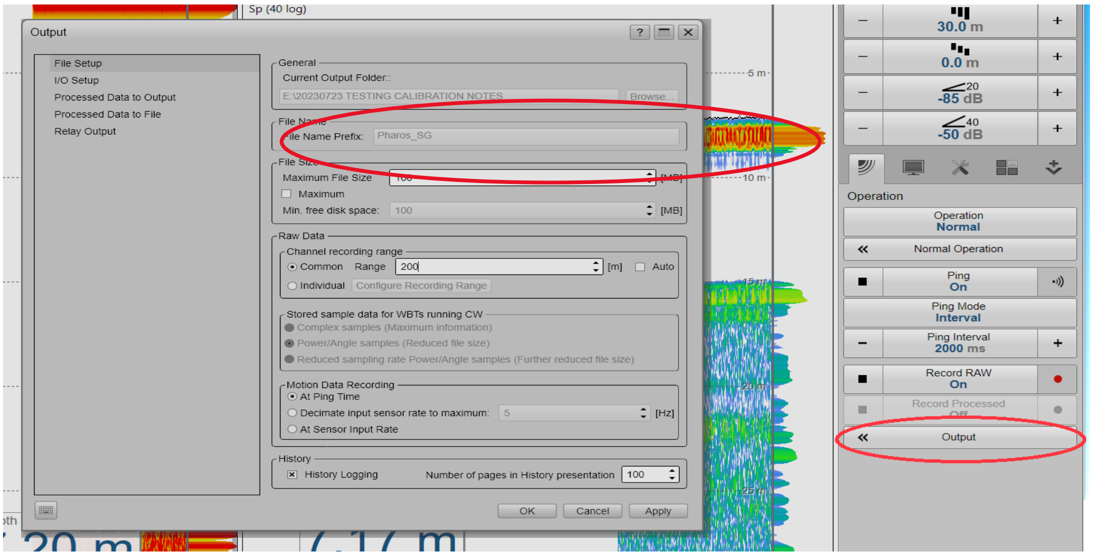


4. Turn recording on and set output folder

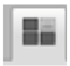
On operation tab 

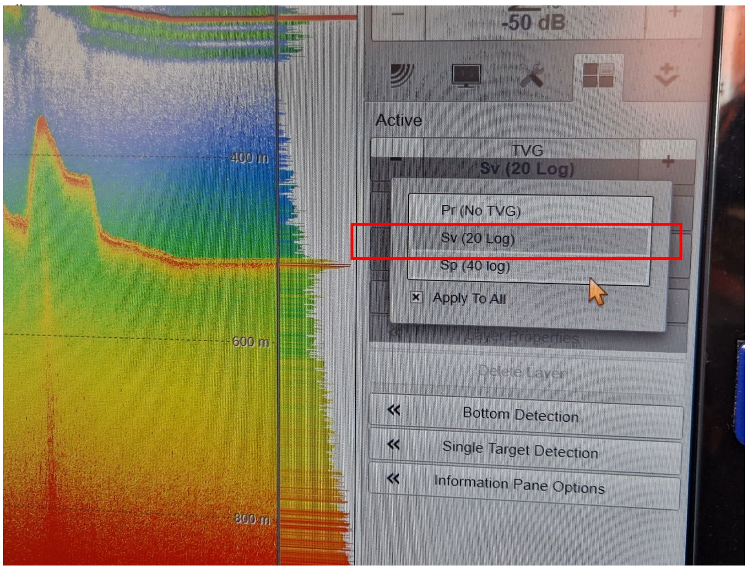
Record RAW ON

Set current output folder – Browse – New Folder – YYYYMMDD_Calibration



1. For the calibration switch to Sp (40 log) and check Apply to All box. This is less sensitive to noise so helps to identify only single targets and possible encroaching seals etc.

