Annex 6

Report of the Working Group on Ecosystem Monitoring and Management (WG-EMM-2025)
(Geilo, Norway, 7 to 18 July 2025)

Contents

Report of the Working Group on
Ecosystem Monitoring and Management
(Geilo, Norway, 7 to 18 July 2025)

Introduction

1.1 The 2025 meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM-2025) was hosted by the Institute of Marine Research of Norway, at the Vestlia Resort in Geilo Norway, from 7 to 18 July 2025, and organised by Ms V. Vilanger (Norway).

Opening of the meeting

1.2 The meeting convener, Dr J. Hinke (United States of America (USA)) welcomed participants (Appendix A) to the meeting and noted the presence of both familiar and new participants. The participants were welcomed to the Vestlia venue, which was humbled by the extensive international involvement to a venue more typical for local people. The participants were also welcomed to Geilo by Dr B. Krafft (Norway). He noted that it was a thrill to have scientists and experts from all over the world in Geilo and pointed them to the reminders of Antarctica present, such as mountains, glaciers, and even reindeer (which until recently could be found within Subarea 48.3). He also noted the ancient cultures and history of the region and encouraged participants to explore the local nature and use the inspiration in their science to provide advice on the sustainable management of Antarctic marine living resources.

Adoption of the agenda, rapporteurs and proposed schedule

1.3 The agenda was adopted without change (Appendix B), noting a request to bring paper WG-ASAM-2025/16 forward to WG-EMM under agenda Item 4.5.

1.4 The Working Group noted that it may be desirable to incorporate direct reporting on WG-EMM work relative to the Terms of Reference (https://www.ccamlr.org/en/science/working-goup-ecosystem-monitoring-and-management-wg-emm) by providing summary text within the report that links the terms of reference to individual paragraphs.

1.5 The Secretariat provided a summary of the improvements made to the Spatial Data Viewer (https://ccamlrgis.shinyapps.io/public/), including several versions that make data available to either public, working groups, or specifically for acoustic survey work.

1.6 The Working Group thanked the Secretariat for the further development of this useful tool, which has provided an intuitive mechanism to bring all participants to the same understanding of the spatial relationships in CCAMLR data. For example, WG-ASAM-2025 found the tool useful for planning acoustic survey design relative to sea ice distribution and polar front features (WG-ASAM-2025). The Working Group encouraged further development of the tool and continuous access for Members to conduct research and support the provision of science to CCAMLR.

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

1.8 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 item 8 'Advice to the Scientific Committee'.

1.9 The report was prepared by P. Brtnik, D. Bahlburg and F. Bellotto Trigo (Germany), C. Cárdenas (Chair of the Scientific Committee), M. Collins (United Kingdom (UK)), M. Eléaume (France), L. Emmerson (Australia), L. Eon (France), S. Fielding (UK), N. Friscourt (France), S. Hill (UK), K. Hoszek-Mandera (Poland), E. Deehr Johannessen (Norway), S. Kawaguchi and N. Kelly (Australia), E. Kim (Republic of Korea (Korea)), B. Krafft (Norway), D. Krause (USA), L. Krüger (Chile), S. Labrousse (France), A. Lowther (Norway), A. Makhado (South Africa), M. Mori, H. Murase and T. Okuda (Japan), A. Panasiuk (Poland), E. Pardo (New Zealand), S. Parker (Secretariat), F. Santa Cruz (Chile), M. Santos (Argentina), F. Schaafsma (Netherlands), Z. Sylvester (Belgium), C. Waluda (UK), X. Wang (People's Republic of China (China)), V. Warwick-Evans (UK), C. van Werven (Secretariat), Y. Zhao and G. Zhu (China).

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

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

1.12 The Working Group noted the workplan set out in Table 8 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'.

1.13 The Working Group noted that scheduling WG-ASAM-2025 adjacent to WG-EMM-2025 provided an opportunity for scientists to participate in both meetings and bringing together the different but related scientific expertise in CCAMLR relative to management and understanding the ecology of krill.

1.14 The Working Group also noted that WG-ASAM-2025/04 was submitted by the Scientific Committee Bureau to identify topics about which WG-EMM sought advice from the expertise within WG-ASAM. The WG-ASAM co-conveners were present at WG-EMM-2025 to bring these considerations and feedback to WG-EMM.

Ecosystem monitoring

2.1 WG-EMM-2025/24 presented the progress towards defining high-level strategic objectives for ecosystem modelling to deliver on the Terms of References (ToRs) of the IWC Intersessional Correspondence Group (ICG) on the provision of advice on cetacean science to inform CCAMLR's revised krill fishery management approach (KFMA), CEMP, and ecosystem modelling. The document outlined a proposed paper to be presented at the IWC

Scientific Committee meeting in April 2026 that will address the high-level strategic objectives, relevant modelling efforts and guidance for modellers. The authors will work with relevant experts from both organisations.

2.2 The Working Group welcomed the paper recognising the value of the work for EMM on krill-whale interactions, including in the Krill Fishery Management Approach (KFMA).

2.3 The Working Group noted the modelling components needed to inform management discussions for both CCAMLR and IWC, pointing out that for this specific task the focus was on whales and krill, while recognising that for future work on food webs, other existing ecosystem models, including those with a broader range of components, could be considered.

2.4 WG-EMM-2025/29 summarised the voyage ACTUATE (AntarCTic soUthern oceAn scientific rEsearch) onboard the RV *Tangaroa* conducted in 2025. The voyage objectives were aligned to the specific objectives and the RMP of the Ross Sea Region Marine Protected Area (RSrMPA). Sampling effort was designed to address a wide range of areas and ecosystems, and the voyage objectives included hydrography, benthic ecology, fish eDNA, oxygen budgets and zooplankton. The main survey area was the Western Ross Sea from Iselin Bank to Cape Adare and as far south as the Ross Ice Shelf front. The paper highlighted the importance and benefits of autonomous monitoring such as ocean gliders and Argo profiling floats.

2.5 The Working Group recognised the success of the voyage, the international collaborations and the value of the data collected in the framework of the research and monitoring plan of the RSrMPA, particularly for its specific objectives and review. The Working Group noted the importance of standardising data collection procedures and protocols for eDNA, inclusion of acoustic data collection as well as predators and bird observations. The authors welcomed further collaboration with other CCAMLR scientists for the next survey planned in 2027.

2.6 WG-EMM-2025/40 presented the current status and advances of the WOBEC (Weddell Sea Observatory of Biodiversity and Ecosystem Change) project, a three-year EU funded research program that started in April 2024. WOBEC project outcomes support the development of a systematic ecosystem monitoring framework for the eastern Weddell Sea / Kong Haakon VII Sea. The paper highlighted the activities and outcomes of the first year, including a first version of a data management plan and a first draft of a catalogue of standard operating procedures to prevent loss of methodological expertise over time. The paper also provided an outlook of upcoming activities such as a second stakeholder workshop in November 2025 and the expedition with RV *Polarstern* (PS152), from December 2025 to February 2026 in the WOBEC study area.

2.7 The Working Group congratulated the authors on the project and the work done so far, in particular the open and transparent data management plan. The authors encouraged CCAMLR scientists to join the project.

Krill biology and ecology

2.8 WG-EMM-2025/48 Rev. 1 presented the preliminary results of a multidisciplinary krill survey covering five core candidate management units (MU) of the revised KFMA in Subarea 48.1 in February 2024. Analyses were focused on potential linkages between krill distribution, stock structure and water masses. Preliminary results indicated distinctive geographic distribution patterns between spawning and juvenile krill. Spawning krill was mainly distributed in offshore waters beyond the shelf break dominated by the Transitional Bellingshausen Water (TBW) and the modified Circumpolar Deep Water (mCDW), while juveniles were mostly observed in the Antarctic Peninsula shelf water within the Bransfield Strait and Joinville Islands waters dominated by the Transitional Weddell Water (TWW) and mCDW. These findings suggested that oceanographic processes may play a critical role on shaping krill stock structure distribution. The authors highlighted the importance of stage-specific distribution information for the development of the Krill Stock Hypothesis (KSH) and the improvement of the KFMA.

2.9 The Working Group congratulated the authors on the amount of valuable data collected, stressing the importance of these datasets to improve KFMA in relation to the KSH and knowledge about stock structure in the region. The Working Group noted that the distribution pattern of the spawning and juvenile kill observed from this survey is consistent with previous findings (Siegel, 1988) and noted that spatial distribution and seasonality of krill stock structure are important for future krill fishery management. The Working Group noted that for biomass estimation purposes, day and night size sampling needs to be analysed separately. The Working Group further noted that such datasets are useful for predator modelling in the Bransfield Strait and encouraged further collaboration on progressing this work.

2.10 The Working Group noted that further analyses are needed to investigate the sex difference in length at 50% maturity observed during this survey, which appears larger than previous estimates from samples collected in early spawning season.

2.11 The Working Group noted that while the Grym assumes equal fishing mortality across age classes, the spatial stage segregation implies that this assumption might not always apply. The Working Group encouraged analysis of the sensitivity of Grym predictions to other assumptions about life stage-specific fishing mortality to be assessed in the future.

2.12 The Working Group further noted that the CMIX method was used for krill cohort analysis based on krill length distribution from this survey and encouraged further development of such method on krill age class identification.

2.13 WG-ASAM-2025/21 Rev. 1 presented the preliminary results from the krill acoustic surveys conducted by the Chinese fishing vessel *Long Fa* in Subarea 48.1 during the austral summer of 2025. Results covered the five MUs in Subarea 48.1 (GS, JOIN, BS, EI and SSIW) of the KFMA and included krill acoustic density, length-frequency distribution and water mass analysis.

2.14 The Working Group congratulated the authors for their comprehensive work that included oceanographic, biological, and acoustic data collection delivered in a short time. The Working Group noted the difference of spatial distribution results between February 2024 and January 2025, probably due to reduced reproductive activity in February, and suggested further work is needed to understand these differences. The authors noted that further surveys are planned for the next seasons provided funding is available. The Working Group noted that the survey was conducted during both daytime and night-time, suggesting that there is variation in the diurnal behaviour of krill and a potential underestimation of the krill biomass distributed near the surface at night.

2.15 WG-EMM-2025/56 presented results from the multidisciplinary oceanographic research voyage onboard IBRV *Araon* in March 2024. The paper reported on the first acoustic survey of Antarctic krill (*Euphausia superba*) density distribution in the Krill Research Zone (KRZ) of the RSrMPA. The results showed that horizontal and vertical distributions of Antarctic krill reveal a pronounced ontogenetic segregation across the Ross Sea survey area, where juveniles were primarily concentrated near the seasonal ice-edge at high-latitude while sub-adult and adult krill are predominantly found at lower latitudes and deeper depths. The results further showed developmental stages differed in swarm depth and packing concentration and showed significant negative correlations with water temperature and distance from the ice edge. The authors highlighted the importance of stage-specific monitoring of krill populations and biomass estimates for management approaches.

2.16 The Working Group welcomed this first krill density and biomass estimation survey in the RSrMPA KRZ especially in regard to the contribution towards the objectives (vi) and (xi) of the RSrMPA and its upcoming review. The Working Group noted that while the area is likely an important foraging area for Antarctic blue whales, the KRZ is a data deficient area for krill. The Working Group acknowledged the new methods used to assess age classes using acoustic data, and noted the possible application of this approach to study interactions of predators with different age classes of krill.

2.17 The Working Group noted that there are regional differences between the Ross Sea and the Antarctic Peninsula with regard to the distribution of spawning krill during autumn, but similarities in age class distribution, and encouraged further investigation of the differences.

2.18 The Working Group recommended work to clarify the nomenclature of age classes and maturity stages and encouraged observations of predators during future surveys.

2.19 WG-EMM-2025/69 presented a study on the physical drivers of larval krill transport into the Bransfield Strait nursery area using a circumpolar regional ocean model system (ROMS) with embedded Lagrangian drifters. Results showed that, along with a combination of bathymetric constraints and development of vertical migration behaviour, summer wind regimes were highly influential on larval transport and also highlighted the importance of capturing interannual variability in environmental forcing and larval behaviour in connectivity models. The findings supported the development of the KSH by identifying key source-sink relationships and suggest the northwestern Weddell Sea to be a spawning or nursery area.

2.20 The Working Group congratulated the authors and recognised the value of their work. The Working Group noted the importance of including multiple years and interannual variability in the model and to independently ground truth assumptions on mortality of embryos based on embryo size and sinking trajectories. The Working Group noted that additional environmental parameters such as sea ice concentration and water temperature were tested but showed no significant relationship and that tidal currents will be addressed by a higher resolution version of the model. The authors shared that the data could be analysed to answer a number of questions and are publicly available from the Biological and Chemical Oceanography Data Management Office (BCO-DMO https://www.bco-dmo.org/dataset/964861). The Working Group noted previous work existed on water transport (WG-EMM-2024/55) and tidal current models (Zhou et al., 2020) that can be used to test theories generated by the model analysis. The Working Group noted the use of models may improve the understanding of the larval krill transport in this region and support the information for the KSH.

2.21 WG-EMM-2025/P06 presented a study on the interannual variability in fatty acids in Antarctic krill based on data collected by krill fishing vessels *Long Teng* and *Fu Rong Hai* in the Bransfield Strait (BS) during five consecutive autumns from 2015 to 2019, revealing seasonal food availability for krill. The results showed that krill were generally in good feeding condition in the BS in autumn, suggesting that BS could be considered an important foraging ground as well as an area that supports overwintering. It further indicated that krill fatty acid content displayed substantial inter-annual variation, which was potentially driven by phytoplankton productivity. The results further showed that krill exhibited differentiated feeding abilities and lipid retention based on their size, with the length-weight relationships and lipids of krill varying interannually. The authors highlighted the need for consideration of the effects of lipid retention when performing a stock assessment.

2.22 WG-EMM-2025/P08 presented a study on diet composition and trophic ecological niches of Antarctic krill and the pelagic tunicate (*Salpa thompsoni*) in the BS during autumn in 2022 using fatty acids, stable isotopes and stomach content analysis. The results showed a low overlap of the trophic niches, while the differentiated feeding pattern occupied by the two species promoted their coexistence.

2.23 WG-EMM-2025/P09 presented a study on the diet variability of Antarctic kill by using fatty acid profiles of the krill-dependent predator mackerel icefish (*Champsocephalus gunnari*) from South Georgia during winter and South Orkney Islands during summer. Results show that fatty acid patterns of *C. gunnari* closely reflected those of krill, indicating that prey diet composition drove predator fatty acid variations rather than dietary diversity of the predator. The authors highlighted the possibility of this novel approach to infer krill feeding ecology and trophic interactions during periods of limited direct sampling.

2.24 The Working Group thanked the authors and welcomed this valuable dataset coming as added value from fisheries activities. The Working Group cautioned using *C. gunnari* collected from krill trawlers alone to describe diet for the species, as they may not represent the feeding ecology of the species as a whole. Some individuals may feed on other sources, for example, from benthic and myctophid species and sampling from fishing vessels may select for those who feed mainly on krill. The Working Group recalled the existence of an alternative food chain for icefish in relation to krill, which is important to consider for using fatty acid profiles of mackerel icefish. The Working Group further noted the ongoing collaboration between the teams from China and the UK may provide an opportunity to address this.

2.25 The Working Group highlighted that additional oceanographic or environmental data are needed to complement fisheries datasets. The Working Group noted that such datasets are welcome to be added into SO DIET, a SCAR database for isotopic datasets. The Working Group recognised that the biomarker approach is a useful tool and could be included in the data collection plans but needed further improvements. The Working Group further noted that biomarkers may be useful to estimate length-weight relationship used for the krill stock assessments.

2.26 The Working Group noted that krill present a flexible strategy in response to co-existence competition for space and resource use, and this provides an insight for the future modelling of krill habitat, as indicated in WG-EMM-2025/P08.

Advice from WG-ASAM

2.27 The co-convener of WG-ASAM (Dr Fielding) presented a summary of the discussions on specific items of mutual interest between WG-ASAM and WG-EMM, which included:

(i) Acoustic survey design for Subarea 48.1 and future application on Subareas 48.2 and 48.3

(ii) Inter-transect and inter-station distance in areas with higher footprint of the fishery (core areas) compared with the open ocean

(iii) Transect extent in relation to areas with limited accessibility (due to sea ice extent in winter) or absence of krill (e.g. areas north of the Polar front)

(iv) Biological sampling requirements (krill length frequency) for acoustic surveys versus other sampling for other biological parameters that might be required for population dynamics or the KSH. This included the review of the biological sampling to be used for the acoustic biomass estimate surveys

(v) Standardisation or comparison of selectivity of different research trawl types

(vi) Noting that after the modifications of the candidate Management units (MUs) boundaries conducted after WG-ASAM-2024, some MUs (such as DP1 and PB2) may not have sufficient data to recalculate biomass estimates

(vii) Development of analyses comparing model-based estimates versus Jolly-Hampton (or design)-based estimates (intersessionally via a Discussion Group).

2.28 The Working Group noted WG-ASAM discussions on the use of several scientific research trawls that are currently used to collect krill length information for acoustic biomass surveys, and the need for identifying the selectivity and avoidance of different research nets. The Working Group discussed and revised some practical guidelines developed by WG-ASAM for standardising and comparing different research trawl types (Table 1). The Working Group requested the Scientific Committee task the Secretariat to circulate the survey form to Members and compile the responses to WG-ASAM-2026 and WG-EMM-2026.

2.29 The Working Group also discussed differences in mesh size for post-larval krill sampling and recommended the use of research trawls for acoustic surveys with a stretched mesh size of 9 mm or less.

2.30 The Working Group noted that biological variables required to be sampled during acoustic surveys may not necessarily be the same as those required for other purposes, such as krill biological parameters to support the development of the KSH. Hence it was noted that discussions among experts from WG-ASAM and WG-EMM during this meeting would be very beneficial to advance on the design of surveys that will inform different purposes. It also noted the importance of discussions among experts of both groups at this stage where there is a need to operationalise the development of acoustic surveys and the collection of other biological parameters.

2.31 The Working Group, in response to WG-ASAM discussions, highlighted the importance of further work on the development of model-based estimators and the integration of different data sources generated from new platforms other than vessels (e.g. gliders, mooring, etc). It also noted the importance of spatial scale and timing required of surveys that will be developed for different purposes.

2.32 The Working Group highlighted the importance of integrating the work of both groups and noted the current adjacent meetings (WG-ASAM and WG-EMM) was a very good opportunity for having experts attending both meetings discussing topics of mutual interest.

Population status and dynamics

2.33 WG-ASAM-2025/15 presented updated Antarctic krill biomass densities in Bransfield Strait using two Teledyne Webb Research Slocum G3 gliders (AMLR03 and AMLR04) during 2023/24 to correct the results presented in WG-EMM-2024/53 using the same datasets. The authors conducted a recalibration procedure using a new method because they hypothesised that error was induced by the original calibration. Their results suggested that this revised calibration procedure corrected previously reported differences. In addition to this, the U.S. AMLR 2025/26 plan includes the deployment of two gliders and up to 12 moorings in collaboration with partners operating in Subarea 48.1. One glider has an echosounder to estimate krill biomass and the other has a shadowgraph camera to capture images of small zooplankton and krill larvae. U.S. AMLR plans to deploy nine moorings, and collaboration is sought to deploy the remaining three in the Bransfield Strait. The moorings are equipped with ADCP, echosounder, and CTD sensors and will form an approximate ring around a historically high krill density area to investigate krill flux.

2.34 The Working Group noted that the U.S. AMLR program has made significant progress with developing autonomous technology to study krill biomass and population structure. It noted that the glider tracks closely followed the planned routes, demonstrating excellent navigation abilities. Nonetheless, the use of such technology requires continued refinement, e.g. additional comparisons of krill length frequencies derived from predator diets versus traditional trawl samples. The Working Group noted some of the challenges and benefits associated with autonomous monitoring and pointed out the benefit of collaboration with other programs particularly around deployment and retrieval.

2.35 The Working Group noted that moorings could be damaged by other operations including fishing and requested Members to provide information about the locations and components of moorings to the Secretariat for communication to Members for both safety and to enhance collaboration on the scientific data generated by the moorings and suggested that the Scientific Committee request mooring locations that may interfere with the fishery be notified to the fishery via the Secretariat.

Krill stock hypothesis and life history parameters

2.36 WG-ASAM-2025/02 presented ideas for integrating the Krill Stock Hypothesis into the revised Krill Fishery Management Approach to (i) ensure that management measures align with the most current and reliable ecological knowledge; (ii) establish a comprehensive framework for assessing catch limits in the face of uncertainties, including those related to climate change, and (iii) support the development of adaptive management strategies that evolve through the continuous collection of data on key ecological factors regarding krill and their primary predators. Implementing this approach will require targeted and collaborative data collection and a centralised data sharing network. The paper presented case studies to demonstrate how fisheries can contribute to data collection while promoting sustainable management. A major challenge in this effort is securing long-term funding for data collection.

2.37 The Working Group welcomed further elaboration of ideas about the development and use of the KSH and noted that the structure and connectivity of the stock should be accounted for in long term management of the fishery. The Working Group noted that the KSH can be used to test assumptions embedded in the KFMA, such as self-sustaining stocks at the subarea scale. The Working Group noted the need for clear language to distinguish between fishable krill stocks and the wider krill population. It discussed the conservation of different krill life stages.

2.38 The Working Group reviewed the trawl gear information survey form that have been developed by WG-ASAM-2025 (WG-ASAM-2025, Table 3). The form was updated by the Working Group to ensure all information required by WG-EMM will be collected, including for the purpose of informing the KSH.

2.39 The Working Group requested the Secretariat to finalise the form and circulate it to all Members to collect information on the sampling nets that are being used for surveys.

2.40 The Working Group recognised the variation between research groups in the design and mesh size of nets that are currently used to sample krill. The Working Group recommended that to ensure the retention of post larval krill the stretched mesh size should be 9 mm or less (paragraph 2.29), and a mesh size of up to 330 micrometres be used for the sampling of the larval stages of Antarctic krill.

2.41 The Working Group developed a plan for the collection of biological information of krill, such as the distribution of larval and post-larval stages, which specifies the frequency and timings of sampling, the spacing between stations, measurements that need to be undertaken, and the timeframe for sample processing (Table 5).

2.42 The Working Group recommended that the Scientific Committee endorse the objective of incorporating a continuously updated KSH into the relevant components of the KFMA to inform the development of measures to conserve krill stocks and hence their predators.

2.43 WG-EMM-2025/P03 presented the results of the investigation of Antarctic krill distribution and biomass using eDNA collected from surface and seafloor in East Antarctica during the 2021 RV *Investigator* TEMPO survey by the development of a set of species-specific genetic markers to quantify Antarctic krill eDNA. Additionally, the eDNA age was estimated based on the level of eDNA fragmentation detected in each sample. This research revealed the following four points: (i) at the surface, there was a higher probability of detecting krill swarms acoustically near newer eDNA than near older eDNA; (ii) at the seafloor, recent eDNA was detected on the continental slope, which was consistent with visual detections; (iii) newer eDNA likely indicated the presence of live krill in the vicinity of the sample; and (iv) eDNA abundance decreased with the increase in the distance to swarms. The authors concluded that this new method helps investigate the distribution and habitat of krill and associated species, especially in hard-to-access areas.

2.44 The Working Group welcomed this interesting result using a new method and discussed the adaptation of this method to other species. The Working Group noted that eDNA could be advected away from the site where it was shed and that the age of the eDNA might help to identify advected distance.

Krill predator biology and ecology

2.45 The WG-EMM-2025/53 reported on the sixth research cruise of the JASS-A (Japanese Abundance and Stock structure Surveys in the Antarctic). The plan for JASS-A program was to cover two-thirds of the circumpolar Antarctic Ocean from 0° to 120°W longitude (IWC Management Areas III–VI and CCAMLR Areas 48, 58 and 88) over an eight-year period from 2019/20 to 2026/27. The research followed IWC's sighting survey guidelines. The 2024/25 survey was conducted during the austral summer of January–February 2025 over a period of 41 days using the research vessels *Yushin Maru No. 2* and *Yushin Maru No. 3*. During the survey, various whale species were observed, including Antarctic blue whales, fin whales, Antarctic minke whales, humpback whales, southern right whales, southern bottlenose whales, and killer whales.

2.46 Research activities involved photo-identification, biopsy sampling, and the deployment of satellite tags. Satellite tags were deployed on 25 Antarctic minke whales, 10 fin whales, and two humpback whales. The survey area was divided into two strata – northern and southern – and followed a zigzag track line design with randomised starting points. The most abundant species was a humpback whale, while the second most frequently sighted species was the Antarctic minke whale, particularly in the southern stratum. The collected data and samples will be analysed and presented to CCAMLR in future reports.

2.47 The Working Group expressed appreciation for the results and noted the research was conducted in line with IWC guidelines using a distance sampling method and zigzag track line design aimed at covering the survey area efficiently in a statistically robust design.

2.48 The Working Group noted that the humpback whale populations in the survey area appear to be recovering, in line with observations in the Antarctic Peninsula area.

2.49 The Working Group noted it would be useful to analyse species distribution or potential overlaps relevant to MPA proposals. The authors further suggested the data may be used for a Spatial Overlap Analysis (SOA) once abundance estimates are derived.

2.50 The Working Group highlighted the large number of satellite tag deployments and inquired as to whether the movement of tagged animals was monitored in the days after a tag is implanted. The authors responded that unusual movement patterns were sometimes observed during this time, and this aspect is worth further investigation.

2.51 WG-EMM-2025/57 provided the first description of the spatial scale of pelagic krill predators and fisheries overlap in Subarea 48.1. The largest overlap between whales and fishery areas was observed with humpback whales in the areas of Gerlache and Bransfield straits.

2.52 The Working Group underlined that given increasing populations of whales and increasing catch in the krill fishery, multidisciplinary research (e.g. acoustic surveys, satellite tagging) is crucial for informing spatial management that could help minimise interactions between whales and fisheries.

2.53 The Working Group noted that some of the spatial overlap may be the result of the number or starting locations of individuals tagged, and that this needed to be accounted for in the analysis.

2.54 The Working Group noted issues in WG-EMM-2025/57, namely that the errors remaining in post-modelled whale location data were of the same scale that overlap was considered to occur, meaning overlap at the scale of 66 sq km / 0.1 degree x 0.1 degree grid cell (as suggested by the authors) could not be assumed. Additional concerns regarding the utility of First Passage Time (FPT) as a metric of search radius were raised, given that the greater accuracy of AIS information from fishing vessels implied a better estimate of search radius for fishing trawlers could be modelled. Similarly, the use of FTP as a metric for search radius of whales was questioned, given that the whale location data were treated by a model which can simultaneously estimate when whales were entering (and exiting) Area Restricted Searching.

2.55 Finally, some participants recognised that the co-location of whales and fishing trawlers at such coarse scales do not necessarily translate into a functional interaction between the two.

2.56 Some participants recognised that despite the methodological issues pointed out, the document is useful for guiding management advice.

2.57 Despite the uncertainties and issues raised regarding WG-EMM 2025/57, the Working Group further noted that understanding the nature of any overlap would require estimating the abundance of cetaceans and their potential krill consumption, as well as the krill biomass variability in the study area by conducting acoustic surveys there. The Working Group also noted that it is necessary to consider the krill flux through the study area and its effect on the krill biomass and distribution in the area.

2.58 The Working Group noted that a shared understanding of terms such as ‘competition’, ‘overlap’, ‘spatial overlap’, ‘functional overlap’ and ‘interaction’ is necessary.

2.59 The Working Group distinguished between the provision of uncertainty around a numerical analysis and the lack of evidence supporting an outcome. It noted that the former should be presented as a range of uncertainty around a parameter estimate, whereas the latter implies that management actions cannot be based on scientific certainty and should proceed under the precautionary approach.

2.60 Some participants of the Working Group recalled the importance of applying the precautionary approach when scientific evidence is uncertain. In particular, an absence of evidence of competition between the fishery and krill predators should not be regarded as evidence of absence of competition.

2.61 The Working Group recognised that estimating status of ecosystem interaction for precautionary krill fishery management would benefit from the development of a standardised approach to data collection and processing; development of scientifically based criteria and diagnostics to assess the possible ecosystem impact of the fishery, taking into account the mixed effects of fishing, environmental variability (or climatic changes), and the competitive relationship between predator species.

Population status and dynamics

2.62 WG-EMM-2025/15 reported on the U.S. Antarctic Marine Living Resources Program (U.S. AMLR) annual field study for 2024/25 assessing the status and trends of CCAMLR Ecosystem Monitoring Program (CEMP) penguin and seal indicator taxa in the South Shetland Islands, Antarctica (Subarea 48.1). Notable results from 2024/25 included the 4th highest krill recruitment event observed in predator diets since the early 1990s and continued, rapid growth in gentoo chick production. The paper also reported on the first census since 1980/81 of a large colony of chinstrap penguins at False Round Point, King George Island. This report updates results first presented in WG-EMM-2024/18 Rev. 1.

2.63 The Working Group recognised that the krill length-frequency distributions from penguin diets presented in WG-EMM-2025/15 demonstrated similar patterns across several species and sites, and these patterns could be used to provide information on krill recruitment cycles.

