Annex 4

Report of the Working Group on
Acoustic Survey and Analysis Methods (WG-ASAM-2025)
(Geilo, Norway, 30 June to 4 July 2025)

Contents

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Introduction

1.1 The 2025 meeting of the Working Group on Acoustic Survey and Analysis Methods (WG-ASAM-2025) was hosted by the Institute of Marine Research of Norway, at the Vestlia Resort in Geilo Norway, from 30 June to 4 July 2025, and organised by Ms V. Vilanger (Norway).

Opening of the meeting

1.2 The meeting co-conveners, Dr S. Fielding (United Kingdom (UK)) and Dr X. Wang (People's Republic of China (China)) welcomed participants (Appendix A) to the meeting and expressed their goals for the meeting. The participants were welcomed to the Vestlia venue and welcomed to Geilo by Dr B. Krafft (Norway). He noted that although the meeting was taking place in the mountains of Norway, the links to Antarctica were present in the climate, the surrounding glaciers, and in the marine work conducted by Norway. He looked forward to a successful meeting and synergism of ideas with WG-EMM-2025.

Adoption of the Agenda

1.3 The agenda was adopted without change (Appendix B).

1.4 Documents submitted to the meeting are listed in Appendix C. The Working Group thanked all authors of papers for their valuable contributions to the work presented to the meeting.

1.5 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been indicated in grey. A summary of these paragraphs is provided under 'Advice to the Scientific Committee'.

1.6 The report was prepared by J. Arata (invited expert), D. Bahlburg (Germany), C. Cárdenas (Chair of the Scientific Committee), M. Cox (Australia), D. De Pooter (Secretariat), T. Dornan (UK), E. Kim (Republic of Korea (Korea)), B. Krafft (Norway), H. Sul La (Korea), H. Murase (Japan), S. Parker (Secretariat), A. Smith (Australia) and G. Zhu (China).

1.7 A glossary of acronyms and abbreviations used in CCAMLR reports is available online at https://www.ccamlr.org/node/78120.

Review terms of reference and workplan

2.1 The Working Group noted the terms of reference agreed by the Scientific Committee in 2022 and set out in SC CIRC 23/52.

2.2 The Working Group noted the workplan set out in Table 6 of SC-CAMLR-43. The Secretariat proposed options to simplify the revision of the workplan by noting revisions proposed in report text of the Working Group, and developing an online composite workplan for the Scientific Committee combining topics for all Working Groups which included specific tasks lead by Members. The Working Group agreed with this approach and to discuss additional modifications to the workplan under 'Future Work'.

Standardised procedures for the collection of acoustic data for krill fishery management

Methods for calibrating echosounders on vessels

3.1 The Working Group considered appropriate methods and procedures for calibration of echosounders on vessels used for acoustic data collection. The Working Group noted that the calibration protocol developed during WG-ASAM-2024 (WG-ASAM-2024, Appendix D) only applied to vessels with EK80 echosounders and discussed the need for advice for vessels equipped with non-EK80 echosounders. The Working Group considered the echosounders installed on krill fishing vessels notified for the 2025/26 fishing season and noted that 9 of the 14 fishing vessels are equipped with an EK80, one with an EK60, and nine of these echosounders operated with a 120 kHz transducer (Table 1). The Working Group concluded that a calibration protocol for the use of non-EK80 echosounders was not needed as a priority.

3.2 The Working Group discussed the stability of echosounder calibrations, how frequently echosounders should be calibrated and the environment the calibration was undertaken in. The Working Group noted that there was evidence in the literature that transducer Gain and S_a correction were affected by changes in temperature (Demer and Renfree, 2008). The Working Group noted that modern transducers (e.g. composite) may be more stable than older models across years and temperature gradients.

3.3 The Working Group compared Gain and S_a correction calibration results from the RRS *Sir David Attenborough* and RV *Aurora Australis*, to explore if the calibration results were stable across time. Results indicated that the modern composite transducer (120-7C) fitted to the RRS *Sir David Attenborough* was stable across 3 years and an approximately 15°C temperature difference, but that the older version of transducer (120-7) fitted to the RV *Aurora Australis* had more variability (Figure 1). The Working Group noted that more data were required to confirm these trends and invited Members to submit calibration results for comparison in the ASAM e-group https://groups.ccamlr.org/group/3/stream. The Working Group welcomed the offer by Dr Cox to conduct a temperature experiment on a 120-7C transducer and report results to WG-ASAM-2026.

3.4 The Working Group also recalled that vessels were requested to conduct impedance tests as these can provide confidence that echosounders are functioning correctly (WG-ASAM-2024, paragraph 3.8). It also recalled checking the general functionality of a split-beam transducer by observing single target distributions within the acoustic beam. The Working Group noted that vessels could conduct impedance tests at the beginning and at the end of surveys, as well as checking general functionality of the split-beam transducer by observing single target distributions throughout the survey. The Working Group recommended that the Secretariat update the calibration protocol.

Acoustic transect design and data collection

Review and recommend spacing and sampling stations for transects

3.5 The Working Group reviewed features of the acoustic survey transect and CTD and krill biological sampling station design in Subarea 48.1 developed in WG-ASAM-2024 (WG-ASAM-2024, Figure 1), noting that boundaries of some of the Management Units (MUs) for Subarea 48.1 had been revised by SC-CAMLR-43, paragraph 2.63. The Working Group considered the three survey designs for Subarea 48.1 developed during WG-ASAM-2024 (WG-ASAM 2024, Figure 1 a–c) and further discussed design rules for acoustic surveys in Subarea 48.1. The Working Group noted that these design rules (paragraph 3.15) should be applicable to other survey areas. It recalled that establishing geospatial rules had been beneficial to coordinating spatial activities within CCAMLR and their transparency (SC-CAMLR-42, paragraph 2.30; https://github.com/ccamlr/geospatial_operations).

3.6 The Working Group noted that in the WG-ASAM 2024 design, the transect spacing is closer within the core strata (GS, BS, JOIN, SSIW, EI survey strata) that cover the footprint of the fishing fleet and the Spatial Overlap Analysis (SOA) and transects further offshore are spaced further apart. The Working Group noted that the transects were designed as a parallel transect survey to allow the use of the Jolly-Hampton survey estimator. The Working Group noted that if a biomass estimate was required for the whole of Subarea 48.1 then the entire area should be surveyed.

3.7 The Working Group further noted that surveys conducted in the core strata could be surveyed annually to understand the dynamics and interannual variability of the krill stock. However, it noted that surveys used to calculate biomass estimates for the core strata should not be extrapolated beyond the area surveyed.

3.8 The Working Group re-iterated the value of continuing time-series of acoustically derived krill biomass estimates, noting the design of the WG-ASAM-2024 Subarea 48.1 survey had utilised the existing core strata transects and extended every 2nd transect further off-shore from the edge of the spatial overlap analysis boundary to the boundary of the 48.1 Subarea (WG-ASAM-2024, paragraph 3.29 (iv)).

3.9 The Working Group reviewed the spatial extent of the Subarea 48.1 survey alongside the distribution of sea-ice in winter (April–September) months and recommended that if a winter (April–September) survey was required, this could occur in late April/May before the development of sea ice which will reduce the survey coverage.

3.10 The Working Group noted that prevailing sea ice conditions meant that the Powell Basin (PB1 south and PB2) and the southern part of Drake Passage (DP2) are unlikely to be surveyable during winter. The Working Group further noted that the proposed design is focused on obtaining biomass estimates but that WG-EMM may want to survey key areas at different times for ecological monitoring.

3.11 The Working Group recommended the distance between sampling stations for acoustic biomass surveys should be 40 nm with the goal of at least 2 sampling stations on each transect with some exceptions (paragraph 3.15 (v), paragraph 3.13). The Working Group noted that sampling station spacing required to provide length frequency information for an acoustic biomass estimate may be different from those required for ecological monitoring or to inform the Krill Stock Hypothesis (KSH).

3.12 The Working Group noted that placing sampling stations at the end of transects that were at the boundaries of strata could cause challenges to fishing vessels to complete and remain in the strata. It also noted that some transects ended in shallow or unsurveyed areas that could compromise vessel safety. The Working Group agreed that sampling stations should be placed at least 10 nm in from the ends of transects. The Working Group noted that the decision on when to end a survey transect or where to conduct a trawl sample would rest with the vessel based on safety or operational considerations.

3.13 The Working Group identified that some transects in the Bransfield and Gerlache Straits were short and may only be allocated one station with the rules on spacing (paragraph 3.15(v)).

3.14 The Working Group discussed how to assess survey coverage and noted the metric devised by Aglen (1989) where survey coverage index is equal to the total transect distance divided by the square root of the area surveyed. The Working Group calculated survey coverage for the proposed transect design from WG-ASAM-2024 for each of the proposed MUs to facilitate their discussions on whether the survey design was appropriate (Table 2). The Working Group also noted that the survey coverage should be considered together with the spatial allocation of transects within survey area.