On Active tab 



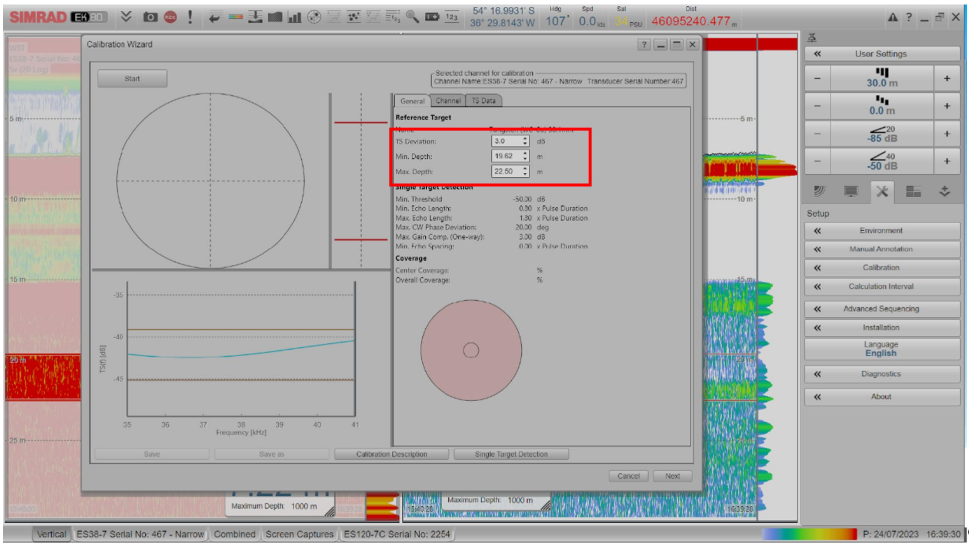
8. Calibration settings

On setup tab 

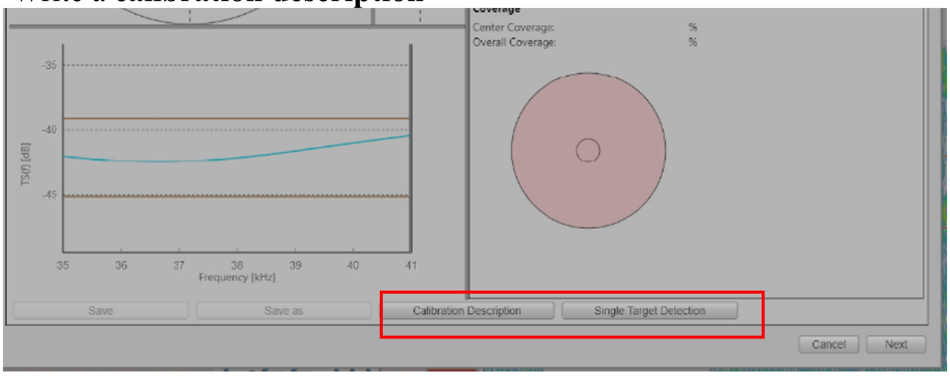
- New calibration from raw data (Real time or Replay) > Next
- ***Channel*** select which Transducer you are calibrating (either 120kHz or 38Khz)> Next
- Select the ***Sphere*** type and size (eg Tungsten 38.1mm) > Next

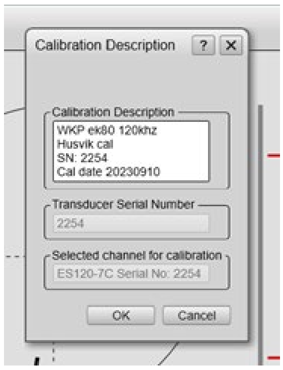
In the calibration wizard, move the **red 'depth' lines** to either side of the calibration sphere (+/- 2.5m). This can be done by either clicking and dragging them on echogram view or by adjusting Min. Depth and Max. Depth values on calibration wizard. The calibration sphere will appear between min and max depth lines with other data greyed out.

- Set the **TS deviation** to 3dB. This will reject any 'hits' that are far from the theoretical TS of the sphere and so may take longer to calibrate but should result in only good data being accepted as the sphere.



Write a **calibration description**

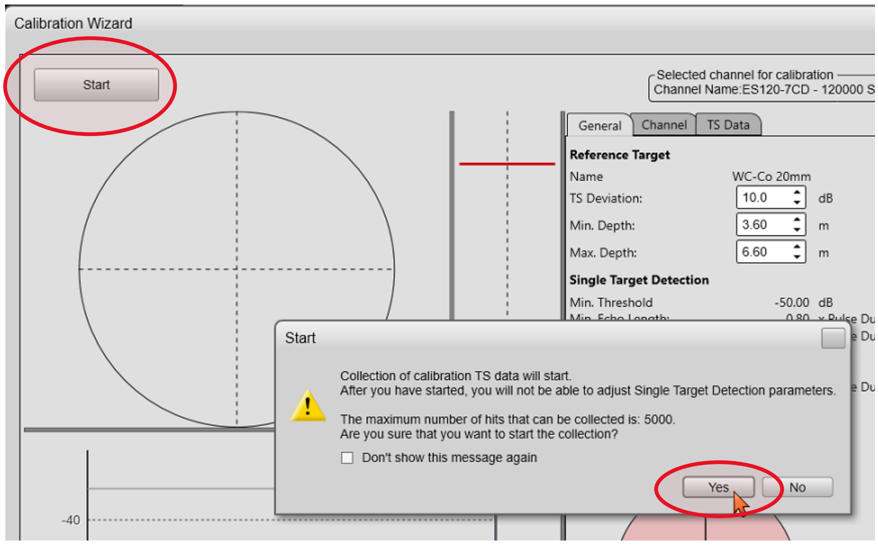




Vessel IMO:
Calibration location: Lat Lon (Decimal degrees)
Calibration Date: YYYMMDD

Leave the **single target detection** parameters are as default.