2.64 The Working Group recognised the value of long-term monitoring datasets and updating historical population counts, in particular updating of information for the False Round Point chinstrap colony, to improve consumption estimates used in the Spatial Overlap Analysis. In this context, the Working Group noted work currently underway at the British Antarctic Survey to analyse 2013–14 surveys of penguin colonies in the South Shetland Islands.

2.65 WG-EMM 2025/32 presented the results of the first synoptic census across the entire range of the South Shetland Islands Antarctic fur seal (SSAFS) population since 2008 conducted by the U.S. Antarctic Marine Living Resources Program. The survey was completed in January 2025, along with collaborators from the Chilean Antarctic Institute (INACH) and the University of Chile. The paper summarised the SSI survey to census SSAFS and collect samples to monitor high pathogenicity avian influenza (HPAI). The paper reported no evidence for HPAI infection in seabird or pinniped colonies. Furthermore, the paper noted that the SSAFS subpopulation has decreased by over 88% since 2008 surpassing the IUCN criteria for a critically endangered subpopulation.

2.66 The Working Group acknowledged that the survey represented in WG-EMM-2025/32 is a valuable update to the status of SSAFS, and noted that the recent increase in pup survival rates had not yet translated into increased recruitment back into the population.

2.67 The Working Group noted that the updated survey data presented in both WG-EMM-2025/15 and WG-EMM-2025/32 incorporated data on different species that exhibit contrasting population trajectories, potentially representing the degree of complexity of the ecosystem. The Working Group further noted the presence of five king penguins at False Round Point, potentially representing how animals are trying to adapt to climate change, and agreed that further monitoring was worthwhile.

2.68 The Working Group noted that a submission to the IUCN Species Survival Group Pinniped Specialist Group to assess Antarctic fur seal population status against the criteria for listing as Critically Endangered may strengthen a case for classifying Antarctic fur seals as a Specially Protected Species. The authors agreed and clarified that an assessment of the whole species is currently under review by the IUCN.

2.69 The Working Group recalled that, in the context of the differing population trajectories presented in WG-EMM-2025/32, gentoos exhibit greater dietary and life history plasticity than other penguin species which may translate into an ability to adapt to ecosystem change. The Working Group discussed the recent increase in SSAFS pup survival in the context of leopard seal predation, noting that the historical declines in pup density may have resulted in leopard seals switching to a different prey source. The Working Group noted that the vulnerable status of the SSAFS population needs to be taken into account while considering future management plans.

2.70 The Working Group noted that although no widespread HPAI infection was detected during the survey (paragraph 2.65), influenza had been observed in Subarea 48.3 (WG-EMM-2025/21), emphasising the importance of continued HPAI surveillance.

CEMP and other ecosystem monitoring needs

2.71 WG-EMM-2025/06 provided an update of data submitted to the Secretariat from nine Members for 20 CEMP sites during the 2024–25 monitoring season. The suspected presence of HPAI was reported to have prevented data collection at several sites. The paper also provided visual summaries of data types and time series, including maps of the spatial overlap between krill fishing effort and catch and current CEMP sites in Area 48 over the past decade. The paper noted that the distribution of distances between CEMP sites and fishing events in the 2024/25 fishing season were significant and may be due to the expiration of Conservation Measure 51-07. The paper also highlighted the utility of the CCAMLR Spatial Viewer tool as a valuable resource for accessing and displaying environmental and fishery spatial data which may aid in the development of an enhanced CEMP approach.

2.72 The Working Group recommended that the Scientific Committee implement revisions to update CEMP data submission forms to allow reporting of HPAI presence at CEMP sites. It reiterated the importance of monitoring the impacts of HPAI and other potential viruses and recognised the need to establish or maintain baseline data. The Working Group clarified that it is the responsibility of each national program to report evidence of HPAI to the SCAR Antarctic Wildlife Health Network (AWHN).

2.73 The Working Group noted the importance of distinguishing between null and zero values in CEMP data submissions, particularly in the context of ongoing efforts to improve data quality and enable further analysis, and tasked the Secretariat with updating the forms to support this distinction.

2.74 The Working Group recognised that some Members are unable to process and submit all recent field season data in time for the annual update to WG-EMM. It tasked the Secretariat with including a summary of previous season submissions in future iterations to ensure the updates remain comprehensive.

2.75 The Working Group recalled WG-EMM-2025/60 (paragraph 2.89), which highlighted the importance of establishing CEMP sites both near to and distant from fishing activity to better distinguish fishery impacts from environmental variation. It noted that while some sites may be ideal for monitoring due to their ecological relevance, practical constraints such as access may limit the establishment of long-term infrastructure. In such cases, these sites could still contribute through less frequent monitoring and integration with existing long-term sites, following the hierarchical approach applied by Australia in WG-EMM-2023/45. The Working Group noted that CEMP data can be submitted to the Secretariat from non-CEMP sites, provided the surveys are conducted using standard CEMP methods and reported through the standard CEMP data submission form, and that such submissions are encouraged. The Working Group recognised that the current CEMP forms would require modification to clearly distinguish between data from established CEMP sites and those from non-CEMP sites. The Working Group tasked the Secretariat with facilitating the necessary updates to the forms.

2.76 The Working Group sought to identify additional spatial data that would assist CEMP review teams and tasked the Secretariat with separating the fishing distance distribution plots into summer and winter to identify when the fishing events were occurring. The Working Group noted that this distinction is important as seasonal differences may impact distances to fishing effort and catch. The Working Group also requested that the overlap maps be seasonal. It was noted that these visuals can be created using the new Spatial Data Viewer, with options to select individual months and species, and requested these standardised views be provided in future iterations of the Secretariat's report.

2.77 WG-EMM-2025/17 identified gaps in data available from ecosystem monitoring in Subarea 48.1 to inform and facilitate enhanced monitoring. The authors identified four key data streams: land-based monitoring, at-sea predator monitoring, krill-related data, and the proposed D1MPA. They highlighted the need to improve spatial and temporal coverage, and better integrate at-sea predator data for effective monitoring in Subarea 48.1. The paper also outlined requirements for an enhanced CEMP, including establishing a minimum monitoring level per management area, setting a timeframe for implementation, and ensuring a functional link between monitoring data and management actions.

2.78 The Working Group welcomed the paper and acknowledged the need to define the specific monitoring questions for potential effect to guide survey methodology (paragraphs 2.133 to 2.144).

2.79 WG-EMM-2025/22 presented a comparison of the performance of three mesozooplankton sampling techniques as to identify the most effective tools for monitoring lower trophic levels. The authors compared in situ imagery using an Underwater Vertical Profiler with benchtop scanning of net samples using Zooscan, and microscopy of net samples. While microscopy was the best for taxonomic identification, it was resource intensive. Benchtop imaging allowed for high-throughput processing, and in situ imagery, and although less destructive for identification of fragile organisms, had very low detection rates. The authors concluded that a combination of these methods would be the most effective.

2.80 The Working Group welcomed the paper and recognised the value of comparing sampling methods, particularly in understanding mesozooplankton like copepods, which are important in krill diets. The Working Group inquired about the difference in depths at which the two net types were sampled, which affected the comparability of the samples collected. The authors noted that logistical problems with net deployments had been resolved.

2.81 WG-EMM-2025/50 provided an update on an eight-year comparative study of DNA metabarcoding from guano samples and stomach lavage for describing the composition of Adélie penguin diets at Signy Island (Subarea 48.2). The paper compared the two approaches and made recommendations for developing a faecal DNA metabarcoding method for diet analysis as an additional method for CEMP Standard Method A8. The authors suggested that they are prepared to develop a protocol and standard method if that would be of use to WG-EMM.

2.82 The Working Group welcomed the study and recognised that DNA metabarcoding is a valuable approach for the analysis of diet data. The Working Group noted that the metabarcoding approach resulted in a higher proportion of fish in the diet than the lavage method in some years and suggested that this may be due to larval fish which are detected in DNA but are not easy to identify in lavage samples. The authors clarified that the weeks '1–5' presented in comparisons were based on a biological cue rather than a calendar date, so they may shift slightly between years but that aligning the time of year would be possible with these data.

2.83 The Working Group recommended the Scientific Committee support the development of a standard faecal DNA metabarcoding method for diet analysis, as an additional CEMP standard method to complement Standard Method A8.

2.84 The Working Group encouraged the authors to coordinate the development of this form with interested researchers and the Secretariat. The Working Group recognised that this method could be updated in the future to incorporate additional genetic markers as needed, and that iterative updates would be required to update taxonomic identifications as new reference DNA sequences become available.

2.85 The Working Group suggested that lavage samples or the collection of stomach contents when the penguins regurgitate can provide a measure of krill length frequency data, and this could be linked with local fishery data. The authors clarified that experiments conducted on captive penguins suggested that the relative abundance reported in DNA samples was similar to the proportion of prey items in their controlled diet. The Working Group also noted that combining tracking and diet data to identify geographic areas of particular prey types (e.g. larval fish), would be valuable in areas where predators and the fishery overlap.

2.86 WG-EMM-2025/59 described the first year of CEMP monitoring of Adélie penguins at Seaview Bay, Inexpressible Island (Ross Sea region) in 2024/25, undertaken by China and Korea. The site hosts a breeding population of approximately 30 000 pairs. High-resolution drone counts and ground observations were applied twice to obtain updated population counts and the body mass of twenty-five individuals was also obtained. South Polar skuas in the same region were also monitored. As this colony is close to the new Qinling research station, this CEMP monitoring program will be further developed in the future.

2.87 The Working Group welcomed the study, field effort and, in particular, the collaboration between several national programs to continue the time series of population counts and establish additional CEMP monitoring in the Ross Sea. The Working Group suggested that traditional ground-based and drone-based census methods be conducted concurrently to validate their methods. It also suggested the use of time-lapse cameras as a monitoring tool for this site given the difficulty of accessing it. The Working Group encouraged the authors explore ways to coordinate efforts from interested Members to contribute to this monitoring program.

2.88 The Secretariat clarified that the new site is in the process of being added to the official CEMP site list.

2.89 WG-EMM-2025/60 presented a spatial modelling approach to identify additional krill predator monitoring sites in Subarea 48.1 with the aim of expanding data collection to facilitate CEMP monitoring. The authors emphasised the importance of matching the spatial scale of data collection relative to a focal management area to allow for meaningful detection of trends amongst the variability of the environment and anthropogenic effects. The paper qualitatively defined potential management areas based on known oceanographic boundaries and focused on penguin breeding colonies as a target monitored species. Using available CEMP data and penguin colonies from Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD), combined with accessibility based on Council of Managers of National Antarctic Programs (COMNAP) station locations and International Association of Antarctic Tour Operators (IAATO) site visitations, they presented two sets of potential monitoring sites; one based on maximising spatial coverage by foraging penguins, and another based on prioritising accessibility.

2.90 The Working Group welcomed the results of the modelling exercise and noted the importance of developing a systematic approach to prioritising potential future monitoring sites for CEMP, and for the KFMA in general.

2.91 Some concerns were made stating that introducing a new set of proposed management boundaries may be counterproductive at this stage and the use of tourist visitation sites may impact future analysis due to known behavioural impacts on predator colonies due to tourism.

2.92 The Working Group commended the approach of WG-EMM-2025/60 for identifying spatially relevant sites. The Working Group noted that adjustments could be made to modelling parameters to prioritise large infrequently surveyed colonies, revise site selection based on the practicality of visitation or establishing monitoring infrastructure, verify the accuracy of input data, and the need to address that circular distance buffers do not describe the actual distribution of foraging effort. The authors welcomed the feedback, noting that the boundaries defined are not intended to be used as management units, but as a framework to identify spatial monitoring needs. The authors also noted that these models are starting points to guide the future development of revised CEMP, with the next steps including predator tracking data, tourist visitation rates, and assessing the accessibility of each site on an individual scale.

2.93 The Working Group noted that the proposed sampling locations are meant to increase the signal-to-noise ratio from specific drivers for addressing CEMP objectives and agreed that further analysis would be needed to understand the effectiveness of any given spatial sampling plan. The Working Group noted that the spatial analysis used MAPPPD data and that any related data (e.g. IAATO visitation rates) could be integrated in future analyses. The Working Group noted the importance of further collaboration with other organisations such as IAATO and MAPPPD for the implementation of the enhanced monitoring plan to ensure the best spatial coverage that will allow detection of potential impacts or trends along such a wide area around the Antarctic Peninsula.

2.94 WG-EMM-2025/64 presented results from a study measuring population dynamics and breeding phenology of a gentoo penguin (*Pygoscelis papua*) colony on Galindez Island (Subarea 48.1), near Akademik Vernadsky Ukrainian Antarctic Station between 2018 and 2025. The authors also reported on CEMP monitoring parameters obtained from time-lapse cameras during the 2023, 2024 and 2025 seasons and compared validation metrics with earlier results. The visual-observer-photo validation revealed more variance in phenological parameters in recent years compared to 2018 and 2019. They provided suggestions for potentially improving the performance of camera-based observations in the future.

2.95 The Working Group thanked the authors for presenting several years of valuable CEMP data, especially from the southernmost CEMP site in the Antarctic Peninsula region. It noted that observations of egg laying and hatch dates for a given nest can be hampered if the angle of the camera prevents visibility of the egg, suggesting that it might be possible to adjust for such issues in the future. The Working Group also emphasised that the authors had contributed to a successful implementation of data collection instruments sponsored through a CEMP Special Fund project. The Working Group further recognised the success and benefits of using the CEMP Special Fund for data collection instruments and encouraged others to take advantage of this funding opportunity.

2.96 The Working Group recalled that several teams were requested (SC-CAMLR-42, paragraph 2.74) to review the monitoring of current and potential sentinel species, and also initiated several teams to progress enhancing CEMP to meet KFMA and ecosystem monitoring goals (paragraphs 2.122 to 2.130).

Analysis of existing monitoring data

2.97 WG-EMM-2025/10 reported on field studies on the diet and habitat use of chinstrap (*Pygoscelis antarcticus*) and gentoo (*Pygoscelis papua*) breeding penguins from two colonies near recent fishing activity in Gerlache Strait during 2024–25. They presented the habitat use of 14 gentoo and 16 chinstrap penguins using GPS biologgers. Utilisation distributions illustrated that gentoo penguins foraged much further from the colony and used a broader area than chinstrap penguins. The diet of both species was dominated by krill, and length frequency distributions of those krill showed that gentoos were on average eating slightly larger krill.

2.98 The Working Group welcomed this predator study and noted the value of this CEMP site because it is located close to an area with increasing fishing activity. It highlighted the value of these data for continued monitoring in the KFMA and the proposed D1MPA areas. It also noted that it would be valuable to deploy position tracking instruments on penguins from this colony during fishing and non-fishing periods to test for differences in foraging behaviour.

2.99 The Working Group discussed the best metrics to assess interactions between foraging penguins and the fishery including overlap in space, time, and depth. The Working Group encouraged the authors to participate in sharing their tracking data with the WG-EMM community and noted their value in developing standard methods to improve inter-site comparisons of behaviour and functional overlap with the fishery.

2.100 The Working Group discussed the scientific value of comparing the penguin-diet-derived krill length frequency distributions with those derived from the fishery that was operating nearby during the same period. It also noted that initial review indicated a shift in size of prey, but the same foraging distribution pattern. The Working Group inquired if krill life stages can be assigned to krill recovered from penguin diet samples and asked if it was unusual to see a gentoo diet that was 100% krill. The authors clarified that identifying life stages can be difficult from diet samples because they are often partially digested, and confirmed that it is common for gentoo diets to be comprised entirely of krill.

2.101 WG-EMM-2025/13 presented an analysis of the foraging behaviour of Adélie penguins (*Pygoscelis adeliae*) using GPS, dive depth, and accelerometer data from penguins breeding at Esperanza/Hope Bay during the 2022/23 and 2023/24 breeding seasons. The spatial extent of foraging varied substantially between seasons, but the majority of foraging activity took place within 30 km of the colony. Accelerometer data revealed that approximately 21% of all dives included active foraging. The authors presented foraging maps generated from data collected in 2013/14 and noted the similarity in foraging patterns.

2.102 The Working Group thanked the authors for sharing valuable krill-predator foraging data which is essential for informing spatiotemporal management under the KFMA and the proposed D1MPA. It further emphasised the value of accelerometry data which supports a higher resolution understanding of behaviour and potential interactions with fishing. The Working Group suggested specific data analysis techniques (e.g. supervised machine learning accelerometry analysis) could allow for comparison of behaviour between species and sites.

2.103 WG-EMM-2025/28 presented a progress report of the 'CEMP – Analysis of Existing Data' team during the 2024/25 intersessional period. Progress included the development of code to clean and merge CEMP data with the aim of analysing temporal and spatial variability in A3 data in Subareas 48.1–48.4. The paper also included a plan to progress the analysis, in collaboration with data holders, before WG-EMM-2026.

2.104 The Working Group thanked the CEMP data team and emphasised the importance of engaging A3 data holders. The Working Group noted that species specific analysis may help to review any potential differences in adaptive strategies of different species to climate change and anthropogenic activities. It further noted that information on extreme events may also be useful in this regard.

2.105 The 'CEMP – Analysis of Existing Data' team refined the plan presented in WG-EMM-2025/28 to engage with data holders to clean and merge data, analyse time series and formulate testable hypotheses. The team will progress their work plan during the intersessional period.

Monitoring of current and potential sentinel species

2.106 WG-EMM-2025/19 presented a study on the trophic ecology of adult female Antarctic fur seals (AFS) at Bird Island (Subarea 48.3), Cape Shirreff (Subarea 48.1), and Marion Island (Subarea 58.7) using stable isotope analysis on blood sampled in winter and summer. The paper provided the first cross-basin and seasonal comparison of the trophic ecology of this species accounting for food web baselines. Female AFS at Marion Island consistently fed on higher trophic level prey year-round, and at Bird Island they fed predominantly on krill during summer. While krill is important prey during summer for Cape Shirreff AFS, they had a mixed diet that included higher trophic level prey items. It was not clear whether AFS from Bird Island and Cape Shirreff shifted to higher trophic level prey such as squid and fish during winter or whether the result reflected the consumption of krill which tend to have higher nitrogen isotopic values in winter. The authors propose that an index of AFS diet through these biomolecular approaches could serve as an indicator of Southern Ocean change and be of value for CEMP.

2.107 The Working Group welcomed insights into AFS trophic ecology across the large spatial scales presented in the paper and discussed the potential to integrate dietary information from scat analyses. The Working Group noted that whiskers collected at Bouvet Island (Subarea 48.6) on female AFS and blood samples for HPAI surveillance at Subarea 48.3 have been collected and may provide an opportunity for analysis to investigate broader geographical comparisons.

2.108 WG-EMM-2025/63 provided an investigation of the diet of non-breeding male AFS at four localities in the South Shetland Islands through the analysis of 1254 scats collected between 1995 and 2004. The main prey items included Antarctic krill, fish and penguins. Antarctic krill was the main prey item by mass at Potter Peninsula and Deception Island (Subarea 48.1), while fish and penguins dominated the diets of AFS at Duthoit Point (except in 2000) and Harmony Point. Myctophid fish, mainly *Gymnoscopelus nicholsi* and *Electrona antarctica*, contributed most by mass to the diet of the AFS at all localities. Although *Pleuragramma antarcticum* was previously an important fish prey for AFS at the South Shetland Islands, it was absent or scarcely represented in the diet of the fur seals in this study. The authors propose using the diet of AFS to monitor the distribution and abundance of myctophid fish and *P. antarcticum*.

2.109 The Working Group recognised the significant effort involved in collecting samples for this study and suggested valuable insights into long-term trends and potential shifts in AFS diet would result from the continuation of this work. The Working Group discussed the observed decline in *P. antarcticum* in AFS diet, noting it could reflect changes in the availability of this prey species or shifts in prey preference by AFS. The Working Group noted South Polar skua diet also showed a reduction in *P. antarcticum* from 2000 onwards in Potter Cove (SSI) despite the species remaining present in skua diet at Cierva Cove. The Working Group encouraged the authors to combine a molecular approach with visual diet component identification to improve the accuracy of diet composition analysis.

2.110 WG-EMM-2025/21 provided an overview of ecosystem monitoring and research activities in Area 48 undertaken by the British Antarctic Survey (BAS) during 2024/25. The study includes monitoring environmental conditions, CEMP (including HPAI surveillance), pelagic survey work, marine debris surveys, and other associated projects and papers of interest to WG-EMM. The paper reported unusual winter sea ice extent in Area 48, with ice approaching South Georgia for the first time since the 1980s, and a strong phytoplankton bloom at South Georgia, particularly in January. The giant iceberg A-23A became grounded on the southwestern shelf of South Georgia in March 2025, shedding multiple smaller icebergs. CEMP monitoring was conducted at Bird Island and Maiviken (Subarea 48.3), Signy Island (Subarea 48.2) and Goudier Island (Subarea 48.1) on penguins (macaroni, gentoo, chinstraps, Adélie), Antarctic fur seals, and black-browed albatrosses. Monitoring revealed that AFS pup production at Bird Island continued to increase following the record low in 2021/22. New outbreaks of HPAI H5N1 were reported near King Edward Point particularly affecting Antarctic fur seals and Southern elephant seals. Pelagic survey work including moorings, acoustic surveys and the Groundfish Survey in Subarea 48.3, along with a cruise onboard the RRS *Sir David Attenborough* focused on ocean circulation, nutrient tracing, and carbon flux in the Scotia and Weddell Seas. Finally, entanglements in marine debris involving AFS (16), and wandering albatrosses (2) were recorded at South Georgia, with the first record of an entangled gentoo penguin recorded at Goudier Island.

2.111 The Working Group welcomed the extensive monitoring effort and noted the importance of these activities for assessing ecosystem variability and responses to environmental change. The Working Group discussed the potential for compiling a catalogue of key or extreme environmental events to complement existing databases, noting that BAS has ongoing research to assess impacts of extreme events on Southern Ocean ecosystems. The Working Group noted that toothfish collected during the surveys in shallow areas were in the 40–55 cm size range. The Working Group discussed the observed krill biomass in the Western Core Box survey area, suggesting that higher primary production compared to previous years could potentially explain the observed distribution, but recognised the challenges in interpreting intra-annual variation and variability in the timing of surveys. Mooring data were presented as a possible option to further resolve these patterns.

2.112 WG-EMM-2025/43 presented a review and recommendations regarding how to incorporate cetacean species into CEMP and the KFMA, with guidance from the IWC-SC and other cetacean experts. The authors provided an overview of population status of species relevant to Area 48, especially humpback, fin and Antarctic minke whales, highlighting their potential as environmental indicators in a region of significant krill fishing activity. The document identified key knowledge gaps in abundance, distribution, krill consumption, impact of climate change and fisheries (entanglement and competition for resource), as well as interactions with other krill-dependant predators. The report highlighted limited winter data for cetaceans in Area 48 and outlined monitoring methods and technology for estimating abundance, distribution, foraging behaviour, population health (i.e. contaminants, body condition, pregnancy rates, and population changes) and krill consumption rates incorporating IWC's 'Requirements and guidelines for conducting surveys and analysing data within the Revised Management Scheme' (IWC, 2012). The authors recommend prioritising collection of data to estimate cetacean abundance, spatial distribution, and seasonal presence (including winter) for humpback, fin and minke whales to assist in development of data layers for the KFMA via the Spatial Overlap Analysis, including into the winter months in Subarea 48.1. The authors recommended considering IWC abundance estimate classifications and identifying those most relevant for different uses in CCAMLR. The paper encouraged continued collaboration between SC-CAMLR and the IWC-SC and invited feedback from the Working Group to refine this ongoing work.

2.113 The Working Group welcomed the review and recommendations presented in WG-EMM-2025/43. The Working Group noted the need to develop appropriate survey designs and clear, transparent definitions of ecological indicators. The Working Group discussed the IWC's abundance classifications and noted the importance of deciding the most useful categories for CEMP monitoring and the KFMA. The Working Group noted that multiple models exist to estimate cetacean prey consumption but highlighted that further work is needed to identify the most appropriate approaches for CCAMLR purposes.

2.114 The Working Group encouraged further collaboration between cetacean experts noting the possible relevance of ongoing eDNA research and welcomed the strengthening of links between SC-CAMLR and the IWC-SC.

2.115 WG-EMM-2025/65 reported an update of ongoing research on the impact of illegal, unregulated, and unreported fishing (IUU) on the efficacy of by-catch mitigation measures for the wandering albatross population at Bird Island. The study compiled diverse data streams to simulate population growth rates under various management scenarios to assess whether improvements in by-catch mitigation in regulated fisheries could enable population recovery, or if IUU fishing was a dominant effect. Preliminary results showed that the baseline demographic model indicated a 2.5% annual population decline (growth rate of 0.975); the population distribution was highly constrained for successful breeders around South Georgia, while juveniles and non-breeders had more widespread distributions in the region. Juveniles and non-breeders exhibited wide-ranging circumpolar distributions, particularly between 40°–60°S, notably around South America; fisheries effort data showed the highest pelagic longline effort in the South Pacific and Indian Oceans, and demersal longline effort concentrated in Chile and Namibia EEZs.

2.116 The Working Group welcomed this work and emphasised the challenges and importance of applying seabird conservation measures at large spatial scales across multiple jurisdictions to improve conservation outcomes. The Working Group noted that the paper focused on longline fisheries and highlighted the need to also consider trawl fisheries. New Zealand has engaged with the authors to discuss this suggestion and facilitate additional data that could be included in this research. The Working Group recommended that the final version of this research is submitted to the next WG-IMAF meeting.

2.117 WG-EMM-2025/66 examined the distribution of baleen whales in Antarctic marine ecosystems and assessed the overlap between species occurrence and existing and proposed MPAs. Using multi-year sighting data (2010–2024) from research cruises and kernel density estimation, the authors analysed the distribution of fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), blue (*Balaenoptera musculus*), and Antarctic minke whales (*Balaenoptera bonaerensis*). Results revealed a latitudinal gradient in species distributions, with fin whales occurring primarily in the northern regions (55°–65°S), while blue and minke whales (largest range) were mostly found south of the Antarctic Circle (55°–77°S and 60°–70°S, respectively). Humpback whales showed a wide latitudinal range (55°–70°S). Higher overlap between the total species distribution and the spatial distribution of krill exists between 55°S and 65°S. The analysis showed that the current South Orkney Islands Southern Shelf (SOISS) MPA offers limited protection for these species. In contrast, overlap with the proposed Antarctic Peninsula and Southern Scotia Arc MPA (D1MPA) and Weddell Sea MPA (WSMPA) Phase 1 would substantially increase protection (*B. physalus* 49.7%, *M. novaeangliae* 62.7%, *B. musculus* 39.3%, and *B. bonaerensis* 59.3%). The authors concluded that updating cetacean distribution data and expanding conservation areas could improve protection of critical habitats and support adaptive management by international bodies.

2.118 The Working Group recognised the effort to model whale distribution in Area 48. The Working Group noted that because distance sampling methodologies were not used, the analysis does not account for survey effort variability, weather conditions, or the detection range from different observation platforms, which could influence the interpretation of the results. The Working Group suggested that breaking down the analysis by management zones within the proposed D1MPA could provide further insights. The Working Group noted that integrating tracking results from other datasets could be useful.

2.119 WG-ASAM-2025/03 presented an overview of the relevance of the Antarctica InSync initiative for CCAMLR to open the discussion on how the CCAMLR scientific community can contribute. Antarctica InSync provides a framework for international collaboration to implement sustainable ocean science as addressed by the UN Ocean Decade and by SCAR, and to provide a milestone towards the International Polar Year 2032/2033 (SCAR/IASC). It aims to strengthen and create partnerships to synchronise and coordinate circumpolar data collection, and to better understand and sustainably manage these regions. The paper described the biological component of InSync, which focuses on interspecific relationships, connective processes and their significance for the recruitment and distribution of species, particularly in relation to the impacts of anthropogenic stressors. The paper highlighted the importance of synchronised, standardised data collection across multiple platforms (research vessels, commercial vessels, autonomous platforms, and biologging). The authors noted the relevance of this initiative to CCAMLR's work, particularly for understanding the effects of krill fisheries at larger spatial and temporal scales than previously studied. The authors invited CCAMLR's scientific community to initiate discussion regarding priority topics in relation to upcoming krill surveys and bringing together tracking studies and how CCAMLR can contribute to the initiative.

2.120 The Working Group discussed potential funding sources to support contributions to InSync, noting that the initiative itself does not provide funding. Possible funding opportunities may arise from the Horizon Europe infrastructure funding call in 2026 and the AWR Fund. It was also noted that the CCAMLR CEMP Special Fund and PolarIN could help support fieldwork activities. The Working Group noted that commercial fisheries remain a key platform for scientific observations, underscoring the importance of aligning scientific activities with operational opportunities. The Working Group highlighted the potential to expand InSync's scope to include krill biology and potentially circumpolar assessments of toothfish fisheries. The Working Group also discussed whether this initiative could serve as a deadline to consolidate and advance discussions held over the last two years and provide a model for the future International Polar Year.

2.121 The Working Group recommended that the Scientific Committee endorse a proposed research topic to InSync including krill fishery-ecosystem interactions in Area 48, as well as a circumpolar assessment of krill biomass, krill biology and characterising krill flux during the InSync timeframe (2026-2030) (Table 2).