3.15 The Working Group agreed on the following design rules to revise the acoustic survey design in Subarea 48.1:

(i) The areas to be surveyed should be defined and reflect the area to which the biomass estimates apply, recognising the intent to conduct surveys both in Summer and Winter seasons. For example, survey areas within Subarea 48.3 could be defined to exclude large areas north of the Polar Front, where waters are too warm for krill and survey areas in MUs in Subarea 48.1 that have limited winter (April–May) access due to ice cover (PB2), could be excluded.

(ii) Transect orientation in each MU (or embayment within an MU) should be specified perpendicular to the bathymetric isobaths or the prevailing current in the area where possible (Rivoirard et al., 2000).

(iii) Transect lines should extend from the MU boundary to either the MU boundary or to land.

(iv) Transects should be based on the existing nominated transects (WG-ASAM-14, paragraph 2.11 and Table 2) to maintain time series of those transects. Transects could be added or removed to attain the appropriate spatial coverage to achieve preferred precision of biomass estimates.

(v) Sampling stations should be designated at 10 nm from the ends of each transects and then at 40 nm equal spacing through the rest of the transect. The goal would be to have at least 2 sampling stations on each transect, although some very short transects (such as those in GS) may only have 1 sampling station.

3.16 The Working Group noted that several exceptions to the above rules are needed to align the rules with the existing timeseries transects in Subarea 48.1:

(i) Very short transects on the edges of MUs can be removed (e.g. NE corner of SSIW MU).

(ii) Transects extended to non-SOA areas can be chosen based on the spatial coverage index, noting that the current approach in Subarea 48.1 was to extend every other transect into the outer areas.

(iii) In the NW of the SSIW MU, a N-S nominated transect was removed and replaced with parallel transects to match the rest of the SSIW nominated transects, to ensure the survey design adhered to the principles required for the Jolly and Hampton estimator.

(iv) The transect spacing in JOIN should be reviewed once the nominated transects are extended and the spatial coverage index is updated, as it currently contains the smallest spatial coverage index.

(v) Two of the nominated transects in the EI MU (T13, between Elephant and Clarence Islands; and T9, the 2nd closest to King George Island) can be removed to align the spatial coverage index with other MUs (Table 2).

3.17 The Working Group agreed that progress on the revision of the survey design using these rules should occur intersessionally through a Discussion Group in collaboration with the Secretariat. The Working Group requested the Secretariat to create an 'Acoustic Survey Design' Discussion Group.

3.18 The Working Group noted that the PB2 MU south of 63°25'S (i.e. following the southern boundary of the JOIN MU) is unlikely to be accessible in summer or winter due to persistent sea ice conditions, and therefore not surveyed. In contrast, surveys in PB1 are expected to be feasible. This suggests a future revision of the SOA boundaries to encompass all of PB1 and the portion of PB2 north of 63°25'S, extending eastward to 50°00'W.

Implementation of acoustic transect surveys

3.19 WG-ASAM-2025/21 presented preliminary results from the krill acoustic survey conducted by the Chinese fishing vessel *Long Fa*, covering five MUs (SSIW, BS, GS, JOIN, EI) in Subarea 48.1 during austral summer 2025. During the field survey, krill biological sampling was carried out at 81 stations using RMT8 trawls and CTD vertical profile sampling was deployed at 138 stations. The acoustic data were processed aboard by scientific observers using automated processing 'RapidKrill' code. The acoustic data were used to identify areas of high NASC values. Concentrations of high-density krill swarms were more frequently observed in the shelf regions to the east and south of the Elephant Island and in the coastal waters of the Gerlache Strait. Smaller krill, with a mean length less than 36 mm, were generally found in the southern shelf regions in the Bransfield Strait, Gerlache Strait and near Joinville Island.

Preliminary results from the CTD data analysis suggested that the Antarctic Coastal Current from the Weddell Sea may play a crucial role in krill flux input to the Bransfield Strait.

3.20 The Working Group thanked the authors for the quick reporting of a survey conducted this season and recognised the value of such surveys data to inform the KSH and identify locations of krill influx to the Bransfield Strait. The Working Group recognised the value of presenting data on water masses alongside NASC and krill length frequency. The Working Group discussed the value of presenting oceanographic properties alongside krill density and krill length frequency distributions. It noted that oceanographic properties could be presented in papers using Temperature-Salinity (TS) plots, velocity measurement from ADCPs, satellite remote sensing data or numerical modelling simulations. The Working Group also suggested that a heat map of krill length frequency with a corresponding heat map of krill length variance would be informative for identifying recruitment. The Working Group suggested that the modified 'RapidKrill' code be deposited in the CCAMLR GitHub repository.

Transect designs for other areas

3.21 The Working Group considered transect designs for future krill acoustic surveys in Subareas 48.2 and 48.3. The Working Group agreed that the design should follow the same rules as those for Subarea 48.1, recognising the value of existing transects and with smaller inter-transect spacing over the shelf and core fishing areas and wider spacing off-shelf for the rest of the Subarea (paragraph 3.8). The Working Group collaborated on a draft design (Figure 2) and noted that this work would be completed intersessionally and considered at WG-ASAM-2026. The Working Group recommended that following progress in the 'Acoustic Survey Design' Discussion Group, the resulting rules could be summarised and applied to Subareas 48.1, 48.2 and 48.3 by the Secretariat and submitted to WG-ASAM-2026.

Krill biological data collection protocols

3.22 WG-ASAM-2025/02 considered the benefits of the KSH within the revised krill fishery management approach (KFMA). The paper noted the revised KFMA involves improvements needed for the spatial overlap analysis, but lacks biological information of krill life history, migrations and spatial connectivity in setting catch limits. The paper recommended revisions of SISO and CEMP protocols to align with KSH data collection requirements and prioritisation of regular coordinated surveys between platforms including research vessels, fishing vessels and autonomous platforms which focus on potential recruitment source regions and population structure on broader scales.

3.23 The Working Group noted the need for clear short-term and long-term outputs from the KSH and how this would align with survey efforts to derive biomass estimates. The Working Group noted a need to use small mesh research trawls (i.e. RMT1) to sample krill early life stages (eggs and larval) and discussed the feasibility of using these gear types on research vessels compared to fishing vessels.

3.24 WG-ASAM-2025/03 presented the aims of the 'Antarctica InSync' program for circumpolar and synchronous assessment of connections between ice, ocean and ecosystems in Antarctica. The paper highlighted the important role CCAMLR could contribute to predatorprey-fishery interactions in understanding ecosystems using fishing vessels. A case study proposed in the paper suggested analysing acoustic data recorded during fishing to detect and map krill predators such as penguins and seals, which could also be paired with tagging data to identify and map predator encounters. The paper also touched on the shared benefits and opportunities for funding to support 'Antarctica InSync' projects.

3.25 The Working Group noted the priorities to be addressed by the 'Antarctica InSync' program, including key circumpolar research questions and identified topics where Members may wish to contribute to data collection and scientific collaboration. The Working Group considered alignment of topics for integration with the upcoming International Polar Year to answer research questions that would require coordinated sampling efforts. The key collaborative research efforts included:

(i) Assessment of krill biomass distribution at circumpolar scales

(ii) Identification of population structure and advective connectivity of krill stocks at scales relevant for the krill fisheries management

(iii) Assessment of ecosystem effects of the krill fishery year-round to help understand anthropogenic effects in the Southern Ocean and to advance CEMP and the Spatial Overlap Analysis

(iv) Identify potential changes in krill biomass distribution due to climate change.

3.26 The Working Group agreed that it would be useful for CCAMLR to understand predator interactions with fisheries through the use of acoustic data recorded during fishing. It considered the cost, benefit and practicality of storing these large volumes of acoustic data in a central repository with intensive remote computation capabilities, potentially hosted by the CCAMLR Secretariat. The Working Group noted that hosting these data could have infrastructure and cost implications for the Secretariat. Distributing a self-contained processing algorithm to individuals with data could be a viable alternative and was suggested if a central repository could not be arranged.

3.27 The Working Group considered that acoustic data from fishing vessels could be used to inform CEMP discussions on predator spatial distribution, making a useful contribution to the SOA and suggested the authors consider prioritising areas such as defined acoustic transects where repeated surveys may provide a time series of mammal and penguin observations.

3.28 WG-ASAM-2025/14 Rev. 1 proposed a coordinated krill fishery data collection plan in support of the revised KFMA, including the KSH. The plan builds on existing practices and ongoing discussions, aiming not to create additional sampling requirements, but to align and optimise data already being collected across platforms, including by fishing vessels. The proposed framework differentiates between two operational modes – acoustic survey mode and commercial fishing mode – with tailored data collection goals for each. It underscored the importance of representative biological sampling, and proposed standardising the trawls to RMT8+1 during the acoustic survey mode, to capture krill population structure and support the development of biomass estimates, SOA, and the KSH. Tables within the paper outlined seasonal and spatial data needs across MUs in Subareas 48.1, 48.2, and 48.3, as well as the potential contributions from different platforms such as fishing vessels, moorings, research programmes, and tourist ships.