Press **Start** > **Yes** to start calibration

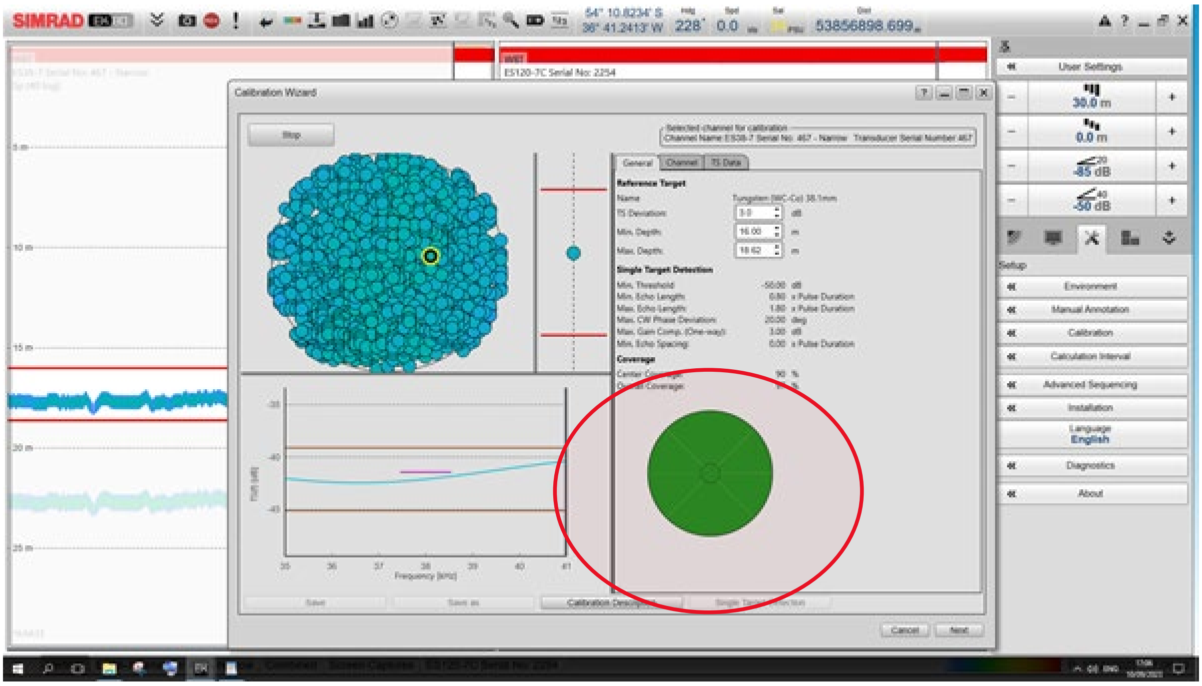


9) Calibration Procedure

1 Adjust line (sphere) as needs be to get sufficient coverage in all quadrants. Hits will appear as dots (colour varies slightly due to the dB of the target) in the target area. The sphere should be moved gradually, remember that currents and vessel movements will affect the sphere position.

2. If a seal or fish get in the way you can STOP the calibration and START again when the sphere is in the clear. The sphere needs to be the only thing in the calibration region between the lines.

3. When **all quadrants and centre circle are green** (or coverage is at **80%** in centre and overall) the calibration can be stopped. However, it is worth collecting more hits as if some need to be suspended later then there should still be enough for a good calibration in post processing. Note that the calibration will stop once a threshold of 5000 pings has been reached.

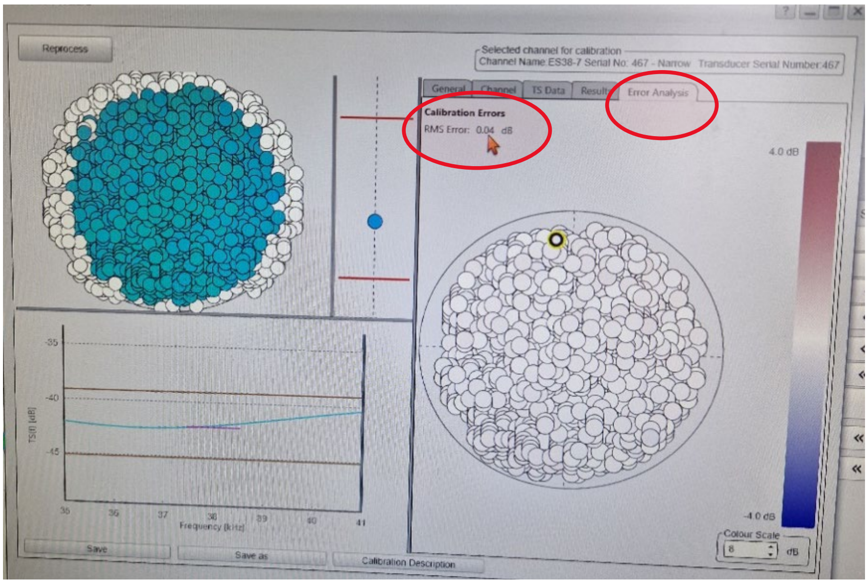


In calibration window press **STOP** > **Next** > **Yes** (save and proceed to next step).