Progress from CEMP review teams: updates, work plans and objectives

2.122 The Working Group recalled that four temporary teams were tasked in 2023 (SC-CAMLR-42, paragraph 2.74) to advance work on (i) analysis of existing CEMP monitoring data (CEMP – Analysis of Existing Data team), (ii) monitoring of current and potential sentinel species (CEMP – Sentinel Species Monitoring team), (iii) krill fishery and at-sea monitoring, and (iv) environmental and non-biological parameters of relevance to wider ecosystem monitoring (CEMP – External Data of Relevance to CCAMLR team).

2.123 In 2024, the Working Group also tasked a team ((v) CEMP – Analysis of Tracking Data team) to focus on assessing the utility of tracking data to determine essential habitats, and along with a team to collate existing external datasets, contribute to the spatial overlap analysis (SOA), provide baseline data for the marine protected areas (MPAs) proposals, ecosystem monitoring under the Ecosystem Health Check concept, and for other CCAMLR purposes (WG-EMM-2024, paragraphs 6.50 and 6.26).

2.124 WG-EMM-2024 also created a team to discuss the potential inclusion of cetaceans in CEMP, the (vi) CEMP – Cetaceans Monitoring team.

2.125 The Working Group recalled the objectives of CEMP and noted that whilst ecosystem change could be indexed by monitoring individual species, disentangling the effects of fisheries from climate will be aided by information about environmental variability, ecosystem changes (such as the recovery of previously over-exploited species), enhancing CEMP, and the functional relationship between CEMP indicator species.

2.126 The Working Group recalled that the enhancement of CEMP as outlined in WG-EMM-2024/08 and WG-EMM-2024 (Figure 12), was to strategically expand the capabilities of CEMP to address three core purposes: (1) the KFMA through data input to SOA, (2) monitoring to detect drivers of change of krill-dependent predators and assess ecosystem status and health including the effects of climate change or 'health check', and (3) MPA Research and Monitoring Plans.

2.127 The Working Group recalled that the review of the CEMP program is expected to take several years to allow an assessment of the current monitoring program, future monitoring needs, the CEMP Standard Methods and protocols, and the incorporation of new information or approaches while still meeting CCAMLR data standards (WG-EMM-2024, paragraph 6.45). It further noted that progress towards an enhanced CEMP requires immediate and longer-term time frames and funding mechanisms and that addressing these should be incorporated into task team work plans.

2.128 The Working Group noted that distinguishing fishing impacts from ecosystem changes may be aided by ecosystem models (WG-EMM-2025/24). Such models require data on distribution and abundance, prey consumption, and interactions between key taxa.

2.129 The Working Group further recalled that WG-EMM-2023 suggested that a health check, or ecosystem status report, like that envisioned in WG-EMM-2023/45, could become a fourth leg of the KFMA.

2.130 The Working Group agreed that ecosystem monitoring delivered through CEMP was created as an integral part of krill fisheries management. It recommended that Scientific Committee consider an enhanced CEMP as an integral part of implementing the KFMA.

2.131 The following sections detail reports on the current CEMP teams.

CEMP – Analysis of Existing Data team (i)

2.132 The report from the CEMP – Analysis of Existing Data team is presented in paragraphs 2.103 to 2.105.

CEMP – Sentinel Species Monitoring team (ii)

2.133 The Working Group recalled the following tasks outlined for 'CEMP Sentinel Species Monitoring team' during WG-EMM-2024 aimed to:

(i) Identify data needs and indicators to monitor the krill fishery and krill-dependent predators, including the connectivity between Subareas 48.1, 48.2, and 48.3, and identify a coordinator to lead this task in Subarea 48.1.

(ii) Identify data or data collection methods to enhance existing CEMP to deliver to the spatial overlap analyses or ecosystem health checks and develop protocols and indicators for integration into CEMP.

(iii) Provide an overview of current data collection and monitoring programs (circumpolar) to identify future monitoring priorities or data needs.

(iv) Consider how tracking data can be incorporated into CEMP to address CCAMLR's data needs, and progress defining an index derived from tracking data for this purpose, noting that considerable work has been conducted under external groups that may expedite this process.

(v) Consider priority areas in which to establish CEMP sites or collect CEMP-like parameters, including areas where change is likely rapidly occurring (e.g. sub-Antarctic islands), sites that are not affected by the fishery, and monitoring of non-krill-dependent species to aid in disentangling fishery from climate change impacts.

2.134 The Working Group noted that identifying data needs and enhancing monitoring in Subarea 48.1 remained a priority (WG-EMM-2024, paragraph 6.53) and identified that the CEMP – Sentinel Species team would work together to review the existing monitoring program (WG-EMM-2025/17) to identify gaps in monitoring and explore potential solutions.

2.135 The Working Group recognised progress to examine the spatial extent of data collection and the location of CEMP monitoring sites in relation to fisheries activities and sentinel species foraging ranges (WG-EMM-2025/06 and WG-EMM-2025/60), and encouraged further work using the approach outlined in WG-EMM-2025/60 with additional data from Members working in this area to identify spatial gaps in monitoring coverage in Subarea 48.1.

2.136 The Working Group recalled that the hierarchical approach to monitoring from combining periodic broad-scale census of sentinel species, underpinned by detailed demographic data at CEMP sites would provide a useful framework for enhancing CEMP monitoring (WG-EMM-2023/45; WG-EMM-2024/31).

2.137 The Working Group acknowledged that different subareas may require different approaches for ecosystem monitoring to achieve CCAMLR's monitoring objectives, and that this may include monitoring of different species, time scales, parameters and the use of various monitoring platforms.

2.138 The Working Group recognised the importance of identifying CEMP parameters that are particularly informative in detecting change or the potential effects of fishing on predators and noted the work from long-term data derived from existing CEMP measures of penguin breeding performance in earlier studies by Krüger et al. (2021) and Watters et al. (2020).

2.139 The Working Group recognised that additional species including whales, crabeater seals, flying seabirds and additional penguin species could enhance CEMP, but that an assessment of their utility and relevance for assessing ecosystem change, ecosystem status reporting, or for fisheries impacts would be important prior to those species being adopted as part of CEMP.

2.140 The Working Group considered additional response parameters that could enhance CEMP and noted that these were being considered in relation to foraging ecology through the work of the CEMP – Analysis of Tracking Data team. The Working Group further noted that the use of molecular techniques for assessing diet as outlined in WG-EMM-2025/50, and a proposed review on the use of biomarkers, including stable isotopes, lipids and fatty acids, genetic analysis of scats, and contaminants for monitoring predator diet and contaminants exposure and changes in food web structure, should be considered.

2.141 The Working Group discussed the importance of understanding the spatial and temporal scales that are integrated in different response parameters. For example, the Working Group noted that potential effects from fisheries may impact some measured parameters immediately while other effects may have a lag. In addition, some effects may span through multiple seasons.

2.142 The Working Group agreed the following tasks for this team, to be reported upon at WG-EMM-2026:

(i) The development of an expanded CEMP monitoring strategy for Subarea 48.1, including the revision of WG-EMM-2025/60 using additional data to identify gaps in current CEMP site, and an assessment of the feasibility and practicality of monitoring suggested additional sites in this high priority area. To be progressed by Dr Collins, Dr Krause, Dr Santos and Dr Johannessen.

(ii) An overview of current monitoring efforts of subantarctic species within the CCAMLR Area, and an outline of a potential plan for enhanced monitoring of subantarctic species. To be led by Dr Makhado.

(iii) An assessment of the methods and feasibility to research and survey populations of Antarctic phocids to better understand their abundance and consumption needs. To be led by Dr Krause and Dr Waluda.

(iv) The identification and assessment of the efficacy of potential additional Antarctic land-based seabird species by region. To be progressed by Dr Kim, Dr Lin and Dr Waluda.

(v) A progress report outlining methods for surveying the distribution and abundance of cetaceans for input for the SOA, noting the CEMP – Cetacean Monitoring team is progressing and developing plans for monitoring cetaceans and have separate work plans (SC-CAMLR-43, Table 8). To be led by Dr Kelly.

(vi) A progress report on the utility of tracking data for CEMP and the development of protocols and indicators to deliver to the spatial overlap analyses and ecosystem health checks, noting the CEMP – Analysis of Tracking Data team will progress this work and have separate work plans (SC-CAMLR-43, Table 8). To be led by Dr Krüger.

(vii) A review of biomarker techniques (including stable isotopes, lipids/fatty acids, and DNA metabarcoding) either to provide new methodology for existing CEMP parameters or for developing new response parameters and approaches for monitoring contaminants relevant for CEMP. To be led by Dr Friscourt, K. Hoszek-Mandera and Professor G. Zhu.

2.143 The Working Group recalled that when CEMP was established, the decisions on species, response parameters and the location of monitoring sites balanced questions of practicality and utility, and that this is important to consider as CEMP is enhanced.

2.144 The Working Group acknowledged as a high priority the importance of not only developing CEMP but also ensuring that the interpretation of the data it generates is directly linked to informed management decisions, and that this may form part of the future analyses for the CEMP – Analysis of Existing Data team.

CEMP – External Data of Relevance to CCAMLR team (iv)

2.145 The Working Group discussed the task teams formed in 2023 (WG-EMM-2023, paragraph 5.65; WG-EMM-2023, paragraph 6.64) and 2024 (WG-EMM-2024, paragraph 6.26). It noted that both tasks had considerable overlap in scope and were both led by Dr Anton Van de Putte. As a result, the working group proposed to merge the two groups into the existing 'CEMP – External Data of Relevance to CCAMLR team'.

2.146 The CEMP – External Data of Relevance to CCAMLR team will receive input from the 'CEMP – Sentinel Species Monitoring team' and the 'State of Environment' Discussion Group on environmental/non-biological parameters of relevance to wider ecosystem monitoring. For these data, the 'CEMP - External Data of Relevance to CCAMLR team' will continue to develop and support access to these types of data through the Geospatial Toolbox maintained by the Secretariat (see WG-EMM-2024, paragraph 6.26), using the overview table in Table 3.

2.147 Intersessionally, the team will further refine the information to be provided within the overview table; it will populate the table based on input received from the 'CEMP – Sentinel Species Monitoring', the 'State of Environment' Discussion Groups, and responses to the circulated survey presented in WG-EMM-2025/42, and collaborate with the Secretariat to determine the most effective mechanism for sharing this table and any supplementary information.

CEMP – Analysis of Tracking data team (v)

2.148 The Working Group noted that priorities for the CEMP – Analysis of Tracking data included the following objectives of WG-EMM-2024 (paragraph 6.54): (ii) to identify data or data collection methods to enhance existing CEMP to deliver to the spatial overlap analyses or ecosystem health checks, and develop protocols and indicators for integration into CEMP, (iv) on how tracking data can be incorporated into CEMP to address CCAMLR's data needs and progress defining an index derived from tracking data, and (v) to identify priority sites for collecting CEMP data.

2.149 The Working Group noted that predator tracking data are an important input to the spatial overlap analysis for the KFMA, that parameters derived from tracking data could be included as response parameters currently monitored in CEMP, and that additional response parameters could be derived from data obtained from telemetry devices to enhance CEMP data collection.

2.150 The Working Group noted that some existing parameters in the CEMP Standard Methods could be derived from tracking data including for penguins: A2 – Duration of the First incubation shift, and Method A5 – Duration of foraging trips, and for seals: Method C1 – Duration of foraging/attendance cycles.

2.151 The Working Group noted that no parameters for flying seabirds in the CEMP Standard Methods could be derived from tracking data, and that although whales are not currently a CEMP species, consideration of what response parameters could be derived from tracking data for other species would form part of this team's work.

2.152 The Working Group decided that an initial table should be developed for different species, life history stage, device type (e.g. GPS location, time-depth recorder, or accelerometer) and potential response parameters that could be derived from that data. The table could be updated to incorporate additional parameters associated with the development of CEMP as advised by the 'CEMP Sentinel Species' Monitoring team.

2.153 The Working Group remembered that protocols have already been developed that could be used as a frame of reference (e.g. Bird Life International, SCAR Retrospective Analysis of Antarctic Tracking Data (RAATD) project) for this team.

2.154 The Working Group noted that intersessional discussions would occur in the online Discussion Group 'CEMP – Analysis of Tracking Data team'. The first task of the team will be to develop an inventory of available tracking data in Subarea 48.1 to enable the identification of sites that should be considered priority for future tracking studies in coming years.

CEMP – Cetacean Monitoring team (vi)

2.155 There is a recognition that considering cetaceans is increasingly important in CCAMLR's ecosystem-based approach to management which includes ecosystem monitoring, management of the Antarctic krill fishery and developing the circumpolar network of MPAs. Following guidance outlined in WG-EMM-2025/43, the Working Group considered recommendations for priority data collection to inform CCAMLR management discussions requiring information about cetaceans. The priority cetacean data collection and analyses were considered to be: (i) population abundance by subarea; (ii) seasonal presence (using methodologies beyond those associated with abundance i.e. PAM, eDNA); and (iii) spatial distribution (via habitat models, passive acoustic monitoring and telemetry). The need to review methods and data to derive krill consumption estimates for baleen whale was also identified as a separate priority research item. Finally, the Working Group noted the need to have an overarching synthesis of cetacean data and methods to inform CCAMLR discussions on the CEMP review and ecosystem-based approaches to management of the krill fishery (including WG-IMAF).

2.156 The Working Group agreed on the work plan to develop guidelines on each of the priority data collection and analyses items, with the following leaders nominated for each item:

(i) Population abundance by subarea (Mr Johannessen and Dr Murase)

(ii) Seasonal presence (IWC-SORP Acoustic Trends Project representative, cetacean eDNA expert)

(iii) Spatial distribution (Dr Lowther and others TBD)

(iv) An overarching/synthesis of cetacean research/data to inform CCAMLR discussions (Dr Kelly and Dr Lowther)

(v) Methods and data for estimating krill consumption by baleen whales (Dr Kelly and whale physiology experts).

2.157 The Working Group noted that development of these data collection and analysis protocols, and methods reviews, will also involve assistance from the IWC collaboration on providing advice on cetaceans for CCAMLR's KFMA, CEMP and ecosystem modelling, the terms of reference for which were endorsed by SC-CAMLR in 2024 (SC-CAMLR-43, paragraphs 2.77 and 2.78).

2.158 The Working Group noted the opportunity to present these guidelines and methods reviews to the next IWC-SC meeting in April 2026 (with an approximate paper due date of mid-April 2026), but that this would require substantial progress before mid-December 2025, prior to the Antarctic fieldwork season. After IWC-Scientific Committee review, these guidelines and methods reviews can be revised and submitted to WG-EMM-2026, and subsequent recommendations made to SC-CAMLR-45.

2.159 The Working Group noted that intersessional discussions would occur through the CEMP – Cetacean Monitoring Discussion Group.

Krill fishery and at-sea data collection plan team (iii)

2.160 The Working Group noted that the 'Krill fishery and at-sea data collection team (iii)' reported under the fishery dependent data collection plan (paragraphs 2.199 to 2.207).

Environmental/non-biological parameters relevant to wider ecosystem monitoring

2.161 WG-EMM-2025/03 summarised ongoing work conducted by the CCAMLR Secretariat on developing standard operations for Geographic Information Systems (GIS) in support of the work of the Scientific Committee and its Working Groups, updating WG-ASAM-2024/01. Following a recommendation by WG-EMM-2024 (WG-EMM-2024, paragraph 6.27), a preliminary analysis of publicly available satellite data was presented as an example. The Secretariat requested collaboration with Members to identify and develop additional satellite-derived summary indices to assist Members in accessing and utilising these types of data for the Convention Area.

2.162 The Working Group welcomed the progress of updating and developing the GIS toolbox and thanked the Secretariat for its work. It noted that all the Scientific Committee's Working Groups have uses for these spatial and requested the Secretariat to create a 'Geospatial toolbox' Discussion Group. The Working Group noted that communication of the availability of the toolbox to the Scientific Committee such as through SC Circs may be considered, or for Scientific Committee Representatives to ensure relevant members of their delegations have joined the Discussion Group.

2.163 The Working Group noted the usefulness of developing a Geospatial Toolbox for common spatial data processing tasks, particularly with regard to the types of data that should be incorporated.

2.164 WG-EMM-2025/42 reported on the initial steps taken to address the need for better documentation of environmental data sources and their access and analysis. The report provided an overview of many external environmental data sources that are valuable to the CCAMLR research community.

2.165 WG-EMM-2025/55 presented a selection of databases and tools related to the work of various CCAMLR-relevant SCAR groups. These groups include the SCAR Krill Expert Group (SKEG), the SCAR Action Group on Fish (SCARFISH), the Expert Group on Birds and Marine Mammals (EG-BAMM), and the Expert Group on Antarctic Biodiversity Informatics (EG-ABI). The authors noted that making these resources available to the CCAMLR community would maximise the use of existing datasets, reduce duplication of effort, and enhance these products by demonstrating how data can be contributed to existing databases.

2.166 The Working Group thanked the authors and SCAR for providing a useful overview of relevant databases. The Working Group recommended integrating links to these databases into the CCAMLR website to make them more visible and accessible. They also suggested adding particularly relevant data layers to the Spatial Data Viewer as they become identified by the Working Groups.

2.167 The Secretariat noted that it is developing scripts in the Geospatial toolbox for handling these data types (paragraph 2.162; WG-EMM-2025/03). The code is available via GitHub.

Communicating results (e.g. ecosystem status reports)

2.168 WG-EMM-2025/16 proposed a collaborative framework for developing ecosystem monitoring in East Antarctica based on datasets generated by existing long-term monitoring programs and using analysis workflows designed using the Galaxy platform, paired with Essential Biodiversity Variables (EBV) used as a common referential to classify the output variables of the workflows. The proposed collaborative framework aims to improve the concordance of ecosystem monitoring analysis processes to the FAIR principles. The Galaxy platform effectively aggregates different data collections while allowing for the inclusion of datasets with varying accessibility status. The atomisation-generalisation approach put forward by the authors shows how the Galaxy platform enables to design modular and interoperable tools, underlining the interest of the platform and its adherence to the FAIR principles. The Galaxy platform allows for the development of automated, transparent, and reproducible workflows that can be used to translate primary data into indicators. These indicators represent a relevant output to communicate results to policymakers. The authors suggested that Research Monitoring Plans (RMP) for existing and potential future Marine Protected Areas (MPAs) could use the Galaxy platform and its workflow design tool to produce the indicators needed within each RMP.

2.169 The Working Group commended the authors on their work and highlighted the usefulness of this approach. The Working Group suggested that workshops be organised in the future to familiarise more participants with the Galaxy platform to enhance CCAMLR scientific works, for example MPA research and monitoring plans. The Working Group further suggested contacting the GOOS BioEco panel to coordinate the concurrent development of essential ocean and biodiversity variables suggested by the authors.

2.170 WG-EMM-2025/38 presented a solution for automating the creation of the State of the Environment Report using the Galaxy platform. This solution addresses the Scientific Committee's request for the report to be easily replicable in other areas of the Convention Area. The proposed automation process enables users to produce graphical illustrations of selected variables and to choose the temporal and spatial extent of the figures produced. These figures are subsequently embedded into a report document via reproducible and transparent workflows for the selected region and year.

2.171 The Working Group welcomed the proposed solution which provides flexibility and improves the efficiency of creating State of the Environment Reports in the future. The Working Group discussed whether structural changes in data used for the State of the Environment Report (such as data from fisheries or changes to environmental variables) may impact the automation of the report generation, as those changes might require regular adjustments of the data processing workflows and may therefore require additional staff time to maintain.

2.172 WG-EMM-2025/25 presented the progress made on developing a regular 'State of the Environment and Antarctic Marine Living Resources' report for CCAMLR, following discussions held during WG-EMM-2023, the 2023 CCAMLR Climate Change Workshop, WG-EMM-2024 and SC-CAMLR-43. The report aims to synthesise the various data sets necessary for an integrated regional understanding of the ecosystem and to provide relevant context for management decisions. The authors requested feedback from the Working Group on which variables should be included in such reports and how the information should be presented. They also asked for input on how to develop indices that effectively communicate the state of the environment and ecosystem to the CCAMLR Commission.

2.173 The Working Group recognised the progress made on the State of the Environment Report and encouraged the authors to continue their work. The Working Group noted that identifying the report's intended audience(s) is important for deciding the best way to present the data. The Working Group also discussed including a circumpolar perspective in addition to regional assessments and emphasised the importance of including additional context, such as the occurrence of extreme events, into the report to support data interpretation and management decisions. The Working Group further suggested that the group for environmental status reporting coordinates with other groups (e.g. the group for external existing data relevant to CCAMLR) to define common key variables and to reduce duplication in reports. The Working Group also noted that this work is essential for meeting the WG-EMM Terms of Reference, parts B and C.

2.174 To progress the State of the Environment Report the Working Group noted that two types of reports should be generated: (i) a technical report (level 1 reporting), and (ii) a summarised, illustrative version of the technical report for presentation to the Commissioners (level 2 reporting). The Working Group identified Climate and Oceanography, Biodiversity/Biology, Fisheries, and Current and Emerging Threats as the four core topics to be addressed in the reports. The Working Group noted that once the content of a report was agreed that the Secretariat would be an appropriate mechanism to update and distribute the reports.

2.175 WG-EMM-2025/51 presented a new framework combining Earth System Models and ecological models to project the current state of the Southern Ocean ecosystem and its future state under climate change scenarios. Within this framework, an Antarctic Ecosystem Value index (AEV) was derived based on the projected abundance and growth potential of krill, two species of penguins, fish, and primary producers. This metric was used to identify potential changes in ecological hotspots, with the aim of informing conservation efforts and future monitoring.

2.176 The Working Group congratulated the authors on their work and acknowledged the framework's potential to predict future ecosystem changes. The Working Group encouraged the authors to include additional trophic levels to improve the AEV's representativeness of the ecosystem, and suggested including uncertainty estimates of model projections to address the specificity of the biological models used in the study and potential mismatches between the spatial scales for which some of the models were originally calibrated and later applied in this study. The Working Group suggested using toothfish fisheries data to evaluate how fishing may affect the AEV index.

Other impacts (e.g. HPAI, toxins)

2.177 WG-EMM-2025/44 Rev. 1 presented work on the presence of endocrine-disrupting phenolic compounds from anthropogenic sources in Antarctic krill samples. The paper emphasised that continued monitoring, broader spatial sampling and further research on the transport and accumulation mechanisms of pollutants in Antarctic marine ecosystems are needed to better assess and manage the risks to the region's living resources.

2.178 The Working Group welcomed the paper and noted the valuable addition to their knowledge and understanding. The Working Group discussed the lipophilic nature of phenolic compounds which are likely to originate from plastics, resins, paints, rubber and industrial cleaning products and noted that krill may ingest phenolic compounds accumulated in predator excrement or those compounds may be absorbed onto krill carapaces. The Working Group discussed the possibility of studying microplastics as a vector for contaminants, noting that there are studies showing that phenolic compounds can be absorbed onto the surface of microplastics.

2.179 WG-EMM-2025/70 proposed a framework for expanded contaminant monitoring under CEMP, highlighting the need for a more systematic and standardised approach to track pollutants in Subarea 48.1. The study recognises that improving contaminant monitoring is crucial to better understand ecosystem responses to the combined pressures of pollution and climate change. The paper further noted that incorporating a harmonised, non-invasive contaminant module would strengthen the objectives of CEMP, as this approach would create a cost-effective extension to current monitoring protocols.

2.180 The Working Group congratulated the authors for their work and highlighted that this study, along with the previous paper (WG-EMM-2025/44 Rev. 1), were both led by a current CCAMLR scholarship recipient, K. Hoszek-Mandera (Poland). The Working Group noted that Dr X. Mu (China), a fellow 2024–2025 CCAMLR Scholar, was unable to attend WG-EMM-2025. The Working Group wished Dr Mu well with her ongoing research work and look forward to welcoming her in future years.

2.181 The Working Group discussed the value of testing samples and comparing results from areas of lower anthropogenic input than Subarea 48.1 and highlighted the longevity of these less well understood contaminants, which can bioaccumulate in animals' internal organs like the liver or brain.

2.182 The Working Group noted the potential transport of contaminants into the Southern Ocean via ocean circulation or atmospheric transfer, noting that some contaminants were banned from use globally many years ago. The Working Group highlighted the potential for future collaborative work such as the analysis of microplastics from penguin guano, comparative studies with stable isotope analyses, and noted the value of this important work to inform the ongoing CEMP review.

2.183 WG-EMM-2025/P05 highlighted the urgent need for coordinated surveillance, response, and policy action to address the spread of HPAI H5 in the Southern Ocean region. The paper also underscores the risk of ecosystem-level impacts and long-term population declines. The authors also made recommendations to help strengthen CCAMLR's capacity to respond to emerging wildlife disease threats, such as supporting ecological assessments of species or colonies most at risk, including disease dynamics and outbreak scenarios into ecosystem models and spatial decision-making processes and minimising non-essential human activity at or near affected wildlife colonies.

2.184 The Working Group welcomed the paper and emphasised the importance of maintaining attention on avian influenza in Antarctic wildlife, noting that the situation can change during a season as demonstrated in other regions (WG-EMM-2025/21).

2.185 The Working Group noted that work undertaken on HPAI in other regions, for example a recent survey around New Zealand and sub-Antarctic Islands, found no cases of HPAI in the region (Waller et al., 2025), whereas high mortalities of skuas have been reported from the South Shetland Islands during surveillance work conducted by Chile (Bennet-Laso et al., 2024; Léon et al., 2025) and mortality of wandering albatrosses, king penguins, giant petrels and skuas and mass mortality of macaroni penguins just after moulting reported from Prince Edward Island due to suspected HPAI.

2.186 The Working Group discussed integrating HPAI monitoring into the CEMP structure and noted the Secretariat has been leading work on current status and species affected submitted to the CEMP (paragraph 2.72; WG-EMM-2025/06).

2.187 The Working Group welcomed suggestions to make on-site PCR testing available and to provide training for interested parties, as well as developing cooperation with partners having infrastructure to test samples. It was proposed that the CEMP Special Fund could help support these efforts. The Working Group noted the value of undertaking additional genomic/molecular studies to understand virus variability and mutations in order to examine potential further spread, connectivity and identify potential source areas of the disease.

Climate change and associated ecosystem research and monitoring

2.188 WG-EMM-2025/P01 outlined New Zealand's historic and recent advances in Antarctic oceanographic research in the Ross Sea region, highlighting emerging systematic observations, ocean modelling, and international collaborations to address climate-driven changes in the region. The paper identified challenges, such as logistical constraints and funding, and emphasised the importance of continued and expanded research to support CCAMLR objectives and the Ross Sea region Marine Protected Area (RSrMPA).

2.189 The Working Group thanked the authors for the comprehensive review and noted that summarising and sharing these findings is highly valuable. Participants suggested that sharing information on future survey plans would increase opportunities for collaboration.

Marine debris

2.190 WG-EMM-2025/52 presented work on broad scale beached debris surveys undertaken near Mawson and Davis stations along with longitudinal beached debris surveys at Bechervaise Island (Division 58.4.1). Debris recovered comprised machined wood, plastic and metal items. The majority of debris recovered were legacy items most likely of base origin, with very little originating from marine sources.

2.191 The Working Group welcomed the paper and noted similarities with the results of marine debris monitoring in other Antarctic regions where machined wood items and plastic also dominate (e.g. WG-EMM-2025/21). The Working Group noted the absence of fishing related debris at the survey sites, recalled that a higher proportion of fishing-related debris has historically been reported from the sub-Antarctic region (e.g. WG-EMM-2025/21), and highlighted the need to provide management advice in the event of increases in fisheries debris. The Working Group noted the presence of a disused research station embedded in iceberg A23-A, the remains of which may be seen in future debris surveys, particularly in Subarea 48.3.

2.192 The Working Group encouraged ongoing monitoring of marine debris whether it be beached or oceanic, and the reporting of lost fishing gear to assess the efficacy of waste management practices. It further highlighted the importance of monitoring to allow Antarctic operators and managers early detection of marine debris arriving from elsewhere and an understanding of its sources.

2.193 The Working Group discussed the value of comparing data from across regions, with the caveat that effort needs to be standardised across sites, and that consideration needs to be given to including null values from surveys which were undertaken but no debris items were observed. The authors noted the importance of removing debris prior to it breaking up into microplastics and the improvements made to waste management at Antarctic research stations in recent decades. The authors noted that data from the report presented will be submitted to CCAMLR and associated with publication as a scientific paper.

Fishery-independent data collection plan

2.194 WG-ASAM-2025/17 presented the outcomes of the SCAR Krill Expert Group (SKEG) Symposium, which was held online from 10 to 12 March 2025. The event convened approximately 90 participants from 15 countries, including representatives from industry, policy, and NGOs. The paper documented the progress of SKEG, including the creation of four task-force groups to address the following subjects: (i) krill flux; (ii) fishery indices; (iii) KRILLBASE; and (iv) communications and outreach. Reports from three of the tasks (krill flux, fishery indices and communications) were presented at WG-ASAM (WG-ASAM-2025/02; WG-ASAM-2025/14; WG-ASAM-2025/17, respectively).

2.195 The Working Group noted that the other SKEG task force focused on the further development of KRILLBASE was developing a data paper on the larval krill data and encouraged participants to submit relevant data through the SKEG website.

2.196 The Working Group noted that the krill flux task force is developing a mooring array to better understand flux in Subarea 48.1. The Working Group noted the SKEG plan to send a questionnaire to fishing companies to seek views on the best locations for moorings.

