Annex 4

Report of the Working Group
on Acoustic Survey and Analysis Methods
(Virtual meeting, 31 May to 4 June 2021)

Content

Report of the Working Group on
Acoustic Survey and Analysis Methods
(Virtual meeting, 31 May to 4 June 2021)

Introduction to the meeting

1.1 The 2021 meeting of the Working Group on Acoustic Survey and Analysis Methods (WG-ASAM) was held online from 31 May to 4 June. The Co-conveners, Dr S. Fielding (UK) and Dr X. Wang (China) welcomed the participants (Appendix A).

1.2 The meeting's provisional agenda was discussed and the Working Group adopted the proposed agenda with minor additions (Appendix B).

1.3 Documents submitted to the meeting are listed in Appendix C. The Working Group thanked the authors of papers and presentations for their valuable contributions to the work of the meeting.

1.4 This report was prepared by the Secretariat and the Co-conveners. Sections of the report dealing with advice to the Scientific Committee and other working groups are highlighted and collated in Agenda Item 5.

Krill biomass survey estimates

Area 48

2.1 WG-ASAM-2021/09 presented the differing spatial scales between existing acoustic survey programs and the fishery's operation in relation to Subarea 48.1 to facilitate the discussions of the Working Group.

2.2 The Working Group noted that scientific large-scale and mesoscale survey transects do not necessarily cover the area where the krill fishery operates today, therefore a future review optimising the temporal and spatial scales of surveys should be considered, including a cost–benefit analysis. The design and intent of future surveys are important considerations, as are fishery locations and the placement of transects, as well as the data collection method (commercial versus research vessel) and the way that the data are processed.

2.3 The Working Group noted the potential utility of re-evaluating the priority and location of transects nominated for collection of acoustic data by fishing vessels by SG-ASAM-2015 (SC-CAMLR-XXXIV, Annex 4, Appendix D, Table 1) to reflect new knowledge gained in recent years.

2.4 WG-ASAM-2021/04 Rev. 1 considered the results from a daytime acoustic survey in Subareas 48.1 and 48.2 by the Russian research vessel *Atlantida*, conducted between 2 January and 22 February 2020. The authors noted that the survey was completed in full compliance with CCAMLR methodology and recommendations (WG-EMM-16/38; WG-EMM-11/20;

SG-ASAM-16/01). The total survey area covered was 474 017 km^2, and total krill biomass for the study area was estimated as 39.287 million tonnes (CV = 9.29%). The mean krill density in the study area was 82.88 g m^{-2}.

2.5 The Working Group recalled that over the last five years two krill identification methods have been used by WG-ASAM, the swarms-based and the three-frequency (38, 120 and 200 kHz) dB-difference, with biomass estimation for both implemented on 120 kHz frequency data. The Working Group noted that the analysis presented in WG-ASAM-2021/04 Rev. 1 used the latter method and that a comparison of the results of an analysis using the swarms-based method would be valuable to build on the work of SG-ASAM-18/04 Rev. 1.

2.6 The Working Group noted that for February 2020 in the Bransfield Strait, the *Atlantida* results were similar to those presented for February 2019 in WG-ASAM-2021/13. However, results in other areas differed from the results of the 2019 International Area 48 Krill Survey. It was noted that an overlay of the daytime transects on the density contour plots could help explain some of these differences and that it would be valuable to relate this survey to previous studies. Differences in krill biomass estimates may be attributed to the specific spatial and temporal distribution of krill in the different strata as well as attributed to the differences in method used by the two surveys.

2.7 WG-ASAM-2021/13 considered biomass estimates from krill surveys conducted by the Chinese fishing vessel *Fu Rong Hai* around the South Shetland Islands from 2013 to 2019.

2.8 The Working Group reiterated the value of including the nautical area scattering coefficient (NASC) values in survey results in addition to krill density estimates, as was done in WG-ASAM-2021/13, since these were often informative of the underlying variability of NASC.

2.9 WG-ASAM-2021/14 considered krill biomass estimates from the 2019 international krill survey, including post-hoc stratification of krill density estimates for Subareas 48.1 to 48.4, on- and off-shelf areas, and estimates for currently fished areas.

2.10 The Working Group noted that large multi-Member surveys were conducted infrequently in comparison to smaller surveys conducted by individual research and fishing vessels.