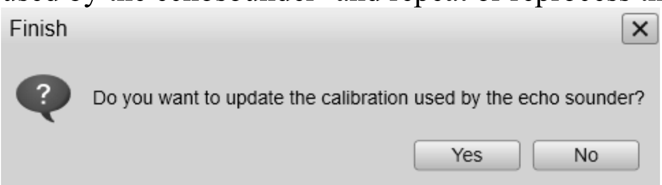
Save As > **Save as .xml** files in an appropriate place. This will be submitted to CCAMLR with survey data

4. Check the *Error Analysis* tab. An **RMS error < 0.2 is ideal**. When the RMS value is in between 0.2 and 0.4 dB, this indicates conditions is not perfect but still acceptable. When the RMS value is higher than 0.4 dB the calibration is poor, and should preferably be rejected and not used for updating of the transducer parameters (Kongsberg Maritime AS, 2012).

5. Acceptable beam widths are ±10% or your transducers nominal beamwidth e.g. **6.3°-7.7°** for a 7° beam angle.



Finish >
If results are poor or you get a warning, click NO to 'Do you want to update the calibration used by the echosounder' and repeat or reprocess the calibration.



The software should alert you if the calibration is poor.

If the results are **good** click **YES** to 'Do you want to update the calibration used by the echosounder'.

1. **If YES > BE PATIENT**

   Give the system time to upload and apply the new calibration. The calibration wizard will close.

   Once uploaded the echosounder will switch off. Go back to operation page and turn back to 'Normal'.

2. Check that all settings are correct and have not reverted to default values.

3. Repeat entire calibration process on the other transducer.

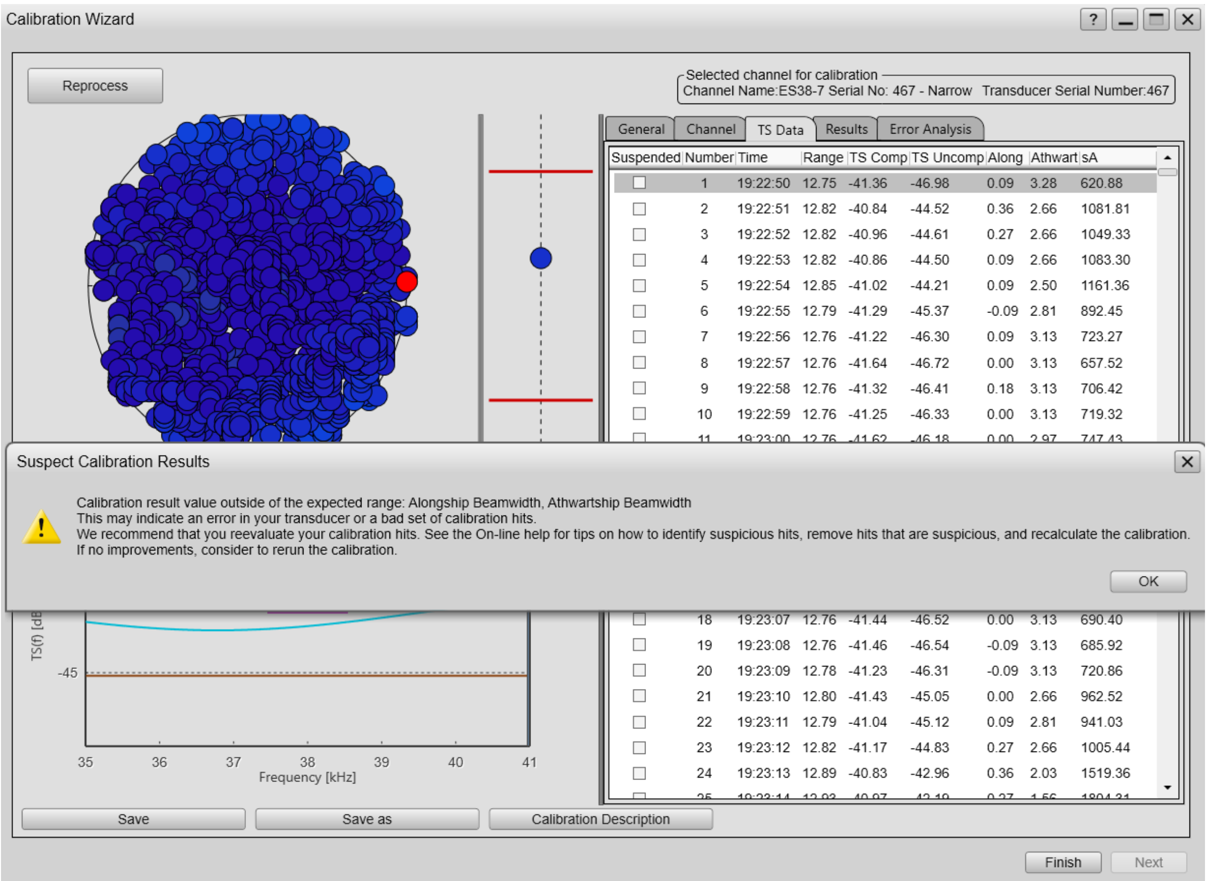
<u>ONCE BOTH CALIBRATIONS ARE COMPLETE CHANGE SETTINGS BACK TO DATA COLLECTION SETTINGS</u>