2.197 Dr S. Kasatkina expressed concern about the use of moorings to investigate flux and emphasised the value of multi-frequency acoustic surveys to determine biomass, such as that conducted on *Atlantida*.

2.198 The Working Group thanked SKEG for their ongoing work on the krill stock hypothesis and noted that SKEG continues to make important contributions to the work of WG-EMM.

Fishery-dependent data collection plan

2.199 WG-ASAM-2025/14 Rev. 1 proposed an at-sea data collection plan for the revised KFMA, including the KSH, noting that much of the requisite data can be collected through existing CMs and SISO. The paper made a series of recommendations for WG-EMM to consider:

(i) CCAMLR to ensure the collection of all krill data required for the implementation of the revised KFMA

(ii) use of RMT 8+1 net (mesh sizes of 4.5 mm and 330 µm for RMT 8 and RMT 1, respectively) for trawling during acoustic transect mode, and biological sampling

(iii) biological sampling be conducted during acoustic transect mode

(iv) increase frequency of krill biological sampling by the SISO observers to one sampling per day throughout the commercial fishing operation

(v) SISO Observer logbook for krill trawl needs to be revised to allow entry of detailed maturity stages and standardised trainings for maturity staging for observers to be conducted

(vi) use Table 1 in WG-ASAM-2025/14 Rev. 1 as a starting point at WG-EMM-2025 to further populate the table and use as guiding tables for the planning of strategic data collection for the long-term monitoring to support the revised KFMA

(vii) key to the integration of data from alternative platforms is the development of krill biomass estimation techniques (i.e. model-based estimators) that can incorporate data from instruments that collect point samples (i.e. sub-surface moorings, landers), or non-random data collection, such as autonomous surface and underwater vehicles (gliders and sail drones).

2.200 The Working Group noted the discussion of the paper at WG-ASAM-2025 (paragraphs 3.28 to 3.33) and agreed that rather than specify the trawl type, the most important information was the size of the mesh and the net mouth opening area.

2.201 The Working Group discussed the frequency and detail of biological sampling in the krill fishery. It was noted that the krill fleet often operated in close association, making daily sampling from all vessels potentially unnecessary, however, this is not always the case, as there are times when vessels are distributed across different subareas.

2.202 The Working Group noted that fishing depth and location can change from hour to hour, and that sampling every three days would not capture this variability. It emphasised the importance of understanding the structure of catch, including size and maturity composition through daily sampling. The Working Group also noted that it is important to prioritise tasks to ensure that the most critical information is collected.

2.203 The Working Group noted that maturity staging is a time-consuming process and suggested that, where onboard capacity is limited, preserving samples for subsequent analysis may be a suitable alternative.

2.204 The Working Group developed a krill data collection plan for krill fishing vessels during routine fishing operations (Table 4). The plan clarifies the role and objectives of sampling activities to be undertaken by the SISO observers and provides examples of additional biological sampling that may be conducted by science programs to progress the understanding of krill biology.

2.205 The Working Group also developed a krill biological sampling plan for vessels undertaking acoustic surveys (Tables 5 and 6). Table 5 focuses on data collection for the KSH, whilst Table 6 focuses on data collection for acoustic transects. It also outlined key components of sampling design, including types of nets to be used, spacing between sampling stations, and the measurements to be taken during acoustic transects.

2.206 The Working Group noted that the sampling plan could be conducted during acoustic surveys or during other type of research surveys.

2.207 The Working Group recommended that the Scientific Committee endorse the sampling plans outlined in Tables 4 to 6 to support the implementation of the revised KFMA. It further noted the relevance of existing protocols, such as krill biology sampling protocol developed by WG-ASAM-2024, which should be used in conjunction with the proposed new data collection plan. The Working Group requested that the Secretariat coordinate with relevant Members to develop a guidance note compiling all relevant protocols, with a view to streamlining the use of these protocols.

2.208 WG-EMM-2025/01 presented an overview of the current classification of fishing events in CCAMLR data reporting and highlighted inconsistencies in the use of fishing type codes (Commercial, Research, and Survey) across different reporting forms and gear types. The current implementation has resulted in a mismatch between what is reported in CE and haul-by-haul data in the different fisheries (i.e. C1, C2) and additionally has resulted in inconsistent reporting of fishing type between both vessels and seasons in haul-by-haul data. For example, catches during fishing on acoustic transects are reported in the same category as commercial fishing, and fishing under CM 24-01 paragraph 3 are reported as 'Research' instead of 'Survey'.

The Secretariat requested that the Working Group assess the purpose and analytical value of fishing event classification data and provide feedback on whether these classifications should continue to be used.

2.209 The Working Group supported the recommendation to remove the field as reporting of acoustic survey trawling events could be recorded in the Acoustic Survey Metadata Form (ASMF), noting that it would simplify fisheries data collection and that C4 data could be collected through haul-by-haul data.

2.210 The Working Group recommended the Scientific Committee consider revising the haul-by-haul and CE forms to remove the 'type of fishing' classification field.

Krill Fishery

3.1 WG-EMM-2025/30 described the introduction of two new krill products by the Chinese fishing vessel *Fu Yuan Yu 9199*: Frozen Wet Meal and a mixture of protein extracts derived from stick water. These products are not currently listed in the fishery notifications conservation measure (CM 21-03) and the C1 data forms. To facilitate better understanding of the products, the paper provided brief descriptions and proposed product codes for implementation. It is suggested that the WG-EMM recommend the adoption of the code 'FWM' for Frozen Wet Meal in the future.

3.2 The Working Group thanked the authors for reporting this interesting development of krill products and supported the recommendation on using 'FWM' as the product code for Frozen Wet Meal.

3.3 The Working Group noted that stick water has been discussed in WG-IMAF meetings, particularly regarding the potential to attract seabirds. The Working Group noted that protein recovery may reduce the attraction of seabirds. The Working Group suggested that the paper may be interesting to WG-IMAF-2026.

3.4 The Working Group noted that stick water could be a useful sample for chemical analyses and encouraged further analysis of the contents and properties of stick water.

3.5 WG-SAM-2025/07 described the separation of C1 haul-by-haul forms into finfish- and krill trawl-fishery specific forms, along with accompanying instructions as requested by WG-FSA-IMAF-2024. These forms include fields recommended by WG-IMAF to clarify the reporting of incidental mortalities on vessels.

3.6 The Working Group thanked the Secretariat for this work and recommended that the Scientific Committee implement these new forms. The Working Group also endorsed the recommendations in the paper that the form nomenclature be revised to avoid confusion in form names, and that any references to conservation measures be identified and revised as necessary.

3.7 The Working Group requested the Secretariat ensure the forms and accompanying instructions were specific to each form type (e.g. not including generic terms such as 'EEZ' in the glossary).

3.8 WG-EMM-2025/07 further discussed the development of new haul-by-haul (C1) forms for CCAMLR trawl fisheries, which have been identified as a priority for several years. The paper highlighted limitations in the current C1 form, which only records codend mesh size per haul and lacks clarity on measurement methods. It notes the absence of key haul-level data such as net dimensions and marine mammal excluder configurations, which restricts analysis of swept area and catchability. The proposed C1 form contains haul-specific fields for net mouth width, height, and mesh size, and the ability to link multiple nets to trawl type codes. Linking this gear data to individual fishing events would enhance spatial and ecological analyses.

3.9 The Working Group expressed their gratitude to the Secretariat for their efforts in making the forms more efficient, reducing redundancy, and enhancing future data use. The Working Group noted that the trawl gear definition should include the area of the fishing circle to avoid confusion with the mouth area of the trawl wings. In addition, the form should specify the mesh sizes of the codend outer mesh and inner mesh liner to prevent confusion in reporting for selectivity studies.

3.10 The Working Group recognised, at present, it is not possible to link the net configuration used for a fishing event to the fine-scale catch and effort data, as the C1 form does not record such detail on a haul-by-haul basis and recommended that the Scientific Committee implement the revised trawl forms and instructions documented in WG-SAM-2025/07.

3.11 The Working Group further noted that linking fishing gear configuration with individual fishing events would permit additional needed analysis of gear selectivity, swept area calculations and gear performance studies, and tasked the Secretariat with updating the historical trawl gear configuration table on the fishing gear library webpage.

Fishing activities

3.12 WG-EMM-2025/09 summarised the fishing activities of the Chilean trawler, *Antarctic Endeavour,* carried out in the Antarctic krill fishery between January and October 2024, capturing 21 872 tonnes (4.39% of the total catches in that fishing season). The paper provided details on catch, CPUE, depth of hauls, and length-frequency distributions of captured krill per trip and across Subareas 48.1, 48.2, and 48.3, along with by-catch estimates, which included some invertebrates and fish. No bird strikes were observed, and one humpback whale mortality occurred on 1 February 2024. Comparisons were drawn across all seven years of operations of this vessel within the subareas, with a focus on catch performance, fishmeal production and conversion factors. The authors encouraged similar periodic reporting from other CCAMLR vessels participating in the krill fishery.

3.13 The Working Group welcomed the paper and congratulated Chile for submitting a summary of the fishing activities regularly. The Working Group noted the value of these data to better understand the population structure and indicated that an aggregation of the data from other CCAMLR krill vessels would provide a more accurate assessment of the overall fishery.

3.14 The Working Group recommended that the Secretariat produce a report summarising the fisheries operations of krill vessels in more detail than in the Fishery Report as a separate monitoring paper submitted to WG-EMM with the intent to identify improved summaries to be included in the Fishery Report.

3.15 WG-EMM-2025/11 analysed krill fishing logbook data (2017–2024) from the Chilean trawler *Antarctic Endeavour* targeting Antarctic krill to identify spatial patterns in fishing activity across Subareas 48.1 to 48.3. The study used a hierarchical agglomerative clustering technique to compare the positions of each fishing haul (Euclidean distance) to explore and identify 'fishing opportunities' (areas with discrete groups of fishing events by that vessel). The paper evaluated three types of fishing opportunities, which included unusual, sporadic and recurrent events. Twenty-seven fishing opportunities were recorded in Bransfield Strait (48.1) and the South Orkney Island (48.2), which were classified as unusual (<10 hauls, <3 years); sporadic (11 < 48 hauls, comprising half of the time series); or recurrent (>50 hauls, covering the most years). Multivariate analysis linked fishing activity to by-catch, water temperature, krill population structure, and CPUE. Results highlighted key breeding and recruitment areas, and indicated potential local depletion in two recurrent fishing grounds based on declining CPUE. Fishing opportunities showed higher performance than other fishing events, illustrating spatial variability in krill productivity at the local scale. While the proportion of gravid females and juveniles indicates areas of importance for krill reproduction and recruitment, the CPUE trend enabled characterisation of fishing opportunities and identification of local depletion. The proportion of gravid females and juveniles indicated potential breeding and recruitment regions (South Orkney Islands and Bransfield Strait, respectively), while the catch per unit effort trend identified local depletion in two recurring fishing opportunities.

3.16 The Working Group thanked Chile for the valuable data presented. The Working Group also noted the recommendations for future work in extending the approaches to the entire fleet data and across a longer period.

3.17 WG-EMM-2025/33 presented an analysis of the spatiotemporal variability of catch per unit effort (CPUE) in areas with recurring fishing effort assessed using data from a single commercial vessel (*Antarctic Endeavour*) operating between 2017 and 2024 in Subareas 48.1 and 48.2. Individual hauls and CPUE data were modelled using hierarchical Bayesian spatiotemporal models fitted with the Integrated Nested Laplace Approximation (INLA), fixed effects of environmental (temperature, wind speed) and operational (fishing depth, course) variables were included. In Subarea 48.1, CPUE was consistently higher and exhibited lower interannual variability than in Subarea 48.2. Conversely, Subarea 48.2 exhibited the lowest CPUE values, consistent with the estimated spatial patterns. Spatial field analysis revealed differences in spatial autocorrelation between subareas. In both subareas, there was no strong evidence of spatiotemporal dependence.

3.18 The Working Group thanked the Chilean delegation for presenting the paper and congratulated the authors on their research. The Working Group discussed potential differences in fishing opportunities across areas and suggested that additional analyses comparing recurrent and sporadic fishing locations could help refine the classification of these areas. The Working Group noted that possible inaccuracies in species identification within the reported by-catch composition reported by vessels may have influenced the analysis (paragraph 3.32; WG-EMM-2025/49; WG-FSA-IMAF-2024, paragraph 5.20). The Working Group noted that environmental variables may be influencing the observed patterns in the presence of female and juvenile krill.

3.19 WG-EMM-2025/62 summarises krill fishing activities conducted by Korean-flagged vessels within the CCAMLR Convention Area from 2020 to 2024, with a particular focus on fishing effort, spatial and temporal patterns, catch per unit effort (CPUE), and the composition of non-target species (by-catch). A total of 14 460 hauls were recorded during this period, yielding annual krill catches ranging from 15 091 to 44 567 tonnes. Monthly catch and CPUE trends exhibited substantial interannual variation, influenced by fleet size, operational strategies, and environmental conditions. Fishing activities were concentrated in Subareas 48.1 and 48.2, particularly in the Bransfield Strait and South Orkney Island sectors, while limited operations occurred in Subarea 48.3. Korean operations complied with voluntary conservation measures, avoiding hauls in ARK's Voluntary Restricted Zones (VRZs) in accordance with their seasonal closure periods. Between 2022 and 2024, a total of 36 finfish species were identified across six taxonomic orders and eight families, with dominant representation from Nototheniidae, Channichthyidae, Myctophidae, and Bathydraconidae. A focused examination of Channichthyidae (icefishes) resulted in descriptions of eight species across developmental stages, documented in WG-EMM-2025/49.

3.20 The Working Group thanked the authors for the information on how the Korean krill vessels have been operating as well as the development of an identification (ID) guide for fishing observers. The Working Group requested that the guide be made available on the CCAMLR website and that it would be very useful to Members if it was translated into English and other languages in use by fishers and observers. It was also noted that the WOBEC program (WG-EMM-2025/40) is in the process of developing ID guides and invited Members to share any known resources, acknowledging that some of the guides may be specifically tailored for fisheries observers.

Scientific observation

3.21 WG-EMM-2025/02 presented proposed modifications to the IMAF and warp strike worksheets for observer trawl finfish and krill fisheries logbooks. These include simplifying the data recording process, the addition of the ability to record whether a warp strike was conducted from a video recording or visual observation data, and whether a mortality was observed. The paper requests WG-EMM approve the proposed additions for inclusion in the 2026 season.

3.22 The Working Group thanked the Secretariat and endorsed the proposed additions on the modifications to the IMAF and warp strike worksheets for observer trawl finfish and krill fisheries logbooks and recommended that the Scientific Committee implement these in the 2026 season.

3.23 WG-EMM-2025/04 presented an annual update of observer sampling rates for each vessel that fished for krill in the last five complete seasons (2020–2024) in Subareas 48.1 – 48.3. The paper summarised the current sampling rate requirements for observers, noting that observer coverage and sampling requirements have evolved over time. It concluded that in general minimum sampling rates (of either once every 3 or 5 days, depending on season) are generally met or close to being met. At a fleet-wide level the requirement to undertake warp observations for 2.5% of the total fishing time was generally met, although several individual vessels did not reach this requirement. The paper suggested that the requirement to meet the new 5% target will require increased duration or frequency of observation and appropriate guidance is requested.

3.24 The Working Group thanked the Secretariat for this analysis and discussed the calculation methods for presenting the sampling rate for warp-strike observation on trawlers with towing twin nets concurrently and referred this topic to the Scientific Committee for clarification. The Working Group requested that future versions of this report include a footnote to the figures to indicate that although the vessel name was reported for understanding the context of the plots, the sampling rates reported were observer duties.

Krill biological sampling

3.25 WG-EMM-2025/P02 presented an automated method for estimating krill body length data employing an in-trawl stereo camera system and custom-trained machine learning model for processing. Results from the automated detection are compared with manually measured krill lengths subsampled from corresponding trawls. It demonstrated the ability to extract krill lengths from underwater images, although mismatches were observed. The authors propose to address these uncertainties by using more advanced camera technology and optimising the observation section of the small-meshed two-layer krill trawl.

3.26 The Working Group thanked the authors and noted this method may be potentially used for estimating krill body length, identifying sex and maturity stages while acknowledging the technology needed to improve in some aspects, including the method for identifying large krill, lighting and camera setup, battery duration, and the calibration. The Working Group further noted these camera data may be used for calibration of microsonar seal-borne derived krill length data collection and encouraged the authors to collaborate with the interested parties.

3.27 Some participants noted that the biological data should include both krill length and weight, sex, and maturity stage in an integrated manner. All of these biological data should be collected in an integrated manner. Furthermore, it is necessary to provide additional data on the comparability of the proposed method for measuring krill length with measurements made by scientific observers. It was further noted that the proposed method may be considered as a complementary method for collecting data on the method by at-sea observer.

3.28 WG-SAM-2025/29 presented an inter-vessel comparison in krill length composition from commercial fishing vessels operating in Subarea 48.2 during March 2024. The paper noted discrepancies in number of samplings undertaken by the vessels. Statistically significant differences in krill length distribution were observed between different vessels and Members. The authors suggested that these differences could be due to both heterogeneity in krill distribution patterns and the catch value, and duration of trawling. The analysis suggested that sampling of 200 krill every 3 to 5 days, regardless of catch per haul or day, under-sampled krill from different length groups and particularly recruitment groups. It was further noted that the SISO manual was not provided to some of the observers on board vessels operated in Subarea 48.2 during March 2024. The authors noted that it is necessary to revise Scientific Observer protocols taking into account the number of hauls per day and the catch value per haul, so that C1 data and samples collected by at-sea observers would provide the best information to support the strategic objectives for scientific observations of the krill fishery.

3.29 The Working Group thanked the authors and noted the comparison of krill length distribution may be biased due to the difference in the nature of the fishing methods and mesh size, limited spatial and temporal scales, inter-swarm variability and the seasonally-differentiated requirements of the SISO manual for observers. It further noted the low number of observations made on some vessels and noted the importance of using data from broad enough period for such analysis in order to avoid any misleading results.

3.30 The Working Group recalled the discussions in the WG-SAM-2025 (paragraphs 2.5 to 2.7) and noted that effective sample size to characterise length frequency distribution should be driven by the intended use of these data. The Working Group noted small krill sampling could be undertaken through structured acoustic surveys or national programs rather than the commercial fishery.

By-catch sampling

3.31 WG-EMM-2025/49 introduced preliminary observations on morphological distinctions among eight species of the family Channichthyidae (icefishes) collected as by-catch during commercial Korean krill trawl operations in Subareas 48.1 and 48.2 in 2023 and 2024. The molecular phylogeny of these eight icefish species was compared with the morphological differences. External features of pelvic fin length and coloration, lateral line patterns, gill pigmentation and body proportions were used to distinguish between species, and these morphological diagnostic characters could be used to improve by-catch species identification protocols and therefore enhance understanding of the spatial distribution and developmental stages of icefish.

3.32 The Working Group welcomed this analysis and noted the work may be used for improving the identification performance of the icefishes by observers, especially the inclusion of the different life history stages. It further noted the juvenile fish identification is an area of improvement for the at-sea observers and encouraged the authors to collaborate with interested parties to enhance this work using the combination of molecular approach and morphological approaches. The Working Group noted the methods like maximum likelihood or Bayesian inference may help improve the robustness of nodes in the phylogenetic tree.

IMAF data collection and sampling

3.33 WG-EMM-2025/27 reported the incidental capture of a humpback whale by the Chilean traditional krill trawler in CCAMLR Subarea 48.2 during the 2024/25 fishing season. The authors noted that this is the second incident reported in the same area involving the same vessel. A high abundance of humpback whales was observed in the days leading up to the incident. On 25 March 2025, a 10-metre-long humpback whale was recovered in the trawl with its head toward the codend. The vessel was operating at the time with no cetacean exclusion device (CED), only a seal net excluder device. The vessel acquired a CED later in the season and used it for the remainder of the current fishing season. The incident was recorded in the vessel's C1 form and in the SISO scientific observer report and logbook, as well as this report to WG-EMM.

3.34 The Working Group thanked the authors for this analysis and welcomed the transparent reporting of this incidental mortality. It noted that design and implementation of marine mammal exclusion devices may be improved through considering whale behaviour and gear technology and suggested this paper should be presented to the WG-IMAF-2026 for discussion. The Working Group noted electronic monitoring may help improve the observation, and the

WG-IMAF should include gear technologies to consult on gear design and performance issues. The Working Group further noted that ongoing investigations including the research project presented in WG-FSA-IMAF-2024/04 may help improve the understanding of potential causal factors that may have contributed to whale mortalities in krill fisheries, and encouraged the authors to collaborate with interested parties. The Working Group recalled this is the eighth humpback whale mortality associated with krill trawling since 2021, and that the collaboration with the International Whaling Commission's experts on whale entanglements is available to provide advice to CCAMLR on how to minimise whale interaction with krill fishery.

Krill Fishery Management

Summary documentation of KFMA

4.1 WG-EMM-2025/05 summarised the ongoing development of the revised krill fishery management approach (KFMA). This is a public facing document that is being developed by the Secretariat and WG-EMM, and previous versions have been reviewed by the Scientific Committee. The Secretariat has provided the updated document to WG-EMM for its review and comment before it is submitted to the Scientific Committee for its endorsement.

4.2 The Working Group thanked the Secretariat for developing such a useful document. It noted that a version authored by the 'Working Group on Ecosystem Monitoring and Management and CCAMLR Secretariat' will be submitted to the Scientific Committee with no further changes, and recommended the Scientific Committee endorse its publication as part of the Fishery Reports documents.

4.3 The Working Group discussed documenting the processes used for the derivation of spatially and temporally resolved catch limits from identified input datasets. This approach could be used to validate existing advice and update advice in the future. The Working Group recommended that the Working Group conveners with assistance from Members, review the sections in WG-EMM-2025/05 to identify process gaps with the aim to document sufficient detail to replicate advice that has been agreed (e.g. SC-CAMLR-41, Table 2). These resulting explanations could be added as an appendix to future revisions of the KFMA summary document.

4.4 The Working Group noted that the KFMA also includes additional elements such as the KSH, ecosystem monitoring, and harmonisation between the KFMA and the proposal Domain 1 MPA which were not included amongst the original three elements of the KFMA (viz., biomass estimates, precautionary yield and spatio-temporal distribution) and that as these components develop, the process for developing advice could be documented and included. The Working Group suggested the Scientific Committee consider including these components in the next version of WG-EMM-2025/05.

Way forward for the revised KFMA

4.5 WG-EMM-2025/23 provided a summary of the current situation surrounding krill fishery management and harmonisation in Area 48, including the issue of the lapse of CM 51-07 in 2024. It further described the status of the D1MPA proposal and the recommendations on catch limits from the Harmonisation Symposium in 2024. With the expiry of CM 51-07, theoretically the fishery is able to fish without any spatial constraint in Subarea 48.1, exacerbating the potential of local concentration of catch. The paper recommends developing an interim Conservation Measure to support orderly development of the krill fishery in Subarea 48.1 in the short term, while allowing time to agree a feedback management approach and the D1MPA proposal. The paper offers some potential ways forward to progress the KFMA.

4.6 WG-EMM-2025/39 summarised the current status of the KFMA and identified some outstanding issues to progress. It described the challenges in the development of scientific methodologies for its successful implementation. The paper suggests a key opportunity lies in harmonising the KFMA with the D1MPA proposal, leveraging their spatial and temporal protection elements, and describes a need for clear delineation of responsibilities, costs, and additional requirements to implement the KFMA in Subarea 48.1. The paper states that significant issues will require decisions by the Commission, including modification of existing CM 51-01 and establishing a Conservation Measure tailored to Subarea 48.1.

4.7 WG-EMM-2025/26 outlined the harmonisation process (SC-CAMLR-2024/29) which aims to achieve compatibility between krill fishery management approach (KFMA) and marine spatial protection in the Antarctic Peninsula and Scotia Arc region (D1MPA proposal). The paper highlights the value of this process as a means of fostering long-term sustainability, reducing potential Members' conflicts, and strengthening the effectiveness of CCAMLR's governance in the area. The paper concluded that, although some relevant issues remain unresolved, CCAMLR is making significant progress to accommodate the diversity of approaches supporting a harmonized approach which may include an increase in PCLs allocated among MUs through summer/winter periods, along with the implementation of GPZ and SPZs, and a holistic KFMA - D1MPA monitoring and data-collection plan.

4.8 The Working Group thanked the authors of the three documents and noted that the three papers collectively provided a list of issues that need to be addressed, including, distribution of precautionary catch limits, trigger level, harmonisation between KFMA and D1MPA proposal, a staged approach, determination of biomass estimates, predator monitoring requirements, Spatial Overlap Analysis, and resource needs for sustainable implementation, to progress the revised KFMA as well as potential solutions for these issues.

4.9 The Working Group noted all three papers shared common views on the needs for an increase in data collection and monitoring (on krill-dependent predators through CEMP and on krill biomass and distribution data from research vessels and structured acoustic surveys using fishing vessels), and that progressing the KFMA, and the harmonisation of KFMA and the D1MPA proposal in Subarea 48.1 is a matter of priority. The three papers also shared the view that while scientific tasks can be addressed at the Working Group level, there may be issues beyond the remit of the Working Group or the Scientific Committee.

4.10 The Working Group recalled the significant progress made in recent years in developing the KFMA, including biomass estimates, harvest rates (Grym) and the spatial overlap analysis.

4.11 The Working Group noted that the Scientific Committee had endorsed biomass estimates, harvest rates, and MUs for Subarea 48.1, and agreed that these should form the basis for the further development and implementation of the KFMA. The Working Group also noted that whilst catch limits for each MU had been recognized as best available science by the

Scientific Committee in 2022 (SC-CAMLR-41, paragraph 3.46), the Scientific Committee could not reach consensus on the implementation of those catch limits (SC-CAMLR-41, paragraph 3.67).

4.12 The Working Group recognised that further work is required towards the full implementation of the KFMA in Subarea 48.1 and that additional work includes inter alia:

(i) development and implementation of a monitoring program that includes CEMP monitoring and at-sea monitoring

(ii) detailed documentation of the KFMA processes that led to the recent calculations of putative catch limits for Subarea 48.1 (paragraph 4.3)

(iii) urgent need to develop a sustainable funding mechanism

(iv) a time-bound implementation plan, including periodic updates of biomass, and review of monitoring (5–7 yr cycle).

(v) a mechanism to objectively evaluate the performance of any implemented measure.

4.13 The Working Group noted the effectiveness of the now lapsed CM 51-07 in spreading the catch limit across Subareas 48.1, 48.2, and 48.3 in the frame of the trigger level allocation. It noted changes in krill fishery dynamics including a significant increase in catch and catch concentration in Subarea 48.1 during the 2024/25 fishing season. It also noted that changes in fishing distribution may have been affected by the heavy sea ice coverage in Subarea 48.2 in the early part of the season.

4.14 Following the expiration of CM 51-07 and in the absence of a fully mature KFMA, the Working Group agreed there is an urgent need to implement an interim conservation measure to distribute catches across the four subareas (48.1 to 48.4).

4.15 The Working Group recognised that whilst CM 51-01 remained in force, an interim measure similar to the lapsed CM 51-07 would be a simple and effective mechanism for distributing catches between the four subareas.

4.16 The Working Group recalled that the original distribution of catches in the frame of trigger level allocation under the now lapsed CM 51-07 was largely based on the sum of maximum historical catches (the trigger level) and the proportions of biomass in each subarea during the first synoptic krill survey in 2000 (the allocations) (WG-EMM-2025/05), and that it would be possible to use the proportions of biomass from the two broad-scale surveys (2000 and 2019; see Krafft et al., 2021) to provide an interim measure.

4.17 The Working Group noted the difference in methodologies between the two surveys to assess krill biomass and its distribution.

4.18 Some participants noted that Krafft et al. (2021) detected no significant difference between the two methods.

4.19 The Working Group thanked Dr Hill (UK) for undertaking the calculations (Appendix D) of potential catch limits in the frame of the trigger level under CM 51-01 for each subarea as follows:

(i) 48.1 248 000 tonnes

(ii) 48.2 263 500 tonnes

(iii) 48.3 201 500 tonnes

(iv) 48.4 93 000 tonnes

4.20 The Working Group noted that this arrangement would reduce fishery concentration and that the catch limits could be implemented with or without the SPZs and GPZs identified during the Harmonisation Workshop.

4.21 With the understanding that there was no consensus view to modify or adjust CM 51-01, another option was presented for an alternative interim measure which would require adjustment of CM 51-01 (Appendix E). This option, based on elements of an option presented in WG-EMM-2025/39, and on the basis of the scientific progress achieved by the Scientific Committee (paragraphs 4.10 and 4.11), was proposed by proponents as an interim solution while we continue to progress implementation of the KFMA and other spatial management initiatives. This option includes the following:

(i) To ensure precautionary catch distribution amongst subareas, the Interim Measure follows the same logic as the lapsed CM 51-07 contained a total 130% distribution of catch, in order to provide flexibility in the location of fishing (in order to (i) allow for interannual variation in the distribution of krill aggregations, and (ii) alleviate the potential for adverse impacts of the fishery in coastal areas on land-based predators). The new suggested Interim Measure removes Subarea 48.1 and keeps the same catch levels for Subareas 48.2 – 48.4 as in the lapsed CM 51-07, leaving a realised trigger of 500 769 tonnes distributed as follows: Subarea 48.2 – 279 000 tonnes; Subarea 48.3 – 279 000 tonnes; Subarea 48.4 – 93 000 tonnes. This approach could offer continuity of trigger limits in 48.2 – 48.4 while further work progresses.