3.29 The Working Group welcomed the comprehensive nature of the plan but raised concerns about specifying the use of only RMT8+1 trawls. The Working Group noted that there were other scientific trawl designs currently in use, and that imposing one gear type may be unnecessarily restrictive. The Working Group identified that the selectivity and avoidance of different scientific trawls on the size class of organisms caught would need to be validated. This was considered critical for enabling consistent data interpretation across vessels and years.

3.30 The Working Group encouraged the development of practical guidelines for standardising, comparing and reporting methods for different trawl types. The Working Group developed a list of variables (Table 3) to enable a consistent description of trawls used during krill acoustic surveys, which would support future inter-gear comparisons. Members were encouraged to submit descriptions of their trawl types to the CCAMLR gear library.

3.31 The Working Group noted that some additional development of the table may be required and suggested that this be considered by WG-EMM (paragraph 3.45).

3.32 The Working Group considered the feasibility of conducting intercalibration experiments of the various trawl designs, and the challenges of such an operation and ship time costs. The Working Group agreed that consulting trawl technology experts to evaluate hydrodynamic flow during trawling events and the selectivity of different trawl types would be a suitable first step.

3.33 Within the data collection plan, the Working Group noted the importance of distinguishing between data collected for routine monitoring versus targeted research. Some biological parameters – such as maturity staging or physiological traits – may not require annual updates and could be addressed through periodic studies or by research vessels. Others, such as length-frequency distributions for biomass estimation, require consistent and frequent sampling. The Working Group noted that while surveying, fishing vessels would operate similarly to research vessels, with onboard scientists conducting biological sampling using research trawls at designated stations alongside CTD casts. The Working Group further noted that during acoustic surveys, the sampling protocol targets measuring at least 100 krill per station while fishery mode protocols for SISO target at least 200 krill, and the survey protocol method for estimating maturity also differed from SISO protocols. The Working Group noted that aligning the biological sampling protocols for surveys with SISO sampling may help to avoid confusion.

3.34 WG-ASAM-2025/17 summarised the 2025 SCAR Krill Expert Group (SKEG) Symposium held online from 10–12 March 2025. The event convened approximately 90 participants from 15 countries, including representatives from industry, policy, and NGOs. The 2025 symposium marked a significant step in enhancing collaboration, supporting early-career researchers, and aligning with CCAMLR priorities. It featured two keynote presentations – one on mesopelagic ecosystems and another on krill vertical distribution – as well as a live demonstration from the RV *Nuyina*. The programme included new presentation formats such as idea pitches and speed introductions to promote engagement. Most notably, SKEG launched a new internal structure comprising four task forces focused on krill flux monitoring, database updates, fisheries indices integration into risk management, and communications/outreach. Additional task forces on carbon export and whale-related issues are under consideration, with the structure designed to be flexible and responsive to emerging priorities.

3.35 The Working Group welcomed the initiative and commended the productivity and clarity of the new format. Members highlighted the timely establishment of task forces and the quick submission of related papers to WG-ASAM as evidence of the symposium's impact. The Working Group encouraged maintaining this streamlined, research-focused format, noting that it fostered meaningful dialogue and strengthened community engagement.

Oceanographic data collection protocols

3.36 The Working Group noted that the underlying oceanographic conditions and current dynamics appeared as a regular consideration in acoustic research presented. The Working Group recommended that future surveys and papers include oceanographic and current data as context to interpret survey acoustic data, which could be sourced from oceanographic models, historical trends, or in situ oceanographic observations.

3.37 The Working Group noted the specific importance of such oceanographic data in interpretations of krill flux within regions and recommended the inclusion of temperature-salinity plots and ocean current figures in its metadata reporting requirements for krill biomass surveys. The Working Group encouraged the Secretariat to include visualisations of major ocean currents as layers in the Spatial Data Viewer.

Submission of acoustic data

3.38 WG-ASAM-2025/01 presented recent developments regarding the CCAMLR Acoustic Data Repository, including feedback from Members' testing of the Acoustic Survey Metadata Form (ASMF), along with updates to the Acoustic Data Viewer and the Krill Biomass Estimates private GitHub repository.

3.39 The Working Group thanked the Secretariat and Members involved in testing for their effort updating the ASMF. The Working Group welcomed the progress to Acoustic Data Viewer and the addition of version-controlled documentation to the Krill Biomass Estimates private GitHub repository.

3.40 The Working Group noted that the ASMF includes requests for both survey metadata and krill biological sampling information, and agreed to separate the krill biological sampling worksheet from the ASMF.

3.41 The Working Group discussed the mechanism for reporting of research trawl catch data, as fishing vessels are required by CM to submit data via the C1 and observer forms. The Working Group recommended the Secretariat identify modifications needed to CM 23-06 (or other CMs) to permit fishing vessels conducting acoustic surveys to submit acoustic trawl sample data from research trawls exclusively through the ASMF instead of through the C1 form, and develop a proposal for the Scientific Committee.

3.42 The Working Group discussed the feedback from Members' testing of the ASMF and agreed that the Vessel and Gear worksheet be reviewed intersessionally via the 'Acoustic Survey Design' Discussion group to determine whether all the variables were required, and to define what they represented.

3.43 The Working Group requested the Secretariat work with Members to draft an instruction manual to facilitate completion of the ASMF.

3.44 Noting that all of the krill fishing vessels in the fleet had fitted Simrad echosounders, the Working Group agreed to use Simrad terminology when describing echosounder settings in the ASMF.

3.45 The Working Group agreed on the addition of the *Volume of water sampled* and *Speed through the water* fields to the 'Trawl Sampling' worksheet of the ASMF (under 'Stations' tab). It noted that vessel speed could be determined as either speed through the water, or speed over ground. The Working Group noted that these fields were not compulsory but highlighted there could be value in recording vessel speed to aid acoustic data interpretation and to aid trawl intercalibration exercises to assess the impact of towing speed on selectivity (Table 3).

3.46 The Working Group identified that only the length of krill was currently used in acoustic krill biomass surveys but noted that other parts of the KFMA may require the collection of data to develop additional parameters.

3.47 The Working Group requested WG-EMM consider what parameters of krill biological sampling may be required to support the development of the KSH (WG-ASAM-2025/14 Rev. 1).

3.48 The Working group noted that factors including morphology in relation to maturity stage and lipid content may impact krill target strength estimation and would be valuable subjects of focussed research to be considered by the discussion group in the intersessional period.

Standardised procedures for analysis and development of krill biomass estimates

Survey stratification and spatial estimators

4.1 In Subarea 48.1, the boundaries of SSIW, GS, DP1 and DP2 were changed after WG-ASAM-2024 (WG-EMM-2024, Figure 11) and were subsequently agreed by the Scientific Committee (SC-CAMLR-43, paragraph 3.63).

4.2 The Working Group recalled that the biomass estimates for the stratum areas in Subarea 48.1 were based on data from multiple Members and multi-year surveys. The Working Group recognised that stratum-level krill biomass estimates have previously been modified in response to minor changes in strata boundaries and shore boundary lines and that these changes were made simply by using the existing krill biomass density (g m^{-2}) for a stratum multiplied by the revised stratum area.

4.3 The Working Group discussed the possibility of recalculating biomass estimates based on available one-nautical-mile krill biomass densities. The Working Group agreed there are some MUs, for example DP1 and PB2 where there is insufficient data to recalculate biomass estimates.

4.4 The Working Group was not in favour of extrapolating existing survey density estimates to wider areas. Furthermore, the Working Group noted that all the data being discussed are more than five years old. The Working Group considered that a recalculation would not provide meaningful improvement to existing biomass estimates.

4.5 The Working Group recognised the importance of progressing and evaluating the use of spatial (model-based) estimators for krill biomass estimation. The Working group agreed that an important aspect of model-based estimators (to be implemented in the medium term) is the incorporation of other sampling platforms such as static instruments (e.g. landers) and mobile platforms, e.g. gilders, into the estimation of biomass.

4.6 The Working Group recognised that krill biomass estimates are currently calculated using a tested, and simple to use, design-based estimator (Jolly and Hampton, 1990) and that the implementation of a model-based approach would require additional procedures and reporting.

4.7 Dr Murase made an International Whaling Commission paper (SC/68A/EM/03) available to the Working Group, which summarised the results of six models, each applied to spatial krill density modelling.