Output > Channel Recording Range (m) > Common 1100m

Ping Interval > 2000ms

Active Screens to Sv (20log) > check Apply to All

10) Reprocessing a calibrations



If you receive a suspect calibration warning it may be possible to reprocess using the collected .raw calibration files but suspending bad data pings.

1. To suspend hits

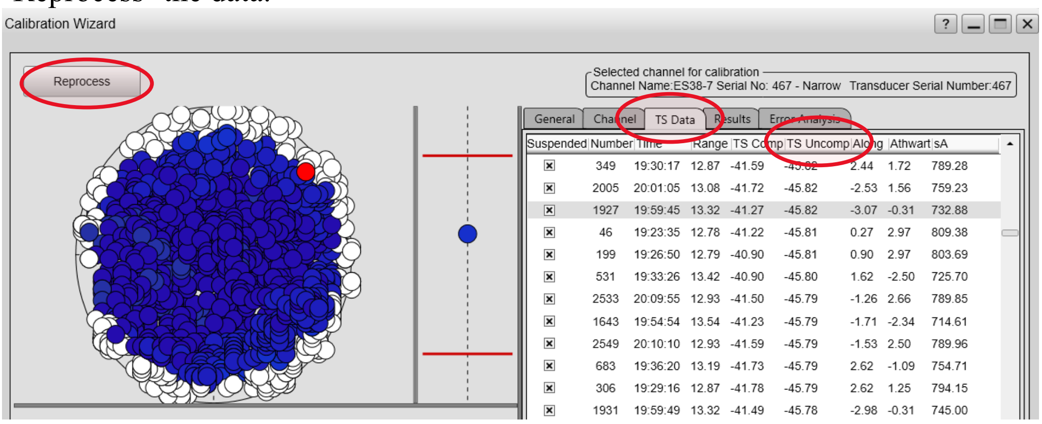
    - On the *TS Data tab* > order the *TS Uncomp* values by clicking *TS Uncomp* header.

2. Suspend hits (by clicking and putting a cross in the Suspended box) with a TS furthest from the expected value of the sphere. Normally it is the lowest TS values that need to be suspended.

    - Suspended hits will appear white in the display.

    - You can suspend lots of hits at once by click a value, holding shift and clicking on the last hit you want to suspend. Then click any highlighted box and all will check with a cross.

3. 'Reprocess' the data.

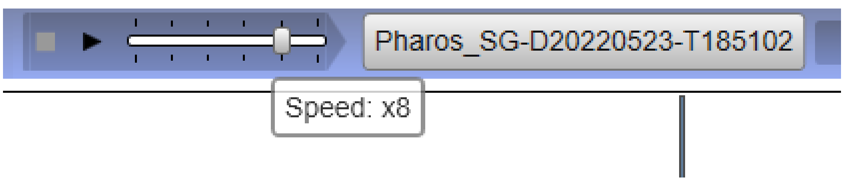


4. This process can be done iteratively, by gradually suspending *TS Uncomp* values and reprocessing until an acceptable calibration is achieved.

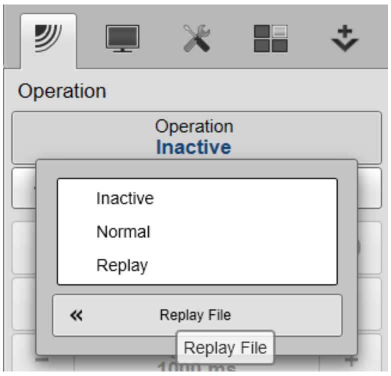
5. Once the reprocessed results are within bounds, you can finish and accept.

Reprocessing calibration RAW data

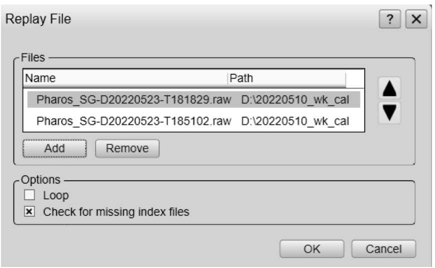
If you receive an error in your calibration it may be possible to reprocess using the collected .raw calibration files but suspending bad data pings. These can be done on time stamps e.g., if an animal gets in the way of the sphere (check by replaying and identifying suspect regions in the file) and/or by suspending pings based on unusually high or low uncompensated TS values. Speed of replay can be controlled using the slider next to the play button.