(ii) Simultaneously, a new interim Conservation Measure will be established for Subarea 48.1 consisting of five management units with the proposed GPZs and SPZs from the harmonisation process (Figure 1). The Subarea catch limit of 668 000 tonnes from SC-CAMLR-41 (Table 3) would be divided between the five management units from the options presented during WG-EMM-2025 (Figure 1) and the catch limits would be introduced through a stepwise approach scaling up to 668 000 tonnes.

4.22 Some participants emphasised that the scenario in (i) and (ii) in the preceding paragraph can also be implemented without GPZs and SPZs (Figure 2).

4.23 Some participants noted that the scaling up to 668 000 tonnes should be determined in accordance with the concerns presented in WG-EMM-2024, paragraphs. 4.13 and 5.42, and SC-CAMLR-43, paragraphs 2.71 to 2.73.

4.24 Some participants noted that other key elements included in WG-EMM-2025/39, such as a monitoring program, regular biomass estimates and krill biological sampling, are not included in the options in paragraphs 4.21 and 4.22.

4.25 Dr Kasatkina noted that the revision of the KFMA in Subarea 48.1, as well as in 48.2 to 48.4, should only be undertaken as part of a coordinated management of the krill fishery in Area 48, taking into account the variability in the spatial distribution of krill and the interrelationships between subareas. CM 51-01 establishes such coordinated management of krill resources in Area 48, ensuring compliance with Article II of the Convention (CCAMLR-41/37). There is currently no scientific basis for revising or adjusting CM 51-01. It was noted that any proposals for subareas catch allocations should be provided in the frame of the trigger level in CM 51-01 (620 000 tonnes). Substantive issues regarding the scientific justification of harmonisation of the KFMA and proposed D1MPA in Subarea 48.1 are not legally justified under existing CMs, for example, establishing the General Protection Zones (GPZ) and the Seasonal Protection Zones (SPZ). Dr Kasatkina noted that the proposals indicated in paragraph 4.19 are not legally justified under existing conservation measures and require additional scientific justification (CCAMLR-43/22). Dr Kasatkina expressed that the Working Group could not reach consensus on the proposal for an alternative interim measure which would require adjustment of CM 51-01 (paragraph. 4.21).

4.26 Some participants noted that the option with GPZs and SPZs (paragraph 4.21) is consistent with the harmonisation process between the KFMA and the D1MPA proposal developed in 2024 (CCAMLR-43/29). They also noted that the modification of MUs into larger units to allow greater flexibility for fishery operations, will be accompanied by an increase in catch limits. For this reason, they noted the inclusion of General Protection Zones (GPZ) and Seasonal Protection Zones (SPZ) is considered essential to safeguard important areas for krill life stages and their predators, especially in light of existing uncertainties and the need for further work (paragraph 4.12)

4.27 The Working Group noted that if this option (paragraph 4.21) with GPZs and SPZs was chosen, it would represent a step towards the implementation of the KFMA. Some participants noted the option still lacked key elements for its full implementation, including the items identified above (paragraph 4.8), and elements of the D1MPA proposal, and that increase of catch limits within each MUs would occur in a stepwise manner, commensurate with an increase in data collection and predator monitoring.

4.28 The Working Group suggested that the implementation of any interim measure should be time limited (e.g. 2–3 yrs), and priority should be given to progress with the development and implementation of the various components of the KFMA and for the further work required for the KFMA, to be completed before the expiry of any interim measure.

4.29 The Working Group noted that including a fallback option for catch limits in Subarea 48.1 in a potential, time-limited new measure is essential. Otherwise, when a temporary measure expires and no agreement on a new measure can be reached, there will be no catch limit regulation in place for Subarea 48.1.

4.30 The Working Group noted the need to evaluate the efficacy of any management scenario but recognised the limitation of current ecosystem monitoring to detect change. The group noted that a metric of catch concentration or realised harvest rate may be informative but accepted that such a metric may not indicate impact.

4.31 The Working Group noted that it is important to progress in developing metrics to assess impact. It further recalled that it is necessary to prevent the risk of changes in the ecosystem.

Krill biomass estimation

4.32 WG-ASAM-2025/P02 described a deep learning approach based on the U-net convolutional neural network to recognise and segment krill swarms using different combinations of acoustic data collected using a Simrad EK60 scientific echosounder. The model which used triple frequencies (38 kHz, 70kHz, and 120kHz) performed best. The model using only 120kHz yielded the highest individual accuracy in krill recognition, which is also the standard frequency recommended for krill biomass estimates. Compared to traditional methods, this approach is more automated, available, and maintains high recognition accuracy in complex marine environments. In addition, deep learning methods can also be applied to define krill swarm characteristics, highlighting its utility in ecological studies and their incorporation into existing acoustic systems or mobile devices. Future work could be expanded to include a broader range of marine environments and krill growth stages, enabling optimization in terms of seasonal and annual variations in krill lipid storage and distribution.

4.33 The Working Group noted that WG-ASAM reviewed this paper and noted the utility of machine learning methods in quick processing of acoustic data, specifically in relation to the detection of the presence of predators in krill swarms (WG-ASAM-2025; WG-EMM-2024/21) and other relevant applications. They further recalled that WG-ASAM-2024/12 used a machine learning approach to determine maturity stages and krill length which showed promising potential for future development.

4.34 The Working Group noted the potential application of machine learning methods on processing data from mobile platforms such as gliders as well as their utility in species differentiation compared to traditional methods, and the ease of application to other vessels. The Working Group suggested that the biomass estimates derived from machine learning approaches need to be compared with existing agreed methods.

4.35 Dr Kasatkina noted the value of standardised data collection and recalled the validity of the three frequencies approach to delineating krill in acoustic signals. Dr Kasatkina further noted that the focus of acoustic data processing on registering krill swarms is unjustified, since it does not take into account the different forms of krill distribution, which will lead to a potential underestimation of krill biomass.

Harvest rate estimation and MSE

4.36 WG-EMM-2025/P04 builds on previous work (WG-EMM-2014/14) and established a description of distinct morphological characteristics in all twelve maturity stages of male and female Antarctic krill, from juveniles to sexually mature adults. The analysis used a model-based approach to assess individual selectivity in various mesh sizes and openings relevant to the krill fishery. The authors found that selectivity varied significantly between maturity stages and sex, where juveniles and males were more likely to escape through smaller mesh sizes compared to mature females. The authors highlighted that mesh sizes could be optimised to minimise by-catch and ensure sustainable harvest levels, emphasising the need for regulations based on scientific findings. Further studies are needed to examine potential long-term population effects of such demographic selectivity.

4.37 The Working Group welcomed these results, noting that WG-EMM encouraged further work (WG-EMM-2014, paragraph 2.24) regarding size selectivity of krill in trawl to inform the effect of fishing on krill populations, as well as to increase the understanding of the ecological effects of fishing on population structure. It was also noted that these results could have implications for the krill fishery management approach, specifically in developing sustainable harvest rates using the Grym, which requires information on size selectivity.

Spatial overlap analysis

4.38 WG-EMM-2025/12 presented an approach to consider consumption of krill by baleen whales during winter in Subarea 48.1 in the Spatial Overlap Analysis (SOA). A key limitation was the lack of winter abundance data for cetaceans, particularly baleen whales, which prevented their winter krill consumption from being fully represented in the SOA. Researchers used tracking data from humpback whales in the Gerlache Strait to estimate their winter presence and modelled different abundance scenarios from April to July. Results showed that including winter krill consumption by whales had only a marginal effect on the spatial and temporal distribution of krill catch, although baseline risk increased. However, the winter krill distribution and density layer significantly impacted SOA outcomes. The authors recommended that both the summer and the winter krill layers are updated to include data collected across a larger proportion of the study area. They noted that SOA can be useful in its ability to subdivide the krill catch limit, but many caveats remain in its structure and implementation. The authors also indicated that consumption rates within the GPZ/SPZ boundaries were not considered.

4.39 The Working Group welcomed the paper and thanked the authors for the large amount of work conducted over several years that has progressed this useful framework.

4.40 The Working Group discussed the spatial layers included in the models. Some participants raised concerns regarding currently lacking or missing data layers, recommending the inclusion of updated krill consumption from predators, more robust cetacean layers, krill advection and flux, updated distributions of krill for winter and summer seasons, and including an updated fish layer, potentially drawing data from fisheries by-catch data. The authors noted that WG-EMM-2025/12 includes a sensitivity analysis and that uncertainties and sensitivities have been documented in previous SOA papers. The authors proposed to document the details of SOA to date to allow the results to be reproduced as part of the effort to document the KFMA process (paragraph 4.3).

4.41 The Working Group recommended that the IWC-CCAMLR collaborative group works to review methods for estimating krill consumption, particularly for humpback, fin, and Antarctic minke whales.

4.42 Dr Kasatkina noted that predator consumption would be dependent on the number of whales and the dynamics of krill biomass under the influence of krill flux in Subarea 48.1. Dr Kasatkina also recalled results from RV *Atlantida* survey in 2020 (WG-ASAM-2021/04 Rev. 1; SC-CAMLR-42/07) which showed fewer predators compared to findings in Warwick-Evans et al. (2021) during February–March and questioned the ecosystem impact of krill fishing during the summer. Dr Kasatkina further noted that shallow coastal waters may be more important for predators, warranting further discussion in the context of summer and winter catch limits for krill (Watters and Hinke, 2022).

4.43 Some participants noted that the MUs agreed at SC-CAMLR-43 (SC-CAMLR-43, paragraph 2.63) and used in the SOA may not align with ecological structures that dictate the spatial distribution of krill and krill-dependent predators in Subarea 48.1. They noted that the scale of this stratification may not be sufficient to account for the advection of krill, potentially increasing up- and downstream effects of fishing. Implications of the spatial boundaries used in Subarea 48.1 for various management initiatives are discussed in detail in WG-EMM-2025/37. They noted that in the absence of uncertainty layers in the SOA, the spatial scale of MUs should be increased as a mechanism to buffer spatial uncertainty into the analysis, noting that the SOA has a metric to measure risk but not uncertainty (WG-EMM-2021/27). Some other participants noted that there was no evidence to support that such a mechanism would decrease the uncertainty and that there is an increase in the SOA risk metric with management unit size (WG-EMM-2021/27).

4.44 The Working Group recalled that the management units used in WG-EMM-2025/12 were based on U.S. AMLR biomass surveys that already considered ecological structure, and which have already been endorsed by the Scientific Committee (SC-CAMLR-43, paragraph 2.63). The Working Group noted that the spatial overlap analysis is a tool with uncertainties and could be used in the absence of complete data. Furthermore, it was noted that the current iteration of the SOA is the result of several years of work which has evolved over time, integrating regular feedback from CCAMLR Working Groups. The Working Group emphasised the need to update data layers as more robust data become available in future to periodically inform the KFMA. Most participants agreed that the SOA presented in WG-EMM-2025/12 for Subarea 48.1 constituted the best available science and should be applied to spread catch limits. The Working Group noted the balance between using smaller management units to avoid the concentration of catch and using larger management units to mitigate the effects of uncertainty in underlying data layers or from advection of krill.

4.45 The Working Group agreed that the SOA is an appropriate tool for providing advice on the spatial and temporal division of catch limits and identified the following options for using it to spatially and temporally divide catch in Subarea 48.1 based on the SOA (Table 7):

(i) use the alphas from 2022

(ii) use the alphas from WG-EMM-2025/12

(iii) recalculate alphas from WG-EMM-2025/12 without including the proposed GPZs and SPZs in the analysis

(iv) use the data layers from 2025, but with different management units.

4.46 The catch allocations (alphas) associated with options (i) to (iii) are given in Table 8.

4.47 The Working Group recalled its previous advice to the Scientific Committee on the lapsed CM 51-07 that the proportion of the trigger level distributed to Subarea 48.1 provides an appropriate balance between fishery desirability and reducing the risk for local krill-dependent predators (WG-EMM-2021, paragraph 2.63). The Working Group agreed that the current situation of trigger level of 620 000 tonnes in CM 51-01 alone is not precautionary due to local concentration of the catch, and stressed the need to re-instate smaller spatial management similar to the lapsed CM 51-07 to minimise the ecological risk of catch concentration until a longer-term measure is agreed. The Working Group recalled the significant scientific progress on the revised KFMA (WG-EMM-2025/05) which distributes catch limits in time and space at the Subarea scale.

4.48 WG-EMM-2025/34 outlined progress on implementing the SOA in Subarea 48.3. The paper described the source data and subsequent species distribution analyses and consumption estimates for krill and various predators, including cetaceans, penguins, demersal and mesopelagic fish, and Antarctic fur seals. Furthermore, the document described missing layers, including seabird and winter krill layers, and concludes by aiming towards having filled these knowledge gaps before WG-EMM-2026.

4.49 The Working Group welcomed the paper, recognising the value of the work. The Working Group noted that acoustic surveys conducted in May, July, September will be used to create a data layer of krill distribution during winter.

4.50 Dr Kasatkina noted that krill biomass in Subarea 48.3 is highly variable, with low values of krill biomass even in the absence of krill fishing, for example as observed in 2009 (WG-EMM-2009/23). The Working Group noted that biological responses had been observed in years of high and low krill biomass, including in 2009.

4.51 WG-EMM-2025/47 presented a proposal to update the Spatial Overlap Assessment (SOA) in Divisions 58.4.1 and 58.4.2-East using new survey and predator data, and invited the WG-EMM to provide feedback or contribute additional data. The SOA was initially applied in Divisions 58.4.1 and 58.4.2 in 2018 (WG-EMM-2018/37). Japan and Australia have recently conducted broad ecological surveys in the Indian Sector. These surveys included data on Antarctic krill, oceanography, primary production, zooplankton, and top predators. Ongoing data collection on land-based predators like penguins and pinnipeds has also contributed valuable information from French, Japanese and Australian research stations in the region.

4.52 The Working Group welcomed the paper recognising the value of the work and commended the structure of the timeline for the proposed SOA.

4.53 The Working Group discussed parameter weighting in future SOAs, when a more comprehensive ecological understanding is established. It noted that the exact mechanism as to how weighting could be prioritised is currently unclear. The Working Group recalled that tracking data from crabeater seals in East Antarctica were available, and crabeater seals were a desirable species to include in the SOA as a krill-dependent species (WG-EMM-2024/35).

4.54 Some participants noted the differences in applying the SOA in Area 48 and Area 58, where the fishery footprint in the latter is based on historical catch data, and that a potential contemporary fishery might use different areas and be influenced by sea ice and wind conditions.

4.55 WG-EMM-2025/P07 presented an overview of results from a large-scale multidisciplinary ecosystem survey conducted by the Japanese research vessel *Kaiyo-maru* in the Indian sector of the Southern Ocean in 2019. The survey covered physical and chemical oceanography, primary producers, meso- and macrozooplankton, Antarctic krill, flying seabirds and cetaceans. Subsequent work resulted in a collection of peer-reviewed articles in a special issue of *Progress in Oceanography*, as well as several articles in other journals, producing biomass estimates of Antarctic krill, a precautionary catch limit for Division 58.4.1, and baseline data to initiate the Spatial Overlap Analysis development in Area 58.

4.56 The Working Group congratulated Japan on their successful survey and the extraordinary amount of work which resulted in fourteen publications in a special issue, and more than twelve in other journals. The Working Group noted the high relevance to CCAMLR science, providing results across a range of disciplines, as well as a contribution to baseline data for the development of the KFMA in Area 58. The Working Group further noted the high utility of collecting the resulting publications in one issue.

Coordination of the KFMA and D1MPA planning

4.57 CCAMLR-43/22 presented comments on the Harmonisation process between the KFMA and the establishment of the proposed D1MPA in Subarea 48.1. The document noted that the scientific based evidence for the urgent establishment of the proposed D1MPA as a tool to protect against threats from anthropogenic and climatic impacts is not provided. The document further noted that the KFMA and the proposed D1MPA in Subarea 48.1 assumes that current fisheries impact on krill resources and their dependent predators, stressing that such assumption requires scientific justification based on the development of evidence-based criteria and diagnostics for assessing the possible ecosystem impact of fishery. This should take into account the mixed effects of fishing, environmental variability and competitive relationship between predator species. The document emphasised that the KFMA in Subarea 48.1 should be implemented within the framework of the coordinated management of the krill fishery in Area 48 in accordance with CM 51-01, ensuring compliance with Article II of the Convention.

4.58 CCAMLR-43/22 noted that the substantive issues regarding the scientific and legal justification of the Harmonised scenario between the D1MPA and the KFMA remain unresolved, including the D1MPA (objectives, boundaries, indicators and performance evaluation metrics, Research and Monitoring Plan); the boundaries of the General Protection Zones (GPZ) and the Seasonal Protection Zones (SPZ); indicators for assessing the effectiveness of the KFMA and DIMPA harmonisation; and violation of the coordinated and rational management of krill fisheries in Area 48 established by CM 51-01. The document further noted that the proposals to establish the D1MPA and harmonise the KFMA and D1MPA in Subarea 48.1 are not legally justified under existing conservation measures. The document emphasised that implementing harmonisation scenarios between KFMA and D1MPA would only be possible within the framework of a conservation measure establishing the D1MPA in the CCAMLR area.

4.59 The Working Group noted that this paper is a resubmission (WG-EMM-2024, paragraphs 5.14, 5.15 and 5.20).

4.60 The Working Group noted that CM 51-07 had lapsed in 2024, allowing concentration of harvesting (paragraph 4.13). The Working Group recalled the significant progress made on KFMA since 2019 and welcomed new data to be included in analyses for future catch limit deliberations, as well as the development of a more standardised methodology for management, and this is currently being considered in the discussions regarding ‘Spatial Overlap Analyses’ and different scales of MUs, for example.

4.61 Some participants highlighted the availability of evidence to suggest fishing is having an impact on predator populations, and that such studies can be found in peer-reviewed research published in high impact-factor scientific journals, in addition to other long-term monitoring programs of top predators in the region. All of these resources should allow for the Working Group to discuss and decide on advice for the Scientific Committee based on Article IX of the Convention. This article indicated that CCAMLR formulates, adopts and revises conservation measures on the basis of the best scientific evidence available.

4.62 WG-EMM-2025/37 highlighted three components of the D1MPA proposal and KFMA marine spatial planning processes that remained unlinked until July 2024 (i.e. Management units, Spatial Overlap Analysis, and the outstanding issues related to the finite-time trial of the harmonised D1MPA/KFMA). The paper attempted to identify redundancies and the remaining hurdles in the integration of krill fishery management and marine protected area planning. It proposed pathways for science-based advice, and a monitoring program to assess the efficacy of the harmonised D1MPA and KFMA in Subarea 48.1.

4.63 The Working Group agreed that many points relevant to WG-EMM-2025/37 have been discussed along with the spatial overlap analysis (paragraphs 4.38 to 4.56).

4.64 WG-EMM-2025/58 proposed a workshop to be held in 2026 to progress development of an adaptive marine spatial planning framework for Subarea 48.2 entitled ‘Workshop on development a revised krill fishery management approach harmonised with the D1MPA proposal in the South Orkney Islands (Subarea 48.2)’. The terms of reference for the workshop will centre on data assimilation and the development of an agreed, sufficiently resolved work plan to achieve the combined goals of developing an adaptive marine spatial planning framework for Subarea 48.2 that includes the management of fishing and monitoring of the ecosystem. It is intended that the workshop will focus on scientific discussion and will be 3–4 days in length. A steering committee will be formed to coordinate and plan the workshop, and authors extended an invitation those with active research activities and interests in the area to join. Funding to host the workshop has been secured, and the authors propose the workshop is in-person and takes place in connection with one of the 2026 intersessional Working Group meetings. It is proposed that the terms of reference will be developed and presented to the Scientific Committee in 2025, and that the outcome of the Workshop will be a report to be presented to the Scientific Committee in Hobart 2026.

4.65 The Working Group thanked the authors for presenting the workshop proposal, noting it was a promising start to progressing KFMA in Subarea 48.2, in particular to make sure the different initiatives develop in a complementary way. The Working Group suggested a minor workshop title change to reflect the initiatives should be harmonised together and not that the krill fishery should be specifically harmonised with the D1MPA proposal.

4.66 The Working Group noted that the workshop would be a good forum within which to synthesise the range of fishery and predator data that is collected in Subarea 48.2 by several Members. The Working Group also identified the importance of the workshop considering the proposed acoustic transects across Subareas 48.1 and 48.2, which are currently being developed by WG-ASAM (WG-ASAM-2025, paragraph 3.21 and Figure 1).

4.67 The Working Group agreed that having the Subarea 48.2 workshop adjacent to a working group like WG-EMM would be both productive and more cost-effective for participants. Finally, the Working Group requested further information on workshop requirements, including the potential need for Secretariat support, extra travel assistance funding or invited experts.

4.68 The Working Group formed a steering committee to guide further development of terms of reference for the workshop, and to begin to collate information on what datasets would be available to support discussions on spatial management, fishery activities and ecosystem function in Subarea 48.2. Thus far, nominations for participation in the steering committee include Dr Wang, Dr Santa Cruz, Dr Santos, Dr Kelly, Dr Waluda and the CCAMLR Secretariat.

4.69 The Working Group requested that the Secretariat set up a CCAMLR Discussions group titled 'Workshop to support harmonisation in Subarea 48.2' to support the work of the steering committee in developing a proposal document for Scientific Committee.

4.70 The Working Group also noted that planning for the workshop, including development of an agenda and consideration of what the Secretariat might be asked to assist with, would only occur in the event that the Scientific Committee endorsed the proposal as a CCAMLR supported meeting. The Working Group also noted the potential for applying to the MPA Special Fund to assist with having external subject matter experts participate in the workshop.

Krill Fishery Management in Area 58

4.71 WG-ASAM-2025/16 summarised 17 multidisciplinary studies (many studies were from the Australian ENRICH voyage in 2019 and the TEMPO voyage in 2021) 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.

4.72 The Working Group thanked the authors of WG-ASAM-2025/16 for presenting an overview of the special volume on Antarctic krill-centred ecosystem in East Antarctica and congratulated all authors who contributed. The Working Group suggested the information reported in the special volume could contribute to a comparative analysis of the Indian and Atlantic sectors, noting that the Indian sector has not been the focus of a krill fishery for several decades. The authors agreed and proposed that the information presented in the special volume, in addition to ongoing CEMP monitoring in the region, would represent baseline data in the event a krill fishery recommenced in East Antarctica. The Working Group also noted that other data gaps in East Antarctica have recently been filled, such as research in the Krill Research Zone in the Ross Sea (WG-EMM-2025/56), which would assist in future spatial management.

Spatial management

5.1 WG-EMM-2025/46 reported on a study on the distribution of fish communities under the fast ice of the Ross Sea shelf. Shelf habitats are under-sampled zones due to logistical constraints but are important to the research and monitoring programmes in the Ross Sea region

MPA. This seasonally ice-covered area spans depths, from tens to a few hundred meters. As part of the RESTORE project, under the Italian National Antarctic Research Program (PNRA), an Unmanned Underwater Vehicle (UUV) was used to visually survey shelf areas in Tethys Bay, along the coast of Terra Nova Bay, during the late austral spring of 2022. Preliminary results showed the presence of 15 demersal fish species from four families (within the suborder Notothenioidei) and two more pelagic species. Species appeared to segregate depending on substrate type and macrobenthos distribution. Settlement of early-life stages of certain species was observed.

5.2 The Working Group welcomed the paper and noted the knowledge gap that this study fills which was an important contribution to the RSrMPA review. The Working Group highlighted the use of a non-invasive method to study fish and the usefulness of the environmental sensors on the ROV, that help to better understand the ecosystem dynamics in this area, for example, the relation between juvenile fishes and other species with different benthic habitats. It was noted that earlier studies conducted in the Dumont-d'Urville region yielded similar results in terms of species richness. The authors acknowledged the extensive training by Marino Vacchi in identifying Antarctic fish species, a difficulty that was emphasised by the Working Group. The ROV survey was suggested to be suited for use in InSync studies. The importance of standardising survey methods and drawing from existing ROV operational protocols to ensure data comparability across studies and timeframes was noted. The Working Group highlighted that the paper was authored by two former CCAMLR scholarship recipients (Dr Di Blasi and Dr Carlig), again stressing the importance of the scholarship program.

5.3 WG-EMM-2025/54 describes a study on the non-breeding distribution and space use of Adélie penguins, by tracking 61 individuals from Terre Adélie over five years using geolocators. Moulting occurred in areas of low sea ice concentration (SIC), whereas during winter, penguins migrated on average 1 550 km westward from the colony to areas along the sea ice edge with high SIC (75%). The inter-annual overlap of wintering grounds revealed high spatio-temporal consistency, indicating productive regions. Despite variability across years, tracked individuals moulted predominantly outside the proposed EAMPA. As the boundaries of the proposed EAMPA are largely based on species' breeding distributions, the study highlighted a relevant gap in spatial coverage of critical moulting and wintering areas of this highly mobile species in the current proposal.

5.4 The Working Group welcomed the contribution and noted its relevance to the broader design and evaluation of MPAs in the Convention Area. The study was seen as a valuable addition to the body of knowledge informing the EAMPA proposal, especially considering recent discussions on refining spatial coverage to better align with biodiversity objectives. as the Working Group encouraged integrating tracking datasets across other taxon including seabirds and marine mammals, to support holistic ecosystem-based MPA planning. The Working Group also noted the habitat use of Adélie penguins varied interannually and suggested the authors investigate the potential drivers that resulted in such variability. Furthermore, the Working Group highlighted the importance of considering both large-scale migratory connectivity and fine-scale habitat protection in MPA planning. The Working Group also noted that the geolocator tracking could expand the understanding of the location of Adélie penguins during the pre-moult hyperphagia which has been identified as a critical period of peak prey consumption, and concurs with the large winter migratory pathway of penguin populations along the east Antarctic coastline. The Working Group acknowledged the Ant-ICON scholarship program as instrumental to bringing this research to WG-EMM and in enabling new voices and advancing collaborative science within the WG-EMM community.

Data analysis supporting spatial management approaches in CCAMLR

5.5 WG-EMM-2025/45 provided an extensive summary of the relevant research and monitoring activities for the RSrMPA undertaken by New Zealand between 2023 and 2025 and demonstrated a vast amount of national and international collaboration in the research efforts. The authors emphasised the work has been done in direct relevance to evaluating the effectiveness and conservation value of the RSrMPA. The paper shows how the RSrMPA has become a focal point for coordinated international science, acting as a driver for ecosystem-scale research aimed at understanding the impacts and value of large-scale spatial protection in the Southern Ocean. Lastly, the authors invited members with contributions to refer to the spreadsheet accompanying the paper, listing all projects, datasets, and points of contact. This spreadsheet will be submitted to the Secretariat and made available at the CCAMLR MPA Information Repository (CMIR) database.

5.6 The Working Group thanked the authors for the report and acknowledged the significant scale and collaborative nature of the research. Participants noted that the paper demonstrates how the RSrMPA is catalysing scientific inquiry and international coordination, and commended New Zealand for their leadership in fostering open data sharing and international engagement. The Working Group expressed appreciation for the scope of the work and its contribution to RSrMPA evaluation efforts. Participants noted that the acoustic datasets collected using echosounders aboard research vessels may be valuable for submission to WG-ASAM, particularly for ecosystem monitoring applications.

Research and monitoring plans for CCAMLR MPAs

5.7 WG-EMM-2025/31 introduced the outcomes of the Ross Sea Research Coordination Network (RCN) inaugural meeting formally launched in June 2025, in Boulder, Colorado, (USA) at the National Center for Atmospheric Research. A total of 128 individuals registered to participate in the meeting (43 in-person and 85 online) from 22 countries. Participants included scientists from a wide range of career stages, disciplines and institutions, as well as individuals from governmental, inter-governmental and non-government organisations, fishing and tourism industries along with representatives from other international organisations, including CCAMLR members. The goal of the RCN is to formalise connections between policy, research, and other communities focused specifically on research and monitoring of the Ross Sea region MPA. To support research and monitoring in the Ross Sea Region Marine Protected Area (RSRMPA), the RCN includes three key components: (i) policy engagement, (ii) community partner engagement, and (iii) integrated science comprising three themes: data science and cyberinfrastructure; biophysical modeling; and observations, which includes monitoring and process studies. During the 4 days, the different groups RCN actively worked to design plans for the RCN to continue work throughout the coming months and years. Specific Working Groups will continue meeting and progressing their planned activities with a focus on key activities in 2025 and 2026, looking to the 2027 RSrMPA review.

5.8 The Working Group welcomed the output of the inaugural RCN meeting, noting the large number of participants, including external scientists from different countries and expertise.

5.9 The Working Group noted that this document allows to set the scene for the RSrMPA review process and that it can be a useful guideline for other MPA proposals. It further encourages the engagement of other Members.