4.8 The Working Group recommended that the processed 120 kHz krill biomass density data (in one-nautical-mile integration intervals) from the 2000 synoptic survey and the 2019 large-scale surveys be used as test datasets to evaluate the performance of model-based estimators. Dr Cox agreed to lead this work intersessionally through a Discussion Group. The Working Group requested the Secretariat create a Discussion Group on 'Model-based acoustic biomass spatial estimators'.

Standardised analysis and reporting of acoustic biomass estimates

4.9 WG-ASAM-2025/13 presented an analysis of krill vertical distribution patterns using a moored echosounder. Ship-based echosounders have a surface acoustic 'blind zone' which often extends 15 m below the surface – in which no krill can be sampled – and the conical beam shape may confound analysis of diel vertical migration (DVM) patterns. The paper also examined the distribution of krill below 250 m to examine the sampling limitations of ship-based surveys. Overall, 1.5 to 3.9% of krill NASC was found shallower than the 15 m cut off and 0.4 to 40.5% of NASC was found below the 250 m cut off and this percentage was higher during the winter. These finding suggest that diel and seasonal vertical movements can lead to underestimation of krill biomass.

4.10 The Working Grouped thanked the authors and noted that in the study there was a large unsampled zone from the depth of the moored echosounder to the seafloor so the proportion of krill NASC falling outside of the 250 m lower integration interval may be higher than estimated in WG-ASAM-2025/13. The Working Group also agreed that the seasonal variation in DVM is an important consideration, and noted that for winter surveys, gliders may provide a more complete picture of DVM by sampling deeper than the moored echosounder depth. Regional (habitat) differences (e.g. on and off shelf) were also identified by the Working Group as influencing DVM patterns. The Working Group suggested that increasing the 250 m lower integration interval in response to seasonal and regional changes in krill vertical distribution should be investigated.

4.11 The Working Group noted that the different acoustic sampling characteristics of the moored echosounder (for example a Nortek Signature 100) and typical ship-based echosounders (for example a Simrad EK80s) should be assessed. The Working group agreed that inter-instrument differences be characterised using the effective observation range, i.e. the maximum range at which a given density of krill could be detected.

Krill biomass estimates

5.1 WG-ASAM-2025/06 presented an acoustic-trawl survey conducted in the Krill Research Zone (KRZ) of the Ross Sea Region Marine Protected Area. Krill were identified using a combination of the swarms-based method and the dB-difference method applied to the identified swarms. The 2-frequency and 3-frequency methods had negligible differences in both integration intervals and vertical distribution. On a transect basis, krill areal biomass density ranged from 0.02 to 15.15 gm^{-2}. Krill distribution was highly variable in the KRZ and the krill biomass was estimated as 0.59 million tonnes (CV = 63%). The highest density of krill was found in the eastern transects of the KRZ.

5.2 The Working Group thanked the authors for conducting a survey in the KRZ, where no survey has been carried out since it was designated in 2017. The Working Group suggested reviewing whether the current Jolly and Hampton statistical method is appropriate for the zig-zag survey design and recommended exploring alternative estimators. The authors confirmed that Antarctic krill maturity stages presented in the report were assessed solely based on krill length, and that ice krill (*Euphausia crystallorophias*) were not found in the trawl samples. The dB-difference method was applied to distinguish ice krill from Antarctic krill in the acoustic record, and biomass estimation was conducted accordingly.

Area 48 biomass estimates

5.3 WG-ASAM-2025/07 presented an acoustic survey conducted in the northern half of the Gerlache Strait during May 2025, which estimated a mean krill biomass density of 197.02 g m^{-2} (CI: 133.56 - 289.95) from 70 kHz acoustic data. The survey was conducted by the crew of the cargo vessel *Antarctic Provider*, without the participation of scientists onboard. The raw acoustic data (10 GB) was transferred via satellite. Transferred files were processed on land (in Bergen) using the *Krillscan* python package to calculate krill biomass density estimates.

5.4 The Working Group noted that the conversion factor in WG-ASAM-2025/07 was higher than in other studies, likely due to the use of 70 kHz instead of the typical 120 kHz, and noted the use of average krill length (35.98 mm) instead of the recommended weighted mean length. The Working Group commended the authors for their rapid processing of the data in time for this meeting. The Working Group suggested a comparison between the 70 kHz data and the 120 kHz would be constructive.

5.5 The Working Group noted that higher krill biomasses occurred in the eastern part of the Gerlache Strait, but krill fishing vessels were also fishing in other areas of the Strait. The Working Group noted that the difference between krill fishing effort (hours trawling as observed through the AIS tracking database of Global Fishing Watch) and the highest estimated krill density may result from the limited area covered by the echosounder, which only detects directly under the vessel, whereas fishing activities may occur away from the echosounder beam area.

5.6 WG-ASAM-2025/09 presented results of an Antarctic krill and ecosystem monitoring survey conducted at the South Orkney Islands in February 2025. An acoustic-trawl and visual predator surveys – observed using distance sampling methods – were presented. A key result was the estimated krill biomass of 6.16 million tons (CV = 74%). From the 28 trawl stations 38 taxonomic groups were identified with the siphonophore (*Diphyes antarctica*) found at 24 trawl stations and *E. superba* was found at 23 trawl stations (mean body length = 42.6 mm, SD = 6.6 mm; range 25.3 to 59.4 mm). Distance sampling methods were used to estimate fin whale (*Balaenoptera physalus*) and humpback whale (*Megaptera novaeangliae*) density.

5.7 The Working Group commended the authors on the rapid processing of the acoustic data to calculate krill biomass from a survey conducted in this year. The Working Group was excited to hear that the distance sampling analysis of predator sighting data is being finalised for publication in the *ICES Journal of Marine Science*. The Working Group noted that Norway is planning to host a workshop in 2026 addressing the need towards marine spatial management in Subarea 48.2 (WG-EMM-2025/58).

5.8 WG-ASAM-2025/18 presented a biomass estimate of Antarctic krill derived from an acoustic-trawl survey conducted in the Western Core Box (WCB) survey area in February 2025 to the northwest of South Georgia (in Subarea 48.3). This was the first krill acoustic-trawl survey conducted from RRS *Sir David Attenborough.* Krill echoes were identified using the three-frequency dB-difference (38, 120 and 200 kHz) method. From a survey conducted during daylight hours, mean areal biomass density was estimated (46.89 g m^{-2}) giving a biomass for the WCB survey stratum of 500 152 tonnes, with a CV of 47.9%.

5.9 The Working Group thanked the authors for the timely presentation of results from a survey conducted during the current season. The Working Group discussed how large-scale environmental processes affect krill biomass and noted that the krill biomass around South Georgia is mainly driven by the water temperature in the six months preceding the survey (Fielding et al., 2014), loosely correlated with the Southern Annular Mode (SAM). The Working Group noted that the survey date has varied throughout the survey series from early to late summer periods. Dr Fielding noted that a previous field program (2002 to 2005), where the WCB stratum was surveyed in early, middle and late periods, had shown no consistent krill biomass pattern with survey period that could be used to standardise for potential changes in krill biomass due to survey timing. The Working Group also noted that data from alternative platforms, such as moorings and gliders, could help supplement ship-based survey data and elucidate intra- and inter-annual patterns.

5.10 The Working Group encouraged further collaboration to assess krill population links between subareas of Area 48. The Working Group identified that the analysis of krill size composition would also be useful for assessing these subarea links. The Working Group acknowledged the WCB stratum as the northern edge of krill distribution and commended the authors for contributing to the long-term dataset from 1996 to 2025.

Area 58 biomass estimates

5.11 WG-ASAM-2025/08 presented a mesoscale biomass estimate of Antarctic krill in the East Antarctic derived from the ENRICH (Euphausiids and Nutrient Recycling in Cetacean Hotspots) acoustic-trawl survey conducted during January 2019. The survey carried out from the RV *Investigator* aimed to present krill biomass density to inform the SOA, to test the use of this dataset for future model-based estimates, and to promote discussion on automated standards for future surveys. The mean areal biomass density of the study areas was 18.3 g m^{-2}, yielding a total biomass of 2.32 million tonnes (CV = 11.1%). Authors noted that the survey targeted a region with high krill density, and results are not representative of the broader region.

5.12 The Working Group noted that krill swarms showed a bimodal vertical distribution, with most individuals located near the surface and a smaller mode found at greater depths (with aggregations detected even at 250 m depth).

5.13 The Working Group noted that the effective detection limit of the 120 kHz frequency was at least 350 m and that of the 70 kHz frequency was greater. The Working Group recommended further research of the swarms-based algorithm to depths below the current 250 m integration limit and how that would impact biomass estimates.

5.14 The Working Group noted that the ENRICH survey design was influenced by practical time constraints as it was part of a multidisciplinary cruise. The Working Group noted that it would be valuable to survey the same area again and that such future surveys should modify the design to improve its coverage by expanding all transects to the same northernmost latitude. However, the authors noted there are currently no plans for a new survey in the area.