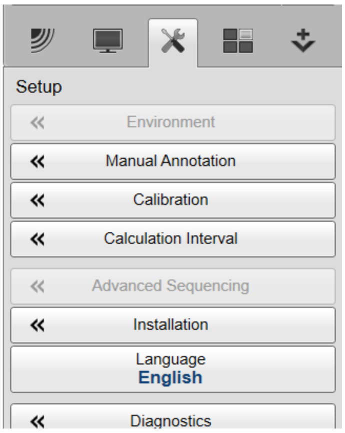
Operation tab > **Operation** > **Replay File**



Add > Browse to .raw files from calibration **Open** > **OK**



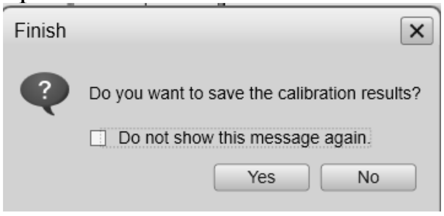
Setup tab > **Calibration** > **New calibration** from raw or replay > **Next** > Select channel (e.g. ES38-7) > **Next** > Select Sphere

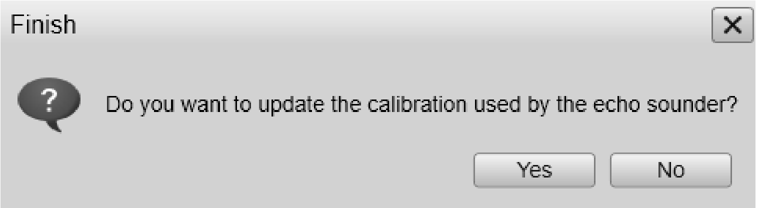


Set TS deviation to 3 dB > START calibration and press Play in main EK80 window.

Check the Results and error analysis to check this is in bounds or identify any issues which have resulted in warnings.

Finish > **Yes** to Save the file > **Yes** to Update the calibration used by the echosounder and upload the file to the echosounder.





If in doubt, **DO NOT** update the calibration but seek assistance from Simrad (they will need a copy of the .raw and .xml files).

km.support.science@km.kongsberg.com

References

Demer et al. 2015. Calibration of acoustic instruments. *ICES Cooperative Research Report*. 326, 136 pp., doi: https://doi.org/10.17895/ices.pub.5494.

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Krafft, B.A., G.J. Macaulay, G. Skaret, T. Knutsen, O.A. Bergstad, A. Lowther, G. Huse, S. Fielding, P. Trathan, E. Murphy, et al. 2021 Standing stock of Antarctic krill (*Euphausia superba* Dana, 1850) (Euphausiacea) in the Southwest Atlantic sector of the Southern Ocean, 2018–19. *J. Crust. Biol.*, 41(3), doi: https://doi.org/10.1093/jcbiol/ruab046.

Renfree J.A., L.N. Andersen, G. Macaulay, T.S. Sessions and D.A. Demer. 2020. Effects of sphere suspension on echosounder calibrations. *ICES J. Mar. Sci.*, 77(7-8): 2945–2953, doi: https://doi.org/10.1093/icesjms/fsaa171.

Appendix E

Acoustic Survey Trawl Sampling Protocol

Objectives of biological data collection

There are two primary objectives for the net sampling programme:

- To validate and identify acoustic targets, confirming which targets can be considered as krill and obtaining krill length frequency data for Target Strength estimation;
- To describe krill demography and large-scale distribution patterns of size groups and maturity stages as well as regional recruitment indices.

Gear selection

Tow samples should be conducted with trawl nets with a minimum mouth opening of 8 m2 and a mesh size ≤4 mm knot-to-knot, or ≤7 mm (stretched) diamond-shaped, from mouth to rear. The most appropriate nets for collecting krill samples are considered to be either the macroplankton trawl, with a mouth opening of 36 m2 and 7 mm stretched diamond-shaped meshes from mouth to rear (Krafft et al. 2018), or the RTM8 (Rectangular Midwater Trawl; Baker et al. 1973), with a mouth opening of 8 m2 and ≤4 mm mesh size. Nets should be equipped with a TDR and flowmeter.

Standard Gear – the Macroplankton trawl

The Macroplankton trawl (Melle et al, 2006; Wenneck et al., 2008; Krafft et al., 2010; Heino et al., 2011) has from 2010 been used on a regular basis to obtain quantitative samples of macro-zooplankton, particularly krill, during the Norwegian South-Orkney surveys conducted with the fishing vessels FV Saga Sea and FV Juvel (Skaret et al., 2023), and more recently the CV Antarctic Provider. This trawl will also give improved quantitative estimates of various types of jellyfish (schyphozoan medusae, siphonophores and salps). Trawl tows should also be used to ground-truth acoustic scattering layers for the type of organisms they contain, particularly when the scattering structures are potentially of zooplankton origin. During shooting/ deployment, it is recommended to reduce ship speed to a minimum to avoid the trawl net from sampling on its way to maximum depth. After reaching maximum depth, the winch should be stopped for about 3 minutes to allow the trawl to stabilize before starting to haul/ retrieve the net obliquely. During hauling, the ship speed should be increased to approximately 1.5-2 knots, and trawl vertical haul speed should be around 16-22 m/min. The total time of the net haul from surface to bottom to surface should be ~40 minutes.