5.10 WG-EMM-2025/36 presented a framework to support the first 10-year review of the Ross Sea region Marine Protected Area (CM 91-05). The authors provided a detailed schedule of the RSrMPA science and review process, including deliverables and timeframes. The schedule includes a proposed workshop in August 2025 to share feedback on the proposed framework from WG-EMM. An updated paper will be submitted to SC-CAMLR and Commission in 2025 (Table 8, derived from WG-EMM-2025/36, Table 1).

5.11 The Working Group welcomed the detailed framework and schedule to follow for the RSrMPA review. The Working Group noted the role of the Secretariat in supporting this process defined by CM 91-05 by compiling and distributing the information.

5.12 Dr Kasatkina noted that the number of publications indicated in the framework is not enough to present as results and indicated that indicators and criteria to achieve objectives and assesses the effectiveness of the MPA performance and undertake the RSrMPA review. It further noted that the Research and Monitoring Plan for RSrMPA was not endorsed by the Commission and recalled that rationale and description of the indicators and criteria for achieving the objectives of the RSrMPA remain unknown, making it difficult to evaluate the MPA effectiveness. Dr Kasatkina emphasised that the absence of the MPA Research and Monitoring Plan approved by the Commission, in principle, makes it impossible to assess the effectiveness of the MPA's performance and to adopt the Report for the first review period 2017–2027. Dr Kasatkina also suggested to segment the Research and Monitoring Plan for the RSrMPA into distinct phases and specifying for each phase the research to be carried out and the data to be reported.

5.13 The Working Group noted the CMIR database maintained by CCAMLR includes all the baseline data for the RSrMPA and several hundred references to research projects had been added since the MPA was created. It was further noted that the RSrMPA RMP was endorsed by SC-CAMLR in 2017 (SC-CAMLR-XXXVI, paragraph 5.45). The Working Group also noted that the proposed research priorities follow the RMP structure and the latest CCAMLR scientific information to address the requirements in CM 91-05 and will advise the Commission in 2027 on progress made in the 11 objectives of the RSrMPA.

5.14 The Working Group noted that CM 91-05, Table 1 specifies the relevance of each objective to the geographical area of each RSrMPA area and that paper WG-EMM-2025/35 includes a summary table with this information.

5.15 The Working group endorsed the table (Table 9; WG-EMM-2025/36, Table 1 – the schedule) for the review process that will be in 2027.

5.16 WG-EMM-2025/35 presented a proposed research approach for the objective-based reporting to support the 10-year review of the RSrMPA review as set forth in CM 91-05. The authors summarised the science requirements to be included in objective-based reports of science activities to support the 10-year review of the RSrMPA and RMP, detailing specific ecological, biological, and conservation objectives across different zones of the MPA. The paper proposes indicators and research approaches for each objective, aiming to assess the effectiveness of the MPA in conserving biodiversity, supporting scientific research and monitoring climate and fishing impact. A revised framework and research approach to support the RSRMPA review will be submitted to the Scientific Committee (SC-CAMLR-44) for its consideration with the feedback incorporated.

5.17 The Working Group welcomed the paper and thanked the authors for the integration of a range of information into a proposed research approach. The Working Group endorsed the proposed approach, after some clarifications. It was noted that the research approach and the specific indicators have been built from the requirements from CM 91-05, including the priority elements for research, protection targets (described in SC-CCAMLR-XXXIII/BG/23 Rev.1, Table 1), the SMART goals paper (CCAMLR-42/44; SCCAMLR-42/BG/08) and guidance form the RMP.

5.18 WG-EMM 2025/41 reviewed of ecological data on Elephant Island, emphasising its ecological significance. The area's high productivity is likely due to the unique hydrological conditions resulting from the influence of specific water masses, but also the seafloor topography, particularly submarine canyons that promote transport of krill onto the shelf area from the open oceanic waters, including the juvenile krill which tend to distribute around the island. Long-term studies on krill abundance variability in the island area have shown clear interannual fluctuations. Although high krill recruitment years have been observed since the beginning of the 20th century, no subsequent high abundances have been recorded in the region after 2000, suggesting high juvenile mortality. The island hosts major chinstrap penguin colonies, most of which have declined since 2000. Macaroni penguins and fur seals are also present, though data are outdated. The island is an important feeding area for fin whales, raising concern about whale by-catch in krill fisheries and suggesting the need for precautionary area closures. The authors highlighted that long-term data was provided by the AMLR program.

5.19 The Working Group welcomed the document noting that it is very timely. The Working Group highlighted the long-term data set considered in the document and agreed that this is a hotspot for krill and dependant predators, and the information presented may be useful for KSH, KFMA and predator conservation needs.

5.20 The Working Group highlighted the importance of contextualising the data on zooplankton. It also emphasised the uniqueness of the island, which hosts colonies of macaroni penguins and where fur seal populations are declining at a slower rate compared to other locations.

5.21 The Working Group noted that there may be a possibility of a geographical gradient in abundance changes that should be explored further. Most colonies have declined by more than 50% in recent years compared to the period prior to the year 2000. However, the local population dynamics remain poorly understood due to the sparse and fragmented nature of the available data.

5.22 The Working Group also emphasised the need for caution when interpreting the results in relation to water masses. It was suggested that incorporating recent studies on krill distribution and abundance could improve the understanding of krill-predator interactions and strengthen the review.

5.23 WG-EMM-2025/20 presented the results of aerial surveys of 12 Adélie penguin breeding colonies along the Northern Victoria Land coast conducted from 2021 to 2024 focusing on areas with previously limited baseline data. The total number of breeding pairs

(223 990 breeding pairs) across 12 colonies increased by 3.9% compared to the baseline and by 48.4% compared to the SMART criteria, although substantial variation was observed among sites. Additionally, the authors analysed temporal changes in the number of breeding pairs and breeding success at two key colonies, Cape Hallett and Inexpressible Island (Subarea 88.1), spanning the 2017/18 to 2024/25 breeding seasons. While Cape Hallett exhibited a long-term decline in breeding pair numbers from the 2017/18 to 2023/24 breeding seasons, with partial recovery in 2024/25, Inexpressible Island maintained stable numbers of breeding pairs. This study addresses key data gaps in the assessment of Adélie penguin population dynamics and contributes to the scientific basis for the upcoming 10-year review of the Ross Sea MPA. The authors further noted that to assess the status of the Adélie penguin population within the RSrMPA it will be necessary to compile data from different countries with help to fill data gaps.

5.24 The authors explained that the first phase of the project took place from 2017 to 2021, and that the second phase, which began in 2022, will conclude next year. The third phase is planned to run from 2027 for 2032, with field activities scheduled to start in 2027. The project will focus on three main topics: (i) distribution and diversity of marine organisms; (ii) ecological response of indicator species; and (iii) changes in marine and ecological environment. The authors expressed their openness to feedback and support from the community for the new phase of the project.

5.25 The Working Group welcomed the paper and noted the relevance of conducting large-scale censuses. It highlighted the importance of a collaborative approach among members to extend data collection and address existing data gaps.

5.26 The Working Group noted that some populations were declining while others remained stable and offered the suggestion to combine data from different sites to understand overall population dynamics. The Working Group welcomed the plan for the upcoming season where information about penguin diet composition, foraging range and oceanographic data will be collected.

5.27 The Working Group recommended the new phase of research project in support of the RSRMPA. The Working Group also highlighted that this was a valuable exercise in demonstrating how to apply SMART criteria in the context of the Ross Sea region MPA review. The Working Group further noted that the value of the collected data is well aligned with the objectives of the MPA review and offers a strong foundation for linking this information to the RMP.

5.28 The Working Group recalled the efforts being conducted toward standardising methods and enhancing data collection to assess ecosystem effects. These efforts aim to ensure that data collected now can be used in the future for more informative and integrated analyses. In this context, the Working Group expressed its support for the new phase of the project. The Working Group noted that penguin populations across different regions of Antarctica exhibit varying ecological dynamics. In the Antarctic Peninsula, krill is the dominant prey species in most cases, while in the Ross Sea, fish play a more significant role. The Working Group highlighted the importance of extending this study as a good example of continuous data collection and emphasised the relevance of using this information to support the enhanced CEMP, particularly in distinguishing the effects of climate change from those of fisheries.

ASPA/ASMA/VME and other spatial management issues

5.29 WG-EMM-2025/08 presents an overview of the progress made by the 2025 CCAMLR Scholarship recipient, Dr Filander, on mapping Vulnerable Marine Ecosystems (VME) in the Weddell Sea. The work involved integrating deep learning image analysis and multivariate modelling techniques applied to still and video imagery from 16 research cruises between 1985 and 2021 with use of photo sleds, towed camera systems (e.g., OFOBS) and remotely operated vehicles (ROVs). The data covered depths ranging from shallow depths as 23 m to nearly 1800 m, thus capturing a wide range of environmental conditions. Differences in data acquisition, processing methodologies, imaging availability and varying levels of benthic annotation that were not specifically designed to match VME taxa identifications defined by CCAMLR, and the authors propose the project undergoes a revision towards producing a presence–absence matrix of VME indicator taxa, maximising use of data to produce a broader spatial coverage.

5.30 The Working Group congratulated Dr Filander and recognised the presentation as an ambitious and valuable contribution to Antarctic marine research. The Working Group highlighted the integration of diverse data sources and noted the potential to support the identification of Vulnerable Marine Ecosystems (VMEs) in the Weddell Sea.

5.31 The Working Group noted the level of taxonomic identification, with experts advising the use of higher-level categories when species-level identification is not possible, particularly for organisms like sponges. The Working Group noted that the long-term dataset was promising for future climate change analysis, though potential biases should be considered.

5.32 The WG noted that this kind of data set and machine learning approach to identifying VMEs could be in the future implemented in the fisheries electronic monitoring.

5.33 The Working group emphasised the importance of coordinating benthic data across the Southern Ocean and encouraged collaboration with existing initiatives in New Zealand, Tasmania and BAS. The work was acknowledged as a good example of capacity building through the CCAMLR Scientific Scholarship Scheme, with appreciation expressed for the mentoring and international cooperation involved.

5.34 WG-EMM-2025/61 presented a summary of the VME dataset currently available at the Secretariat, which includes data collected for the past 15 years through commercial fisheries records of VME indicator taxa by-catch (CM 22-07) within the Convention area. Comparisons between observers and vessels data showed mismatches in the number of records, likely a result of recording or data quality issues.

5.35 The Working Group thanked the Secretariat and noted that the project was undertaken through the CCAMLR international internship programme with support provided by China Fund. The Working Group noted that there are various ways errors could be incorporated into the data, including individual variability from observers. It was noted that since the CM 22-07 entered in force, observers needed training in the identification of taxonomic groups, therefore, time was necessary for the CM to be effective. Some discrepancies between observers and vessel reporting could be traced back to this initial period after the CM 22-07 entered in force in 2014. It reinforced the need to improve the data loading procedures to include rules to check for inconsistencies while data is being loaded, and the need to develop a way to correct those errors once identified.

5.36 The Working Group highlighted the importance of CM 22-07 as a source of data but called attention to the need for looking more carefully at the approach to use VME organisms as indicators, as addressed in the VME workplan developed at WG-FSA-2019 (WG-FSA-2019, Table 12).

5.37 The Working Group noted that this information could be made publicly available through the CCAMLR Spatial Data Viewer, recognising that VME data may inform ecosystem health checks. The Working Group noted that careful checks for data quality would be required, and the data should be anonymised before being made available to the public.

5.38 WG-EMM-2025/68 presented imagery data from Remotely Operated Vehicle deployed by the *M/Y Legend* off the east coast of the Cuverville Island in the Errera Channel (Subarea 48.1) to calculate relative percent cover of Vulnerable Marine Ecosystem (VME) taxa indicator species. The site corresponds to a wall with rock and rubble substrate leading down to a steep rocky slope. Analysed imagery had VME percent coverage above 50%, with the majority of imagery with VME coverage between 70% and 80%. The site holds a high diversity of demosponge species, hard bryozoans that form extremely fragile reef-like structures and kelp forests at the shallow depths of the wall. The authors propose the inclusion of this site in the VME site list. Data on this VME can be found in SCAR/AntObis/ GBIF database ((https://ipt-obis.gbif.us/resource?r=vme_rov_cuverville_2025).

5.39 The Working Group acknowledged the study for its transparency, data accessibility and the use of non-destructive ROV techniques, which are becoming a widely accepted method for assessing deep benthic habitats.

5.40 The Working Group noted that the inclusion of the VME in the VME register would assist in ensuring ecological information is preserved and available and suggested that retrospective revisions could be made if needed, noting that the proposal methodology used aligns with protocols accepted by the Scientific Committee since 2010 (WG-EMM-10). The Working Group noted precedents where VMEs were registered based on video-derived quantitative criteria, such as percent cover and taxon density.

5.41 Some participants expressed concern about the absence of formally consolidated and Scientific Committee-approved criteria for using video/imagery in VME identification, and noted that further development of standardised, quantitative protocols to ensure consistency and comparability with existing (e.g. fishing-based) criteria, including the need for defining existing fishing-derived metrics in Annex 22-06/B.

5.42 The Working Group recalled that the first VMEs were identified in areas that were closed for fishing, and noted that several VME sites have been designated in recent years using similar survey approaches.

5.43 Some participants recalled that the existing VME notification process does not require the identification of current threats. They noted that the inclusion of this site will provide information to reduce risk to VMEs in the future. They also recalled that the notification process contributes in generating a database for future comparisons and to test whether VMEs change in time.

5.44 WG-EMM-2025/67 presents updates on the changes of the ice coastline and surface area of the Pine Island Glacier (Subarea 88.3), which is a dynamic glacier that have undergone rapid changes. Pine Island Glacier sea ice coastline retreated substantially from its 2017 baseline, reaching its lowest area in 2021, then expanding and increasing area until 2025. While the glacier's area in 2025 is still significantly lower than the 2017 baseline, it no longer meets the criteria for Special Area for Scientific Studies (SASS) designation set out in CM 24-04. Authors will not seek re-notification of Stage 1 designation, but do not exclude potential future notification due the highly dynamic nature of the glacier. The authors highlighted the importance of regular monitoring of updated satellite image of ice shelves, glaciers and ice tongues in Subareas 48.1, 48.5 and 88.3 to identify other areas that may meet the criteria for SASS designation under CM 24-04.

5.45 The Working Group noted that understanding the history of seafloor exposure is critical to interpreting ecological dynamics, particularly the process of ecosystem colonisation and succession following ice retreat. Temporarily exposed areas can provide valuable insights into early colonisation stages, especially when comparing previously exposed sites with newly revealed ones. This could support future studies of ecosystem resilience and adaptation studies.

5.46 The Working Group emphasised the importance of minimising human activity in newly exposed areas to allow for unbiased scientific observation and data collection. The Working Group noted that while the site does not currently meet the SASS criteria, the dynamic nature suggests that future calving or collapse events could expose new areas that might qualify. The Working Group encouraged Members to maintain close satellite monitoring of Pine Island Glacier and other key glacial fronts in designated subareas to detect future changes.

Other business

Joint SC-CAMLR – CEP Workshop 2026

6.1 The Working Group noted the proposed Joint SC-CAMLR – CEP Workshop scheduled for May 2026 in Hiroshima, Japan, as outlined in paper WP37 submitted to the ATCM. The paper described the intended format and organisational approach for the workshop, which has been under development for several years and now includes a timeline and terms of reference, although a formal agenda is yet to be developed. Participants of WG-EMM were invited to provide suggestions for additional discussion topics to be considered by the Workshop Steering Committee. It was emphasised that this is an opportune time to contribute ideas before the joint draft agenda is presented to the Scientific Committee.

6.2 The Scientific Committee Chair provided an update on recent CEP discussions in Milan and identified ballast water management, bio-fouling, and invasive species range shift/expansion in response to climate change as examples of relevant joint topics.

6.3 The Working Group noted that based on precedents, the outcomes of the Workshop will be submitted to WG-EMM and Scientific Committee and could be made publicly available. The Working Group further noted that formal Scientific Committee-endorsed workshops are included on the CCAMLR website, while informal workshops or those with no formal adopted reports are not.

6.4 The Working Group noted that if the workshop accepts papers, Members may consider submitting papers to the Workshop. The Working Group recalled the value of previous joint workshops between the Scientific Committee and CEP, and highlighted the importance of maintaining progress on topics of common interest.

6.5 The Working Group recalled the six joint priority areas of common interest to the CEP and SC-CAMLR (as listed below), and noted their relevance to the remit of WG-EMM:

(i) climate change and the Antarctic marine environment

(ii) biodiversity and non-native species in the Antarctic Marine environment

(iii) Antarctic species requiring special protection

(iv) spatial marine management and protected areas

(v) ecosystem and environmental monitoring

(vi) marine debris.

Workplan and krill

6.6 The Working Group recalled previous discussions at SC-CAMLR-43 (paragraph 11.22) regarding the responsibilities of different working groups in developing advice related to krill fisheries management. It noted that working group participants often possess different areas of expertise, and that topics are frequently referred between Working Groups to develop comprehensive advice.

6.7 The Working Group highlighted the fragmented handling of krill-related issues across multiple working groups and supported the consolidation of such work. The Working Group noted that a dedicated meeting or the re-establishment of WG-Krill could be considered to bring together relevant expertise from WG-EMM, WG-SAM and WG-ASAM.

6.8 However, the Working Group emphasised the importance of maintaining an integrated ecosystem perspective within WG-EMM to ensure relevant expertise informs the work.

6.9 The Working Group agreed that further discussion by the Scientific Committee would be beneficial to explore options for improving coordination of krill-related work across working groups. The Working Group noted that the WG-EMM terms of reference had been formulated prior to the currently urgent needs to develop the KFMA. It further noted that a holistic approach to reviewing the terms of reference for all CCAMLR working groups, perhaps during the 2027 review of the strategic workplan by the Scientific Committee, was a desirable approach as the Scientific Committee is ultimately responsible for tasking the working groups to manage crosscutting issues.

Status of commercial fisheries in the Convention Area

6.10 The Working Group recalled that WG-FSA-2024 developed three CCAMLR fisheries status assessment categories for commercial fisheries in the Convention Area:

(i) Category 1: Integrated stock assessments (e.g. *Dissostichus spp.*) or 2-year projections based on recent trawl surveys (e.g. *Champsocephalus gunnari*)

(ii) Category 2: 20-year projections based on hydroacoustic survey results conducted more than five years ago (e.g. *Euphausia superba*)

(iii) Category 3: Trend analyses of catch per unit effort or mark-recapture estimates of vulnerable biomass with target harvest rates (e.g. 4% for *Dissostichus spp.*).

6.11 The Working Group noted that SC-CAMLR-43 assigned Category 2 assessments to krill fisheries in Subareas 48.1, 48.2, 48.3, 48.4 and Divisions 58.4.1 and 58.4.2, and that no assessment category was assigned for other areas. SC-CAMLR-43 further noted (SC-CAMLR-43, Table 1, footnote 4) that that the krill assessment categories would be refined during 2025.

6.12 The Working Group agreed that the category 2 description should read: "Precautionary harvest rate that achieves 75% escapement derived from 20-year projections based on population parameters".

Future work

Review of workplan

7.1 The Working Group considered revisions to its current workplan as described in SC-CAMLR-43, Table 8 and recommended the following changes:

(i) revise the term 'Contributor' as a column name to 'Lead'

(ii) remove Dr Labrousse from item 2 a i 2.

(iii) add the CEMP review teams to 2 a (i) 1 and add team leaders (paragraph 2.96).

(iv) add 'Urgency: High to 2 a (i) 1 (i).

(v) remove names for 2 a (ii) Ecosystem modelling.

(vi) noting their recent retirements, remove Dr Watters and Dr Reiss throughout

(vii) remove Dr Lowther and Mr Johannessen from 1 a (v) 1.

(viii) add 'RSRMPA review in 2027' to 2 b (ii).

(ix) remove Dr Hill from 1 b (v) (vii) and Dr Makhado from 2 a (ii)

(x) add 'Ecoregionalisation of Subantarctic Indian Ocean' to 2 b (i) 2 with Dr Makhado and Dr Koubbi as lead

(xi) revise 1 b (v) to read 'Develop the Revised Krill Fishery Management Approach (KFMA)'

(xii) add Dr Panasiuk to 1 a (vi)

(xiii) remove Dr Meyer from 1 a (iv).

Advice to the Scientific Committee and its working groups

8.1 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) WG-ASAM-2025 Research trawl questionnaire (paragraph 2.28)

(ii) research trawl minimum mesh size (paragraphs 2.29 and 2.40)

(iii) utility of adjacent WG-EMM / WG-ASAM meetings (paragraph 2.32)

(iv) reporting of moorings affecting fisheries (paragraph 2.35)

(v) incorporating KSH into KFMA (paragraph 2.42)

(vi) update CEMP forms to note disease (e.g. HPAI) (paragraph 2.72)

(vii) add faecal DNA metabarcoding to CEMP (paragraph 2.83)

(viii) strengthening ties between SC-CAMLR and IWC-SC (paragraph 2.114)

(ix) proposed topics for Antarctica InSync (paragraph 2.121)

(x) CEMP as part of the KFMA (paragraph 2.130)

(xi) krill data collection plan (paragraph 2.207)

(xii) fishing event classification codes (paragraph 2.210)

(xiii) krill product reporting codes (paragraph 3.2)

(xiv) fishery-specific trawl haul-by-haul data forms (paragraph 3.6)

(xv) linking trawl gear configuration to individual hauls (paragraph 3.10)

(xvi) modify IMAF reporting form (paragraph 3.22)

(xvii) calculation of warp-strike reporting rate (paragraph 3.24)

(xviii) KFMA summary document (paragraphs 4.2 to 4.4)

(xix) needs to implement the KFMA (paragraph 4.12)

(xx) krill fishery distribution in 2024/25 season (paragraph 4.13 and 4.14)

(xxi) trigger level catch allocations among subareas (paragraph 4.19, 4.29 and 4.47)

(xxii) SOA alphas for spatial and temporal allocation of catch limits (paragraph 4.45)

(xxiii) RSRMPA review timetable and framework (paragraphs 5.15 and 5.17)

(xxiv) WG-EMM scope of work (paragraphs 6.7 and 6.8)

(xxv) CCAMLR stock status classification (paragraph 6.12)

(xxvi) review of WG-EMM workplan (paragraph 7.1).

Adoption of the report and close of the meeting

9.1 The report of the meeting was adopted requiring 10.9h of discussion.

9.2 At the close of the meeting Dr Collins expressed his gratitude to the convener for his expertise in guiding the sometimes tricky discussions with humour and skill.

9.3 Dr X. Zhao (China) thanked the convener, the host and ARK for a fantastic venue for the meeting.

9.4 Dr Krause thanked the Secretariat for their expert support in preparing the meeting and for their assistance during the meeting.

9.5 Dr Krafft noted the impressive papers, high quality presentations brought to the meeting and welcomed the presence of the diverse next generation of CCAMLR scientists who bring expertise and perspectives from work across the Southern Ocean. He noted that the work of WG-EMM is challenging but constructive and thanked the convener, participants, the Secretariat for their dedication to achieving the big picture of the meeting. He wished all participants safe travels home.

9.6 The Working Group acknowledged Dr George Watters for his invaluable contributions to the group over the years. His work has been central to discussions on key topics such as the Krill Fishery Management Area and the development of the Ross Sea Marine Protected Area. Beyond his role as an outstanding scientist, Dr Watters has been especially appreciated for his ability to guide complex discussions toward common ground, always with wisdom and a sense of humour. His leadership and collegiality have greatly contributed to the group's progress, even in the most challenging debates. With sincere appreciation (and some regret), the Working Group wished 'The Wombat' a happy and well-deserved retirement.

9.7 The Working Group also acknowledged the retirement of Dr Christian Reiss, who brought a wealth of expertise, innovative solutions, and entertainment to the discussions of acoustics and krill as a participant in several working groups and in his role as co-convener for SG-ASAM. The Working Group wished him well in his retirement.

References

Bennett-Laso, B, B. Berazay, G. Muñoz, N. Ariyama, N. Enciso, C. Braun, L. Krüger, M. Barták, M. González-Aravena and V. Neira. 2024. Confirmation of highly pathogenic avian influenza H5N1 in skuas, Antarctica 2024. *Front. Vet. Sci.*, 11:1423404. https://doi.org/10.3389/fvets.2024.1423404.

IWC. 2012. Requirements and guidelines for conducting surveys and analysing data within the revised management scheme. *J. Cetacean Res. Manage.*, 13: 509–516.

Krüger, L., M.F. Huerta, F. Santa Cruz and C.A. Cárdenas. 2021. Antarctic krill fishery effects over penguin populations under adverse climate conditions: Implications for the management of fishing practices. *Ambio*, 50: 560–571. https://doi.org/10.1007/s13280-020-01386-w.

Léon, F. et al. 2025. Skuas mortalities linked to positives HPAIV/H5 beyond Polar Antarctic Circle. bioRxiv, 2025.03.02.640960. https://doi.org/10.1101/2025.03.02.640960.

Siegel, V. 1988. A concept of seasonal variation of krill (*Euphausia superba*) distribution and abundance west of the Antarctic Peninsula. In: Sahrhage, D. (Ed.). *Antarctic Ocean and Resources Variability*. Springer-Verlag, Berlin Heidelberg: 219–230.

Waller, S.J., J.R. Wierenga, L. Heremia, J.A. Darnley, I. de Vries, J. Dubrulle, Z. Robinson, A.K. Miller, C.N. Niebuhr, D.S. Melville, R. Schuckard, P.F. Battley, M. Wille, B. Alai, R. Cole, J. Cooper, U. Ellenberg, G. Elliott, J. Faulkner, J.H. Fischer, J. Fyfe, L. Hay, D. Houston, B.C. Keys, J. Long, R. Long, T. Mattern, H. McGovern, L. McNutt, P. Moore, O. Neil, J. Osborne, A.S. Pagé, K.A. Parker, M. Perry, B. Philp, J. Reid, K. Rexer-Huber, J.C. Russell, R. Sagar, T.T. Ruru, T. Thompson, L. Thomson, J. Tinnemans, L. Uddstrom , T.A. Waipoua, K. Walker, E. Whitehead, C. Wickes, M.J. Young, K. McInnes, D. Winter and J.L. Geoghegan. 2025. Avian Influenza Virus Surveillance Across New Zealand and Its Subantarctic Islands Detects H1N9 in Migratory Shorebirds, but Not 2.3.4.4b HPAI H5N1. *Influenza Other Respir Viruses*, 19(4): e70099. https://doi.org/10.1111/irv.70099.

Watters, G.M., J.T. Hinke and C.S. Reiss. 2020. Long-term observations from Antarctica demonstrate that mismatched scales of fisheries management and predator-prey interaction lead to erroneous conclusions about precaution. *Sci. Rep.*, 10: 2314. https://doi.org/10.1038/s41598-020-59223-9.

Zhou, X.Q., G.P. Zhu and S. Hu. 2020. Influence of tides on mass transport in the Bransfield Strait and the adjacent areas, Antarctic. *Polar Science*, 23: 100506.

Table 1: Variables required to describe research nets used for krill sampling during acoustic surveys.

1) Net name: _________

2) Mesh:

- Mesh size: stretched inside mesh size _______ mm ;
- Mesh design: Diamond ______; Square _______ (mark one)
- Material: ___________; Diameter: _______mm
- Twine type (twisted/braided)

3) Net size:

- Mouth size: horizontal opening _______m; vertical opening________m
- Frame type: beam trawl ________ ; rigid frame __________ ; top and bottom cross bars with vertical wires; other ______ (describe)
- No. towing wires:______; no. warps attached to the frame

Open-closing net _____

- Net length: ________m

4) Operational:

Towing speed: ________ knots through the water

How towing speed is measured:

Hauling speed: ________ m/s

Oblique or V-haul/Double oblique haul:

Depth range net 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:

- Stretched inside mesh size: using a calliper, measure the distance of one mesh side, from corner to corner (or knot-to-knot)

Table 2: Overview of the proposed schedule for CCAMLR InSync activities.

Aims and timeline for CCAMLR's InSync activities

- 2024–2026 – Preparatory Phase
- 2027–2029 – Implementation Phase
- 2029–2030 – Completion and Reporting Phase

Proposed CCAMLR WG-EMM subtopics to be included within the InSync initiative

1. Ecosystem effects of the krill fishery in Area 48
2. Circumpolar biological krill surveys
3. Characterising krill flux

Research questions identified by the WG-EMM to be addressed within the proposed subtopics (see above)

At this stage, the specific research questions and required data products will serve as references for coordinating the planned data collections and surveys during the InSync Implementation Phase. Therefore, the list of research questions will be further developed in a CCAMLR Discussion Group with CCAMLR members and external experts throughout the InSync Preparatory Phase as field campaigns are organised and feasibility checks are conducted.