5.15 The Working Group noted that while this survey did not detect a DVM signal, the 2021 survey in CCAMLR Division 58.4.2 did detect a DVM signal using a similar methodology. The Working Group reflected on potential spatial and temporal variability in krill behaviour and the importance of understanding differences in krill behaviour at a circumpolar scale. It also noted the value of autonomous sampling instruments such as moorings and the importance of finding ways of combining data from different platforms to detect this variability.

5.16 The Working Group also discussed the analysis presented by Dr Cox, which aimed to detect the effect of sampling design by removing a number of transects on CV values. It noted the potential of this approach for analyses of area coverage to be applied in other areas such as Subarea 48.1, currently under discussions within the KFMA. In response to the comments Dr Cox agreed the analysis has good potential; however, he noted the caveats of the current analyses as permutations at some point will remove consecutive transects, heavily altering the survey area represented by the transects, rather than the survey coverage.

5.17 The Working Group recalled that a large-scale biomass survey was conducted by Japan in Division 58.4.1 during 2019 (WG-ASAM-2021/06). It noted that the biomass estimate in WG-ASAM-2025/08 was approximately half of that reported by the Japanese survey for the entire Division 58.4.1 and considered whether the data from both surveys could be combined. The Working Group noted that this would require further discussion and analyses as both surveys had different purposes and methodologies and agreed to discuss intersessionally how data from both surveys may be combined to recalculate a biomass estimate for Division 58.4.1.

5.18 The Working Group noted that version 6 of the Echoview Swarms template provided slightly different results for the Division 58.4.1 biomass survey than version 7. The Working Group agreed that changes to the template should be presented to WG-ASAM and requested the Secretariat to update the Krill-Biomass-Estimates GitHub repository to provide access to the Echoview Swarms template in a version-controlled manner.

5.19 The Working Group recalled that the swarms-based algorithm was developed primarily for fishing vessels with limited equipment capacity, as it requires only a single frequency. It noted that while large-scale surveys conducted by research vessels which frequent areas with lower krill density could use the swarms-based algorithm, comparison with the three-frequency dB difference target identification algorithm may be beneficial. The Working Group recalled that both the swarms-based and dB-difference methods are acceptable krill identification methods used for biomass estimation (SG-ASAM-2019/10; WG-ASAM 2022, paragraph 2.3 and Table 1).

5.20 The Working Group recalled its recommendation to develop test datasets to benchmark processing software and methods (WG-ASAM-2022, paragraph 2.13; WG-ASAM-2023, paragraph 4.12; WG-ASAM-2024, paragraph 3.20) and welcomed the proposal by Dr Cox to contribute the data from the 2019 ENRICH acoustic-trawl survey dataset for this purpose. Any request for these data could be made through the Secretariat.

5.21 WG-ASAM-2025/16 summarised 17 multidisciplinary studies (many studies were from the Australian 2019 ENRICH and 2021 TEMPO voyage) on Antarctic krill in the East Antarctic ecosystem, which have recently been published as a Research Topic in the peer-reviewed journal Frontiers in Marine Science. The paper highlights climate-driven habitat degradation and krill redistribution due to sea-ice dynamics, the critical role of krill swarm structure for predator foraging success and the advances in autonomous sampling which enable high-resolution monitoring of these dynamics to inform CCAMLR's ecosystem-based management.

5.22 The Working Group congratulated the authors and thanked them for the valuable work conducted by collecting this extensive dataset. The Working Group noted that combining these data with data collected from other regions could allow detection of circumpolar trends. It noted the potential of circumpolar studies such as the forthcoming 'Antarctica InSync' initiative to further improve our understanding on trends at large scale levels.

Acoustic methods for measuring biomass, flux, seasonality, and behaviour from alternative platforms

6.1 WG-ASAM-2025/12 described a method employing a single upward looking moored ADCP and echosounder data for estimating temporal variability of krill biomass densities and oceanographic current patterns in East Antarctica. Biomass densities were found to be highest in winter and lowest during summer. Integrating the acoustic signal over short distances (1 nm) based on the integrated water flow above the mooring, and converting it to biomass densities based on historical, interpolated length-frequency data from the same region led to high covariances for biomass densities. Using integration distances comparable to those from ship based transect surveys (250 nm) significantly reduced the covariance while the biomass density estimates remained robust. The study concluded that scaling mooring echosounder data to survey area biomass estimates requires an array of moorings and appropriate methods must be determined to derive spatial variance from stationary platforms. The authors noted that autonomous platforms are increasingly used to monitor Antarctic krill, and in areas and seasons inaccessible to traditional ship-based surveys this method could provide an alternative solution.

6.2 The Working Group congratulated the authors on the work and highlighted that increased use of alternative monitoring platforms can provide a deeper understanding and data to support management and conservation decisions. The Working Group noted that future work could consider the depth-stratification of currents above the mooring when integrating the acoustic signal, and that arranging moorings in arrays has great potential to track the movement of krill swarms in relation to current flow, and to advance our understanding of krill flux.

6.3 WG-ASAM-2025/15 reported from the work performed by the U.S. Antarctic Marine Living Resources (U.S. AMLR) on deploying two gliders equipped with oceanographic sensors and a wide-band echosounder to estimate krill biomass in the Bransfield Strait. Initial discrepancies in biomass density estimates between the two gliders were resolved by using a more rigorous calibration procedure. Length frequency data of krill derived from penguin diet analyses were used to convert the acoustic signal into biomass density estimates. The authors emphasised that more suitable methods for providing representative length frequency estimates are needed. Revised biomass densities based on the 120 kHz ranged from 35.67 to 37.4 g m^{-2} using the 'ALL energy' method and from 32.81 to 33.82 g m^{-2} using the swarms-based method. The authors also presented a new way of calculating variance estimates for the obtained biomass densities based on spatial gridding of the acoustic observations and random resampling. The reanalysis supports the use of autonomous gliders for acoustic surveys of krill biomass, suggesting they could be a key data source for assessing krill populations at least for some parts in the Southern Ocean. The findings highlight the effectiveness of using autonomous gliders for krill biomass estimation and the ongoing efforts to improve and expand this monitoring method.

6.4 The Working Group expressed their appreciation for the progress made in developing alternative data collection platforms. It noted the use of vertically downward-facing transducers and highlighted the potential of shadowgraph systems for measuring organisms. The Working Group was particularly impressed by the alignment of cruise tracks between the two gliders.

6.5 The Working Group emphasised the importance of considering how these measurements could be integrated into fisheries management and the broader understanding of regional ecosystems. The Working Group noted that the transects from the annual Chinese acoustic surveys (WG-ASAM-2025/21 Rev. 1) align well with the transects carried out by the glider deployments and suggested that this alignment could facilitate platform comparisons on biomass densities and other relevant metrics.

6.6 WG-ASAM-2025/20 provided an overview of the recent deployment of echosounders on autonomous platforms to enhance understanding of krill distribution and behavior across the Southern Ocean. The paper aimed to stimulate discussion and foster collaboration at WG-ASAM-2025 regarding the broader use of autonomous platforms, particularly in relation to the WG-ASAM work plan item 2 (b) (i) (1). It highlighted how autonomous platforms were being used to study krill in the Southern Ocean and the strengths and weaknesses of different platforms. The authors concluded that autonomous platforms were able to effectively study krill and ecosystems.

6.7 The Working Group acknowledged the importance of clarifying the usage and utility of each platform, identifying what each can deliver and how they can complement each other. It was noted that autonomous platforms, including moorings and gliders, can provide valuable data on krill behavior, vertical distribution, flux, and biomass estimates. As such, the Working Group considered it necessary to identify the best use of each platform to contribute to the general management of the krill fishery.

6.8 The Working Group identified that summarizing the application of each platform and which variables it could measure would be useful information to consider how autonomous vehicles may contribute to either krill biomass, distribution or behaviour studies. It noted that some technology, such as gliders, were quite advanced in the development of methods and encouraged the authors of WG-ASAM25/20 to develop guidelines for surveying krill from gliders.

6.9 WG-ASAM-2025/19 reported from a comprehensive study of krill flux and emphasises the need for consistent standardised methods for gathering and analyzing data from various survey types. Combining acoustic, oceanographic, and trawl data can provide a holistic view of krill flux. A practical implementation was carried out on the research vessel RV *Atlántida* to assess the movement and distribution of krill in relation to ocean currents and analyse how krill distribution varies spatiotemporally. The study demonstrated the practical significance of standardised data collection and integration of multiple data sources. These findings are crucial for developing effective krill fishery management schemes that are informed by ecosystem dynamics.

6.10 The Working Group noted that the paper is an updated version of a paper submitted to previous meeting WG-ASAM-21/05 and recalled the previous discussion (WG-ASAM 2021, paragraphs 4.1 to 4.5).