Standard Gear – the RMT8 trawl

The RMT8 (Rectangular Midwater Trawl; Baker et al. 1973) was used during the CCAMLR-2000 and Large-Scale 2019 Krill Surveys of Area 48. Below is a description for a typical RMT8 net. Alternatives net types should modify this protocol to achieve same results. At each station a quantitative standard double oblique tow will be conducted from the surface down to 200 m (250 m optimal), or within 10 m of the bottom at stations shallower than 250 m in depth. This depth range is considered the best compromise between the time available for sampling and the likely vertical depth range of krill. During the hauls, a constant ship's speed of 2.5 ± 0.5 knots is suggested. It is recommended to maintain a wire speed of 0.7 to 0.8 m/sec (42 to 48 m/min) during paying out and of 0.3 m/sec (18 m/min) during hauling. The net mouth angle is remarkably constant during hauling within the speed ranges given above. When the net reaches maximum depth, the winch should be stopped for about 30 seconds to allow the net to stabilize before starting to retrieve the net. If the net is hauled from the stern of the ship, then the propeller of the ship should be stopped when the net reaches a depth of 15 to 20 m; this is to minimize the effects of the propeller action on the net operation and avoid damage to the samples. The total time of the net haul from surface to bottom to surface should be 40 minutes. The use of a real-time TDR is highly recommended to maintain a smooth net trajectory and control the maximum fishing depth. Calibrated flowmeters should be used to give a measure of net speed during the haul as well as the total distance travelled. The flowmeter should be mounted outside the net opening to avoid clogging, which may reduce efficiency. The dependence of mouth angle to the vertical of net speed has been investigated for the RMT system. The formula of Pommeranz et al., (1982) should be used to calculate the filtered water volume for oblique hauls (if horizontal hauls are used, then the formulas of Roe et al., (1980), should be used). Data from these sensors can be logged on to a computer, preferably at the ship's bridge, for later determination of trawl profile and calculation of the water volume sampled. In addition to the flowmeter and TDR, the trawl should be fitted with a CTD to collect information on temperature, conductivity and depth.

Sampling frequency and protocol

It is recommended that nets for biological data collection are deployed along transects at a subset of stations along a pre-defined 20 nm grid, although recognising the time demands of sorting large catches, it is not practicable to recommend every 20 nm station is sampled in such circumstances. The minimum rate of net sampling should be two stations per 60 nm of transect. Where a haul brings up no Antarctic Krill, ideally the next station on the 20 nm grid should be sampled. Where transects include onshore and offshore regions, at least one haul should be conducted in each region.

At each station, a quantitative standard double oblique tow should be conducted from the surface down to 200 m (or to within 10 m of the bottom at stations shallower than 200 m). Such a depth range is considered to be the best compromise between the time available for sampling and the likely vertical depth range of krill. During the hauls a constant vessel speed of 2.5 ± 0.5 knots is suggested. It is recommended to maintain a wire speed of 0.7 to 0.8 m/sec (42 to 48 m/min) during paying out and of 0.3 m/sec (18 m/min) during hauling.

Target trawls

Directed or targeted net sampling effort is necessary to reduce the uncertainty associated with the delineation of krill in the acoustic data record. Such target net hauls will be carried out both day and night and should, as a general rule, be undertaken when significant changes in the acoustic scattering structures, or marks, are observed that are consistent with the identification of 'swarms'. After the target net haul the vessel will return directly by the shortest route to the point on the acoustic transect line where the vessel broke off from, and continue the acoustic transect from that point (see Fig. 1).

It is recommended that nets for targeted sampling effort are carried out at a minimum rate of one per day. The contents of target haul catches must be sorted in the same way as for standard hauls. Specifically, this requires the measurement of a random subsample of at least 100 krill for length frequency, sex and maturity stage; and to record bycatch (see the following section for details).