Subtopic 1: Ecosystem effects of the krill fishery in Area 48:

Topic	Research Question	Proposed data product requirements
Spatiotemporal overlap of fisheries and krill predators and associated functional responses	*Quantify the degree of horizontal and vertical overlap of fishing and predator foraging events, and does this translate into a functional response by predators to fisheries-induced changes in krill availability?*	Fisheries acoustics Fishing net depth Vertical dive profiles of predators based on animal-borne logging data (e.g. time and depth recorders) Predators foraging areas (horizontal telemetry data) Envelopes of several krill-dependant predator distributions based on

		animal-borne data (from the number of locations or the number of dives or the sum of dive duration) Depth and frequency of prey capture attempts (accelerometer-based estimates) Variability in predator foraging behaviour (trips duration, energy expenditure, successful capture attempts, prey intake) in response to krill availability or proximity of fishing activity during key stages of the breeding cycle Data on diet of predators in fishing areas and non-fishing areas (scats and biomarkers) and data on available prey in the regions Data on diet of predators before and after fishing events Krill catches Krill biomass estimates Horizontal and vertical prey field structure Changes in temporal availability of krill during key stages of the breeding season Deployment-associated diet studies (biogeochemistry, molecular genetics, direct sampling) Energetic cost of foraging
Spatiotemporal overlap of fisheries and krill predators and associated functional responses	*What is the seasonality and magnitude of krill flux at local and subarea scales (spatiotemporal patterns of advection-driven krill stock replenishment)*	Continuous echosounder data of the upper 300 m either from gliders, repeat boat/ship based tracks, or an array of bottom-mounted acoustic buoys – all would need to be sampled densely enough to characterise flux over a time and spatial scale relevant to foraging behaviour
Numerical / demographic responses to fishing pressure	*Are functional responses to human-driven changes in krill availability (through fishing) translated into population abundance changes of predators?*	Aerial surveys of land-based predator colonies (UAV, piloted aircraft, ground counts)
Behavioural interactions between the krill fishery and krill-dependent predators	*Does nearby fishing change the foraging behaviour of krill predators?*	Fisheries acoustics Fishing net depth Vertical dive profiles of predators based on animal-borne data Predator-specific prey capture rates Change in foraging tactics (shape of dives, changes in pattern of acceleration…) Change in predator body condition from accelerometry data Fishing fleet position data

Behavioural interactions between the krill fishery and krill-dependent predators	*Can nearby (or remote) fishing activity alter the spatial movements of krill predators?*	Fishing fleet position data Fishing effort data Predator telemetric data
Behavioural interactions between the krill fishery and krill-dependent predators	*What is the impact of fishing activity on the temporal depletion of krill in the upper layers of the water column and/or on the structure of krill swarms near central-place foragers colonies?*	Individuals' physiological condition and breeding output under different scenarios of krill availability in the surroundings of breeding colonies Krill fisheries acoustic data An array of acoustic buoys that is placed densely enough to characterise the flux through an area relevant to the scale of potential fishery depletion.
Behavioural interactions between the krill fishery and krill-dependent predators	*How does the spatial distribution of different krill-dependent predators relate to documented direct interactions with fishing vessels?*	Predator survey data Predator telemetric data Fisheries acoustics Fishing fleet position data

Subtopic 2: Circumpolar biological krill survey

Topic	Research Question	Proposed data product requirements
Large scale krill biomass estimates	*Can a synoptic or semi-synoptic krill acoustic survey be completed across Subareas or at circumpolar scales?*	Calibrated acoustic data from vessels following systematic survey grids Acoustic glider data (if a suitable biomass model can be designed)
Large scale krill population structure	*Can we identify source and sink regions as well as potential advective connectivity between different krill populations at large scales based on population structure?*	Krill length frequency distribution Krill sex/maturity stage composition
Large scale dynamics in krill vertical distribution	*Can we identify general mechanisms and drivers of the vertical distribution of krill swarms?*	Fisheries acoustics Glider acoustics Mooring/lander acoustics Acoustic data from research surveys (conducted by fishing and research vessels)

Subtopic 3: Characterising krill flux

Topic	Research Question	Proposed data product requirements
Area or management unit scale estimates of krill flux at a seasonal scale	*Can we estimate krill density and movement (flux) into and out of a biologically or ecologically relevant area (e.g. Bransfield Strait)*	A large array of acoustic buoys with ADCP and echosounder sensors

Table 3: Initial table outlining essential variables and indices identified by the CEMP Monitoring Plan and Ecosystem Status Reporting teams, including methods for accessing raw data, scripts used for data reformatting, and locations of processed output files.

		Data scope		Data Source			Workflow	Output
Essential Variable	CCAMLR Index	Relevant CEMP site(s)	Relevant region	DOI/API	Resource contact	National program (if applicable)		

Table 4: Krill biological data collection plan on the krill fishing vessels during commercial operation.

Krill biological sampling by SISO Observers during fishing operations (CM 51-06)

Sampling frequency and sample size	Measurements	Objectives
Every 3 days or every 5 days, random 200 individuals SISO Protocol for details	Krill length (in mm)	<u>Operational:</u> Size composition of catch in space and time, and in relation to gear selectivity. <u>Stock assessment parameters:</u> Spawning season parameters for Grym. Inform future integrated stock assessment for krill. <u>KSH:</u> Spatial krill length frequency distribution (LFD) and life stage distribution patterns (such as in relation to topography or Management Units).

Krill biological sampling for Science Programs (Note: Sampling during acoustic transects are detailed in Table 5)

Sampling frequency and sample size	Measurements	Objectives
Project dependent	Detailed LFD and maturity stages, and weights.	<u>Stock assessment parameters:</u> Length-weight relationship Maturity parameters to determine recruitment <u>KSH:</u> LFD and maturity distribution pattern (such as in relation to topography) of post-larval krill (juveniles, subadults, and adults) within fishing grounds and hotspots.
	Environmental data (e.g. SST, salinity, sea ice, wind, chl-a, eDNA,	Ancillary environmental parameters to support taken by vessels to understand habitat condition and its relation to krill life stage distribution throughout the period.
	Genetics)	Development of molecular markers for analysing subarea level population. Molecular analysis of microbiome assembly that are geographically structured. Understand connectivity and retention.

Table 5: Biological sampling plan for KSH during acoustic transects

Trawl type	Measurement	Data to be used for	Number of individuals to be measured	Net Towing method	Spacing between sampling stations	Season	Processing
Post-larval krill sampling net	Essential Length Basic staging (Juveniles, Adult Males, Adult Females, Gravid females) Determined by scientists or image-based methods	Recruitment index for Grym	100-150 (randomly grabbed and all individuals to be measured	Double oblique 0-200 m (the depth of towing net depends on the weather)	During acoustic transects station spacing 20-40nm	Summer (Jan) and Winter (May)	On board
	Optional Detailed maturity staging using Makarov and Denys (1981 staging key)	Maturation parameter for Grym Detailed maturity information of post-larval krill to advance KSH					Post processing (within 1 year after survey)
Larval krill sampling net	Antarctic krill larvae	Identification of nursery ground for KSH	1. Using splitter to subsample. 2. Record split factor and 3. Mark Furcilia numbers in subsample as follows: 1-10: + 10-20: ++ >20: +++	Double oblique 0-200 m	During acoustic transects station spacing 20-40nm	Only winter	Post processing (within 1 year after survey)

Table 6: Biological sampling plan for acoustic biomass

Trawl type	Measurement	Data to be used for	Number of individuals to be measured	Net Towing method	Spacing between sampling stations	Season	Processing
Post-larval krill sampling net	Length	Acoustic biomass estimate	100	Target trawl/oblique tows	Directed tows on acoustic marks	Summer and Winter	On board

Table 7: Options for spatial and temporal catch allocations (alphas) in Subarea 48.1 based on the Spatial Overlap Analysis. These options were proposed by participants and none of them represent the consensus view of WG-EMM. The statements in the 'Justification' column are the views of proponents and do not represent the consensus view of WG-EMM. The 'decreasing humpbacks' scenarios in WG-EMM-2025/12 refers to the gradual seasonal migration of humpback whales out of Subarea 48.1.

Option	Alphas	Management units	Justification	Additional work required to develop advice and indicative timescale
1 (2022 alphas)	SC-CAMLR-41, Table 2 (2022)	SC-CAMLR-41, Figure 1 (2022)	Based on best available science in 2022 (SC-CAMLR-41, paragraph 3.46).	NA (alphas in Table 8)
2 (2025 alphas-harmonised)	WG-EMM-2025/12 Table 2 ('Decreasing humpbacks' scenario)	WG-EMM-2025/12, Figure 1	Uses management units endorsed by SC-CAMLR-43 (paragraph 2.63) adapted to include the SPZs and GPZs proposed by HS (2024), and includes updated whale layer compared to option 1.	NA (alphas in Table 8)
3 (2025 alphas-KFMA)	As above but updated to remove SPZs and GPZs from management unit structure	SC-CAMLR-43, Figure 1 (2024) Original version in WG-EMM-2024/25, Figure 1 (scenario 2)	Uses management units endorsed by SC-CAMLR-43 (paragraph 2.63) and includes updated whale layer compared to option 1.	NA (alphas in Table 8)
4 to 8 (Revised management units)	Alphas to be calculated. Data layers from 2025 WG-EMM-2025/12	Five configurations of management units including management units endorsed by SC-CAMLR-43 (paragraph 2.63) Configurations to be considered with and without SPZs and GPZs	Allocations are potentially not robust to the effects of uncertainties in the SOA, including krill flux (WG-EMM-2024/27). Managing at progressively larger scales may integrate out the noise of flux. Multiple options required to allow managers to make a choice based on the trade-off between risk and uncertainties.	MU configurations provided during WG-EMM-2025. Shapefiles to be clipped to fit SOA footprint. Run SOA with proposed MU configurations in advance of SC-CAMLR-45.

Table 8: Spatial and seasonal catch allocations (alphas) for three options detailed in Table 7 ('Options for spatial and temporal distribution of catches'). Note that the shapes of the management units vary between options, and that each set of alphas sums to slightly more than one due to rounding.

Option name	2022 alphas		2025 alphas harmonised		2025 alphas KFMA	
Source	SC-CAMLR-41, Table 2 (2022)		WG-EMM2025/12, Table 2 'decreasing humpbacks' scenario		New analysis, as '2025 alphas harmonised' but without GPZs and SPZs	
Management unit	alpha summer	alpha winter	alpha summer	alpha winter	alpha summer	alpha winter
Joinville	0.0008	0.0178	0.006	0.022	0	0.018
Elephant Island	0.0662	0.1097	0.075	0.068	0.081	0.091
Bransfield Strait	0.0061	0.1094	0.007	0.12	0.007	0.096
South Shetlands Islands West	0.0549	0.0731	0.05	0.037	0.069	0.064
Gerlache Strait	0.0238	0.2116	0.055	0.245	0.051	0.220
Powel Basin and Drake Passage	0.045	0.2815				
Powell Basin 1			0.051	0.078	0.043	0.062
Drake Passage 1			0.036	0.155	0.025	0.174
Total	0.1968	0.8032	0.28	0.725	0.276	0.725

Table 9: Proposed timeline for development of the 10 year review for the RSRMPA to be completed in 2027.

	When	What	How	Description	Who
2025: scoping	July 2025	Proposal for Review Framework	WG-EMM paper	A draft RSrMPA review Framework is submitted for discussion (this paper).	Members and science community.
	August 2025	Workshop on the RSrMPA review	Online meeting	Workshop to agree on approach and timeline.	SC Reps, Commissioner, policy and science leads.
	October 2025	RSrMPA Framework proposal	SC-CAMLR and CCAMLR-44 papers	MPA review requirements paper. Proposed Framework approach paper. Workshop report paper. Open collaboration for the review.	Members and science community.
2026: Research delivery	February 2026	(tentative) RSrMPA Science Workshop	Online	MPA review workshops –science approach and delivery.	Science community.
	July 2026	RSrMPA, including SRZ, review scientific papers	WG-EMM papers	Initial reporting on progress and/or key science papers. Scientific papers submitted to support SRZ review.	Members, science leads and science community.
	October 2026	SRZ review papers RSrMPA science progress	WG-FSA SC-CAMLR Commission	SRZ review papers. Science progress papers for the RSrMPA review.	NZ (paper on SRZ) & Members.
	December 2026	Finalise compilation of 5 - year reports	Online coordination	Members to coordinate intersessional compilation of research projects for the 5-year RSrMPA report.	Members and science community.
		Submission of report on activities for 5 - year review	Online to Secretariat	Members' five-year reports on their activities against objectives.	Members.
2027: Presenting review outcomes	March 2027	Compilation of 5 - year reports on activities	Online, WG-EMM, SC	Secretariat to compile 5-year reports.	Secretariat.
	July 2027	Delivery of RSrMPA analysis reports, including 5-year review reports	WG-EMM	Science papers in support of RSrMPA review. RSrMPA report assessing objectives and research and monitoring, including management recommendations and 5-year review reports.	Members and Secretariat.
	August 2027	WG-EMM feedback addressed	Online	Members address WG-EMM feedback into a final summary and proposal for SC-CCAMLR.	Members and Secretariat.
	October 2027	RSrMPA final deliverables and science products	SC-CAMLR and Commission	RSrMPA assessment paper and management recommendations.	Members and Secretariat.

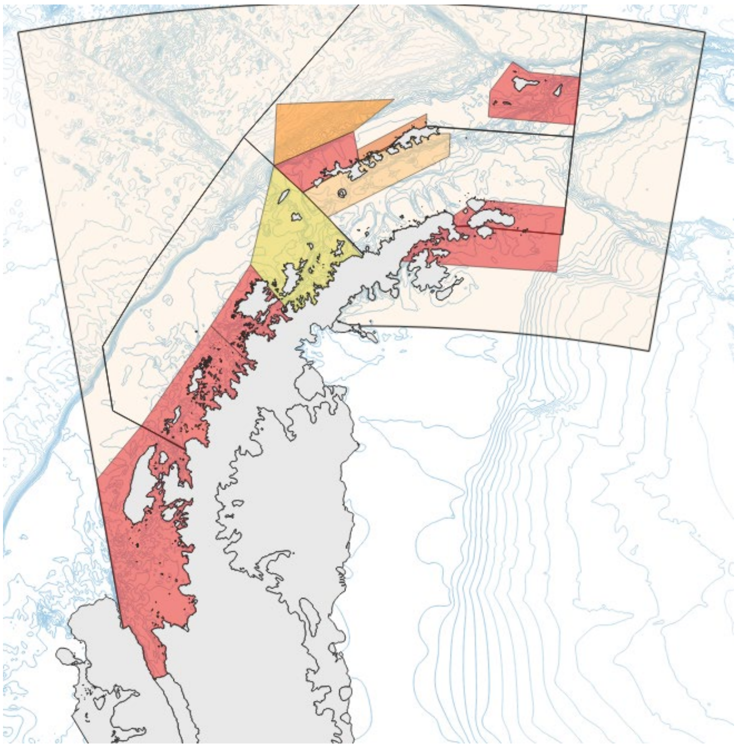

Figure 1: Subarea 48.1 with five candidate management units proposed in paragraph 4.21 and the proposed D1MPA (GPZs and SPZs as presented in CCAMLR-43/37).

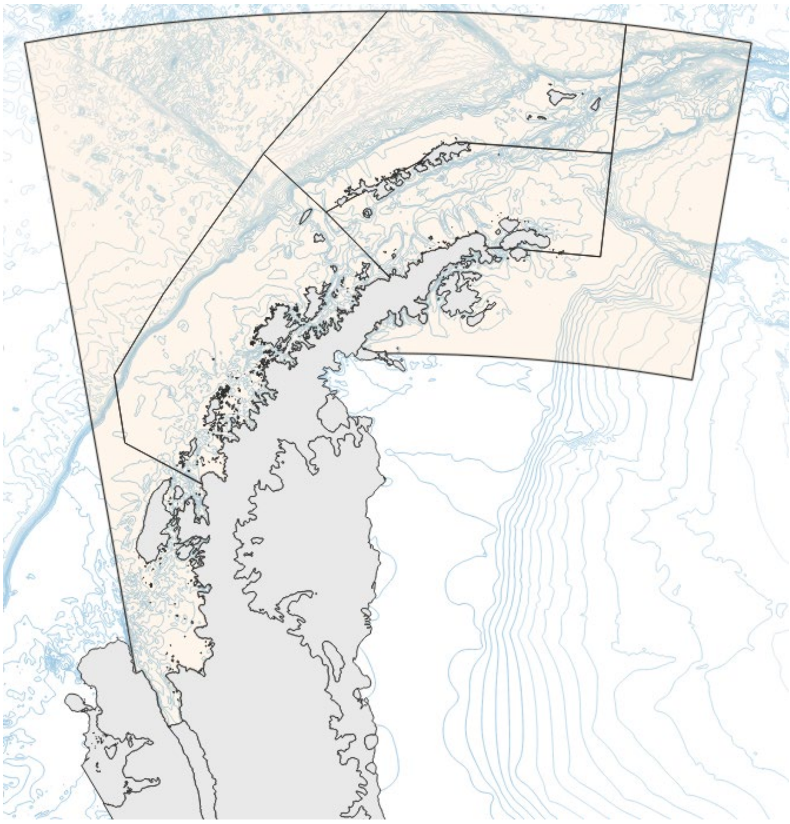

Figure 2: Subarea 48.1 with five candidate management units proposed in paragraph 4.21.

Appendix A

List of Participants

Working Group on Ecosystem Monitoring and Management
(Geilo, Norway, 7 to 18 July 2025)

Chair	Dr Jefferson Hinke National Marine Fisheries Service, Southwest Fisheries Science Center
Argentina	Dr María Mercedes Santos Instituto Antártico Argentino
Australia	Dr Martin Cox Australian Antarctic Division, Department of Climate Change, Energy, the Environment and Water
	Dr So Kawaguchi Australian Antarctic Division, Department of Climate Change, Energy, the Environment and Water
	Dr Louise Emmerson Australian Antarctic Division, Department of Climate Change, Energy, the Environment and Water
	Dr Nat Kelly Australian Antarctic Division, Department of Climate Change, Energy, the Environment and Water
	Dr Abigail Smith Australian Antarctic Division
Belgium	Dr Anton Van de Putte Royal Belgian Institute for Natural Sciences
	Dr Zephyr Sylvester University of Colorado Boulder
Chile	Mr Francisco Santa Cruz Instituto Antartico Chileno (INACH)
	Dr César Cárdenas Instituto Antártico Chileno (INACH)
	Dr Lucas Krüger Instituto Antártico Chileno (INACH)

China	Dr Xianyong Zhao Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
	Mr Ling Zhi Li East China Sea Fisheries Research Institute
	Mr Dongming Lin Shanghai Ocean University
	Dr Xinliang Wang Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
	Dr Yunxia Zhao Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
	Professor Guoping Zhu Shanghai Ocean University
France	Dr Marc Eléaume Muséum national d'Histoire naturelle
	Ms Laureen Eon Muséum national d'Histoire naturelle
	Dr Noémie Friscourt University of Tasmania, Institute for Marine and Antarctic Studies
	Dr Sara Labrousse Sorbonne Université
Germany	Professor Bettina Meyer Alfred Wegener Institute for Polar and Marine Research
	Mr Dominik Bahlburg Alfred-Wegener-Institut
	Dr Flavia C Bellotto Trigo Alfred-Wegener-Institut
	Ms Patricia Brtnik Federal Agency for Nature Conservation
Italy	Dr Erica Carlig National Research Council

Japan	Dr Hiroto Murase Tokyo University of Marine Science and Technology
	Dr Takehiro Okuda Fisheries Resources Institute, Japan Fisheries Research and Education Agency
	Dr Mao Mori Japan Fisheries Research and Education Agency
Korea, Republic of	Dr Eunjung Kim National Institute of Fisheries Science
	Dr Sangdeok Chung National Institute of Fisheries Science (NIFS)
	Dr Jeong-Hoon Kim Korea Ocean Polar Research Institute (KOPRI)
	Dr Hyoung Sul La Korea Ocean Polar Research Institute (KOPRI)
Netherlands, Kingdom of the	Dr Fokje Schaafsma Wageningen Marine Research
New Zealand	Mr Enrique Pardo Department of Conservation
Norway	Dr Bjørn Krafft Institute of Marine Research
	Dr Andrew Lowther Norwegian Polar Institute
	Mr Elling Deehr Johannessen Norwegian Polar Institute
	Dr Ulf Lindstrøm Institute of Marine Research
Poland	Dr Anna Panasiuk University of Gdańsk
	Ms Kinga Hoszek University of Gdańsk
Russian Federation	Dr Svetlana Kasatkina AtlantNIRO

South Africa	Dr Azwianewi Makhado Department of Forestry, Fisheries and the Environment
	Dr Zoleka Filander Department of Forestry, Fisheries and the Environment
Spain	Dr Zuzana Zajková Institute of Marine Sciences ICM-CSIC
Ukraine	Mr Viktor Podhornyi Institute of Fisheries, Marine Ecology and Oceanography (IFMEO)
United Kingdom	Dr Martin Collins British Antarctic Survey
	Dr Sophie Fielding British Antarctic Survey
	Dr Simeon Hill British Antarctic Survey
	Dr Claire Waluda British Antarctic Survey
	Dr Vicky Warwick-Evans British Antarctic Survey
United States of America	Dr Douglas Krause National Marine Fisheries Service, Southwest Fisheries Science Center
Uruguay	Professor Alvaro Soutullo Universidad de la Republica
Secretariat	Dr Steve Parker Science Manager
	Claire van Werven Research, Monitoring and Compliance Analyst

Appendix B

Agenda

Working Group on Ecosystem Monitoring and Management
(Geilo, Norway, 7–18 July 2025)

1. Introduction

    1.1 Opening of meeting

    1.2 Adoption of the Agenda

2. Ecosystem monitoring

    2.1 Krill biology and ecology

        2.1.1 Advice from WG-ASAM
        2.1.2 Population status and dynamics
        2.1.3 Krill stock hypothesis and life history parameters

    2.2 Krill predator biology and ecology

        2.2.1 Population status and dynamics

        2.2.2 CEMP and other ecosystem monitoring needs
            2.2.2.1 Analysis of existing monitoring data

            2.2.2.2 Monitoring of current and potential sentinel species

            2.2.2.3 Environmental/non-biological parameters relevant to wider ecosystem monitoring
            2.2.2.4 Communicating results (e.g. ecosystem status reports)

    2.3 Other impacts (e.g., HPAI, toxins)

    2.4 Climate change and associated ecosystem research and monitoring

    2.5 Marine debris

    2.6 Fishery-independent data collection plan

    2.7 Fishery-dependent data collection plan

3. Krill Fishery

    3.1 Fishing activities

    3.2 Scientific observation

        3.1.1 Krill biological sampling

        3.1.2 By-catch sampling

        3.1.3 IMAF data collection and sampling

4. Krill Fishery Management

    4.1 Advice from the Commission

    4.2 Advice from other Working Groups

    4.3 Implementation of the revised krill fishery management approach

        4.3.1 Krill biomass estimation

        4.3.2 Harvest rate estimation and MSE

        4.3.3 Spatial overlap analysis

    4.4 Coordination of the KFMA and D1MPA planning

    4.5 Krill Fishery Management in Area 58

5. Spatial management

    5.1. Data analysis supporting spatial management approaches in CCAMLR

    5.2. Research and monitoring plans for CCAMLR MPAs

    5.3. ASPA/ASMA/VME and other spatial management issues

6. Other business

7. Future work

    7.1. Review of workplan

8. Advice to the Scientific Committee and its working groups

9. Adoption of the report and close of the meeting

Appendix C

List of Documents
Working Group on Ecosystem Monitoring and Management
(Geilo, Norway, 7–18 July 2025)

WG-EMM-2025/01	Classification of fishing events in CCAMLR reporting forms CCAMLR Secretariat
WG- EMM-2025/02	Modification of IMAF data collection forms for Observer Trawl Finfish and Krill Fisheries CCAMLR Secretariat
WG-EMM-2025/03	2025 GIS projects update. CCAMLR Secretariat
WG-EMM-2025/04	Observer sampling rates in the krill fishery - 2025 update. CCAMLR Secretariat
WG-EMM-2025/05	CCAMLR's revised Krill Fishery Management Approach (KFMA) in Subareas 48.1 to 48.4 as progressed up to 2024. CCAMLR Secretariat
WG-EMM-2025/06	Summary of the CCAMLR Ecosystem Monitoring Program (CEMP) data holdings through the 2024/25 monitoring season CCAMLR Secretariat
WG-EMM-2025/07	Trawl gear configuration reporting and linking to individual fishing events CCAMLR Secretariat
WG-EMM-2025/08	Advancing Vulnerable Marine Ecosystems (VMEs) research in the greater Weddell Sea: 2025 scholarship progress overview Filander, Z., K. Teschke, and A. Makhado
WG-EMM-2025/09	Chilean operation in the Antarctic krill fishery, 2023-2024 season Arana, P.M. and R. Rolleri
WG-EMM-2025/10	Habitat use by chinstrap and gentoo penguins from two Gerlache Strait colonies during the 2024/25 breeding season Rozas Sia, M.G., A. Soutullo, M.A. Juáres, J. Negrete and M. Santos
WG-EMM-2025/11	Identification and Assessment of Fishing Grounds Based on Fishing Opportunity in the Antarctic Krill Fishery (*Euphausia superba* Dana, 1850) Torretti, G. and L. Cubillos

WG-EMM-2025/12	Including krill consumption by humpback whales in winter in the Spatial Overlap Analysis in Subarea 48.1 Warwick-Evans, V., M.A. Collins, A. Friedlaender, S., Hill, T. Jones, T. Joyce and N. Kelly
WG-EMM-2025/13	Key foraging areas for Adélie Penguins at Esperanza/Hope Bay, Antarctic Peninsula Santos, M. A. Silvestro, M.A. Juáres and A. Soutullo
WG-EMM-2025/14 Rev. 1	Monitoring Antarctic krill (*Euphausia superba*) distribution in the Southern Ocean: environmental DNA (eDNA) adds to the toolbox Suter, L. A. Burns, S. Bestley, J. Bird, M. J. Brasier, M. Cox, D. Hamer, O. J. Johnson, S. Kawaguchi, R. King, A. Klocker, J. Melvin, C. K. Weldrick, S. Wothersoon and B. Raymond
WG-EMM-2025/15	2025 update on the status and trends of CEMP indicator species in U.S. AMLR Program studies Hinke, J.T., S.M. Woodman and D.J. Krause
WG-EMM-2025/16	A proposed collaborative framework to develop ecosystem monitoring in East Antarctica Eon, L. Y. Ankerl, A. Barreau, A. Kondratyeva, Y. Le Bras, J. Le Cras, E. Le Mestric, C. Royaux, P. Seguineau, P. Ziegler, C. Masere and M. Eléaume
WG-EMM-2025/17	A review of ecosystem monitoring in Subarea 48.1 to identify gaps and inform future enhanced monitoring programmes in support of CCAMLRs conservation objectives Waluda, C.M., D. Bahlburg, M.A. Collins, L. Emmerson, N. Fenney, T. Hart, G. Humphries, E.D. Johannessen, S. Kawaguchi, N. Kelly, L. Kruger, B. Meyer, F. Santa Cruz, M. Santos and the CCAMLR Secretariat
WG-EMM-2025/19	Antarctic fur seals as bioindicators of seasonal and ocean basin scale variation in the Southern Ocean food web Friscourt, N., A. Walters and M.-A. Lea
WG-EMM-2025/20 Rev. 1	Breeding Population Survey of Adélie Penguins along the Northern Victoria Land Coast, Ross Sea, Antarctica Kim, J.-H., Y. Kim, J.-U. Kim, Y. Oh, Y. Jeong and H.-C. Kim
WG-EMM-2025/21 Rev. 1	British Antarctic Survey: Ecosystem Monitoring in Area 48 (2024/25) Waluda, C.M., S.E. Thorpe, A. Bennison, J.B. Cleeland, M.J. Dunn, K.A. Owen, S. Fielding, A.H. Fleming, R.A. Saunders, G.Stowasser, G.A. Tarling and M.A. Collins

WG-EMM-2025/22	Comparative evaluation of mesozooplankton sampling techniques around South Georgia: traditional and imaging approaches Dewar-Fowler, V., G. A. Tarling, M. Wootton and C. M. Liszka
WG-EMM-2025/23	Krill fishery management in Area 48 – potential ways forward Collins, M.A., S.L. Hill, S. Fielding, V. Warwick Evans, S.E. Thorpe and C.M. Waluda
WG-EMM-2025/24	Progress on defining high-level strategic objectives for ecosystem modelling Hill, S. and N. Kelly
WG-EMM-2025/25	Progress, options, and next steps for developing CCAMLR State of the Environment and Antarctic Marine Living Resources reports Waluda, C.M., S. Grant, S.E. Thorpe, R.D. Cavanagh, A.H. Fleming, S.L. Hill, A. Barreau A.L. Eon, Y. Le Bras, C. Royaux, P. Seguineau, M. Eléaume, E. Pardo, S. Parker, A.P. Van de Putte and M.A. Collins
WG-EMM-2025/26	Re-emphasising harmonisation as a relevant tool for precautionary, ecosystem-based and adaptive fisheries management and spatial protection along the Antarctic Peninsula and the Scotia Arc region Santa Cruz, F., M. Santos, D. Deregibus, L. Krüger and L. Rebolledo
WG-EMM-2025/27	Report of incidental capture of a humpback whale by the traditional Chilean krill trawler in CCAMLR Subarea 48.2 during the 2024/25 fishing season Delegation of Chile
WG-EMM-2025/28	Report of the Analysis of Existing CEMP data team to WG-EMM 2025 Hill, S., S. Labrousse, S. Parker, S. Thanassekos and C. Van Werven
WG-EMM-2025/29	Research Vessel Tangaroa 2025 Ross Sea Antarctic "ACTUATE" Voyage, 15 January - 23 February 2025 Stevens, C., D. Fernandez and M. Pinkerton
WG-EMM-2025/30	Introduction of two new types of krill products from the Chinese krill fishing vessel FU YUAN YU 9199 Zhu, J., G. Fan, J. Luo, X. Zhao, X. Wang, Y. Ying and J. Miao