6.11 The Working Group noted the improvements made in the revised paper and recognised the ongoing efforts to enhance the understanding of krill biomass and distribution. The Working Group noted that integrating oceanographic data, providing standardised reporting, and focusing on numerical support for assertions, CCAMLR may be able to better manage krill populations and the Southern Ocean ecosystem.

6.12 The Working Group noted that several papers have identified the importance of integrating oceanographic data with acoustic survey data to improve krill biomass estimates and emphasised the need for standardised statistical reporting, namely the inclusion of summary statistics, to ensure consistency and comparability of data.

6.13 WG-ASAM-2025/P01 assessed the importance of seasonal variation in the diel vertical migration of krill for fecal pellet-driven particulate organic carbon export based on one year of acoustic observations from East Antarctica and a numerical model. The study demonstrated that the total POC flux from krill fecal pellets was estimated to be 9.68 milligrams of carbon per square meter per day (mg C m^{-2} day^{-1}). A maximum of 25% of krill migrated to depths greater than 200 m, and showed a strong seasonal component. This migration transported less than 10% of the total krill POC flux (1.28 mg C m^{-2} day^{-1}) to the deep ocean. The study noted that accurate estimates of seasonal carbon flux are essential for informing climate policy and mitigation strategies and concluded that models including vertical migration will overestimate active carbon export by vertical migration if they do not account for the seasonality of krill migration.

6.14 The Working Group congratulated the authors on their work and emphasised the importance of acknowledging the variability in the diel vertical migration behaviour of krill observed in many regions when estimating carbon flux, biomass and observing ecosystem processes. The Working Group also noted that the growing number of long-term krill behaviour observations from various Southern Ocean regions provides significant opportunities for collaborative research on the drivers of krill behavioural variability on a large scale.

6.15 WG-ASAM-2025/P02 presented a method for identifying krill swarms using vessel-based acoustics and U-Nets, which are convolutional neural networks originally developed for biomedical image processing. The study compared U-Nets trained on single-frequency data with those trained on two- and three-frequency data. While the three-frequency U-Net demonstrated the best performance, all U-Nets achieved high accuracies of more than 90%. The study noted that due to their computational efficiency, U-Nets could be useful tools for identifying krill swarms, particularly for processing large batches of data.

6.16 The Working Group welcomed the study and recognised the usefulness of U-Nets for analysing acoustic data. The Working Group noted that additional analyses assessing the performance of U-Nets when applied to acoustic data from different platforms would help evaluate their robustness. Additionally, the Working Group encouraged systematic comparisons of biomass densities predicted by U-Nets versus established methods, such as the dB-difference and the swarms-based identification methods. The Working Group recognised this study's contribution to the advancement of open-source acoustic data processing tools.

Develop methods to estimate biomass of finfish using acoustic techniques

7.1 WG-ASAM-2025/11 proposed to conduct an acoustic-trawl survey of mackerel icefish *Champsocephalus gunnari* in Subarea 48.2, beginning from the 2025/2026 fishing season (during three fishing seasons). The main objective of this proposal is to determine the distribution and abundance of *C. gunnari* in Subarea 48.2 and understand the stock structure. The survey also aims to estimate the catchability of fishing gear (midwater trawl) for *C. gunnari*, using available acoustic data and video data from a trawl video camera system. It will collect data on the spatial and depth distributions of by-catch species, conduct by-catch mitigation measures, and compare the main biological parameters of *C. gunnari* from catches during the survey with those obtained in previous years of research (historical scientific data). Plankton samples and oceanographic research will also be undertaken in this proposed survey.

7.2 The Working Group welcomed this updated proposal which included addressing previous suggestions including the installation and calibration of the 38 kHz echosounder. The Working Group commended the collaboration between Norway and Ukraine to produce a fast and reliable calibration method for the MV *More Sodruzhestva,* and the potential for further support when analysing the resultant survey data.

7.3 The Working Group noted that stomach content examination would be helpful to understand the trophic interaction between *C. gunnari* and krill. The Working Group encouraged examination of the target strength of *C. gunnari* using various models, to help improve the acoustic assessment of this species biomass.

7.4 The Working Group noted the addition of two transects (T8 and T9), perpendicular to the other transects. It encouraged the authors to add an additional transect to that area to create a new stratum (comprised of T8, T9 and an additional parallel transect), which would enable the use of the Jolly-Hampton survey estimator to calculate the CV of an acoustic biomass estimate.

7.5 The Working Group noted the difference between the towing duration for pre-determined stations (30 minutes) and targeted stations (60 minutes). It recommended the authors explain the reason for the different tow durations for consideration by WG-FSA-2025.

7.6 With the change to the survey design and with the considerations by WG-FSA-2025 on towing duration, the Working Group agreed that the survey design and echosounder use was appropriate for the research proposal purpose and should be considered by the Scientific Committee.

Future work

8.1 The Working Group considered revisions to its current workplan as described in SC-CAMLR-43, Table 6 and recommended the following changes:

(i) The Working Group discussed the use of contributor names in the table and recommended that names be used, but that the caption should indicate that, in the case where the named scientists were not present, the lead developer of work on the specified topic would revert to the Scientific Committee Representative of the relevant Member.

(ii) Revise the term ‘Contributor’ as a column name to ‘Lead’

(iii) Remove 1 a (i) as it is included within the scope of 1 a (ii)

(iv) Add a new Task (5): Develop spatial estimators for acoustic biomass data

(v) The Working Group noted that 1 a (iii) on the specification of sample sizes has been completed and this item can be removed.

(vi) The Working Group noted that item 1 a (iv) (6) has made significant advances in analysis of acoustic data using new technologies

(vii) Add ‘including seasonal and regional effects of developmental stage’ to Task 3 and remove 1 a (iv) (4).

(viii) The Working Group noted progress on the development of biomass estimates in 48.1 (1 b (iv) 1), for example paper WG-ASAM-2025/21 Rev. 1.

(ix) In item 1 b (v), change the word ‘species’ to ‘krill’

(x) In item 1 b (iv) 1, change ‘Movement’ to ‘Advection’, and add two additional items, ‘Vertical distribution’ and ‘Seasonal variability’

(xi) Item 1 b (iii) regarding ecosystem indicators can be removed as it applies to other working groups.

(xii) Regarding item 2 a (i), the Working Group noted that there are many products that can be derived from acoustic data that could be used by other working groups (e.g. WG-ASAM-2025/04, monitoring of krill predators from acoustic data, or environmental data recorded during acoustic surveys). Therefore, revise 2 a (i) 1 to 'CEMP related products for use by other working groups' and 2 a (i) 2 to 'Fishery via SISO related products for use by other working groups'

(xiii) Revise 2 b (i) (1) to 'moored or autonomous platforms'

(xiv) Remove the references to Annex 4, Table 2, 1.a.iv under Timeframe.

8.2 The Working Group noted that several papers submitted to this meeting were based on data collected in the current fishing season, and commended authors on the rapid analysis and provision of papers to WG-ASAM. The Working Group further noted that the ability to provide work so quickly may be a result of holding the WG-ASAM-2025 meeting a month later than typical.

Other business

9.1 The Working Group noted that WG-SAM-2025 had referred paper WG-SAM-2025/28 to WG-ASAM for review as it was mostly about acoustic survey design and analysis. However, the Working Group noted that the short period between WG-SAM and WG-ASAM did not allow enough time for review and further noted that it would be beneficial to have the author of the paper present to discuss the work. Therefore, the Working Group encouraged the author to submit the paper to WG-ASAM-2026 for review and discussion.

9.2 The Working Group noted that in recent years, acoustic surveys and analysis methods work had become even more relevant in providing advice on the management of krill and ecosystems, and that these demands required broader participation than acousticians to develop advice.

9.3 The Working Group noted that with the broader uses of acoustic data and analysis, the topics discussed may exceed the Terms of Reference for the Working Group and suggested the Scientific Committee consider revising the Terms of Reference when the strategic workplan is revised in 2026.

9.4 The Working Group noted that the number of papers and participants in WG-ASAM had increased through time, but that the number of participating Members had not increased and encouraged Members to send participants to contribute relevant expertise and new perspectives to WG-ASAM meetings.

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) Core strata acoustic surveys (paragraph 3.7)

(ii) Winter acoustic surveys (paragraph 3.9)

(iii) Spacing of survey trawl sampling (paragraph 3.11)

(iv) PB1/PB2 boundaries (paragraph 3.8)

(v) Reporting of survey trawl catch data (paragraph 3.41)

(vi) Revisions to the WG-ASAM workplan (paragraph 8.1)

(vii) Revision of the WG-ASAM Terms of Reference (paragraph 9.3).

Adoption of the report and close of the meeting

11.1 The report of the meeting was adopted, with the adoption process requiring 3.8 hours of discussion.

11.2 At the close of the meeting, Dr Fielding thanked the participants for their work and a successful meeting.

11.3 Dr X. Zhao (China) expressed his gratitude and thanks to the conveners for leading the Working Group and especially to Dr Fielding for her skilful mastery of the group and for her contributions to the work of CCAMLR in developing the KFMA. He looked forward to the growing advice from WG-ASAM.