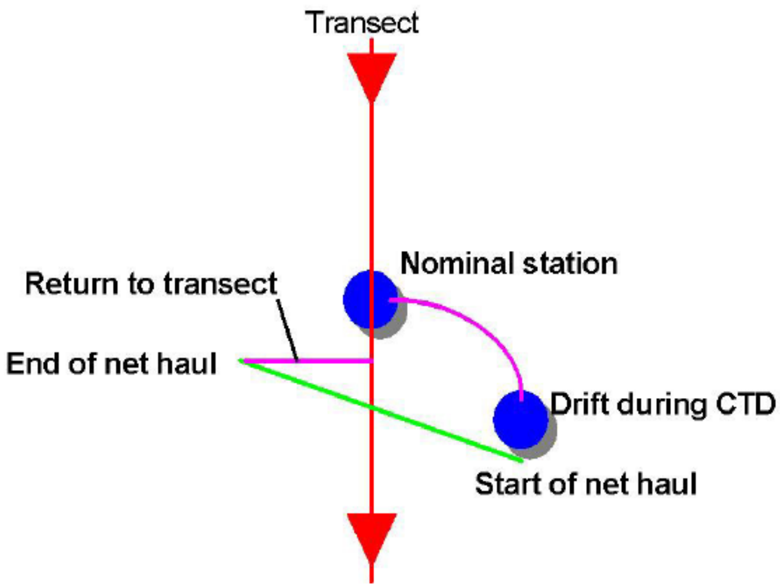

Fig. 1: Illustration of potential configuration of a target trawl and return to the transect break-point

Observer sampling and subsampling

For the purposes of this document, we focus principally on sampling for determination of krill length-frequency and ground-truthing the acoustics. We acknowledge that vessels undertaking acoustic and biological surveys may have additional objectives to consider which may require a more detailed laboratory sampling procedure. A description of laboratory sampling protocols is available on http://archive.ccamlr.org/pu/E/sc/ipy/RMT8protocol.pdf or alternative procedures may be followed, noting the minimum requirements set out below for krill length-frequency measurement and bycatch quantification.

Krill length-frequency measurements, sex and stage determination

The minimum requirement is to measure all krill caught when the catch abundance is fewer than 100 individuals, or to take a subsample of at least 100 krill when the catch is larger than 100 individuals. A subsample must be obtained following the protocol described in WG-KFO-2023, Appendix D, and summarized below:

Take 1 to 3 x 1 Litre samples of krill, according to availability. Place your subsamples into a bucket and mix gently; if required add some seawater to prevent damage to the krill during mixing.

From this bucket, fill one graduated measuring jug to the ~150 ml mark and transfer it to a bucket previously filled with cool surface seawater to prevent degradation of the krill. The 100 ml size is suggested as this should contain approximately 100 krill, however as krill size is variable, this 150 ml subsample could be adjusted appropriately.

Take a second sample with the ladle and fill another graduated measuring jug to the ~50–100 ml mark, and transfer it to a second bucket previously filled with cool surface seawater.

In the laboratory, place the bucket with the ~150 ml krill, when possible, on ice and store he bucket with the ~50–100 ml subsample in a refrigerator. Measure the length, sex, and stage for all the krill from the 150 ml subsample. (If the number of krill is below 100, process all krill from the ~50–100 ml subsample.)

Bycatch quantification

In order to quantify the bycatch of fish and invertebrates, the observer should collect a maximum 25 kg sample of krill from a point on the vessel where no pre-sorting of the catch has occurred. Sort through this sample, identify all bycatch species and record the number and total weight for each species.

Data and information to be reported

Record information in accordance with the Acoustic Survey Metadata form (tabs Set and Haul Details, Haul Catch, Krill Biological) and submit the form to the CCAMLR Secretariat.

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Acoustic Survey CTD Sampling Protocol

What is a CTD profile

CTD stands for conductivity, temperature, and depth, and refers to a package of electronic devices used to detect how the conductivity and temperature of water changes relative to depth. It is useful to collect other oceanographic parameters while taking a CTD profile, such as turbidity, chlorophyll, etc if sensors are present.

How to take a CTD profile

A CTD profile can be taken standalone with a specified winch or similar. Or a CTD profile can be taken by attaching a CTD data logger on the bio-sampling trawl gears such as the trawl net beam, when a CTD profile is taken while bio-sampling is taken.

When to take a CTD profile

To save survey cruise time, CTD profiles can be taken at bio-sampling/trawl stations. Otherwise, CTD profiles can be taken each 20nmi station but that it would be acceptable to sample 2-3 stations per 60 nmi of transect.

Specification for taking a profile

A CTD profile shall be down to 250m if a water depth is more than 250 m. Otherwise the CTD profile can be down to 10 m above the sea floor. It is acceptable that a CTD profile is taken down to the depth of 200 m if a CTD logger is mounted on the bio-sampling trawl gears. Considering the CTD data logger sampling rate, the CTD data logger shall ensure that it could collect data with a depth resolution of 1 m. For instance, SeaBird Microcat CTD data logger has the fastest sample rate 1 sample/6 seconds, and hence the CTD logger shall be released/retrieved at a vertical moving speed 1 m/6 seconds.

CTD instrument calibration

A CTD instrument shall have valid a calibration certificate when it is used to take a CTD profile. CTD instruments must be calibrated according to the manufacturer recommendations such as once a year. Otherwise, it must be specified in the meta data that a CTD profile is taken with invalid calibration alongside the instrument calibration date.