WG-EMM-2025/31	Ross Sea Region Marine Protected Area Research Coordination Network Inaugural Meeting Brooks. C. S. Stammerjohn, G. Ballard, C. Christian, L. Ghigliotti, E. Hofmann, J-H. Kim, M. LaRue, C. Nissen9, A.J. Orona, B. J. Pan, J. Park, S. Parker, N. Walker and J. Weller
WG-EMM-2025/32	South Shetland Island archipelago krill-predator survey 2025: region-wide census of imperiled fur seals and HPAI testing results Krause, D.J., S.M. Woodman, J.L. Leslie, K.F. Alvstad and J.T. Hinke
WG-EMM-2025/33	Spatial and temporal analysis of the Antarctic krill (*Euphausia superba*) CPUE in recurring fishing opportunities in subareas 48.1 and 48.2 Torretti, G. and L. Cubillos
WG-EMM-2025/34	Spatial overlap analysis in Subarea 48.3: Progress update Jones, T. V. Warwick-Evans, S. Hill and M. A. Collins
WG-EMM-2025/35	2027 Ross Sea region MPA review - Requirements and science needed for objective-based reporting Pardo, E., N. Walker, S. Lamping, L. Ghigliotti, J-H. Kim, C. von Quillfeldt, C. Brooks, M. Santos, M. Pinkerton, H. Weiskel, J. Fenaughty, S. Parker, P. Castillo-Briceno and M. Anderson
WG-EMM-2025/36	A proposed framework to support the Ross Sea region MPA review Lamping, S., L. Ghigliotti, E. Pardo, N. Walker, J-H. Kim, M. Santos, C. von Quillfeldt, C. Brooks, H. Weiskel, J. Fenaughty, S. Parker, P. Castillo-Briceno and M. Anderson
WG-EMM-2025/37	Advancing harmonisation of marine spatial planning in Domain 1: identifying duplication, redundancy and gaps Lowther, A. Johannessen, E., Lindstrøm, U. and Krafft, B.
WG-EMM-2025/38	Automating the State of the Environment Report: A reproducible workflow with Galaxy Barreau, A., L. Eon, Y. Le Bras, C. Royaux, P. Seguineau, A. Van de Putte, C.M. Waluda, S. Grant, S.E. Thorpe, R.D. Cavanagh, A.H. Fleming, S.L. Hill, M.A. Collins, L. Emerson, C. Masere, P. Ziegler and M. Eléaume
WG-EMM-2025/39	Establishing a Framework for a Revised Krill Fishery Management Approach in Subarea 48.1 Krafft, B.A., A.-L. Agnalt, U. Lindstrøm, A. Lowther, E. Johannessen, T. Knutsen, J. Arata, F. Santa Cruz, D. Bahlburg and B. Meyer

WG-EMM-2025/40	Establishing a Weddell Sea observatory: Advances through the WOBEC initiative for long-term biodiversity and ecosystem monitoring Teschke, K., A.P. Van de Putte, T. Vandenberghe, E. Campbell, K. Campbell, M. van Leeuwe, M. Lenss, H. Link, F. Mark, Z. Mohamed, S. Moreau, S. Niiranen, M. Różańska-Pluta, C. Papetti, R. Roura, F. Schaafsma, N. Van den Steen, J. Stefels, W. Werna, M. Vortkamp, M. Wietz1, J. Wiktor, A. Wold and H. Flores
WG-EMM-2025/41	Hydrological and ecological uniqueness of Elephant Island (Western Maritime Antarctic Peninsula) – case study in the context of planning MPAs Panasiuk, A., H. Herr, K. Hoszek-Mandera and L. Krüger
WG-EMM-2025/42	Initial Overview of External Environmental Data Sources Relevant for CCAMLR Deschepper P., C. Plasman and A. Van de Putte
WG-EMM-2025/43	Integrating cetacean research into the CCAMLR Ecosystem Monitoring Program and the revised Krill Fishery Management Approach: Review and recommendations Johannessen, E.D., R. Reisinger, H. Murase, M. Biuw, E. Seyboth, E. Vermeulen, S. Bengtson Nash, B. Miller, A. Henderson, C. Waluda, J. Jackson, B. Krafft, F. Santa Cruz, F. Castro and N. Kelly
WG-EMM-2025/44	Monitoring of phenolic compounds in Antarctic Krill – a warning signal for the Southern Ocean food web Hoszek-Mandera, K., J.T. Hinke, M. Staniszewska, M. Bełdowska, K. Fudala, R. Bialik and A. Panasiuk
WG-EMM-2025/45	New Zealand research and monitoring in support of the Ross Sea region Marine Protected Area: 2023-2025 update Pinkerton, M., J. Devine, I. Hawes, E. Pardo, E. Robinson and C. Stevens
WG-EMM-2025/46	On the use of ROV for fish communities research and monitoring under sea ice at Terra Nova Bay (RSRMPA) Di Blasi, D., E. Carlig, A. Odetti, S. Aracri, G. Bruzzone, R. Ferretti, L. Ghigliotti, E. Spirandelli and G. Bruzzone
WG-EMM-2025/47	Planning for an upcoming update of the Spatial Overlap Analysis in CCAMLR Divisions 58.4.1 and 58.4.2 Kelly, N., H. Murase, L. Emmerson, N. Kokubun, M. Mori, F. Schaafsma, C. Southwell, M. Eléaume and S. Kawaguchi

WG-EMM-2025/48 Rev. 1	Preliminary analysis on the stock structure and biological characteristics of the Antarctic Krill in the Antarctic Peninsula region Ying, Y., Y. Zhao, P. Luo, W. Li, X. Zhao, X. Wang, G. Fan, J. Wang, C. Sun, X. Mu and J. Zhu
WG-EMM-2025/49	Preliminary Observations on Morphological Distinctions Among Eight Crocodile Icefishes (family Channichthyidae) Collected in the Antarctic Krill Fishery Lee, Y.-J., E. Kim, and J.-L. Kim
WG-EMM-2025/50	A comparative multi-year study of Adélie penguin diet using stomach lavage and scat DNA metabarcoding MacDonald, A.J., A. Polanowski, J. McInnes, B. Deagle, M. Dunn, L. Emmerson, B. Raymond, L. Suter and C.M. Waluda
WG-EMM-2025/51	Quantifying the present and future value for Antarctic ecosystems from phytoplankton to penguins DuVivier, A.K., K. M. Krumhardt, L. L. Landrum, Z. Sylvester, B. Şen, S. Labrousse, C. Che-Castaldo, A. Eparvier, M. M. Holland,M. A. LaRue, C. Nissen, M.N. Levy, S. Jenouvrier and C. Brooks
WG-EMM-2025/52	Results from beached debris surveys near Australian operated research stations in East Antarctica Emmerson, L., S. Donoghue and C. Southwell
WG-EMM-2025/53	Results of the Japanese Abundance and Stock structure Survey in the Antarctic (JASS-A) during the 2024/2025 austral summer season Katsumata, T., M. Kawasaki, C. Ohmukai, M. Yamazaki, H, Kasai, N. Abe, H. Murase and T. Isoda
WG-EMM-2025/54	Revisiting the East Antarctic Marine Protected Area proposal: Insights from long-term wintering distribution of Adélie penguins Zajková, Z., A. Kato, T. Raclot, F. Angelier, J.B. Thiebot, A. Takahashi and Y. Ropert-Coudert
WG-EMM-2025/55	SCAR Databases and Tools of Relevance to CCAMLR Van de Putte A.P., D. Maschette, B. Raymond, M. Sumner and C. Plasman
WG-EMM-2025/56	Spatial distribution of Antarctic krill (*Euphausia superba*) density in the Krill Research Zone of the Ross Sea Region Marine Protected Area, Antarctica La, H.S., W. Son and J.-H. Kim

WG-EMM-2025/57	Spatiotemporal overlap of minke and humpback whales with krill fishing vessels in the Western Antarctic Peninsula Mestre, J., P.N. Trathan, J.W. Durban, A.S. Friedlaender, A. Hutchinson, T.W. Joyce, A. Rogers and R.R. Reisinger
WG-EMM-2025/58	Starting the development of science-based management advice for Subarea 48.2 Lowther, A., E. Johannessen, U. Lindstrøm and B.A. Krafft
WG-EMM-2025/59	A preliminary report on the 2024-25 season field survey of the CCAMLR Ecosystem Monitoring Program in Seaview Bay of Inexpressible Island, Ross Sea Region Delegations of China and Korea
WG-EMM-2025/60	Strategic spatial selection of marine ecosystem indicator sites to monitor a complex coastal environment Johannessen, E.D., F. Santa Cruz, C. von Quillfeldt, B.A. Krafft and A. Lowther
WG-EMM-2025/61	Structure and summary of vulnerable marine ecosystem data collection in CCAMLR Aerts, D., A. Van de Putte and the CCAMLR Secretariat
WG-EMM-2025/62	Summary of Korean Krill Fishing Activities and Bycatch Observations in recent 5 years (2020–2024) Kim, E., J. Park, S. Chung, Y.-J. Lee and J.-K. Kim
WG-EMM-2025/63	The diet of non-breeding male Antarctic fur seals in the South Shetland Islands Casaux, R., J. Negrete , A. Corbalán, A. Farace Rey, M. Juáres and A. Carlini
WG-EMM-2025/64	The Galindez Island Gentoo penguin (*Pygoscelis papua*) population during 2024/2025 season and time-lapse camera data validation results Davydenko, S., E. Dykyi, P. Khoetsky, O. Savenko, G. Milinevsky, A. Simon, L. Pshenichnov, V. Tkachenko, K. Demianenko, A. Dzhulai and S. Gogol
WG-EMM-2025/65	The impact of illegal fishing on efficacy of bycatch mitigation for wandering albatrosses Becker, S.L. D.F. Doak, T. Clay, C. Brooks and R.A. Phillips
WG-EMM-2025/66	The proposed Marine Protected Areas could make a difference for baleen whales in Antarctica Vitale, A.S., J.L. Orgeira, P. Benedetti and F. Alvarez
WG-EMM-2025/67	Update on the Stage 1 Special Area for Scientific Study at Pine Island Glacier Grant, S.M. and A. Skachkova

WG-EMM-2025/68	Vulnerable Marine Ecosystem detected via ROV at Cuverville Island, Western Antarctic Peninsula (Subarea 48.1) Lockhart, S.J., E. Darani, A. Kuhn and R.C. Izendooren
WG-EMM-2025/69	Wind-Driven Variability in Larval Krill Connectivity: Implications for Spawning and Nursery Ground Linkages along the Western Antarctic Peninsula Sylvester, Z., M. S. Dinniman, S. Thorpe, K. Bernard and C. M. Brooks
WG-EMM-2025/70	Preliminary framework of pollutants non-invasive monitoring approach Hoszek-Mandera, K., M. Bełdowska, D. Saniewska and A. Panasiuk

Other

CCAMLR-43/22	Comments on the harmonization of the implementation of the revised krill fishery (KFMA) and the establishment of Doman 1 MPA in Subarea 48.1 Russian Federation
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-2025/15	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-2025/17	SKEG Symposium 2025 Report Bahlburg, D., S. Kawaguchi, B. Meyer and Z. Sylvester
WG-SAM-2025/07	Proposed new separate C1 trawl haul by haul forms for krill and finfish fisheries CCAMLR Secretariat

WG-EMM-2025/P01	Aotearoa New Zealand Developments in Ocean Science in the Ross Sea – from the Southern Ocean to the Ice Shelf Grounding Line Stevens, C. and D. Fernandez *CLIVAR Exchanges*, Special Issue: Advances in Emerging Antarctic Research Programs, 83: 30–35 (2024). doi: https://doi.org/10.36071/clivar.83.2024
WG-EMM-2025/P02	Automated krill body length estimation based on stereo camera images Svantemann, M.M.., B.A. Krafft, F.F.Thompson, G. Zhang and L.A. Krag *ICES J. Mar. Sci.*, 82(5): fsaf058 (2025). doi: https://doi.org/10.1093/icesjms/fsaf058
WG-EMM-2025/P03	Monitoring Antarctic krill (*Euphausia superba*) distribution in the Southern Ocean: environmental DNA (eDNA) adds to the toolbox Suter, L. A. Burns, S. Bestley, J. Bird, M. J. Brasier, M. Cox, D. Hamer, O. J. Johnson, S. Kawaguchi, R. King, A. Klocker, J. Melvin, C. K. Weldrick, S. Wothersoon and B. Raymond *Front. Mar. Sci.*, 12 (2025). doi: https://doi.org/10.3389/fmars.2025.1502498
WG-EMM-2025/P04	Assessing trawls size selectivity in Antarctic krill: The role of sex and maturity stages Krag, L.A., J. Brcicb, B. Herrmann, M. Nalon and B.A. Krafft *Reg. Stud. Mar. Sci.*, 87: 104223 (2025). doi: https://doi.org/10.1016/j.rsma.2025.104223
WG-EMM-2025/P05	Emergence, spread, and impact of high-pathogenicity avian influenza H5 in wild birds and mammals of South America and Antarctica Kuiken, R., R.E.T. Vanstreels, A. Banyard, L. Begeman, A. Breed, M. Dewar, R. Fijn, P.P. Serafini, M. Uhart and M. Wille *Conserv. Biol.*, e70052 (2025). doi: https://doi.org/10.1111/cobi.70052
WG-EMM-2025/P06	Interannual variability in fatty acids revealing autumn food availability for Antarctic krill (*Euphausia superba*) in Bransfield Strait Zhang H.T., G.P. Zhu, H. Liu and K.M. Swadling *Mar. Ecol. Prog. Ser.*, 730: 31–42 (2024). doi: https://doi.org/10.3354/meps14517

WG-EMM-2025/P07	Overview of the multidisciplinary ecosystem survey in the eastern Indian sector of the Southern Ocean (80–150◦E) by the Japanese research vessel Kaiyo-maru in the 2018–19 austral summer (KY1804 survey) Murase, H, K. Abe, F. L. Schaafsma and K. Katsumata *Prog. Oceanogr.*, 233: 103456 (2025). doi: https://doi.org/10.1016/j.pocean.2025.103456
WG-EMM-2025/P08	Shifts in food composition of Antarctic krill (*Euphausia superba*) enhance coexistence with the pelagic tunicate (*Salpa thompsoni*) Zhu G.P. and F. Xue *Mar. Biol.*, 172:1 (2024). doi: https://doi.org/10.1007/s00227-024-04553-9
WG-EMM-2025/P09	Using fatty acid profiles of krill-dependent predator to reveal variability in the diet of Antarctic krill (*Euphausia superba*): a case study of mackerel icefish (*Champsocephalus gunnari*) Zhu G.P., J.Y. Zhu, Q.Y. Xue, M. Xue and C.B. Yan *Mar. Ecol. Prog. Ser.*, 27: 145–160 (2025). doi: https://doi.org/10.3354/meps14816

Recalculating interim subarea area catch allocations using data from two large scale surveys

Simeon Hill

Introduction

This document explains the calculation of subarea allocations of the CM 51-01 trigger level using the average distribution of biomass observed in the 2000 and 2019 large scale surveys, and the approach employed to calculate the subarea allocations in CM 51-07. The allocations calculated in the current document improve on those in CM 51-07 in three ways. Firstly, they use the most up-to-date analysis of biomass from the 2000 survey (Fielding *et al*. 2011). Secondly, they incorporate results from a second large-scale survey conducted in 2019 (Krafft *et al*., 2021). Thirdly, a consistent method was used to allocate catch to each of the four subareas, in contrast to the separate treatment of Subarea 48.4 in CM 51-07.

Derivation of Subarea allocations in CM 51-07

The process for deriving the subarea allocations in CM 51-07 is not clearly documented, but it can be reconstructed from SC-CAMLR and CCAMLR reports.

SC-CAMLR-28 (2009) (Table 1) proposed five "models" for distributing the CM 51-01 trigger level between subareas using:

(i) Biomass observed in the FIBEX survey.
(ii) Survey area in the CCAMLR 2000 synoptic survey.
(iii) Biomass observed in the CCAMLR 2000 synoptic survey.
(iv) Biomass observed in the CCAMLR 2000 synoptic survey, with a further allocation between coastal and pelagic areas in each subarea using the ratio 27:73, and with an additional 20% added to each allocation.
(v) 40% of the trigger level in each subarea.

CAMLR-28 (2009) (Table 1) shows the allocations chosen by the Commission. These appear to be a hybrid of options (iii) and (iv) – i.e. 120% of the option (iii) allocations – albeit with an additional allocation to subarea 48.4. Thus the proportional allocation is calculated as:

$$A_s = \frac{B_s}{\sum B_s} \times 1.2 \qquad [1]$$

for subareas 48.1 to 48.3, and

$$A_s = \frac{B_s}{\sum B_s} \times 1.2 + X \quad [2]$$

for subarea 48.4, where A_s is the proportional allocation to subarea s, B_s is the estimated biomass in subarea s and X is an additional proportional allocation to Subarea 48.4. The proportional allocations are then rounded to the nearest 5%.

Table 1 shows the 120% of option (iii) proportional allocations calculated from SC-CAMLR-28 (2009) (Table 1), compared to the proportional allocations in CM 51-07. For Subareas 48.1 to 48.3 the CM 51-07 proportional allocation is 1% above the 120% of option (iii) proportional allocation, consistent with equation 1. For Subarea 48.4, the CM 51-07 proportional allocation is 8% more than the 120% of option (iii) proportional allocation, indicating that the value of X in equation 2 is 8%. Consequently the CM 51-07 proportional allocation for Subarea 48.4 is approximately double the 120% of option (iii) proportional allocation (7%)

Table 1. Subarea catch allocations in CM 51-07 compared with option (iii) in Table 1 of SC-CAMLR-28 (2009) (also included in CCAMLR-28 (2009) as Table 1).

Subarea	% Allocation	Tonnes	Option iii	120% of Option iii
48.1	25%	155,000	20%	24%
48.2	45%	279,000	37%	44%
48.3	45%	279,000	37%	44%
48.4	15%	93,000	6%	7%
Sum	130%	806,000	100%	120%

Biomass estimates

The source of the subarea biomass estimates used in option (iii) is of SC-CAMLR-28 (2009) is cited as SC-CAMLR-19 (2000). The biomass estimates form the 2000 synoptic survey that were available in 2000 are now obsolete following the reanalysis by Fielding *et al*. (2011). Hill *et al*. (2016) estimated subarea biomass using this reanalysis. They assigned biomass from the survey strata to the subareas according to the distribution of stratum survey effort amongst subareas (**Table 2**).

Table 2: Distribution of stratum survey effort among subareas in the CCAMLR 2000 synoptic survey.

	% of stratum effort in subarea			
Survey stratum/Subarea	48.1	48.2	48.3	48.4
Antarctic Peninsula	100%			
Scotia Sea		48%	47%	5%
Eastern Scotia Sea				100%
South Shetland Islands	100%			
South Orkney Islands		100%		
South Georgia			100%	
South Sandwich Islands				100%

The resulting subarea biomass estimates assign a greater proportion of the biomass to Subarea 48.1, implying that Subarea 48.1 would have been allocated a higher catch if the allocations in CM 51-07 were recalculated using the Fielding *et al*. (2011) analysis of the 2000 synoptic survey (Table 3).

Table 3. Effect of updated analysis of **CCAMLR 2000 synoptic survey biomass** (Fielding et al 2011) on the calculations used to set subarea allocations in CM 51-07. The allocation was calculated using equations 1 and 2. The value of X used in equation 2 was set to 11% to achieve a total % allocation of 130% as in CM 51-07.

Subarea	Biomass	% Biomass	% Allocation	Tonnes
48.1	15,892,735	26%	32%	196,101
48.2	24,638,790	41%	49%	304,019
48.3	17,211,300	29%	34%	212,371
48.4	2,553,600	4%	15%	93,509
Sum	60,296,425	100%	130%	806,000

A second large scale survey was conducted in 2019 (Krafft *et al*., 2021). This survey has not produced estimates of biomass at the subarea scale, nor was information on the allocation of stratum survey effort to individual subareas available to WG-EMM-2025. Nonetheless six of the seven survey strata were wholly contained within one of the subareas allowing confident allocation of stratum biomass to the relevant subarea. For the remaining stratum, an approximation of the allocation of stratum biomass to the relevant subareas can be calculated using the 2000 survey effort, as shown in Table 2. The resulting subarea biomass estimates are given in Table 4.

Table 4. Subarea biomass estimates calculated using the results of the 2019 large scale survey (Krafft *et al.*, 2021).

Subarea	Biomass	% Biomass
48.1	22,453,000	36%
48.2	15,759,374	25%
48.3	13,694,128	22%
48.4	10,708,498	17%
Sum	62,615,000	100%

It is pragmatic to assume that the average of the 2000 and 2019 surveys provides a better indication of biomass distribution than either individual survey. There were methodological difference between the two surveys and the resulting biomass estimates are not directly comparable. Nonetheless the average of these two surveys provides the best currently available representation of long-term biomass distribution calculated from acoustic data.

The proportion of estimated biomass in 48.4 was much higher in 2019 (**Table 4**) than it was in 2000 (**Table 3**). Given the lack of fishery interest in this subarea it seems inappropriate to inflate the allocation to this subarea using equation 2. Instead, the allocation to each subarea could be calculated using a single equation:

$$A_s = \frac{B_s}{\sum B_s} \times 1.3 \qquad [3]$$

The average biomass distribution and its implications for subarea allocations are shown in **Table 5**. As with CM 51-07, the allocations sum to 130% of the trigger level to allow flexibility for the fishery. Rounding all subarea allocations to the nearest 5% would result in a total allocation greater than 130% of the trigger level, so an alternative rounding is suggested for 48.2 and 48.3.

Table 5. Calculation of subarea allocations of the CM 51-01 trigger level using the **average biomass distribution from the 2000 and 2019 surveys.** The allocation was calculated using equation 3.

Subarea	% Biomass	% Allocation	Tonnes	Possible rounding	Tonnes
48.1	31%	40%	250,732	40%	248,000
48.2	33%	43%	266,107	42.5%	263,500
48.3	25%	33%	203,172	32.5%	201,500
48.4	11%	14%	85,989	15%	93,000
Sum	100%	130%	806,000	130%	806,000

References

Fielding, S., J. Watkins and ASAM participants: A. Cossio, C. Reiss, G. Watters, L. Calise, G. Skaret, Y. Takao, X. Zhao, D. Agnew, D. Ramm and K. Reid. (2011). The ASAM 2010 assessment of krill biomass for Area 48 from the Scotia Sea CCAMLR 2000 Synoptic Survey. Document WG-EMM-11/20. CCAMLR, Hobart, Australia: 10 pp

Hill, S.L., Atkinson, A., Darby, C., Fielding, S., Krafft, B.A., Godø, O.R., Skaret, G., Trathan, P. and Watkins, J. (2016). Is current management of the Antarctic krill fishery in the Atlantic sector of the Southern Ocean precautionary? CCAMLR Science 23, 31-51.

Krafft, B.A., Macaulay, G.J., Skaret, G., Knutsen, T., Bergstad, O.A., Lowther, A., Huse, G., Fielding, S., Trathan, P., Murphy, E. and Choi, S.G. (2021). Standing stock of Antarctic krill (*Euphausia superba* Dana, 1850) (Euphausiacea) in the Southwest Atlantic sector of the Southern Ocean, 2018–19. *Journal of Crustacean Biology*, *41*(3), p.ruab046.

Appendix to Option 2 for an Interim solution to catch distribution prior to the full implementation of KFMA

Bjørn Krafft

Scenario #2: Modify existing Conservation Measure 51-01 and establishing a distinct Conservation Measure tailored to Subarea 48.1, simultaneously.

-CM 51-01 includes the old 51-07 except the trigger for subarea 48.1. This means to retain the current distribution of catch limits—45%, 45%, and 15% of the established trigger level for Subareas 48.2, 48.3, and 48.4, respectively (but deducting the 25% (155,000 tonnes) allocated to Subarea 48.1.)

To ensure precautionary catch distribution amongst subareas, the Interim Measure follows the same logic as the original CM51-07 contained a total 130% distribution of catch, in order to provide flexibility in the location of fishing (in order to (i) allow for interannual variation in the distribution of krill aggregations, and (ii) alleviate the potential for adverse impacts of the fishery in coastal areas on land-based predators), resulting in a theoretical catch limit of 806,000tonnes or 23% more than the trigger level of 620,000tonnes in CM51-01. The new suggested Interim Measure removes Subarea 48.1 and keeps the same catch levels for Subareas 48.2 – 48.4 as in the original CM51-07, totalling a theoretical trigger level for the three subareas of 651,000tonnes. A reduction in this theoretical trigger level of 23% (or the same reduction in the original CM51-07) leaves a realised trigger of 500,769 tonnes distributed as follows: Subarea 48.2 – 279,000tonnes, Subarea 48.3 – 279,000tonnes, Subarea 48.4 – 93,000tonnes.

This approach could offer continuity and precaution in 48.2-4 while further work progresses.

-Simultaneously, a new Conservation Measure is established for Subarea 48.1. This represents an interim solution [2-3years] on the path toward full implementation of the KFMA. Full implementation would entail comprehensive monitoring, an operational three-legged stool approach, fully dynamic quotas updated every five years across all designated management units, and a D1MPA solution.

The interim solution involves merging some of the original seven management units, (which were endorsed by the Scientific Committee last year with the possibility of future adjustments X-REF SC-43 para 2.63). Smaller management units reduce the risk of negative impacts on predators from fishing activities. However, there is uncertainty associated with the SOA method and the data layers within, as well as the assumption that the Subarea 48.1 scale the ecosystem can be considered as a closed system, but at smaller scales flux increases the uncertainty around biomass and distribution (and therefore quota) stability.

To compensate for this uncertainty, the size of the management units can be increased (Figure 1). These units can then be reduced in size as more knowledge becomes available about krill advection. Such knowledge has already been accumulated from recent findings on potential linkage between krill stock distribution and typical water masses in Subarea 48.1 (e.g., WG-EMM-2025/21 Rev.1).

It also includes implementing the quota proposed in Table 10 of the FSA (X-REF FSA-2022 Table 10)), but redistributed according to the design in Figure 1 (proposed MU catch limits presented in Table 1). The precautionary catch limits in Table 1 may also be introduced through a step-wise approach.

Table 1Within-Subarea 48.1 catch limits based on reconfigured MU as presented in Figure 1.

Scenario 4

Management Unit	Summer	Winter	Total
BS + JI	4,600	84,972	89,572
EI + SSIW	80,947	122,155	203,103
Gerlache Strait (GS)	15,921	141,378	157,300
Powell Basin (PB) + Drake passage (DP)	30,046	188,079	218,125
Total	131,515	536,585	668,101

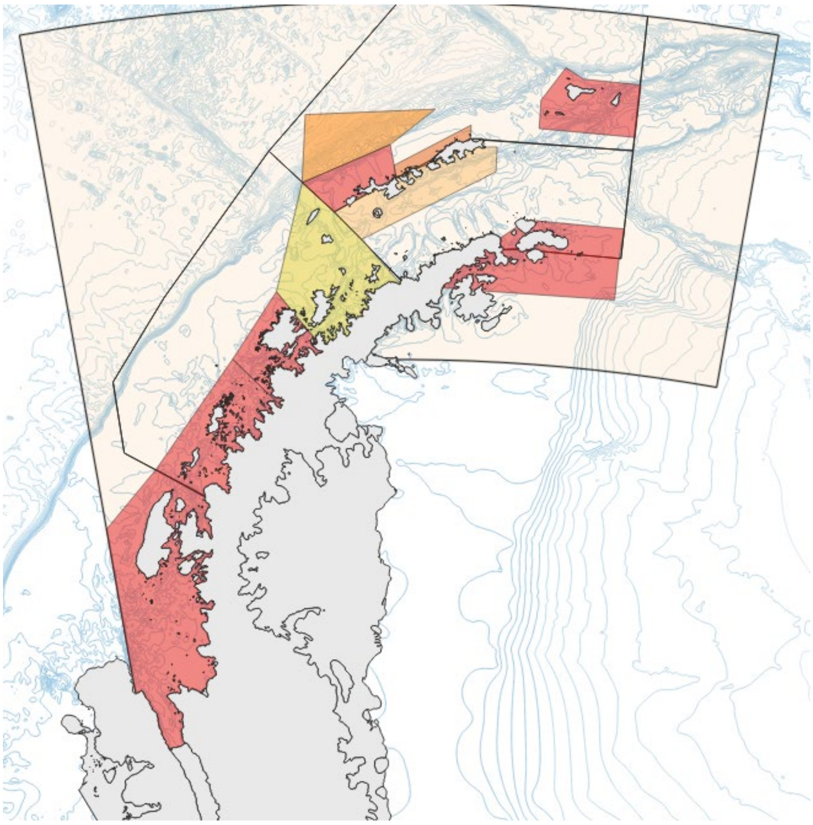

Figure 1: Alternate configurations of Scenario 4, with GPZ and SPZ configurations included.