11.4 Dr Krafft thanked the conveners and participants for coming to Geilo for a productive week and wished safe travels home to those not remaining in Geilo for WG-EMM-2025.

11.5 Dr Cárdenas thanked the conveners for their service and great work, and reflected on the experience from his second time participating in WG-ASAM, noting that the work of WG-ASAM continued to grow and provide important advice.

11.6 Dr Wang thanked the Secretariat for their support and especially Dr S. Thanassekos (Secretariat) for his expert and quick remote support in the development of the acoustic survey design framework.

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Table 1 Details of scientific echosounders installed on fishing vessels notified for the 2025/26 fishing season. 1 = present. The transducer frequencies are marked as present solely if the vessel is equipped with a scientific echosounder (either EK80 or EK60)

Vessel	**Echosounder**		**Frequency (kHz)**			
	EK80	**EK60**	**200**	**120**	**70**	**38**
Antarctic Endeavour	1			1	1	
Antarctic Endurance	1			1	1	1
Antarctic Navigator	1		1	1	1	1
Antarctic Sea						
Fu Xing Hai	1			1	1	1
Fu Yuan Yu 9199	1			1	1	1
Hua Xiang 9		1		1	1	1
Long Fa	1			1	1	1
More Sodruzhestva						
Sae In Leader						
Saga Sea						
Sejong	1			1	1	1
Shen Lan	1					1
Yong Li	1			1	1	
TOTAL	9	1	1	9	9	8

Table 2 Spatial coverage results for Subarea 48.1, including estimated time required to complete surveys by a single vessel assuming a station distance of 40 nm (WG-ASAM-2024 Figure 1b) no transit between transects and a station duration of 1.5 hours and a vessel speed of 10 kn. MU = Management unit. EI = Elephant Island, JOIN = Joinville Island, BS = Bransfield Strait, SSIW = South Shetland Islands West, GS = Gerlache Strait, DP = Drake Passage, PB = Powell Basin

MU	Area (km^2)	Transect length (km)	Survey coverage index ($T/\sqrt{A}$)	Transect length (nm)	No of stations	Time (hrs)	Time for stations	Total time (transects + stations) (hrs)	Total time (transects + stations) (days)
EI	51669	1311	5.78	707.88	17.70	70.79	26.55	97.33	4.06
JOIN	23033	306	2.02	165.23	4.13	16.52	6.20	22.72	0.95
BS	35208	525	2.80	283.48	7.09	28.35	10.63	38.98	1.62
SSIW	59293	1359	5.58	733.80	18.35	73.38	27.52	100.90	4.20
GS	61088	1262	5.11	681.43	17.04	68.14	25.55	93.70	3.90
DP1	41688	678	3.32	366.09	9.15	36.61	13.73	50.34	2.10
DP2	224045	2427	5.13	1310.48	32.76	131.05	49.14	180.19	7.51
PB1	45456	985	4.62	531.86	13.30	53.19	19.94	73.13	3.05
PB2	99236	1906	6.05	1029.16	25.73	102.92	38.59	141.51	5.90
Total	640716	10759		5809.40	145.23	580.94	217.85	798.79	33.28

Table 3 Variables required to describe research trawls used for krill sampling during acoustic surveys.

1) Trawl name: _________ (i.e., RMT8, Macroplankton)
2) Mesh:
   - Mesh size: bar length _______ mm ; diagonal (stretch) length ______ mm
   - Mesh design: Diamond ______; Square _______ (mark one)
   - Material: ___________; Diameter: _______mm
3) Trawl size:
   - Mouth size: horizontal _______m; vertical ________m
   - Frame type: beam trawl ________ ; rigid frame __________ ; other ______ (describe)
   - Open-closing trawl _____
   - No. warp cables: _______
   - Net length: ________m
4) Operational:
   - Towing speed: ________ knots through the water / over ground (mark one)
   - How towing speed is measured:
   - Veering (setting) speed: ________ m/s
   - Hauling speed: ________ m/s
   - Oblique or V-haul/Double oblique haul:
   - Depth range trawl was open (sampling):
     (i) Min _______ m ; Max _______m
     (ii) Min _______ m ; Max _______m
     (iii) Min _______ m ; Max _______m
5) Instrumentation:
   - Flowmeter in trawl?: ______ (yes/no); If yes: Make _________; model ________
   - TD in the trawl? ______ (yes/no); If yes: make ________ ; model _______
   - CTD in the trawl? ______ (yes/no); If yes: make ________ ; model _______

Mesh size measurement:

- Bar length or corner-to-corner length: using a calliper, measure the distance of one mesh side, from corner to corner (or knot-to-knot)
- Diagonal (or stretched) length: measure the length by stretching a mesh over a ruler or mm paper

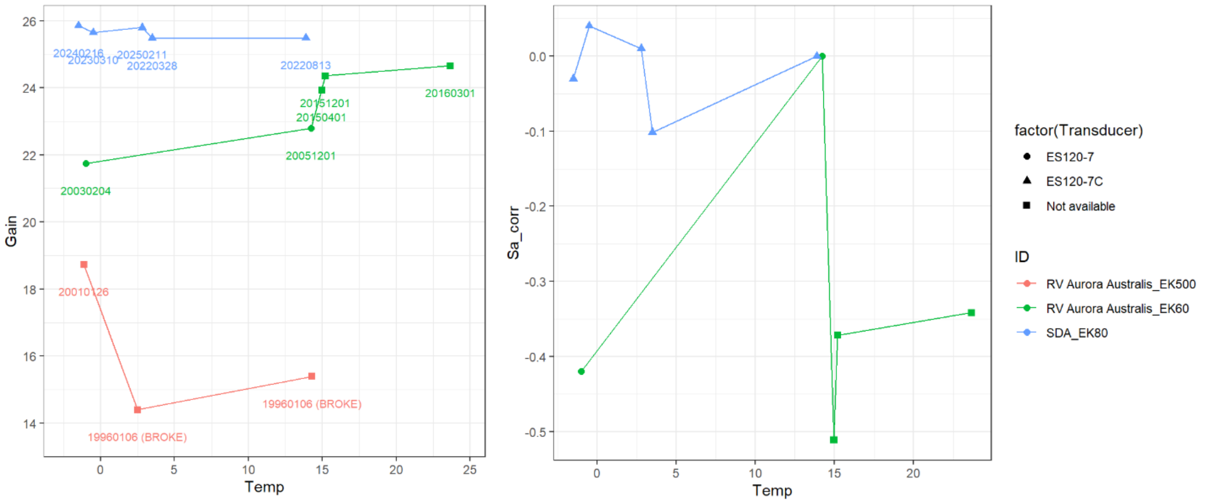

Figure 1: Results of how echosounder Gain (left) and S_a correction (right) vary with temperatures for different platforms and transducers. Labels on the Gain plot are dates of calibration. Note that ice windows on the *RV Aurora Australis* were changed between 2005 and 2015 and are the likely source of the change at this time.

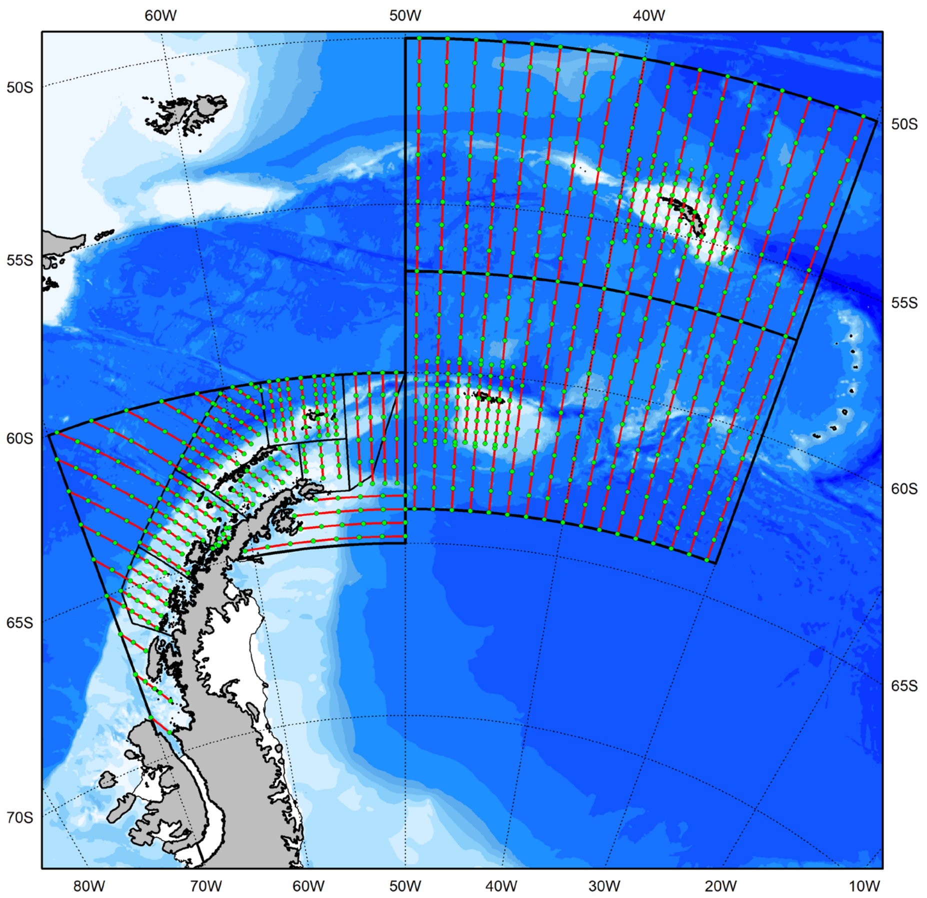

Figure 2: Draft acoustic-trawl survey design for Subareas 48.1, 48.2 and 48.3 to be further developed intersessionally and considered at WG-ASAM-2026.

Appendix A

List of Participants

Working Group on Acoustic Survey and Analysis Methods
(Geilo, Norway, 30 June to 4 July 2025)

Co-convener	Dr Sophie Fielding British Antarctic Survey
Co-convener	Dr Xinliang Wang Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
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
	Dr Abigail Smith Australian Antarctic Division
Chile	Dr César Cárdenas Instituto Antártico Chileno (INACH)
China	Dr Xianyong Zhao Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
	Mr Shuai Li East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences
	Mr Ling Zhi Li East China Sea Fisheries Research Institute
	Dr Yunxia Zhao Yellow Sea Fisheries Research Institute
	Professor Guoping Zhu Shanghai Ocean University
Germany	Mr Dominik Bahlburg Alfred-Wegener-Institut

Japan	Dr Hiroto Murase Tokyo University of Marine Science and Technology Dr Tomohiko Matsuura Japan Fisheries Research and education agency
Korea, Republic of	Dr Eunjung Kim National Institute of Fisheries Science Dr Hyoung Sul La Korea Ocean Polar Research Institute (KOPRI)
Norway	Dr Bjørn Krafft Institute of Marine Research
Ukraine	Mr Viktor Podhornyi Institute of Fisheries, Marine Ecology and Oceanography (IFMEO)
United Kingdom	Dr Tracey Dornan British Antarctic Survey
CCAMLR Secretariat	Dr Steve Parker Science Manager Daphnis De Pooter Science Data Officer

Appendix B

Agenda
Working Group on Acoustic Survey and Analysis Methods
(Geilo, Norway, 30 June to 4 July 2025)

1. Introduction

    1.1 Opening of meeting

    1.2 Adoption of the Agenda

2. Review terms of reference and workplan

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

    3.1 Methods for calibrating echosounders on vessels

    3.2 Acoustic transect design and data collection

        3.2.1 Review and recommend spacing and sampling stations for transects

        3.2.2 Implementation of acoustic transect surveys

        3.2.3 Transect designs for other areas

    3.3 Krill biological data collection protocols

    3.4 Oceanographic data collection protocols

    3.5 Submission of acoustic data

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

    4.1 Survey stratification and spatial estimators

    4.2 Standardised analysis and reporting of acoustic biomass estimates

5. Krill biomass estimates

    5.1 Area 48 biomass estimates

    5.2 Area 58 biomass estimates

6. Acoustic methods for measuring biomass, flux, seasonality, and behaviour from alternative 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 the report and close of the meeting

List of Documents
Working Group on Acoustic Survey and Analysis Methods
(Geilo, Norway, 30 June to 4 July 2025)

WG-ASAM-2025/01	Updates to the CCAMLR Acoustic Data Repository CCAMLR Secretariat
WG-ASAM-2025/02	The benefits of integrating the Krill Stock Hypothesis (KSH) as an integral Part into the Revised Krill Stock Management Approach (KSMA) Meyer, B., D. Bahlburg, C.A. Cárdenas, S.L. Hill, S. Kawaguchi, B.A. Krafft, S. Labrousse, D. Maschette, Z. Sylvester, P. Ziegler and J.A. Arata
WG-ASAM-2025/03	"International Science & Infrastructure for Synchronous Observation (Antarctica InSync)" – how can CCAMLR`s needs be met? Meyer, B. and B. Krafft
WG-ASAM-2025/04	Potential topics of mutual interest to WG-ASAM and WG-EMM for joint discussion Scientific Committee Bureau
WG-ASAM-2025/05	SKEG Symposium 2025 Report Bahlburg, D., S. Kawaguchi, B. Meyer and Z. Sylvester
WG-ASAM-2025/06	Acoustic estimation of Antarctic Krill Biomass using two- and three-frequency methods in the Krill Research Zone of the Ross Sea Region Marine Protected Area Son, W., J. Kim and S. La
WG-ASAM-2025/07	Acoustic survey of Antarctic Krill abundance in Gerlache Strait in May 2025 Menze, S. B.A. Krafft, G. Zhang and J. Arata
WG-ASAM-2025/08	An estimate of mesoscale biomass of Antarctic krill (*Euphausia superba*) in the East Antarctic Cox. M., N. Kelly, S. Kawaguchi, M. Double and E. Bell
WG-ASAM-2025/09	Antarctic krill and ecosystem monitoring survey off the South Orkney Islands in 2025 Krafft, B.A., L. Krag, G. Zhang, S. Menze, G.E. Aguirre and A.F. Rasmussen
WG-ASAM-2025/11	Fishery Research Proposal: The Acoustic-Trawl Survey *Champsocephalus gunnari* in the Statistical Area 48.2 Delegation of Ukraine

WG-ASAM-2025/12	Krill biomass estimations from moored upward looking echosounders A.J.R. Smith, S. Wotherspoon, G.R. Cutter, G.J. Macaulay, M.J. Cox
WG-ASAM-2025/13	Observations of krill vertical distributions: implications for correction factors and timing of traditional acoustic surveys Zhang G. and B.A. Krafft
WG-ASAM-2025/14 Rev. 1	Proposed at-sea krill data collection plan and protocol for fishing vessels Kawaguchi, S., D. Maschette, Y. Ying, J. Arata, M. Cox, T. Ichii, N. Kelly, B. Meyer, A. Pettersen, F. Santa Cruz, A. Smith and M. Kane
WG-ASAM-2025/15	Revised biomass density estimates of Antarctic krill in Bransfield Strait during the 2023/24 austral summer from a new glider-based wideband echosounder; forthcoming biomass estimates from the 2024/25 glider deployment and mooring and glider deployment plans for 2025/26 Cossio, A.M. and C.S. Reiss
WG-ASAM-2025/16	Summary of Australia's recent research on Antarctic krill and interactions in the East Antarctic ecosystem Cox, M.J., A.J.R. Smith and S. Kawaguchi
WG-ASAM-2025/17	SKEG Symposium 2025 Report Bahlburg, D., S. Kawaguchi, B. Meyer and Z. Sylvester
WG-ASAM-2025/18	Update to the Polar Ocean Ecosystem Time-Series Western Core Box krill density Fielding, S., G Tarling, R Saunders, G Stowasser and S Thorpe
WG-ASAM-2025/19	Proposal for estimating krill flux indices Kasatkina S, and V. Shnar
WG-ASAM-2025/20	Use of autonomous platforms to study krill in the Southern Ocean Dornan, T., S. Fielding, B.A. Krafft, C. Reiss, A. Cossio and M.J. Cox
WG-ASAM-2025/21 Rev. 1	Preliminary results from the acoustic surveys of Antarctic krill conducted by the Chinese fishing vessel in Subarea 48.1 during austral summer 2025 Wang, X., Y. Zhao, J. Wang, H. Zhang, J. Zhang, Y. Ying, G. Fan, J. Zhu and Xianyong Zhao

Other

WG-ASAM-2025/P01	Antarctic krill vertical migrations modulate seasonal carbon export Smith, A.J.R., S. Wotherspoon, L. Ratnarajah, G.R. Cutter, G.J. Macaulay, B. Hutton, R. King, S. Kawaguchi and M.J. Cox *Science*, 387:6732 (2025). doi: https://doi.org/10.1126/science.adq5564.
WG-ASAM-2025/P02	Using U-Net convolutional neural network to enhance multi-frequency acoustic signal extraction of Antarctic krill (*Euphausia superba*) Zhu, G.P., Q.H. Mao, Z. Chen and Y.D. Li *Mar. Ecol. Prog. Ser.*, 760:55-69 (2025). doi: https://doi.org/10.3354/meps14842.