2.11 The Working Group noted that subarea-based estimates of krill biomass are a plausible unit of management, but that the fishery operates at a much smaller scale. When scaling the mesoscale survey data up to the subarea level, the variances need to be considered appropriately.

2.12 The Working Group agreed to update the table of metadata on acoustic surveys with the results reported in WG-ASAM-2021/04 Rev. 1 and 2021/13.

2.13 The Working Group recalled the request from the Commission for the regular update of biomass estimates at the subarea scale as well as potentially at multiple scales (CCAMLR-38, paragraph 5.17). The Working Group noted that the subarea estimates provided in WG-ASAM-2021/14 demonstrated an example of how density estimates made using ASAM-reviewed methods (e.g. krill identification and target strength (TS) to biomass) could be extrapolated to the subarea scale.

2.14 The Working Group further noted that the methodology in WG-ASAM-2021/14 did not allow for the calculation of CVs in the results. It noted that CVs were a requirement for inclusion of biomass estimates for management.

2.15 The Working Group also noted that various approaches could be used to average density estimates from multiple surveys, including means weighted by the areas to which density estimates applied, by the inverse of the variances of such estimates, or by the recentness of such estimates. Subarea-scale density estimates could be developed from stratified estimators and model-based estimators (e.g. generalised additive models). Variance estimates for subarea-scale biomasses could also be estimated analytically using model-based estimators or via bootstrapping.

2.16 The Working Group agreed to summarise the acoustic survey biomass estimates from the updated table of metadata collated during WG-ASAM-2021 (also see paragraph 2.12) in an intersessional e-group, and undertook to provide advice on biomass and krill density estimates to WG-EMM-2021 at the subarea and any other appropriate spatial scales, with preliminary results on estimates of uncertainty provided to WG-SAM-2021 to assist with generalised R yield model (Grym) projections. A draft template developed by the Working Group for the summary of estimates is shown in Table 1.

2.17 The Working Group noted that the intersessional group should consider the following issues when compiling the summary table:

(i) the extrapolation of krill biomass density estimates made from surveys with various spatial scales to subarea scales, keeping in mind the need for a precautionary approach and the potential differences between on-shelf and off-shelf krill density

(ii) the metadata table contains biomass density estimates obtained using different methodologies (e.g. TS, krill identification methods and net sampling) and conducted in different seasons

(iii) the necessity to clearly identify how estimates from different surveys are allocated to a stratum

(iv) how estimates from each stratum may be combined to provide larger-scale estimates.

2.18 WG-ASAM-2021/P01 considered glider-based estimates of krill biomass around the northern Antarctic Peninsula, and comparisons with current and previous ship-based surveys conducted in the region.

2.19 The Working Group welcomed the results presented and noted the potential utility of gliders for surveying areas, both for biomass and for predator–prey related studies. The Working Group noted that establishing accepted protocols for krill biomass estimates from gliders should be agreed in the future.

2.20 The Working Group welcomed future developments planned for glider studies, including cameras for estimating krill length frequencies and real-time transmission of acoustic data, and encouraged the authors of the study to continue with their research program.

Area 58

2.21 WG-ASAM-2021/06 considered a revised biomass estimate for Division 58.4.1 from a survey conducted by the Japanese vessel *Kaiyo-maru* in the 2019 season. The total survey area was 909 000 km^2, the revised biomass estimate was 4.325 million tonnes (CV = 17.0 %) based on the swarms-based method, and overall survey mean areal krill biomass density was 4.758 g m^{-2}.

2.22 The Working Group welcomed the results from the Japanese survey and noted the undertaking to compare the biomass estimation with the 'traditional' dB-difference method, as well as the comparison of difference of biomass between daytime and night-time.

2.23 The Working Group advised the Scientific Committee that the krill biomass estimate of 4.325 million tonnes, with a CV of 17.0%, represented the best available estimate for Division 58.4.1.

2.24 WG-ASAM-2021/12 considered a biomass estimate for the eastern sector of Division 58.4.2. The total survey area was 775 732 km^2, the revised biomass estimate was 6.477 million tonnes (CV = 28.9%) based on the swarms-based method and using the daytime mean areal biomass density of 8.3g m^{-2}.

2.25 At the time of report adoption, Dr S. Kasatkina (Russia) noted that WG-ASAM-2021/12 showed estimates of krill biomass and density that are significantly lower than those from the previous survey (WG-EMM-12/31). The new estimates are accompanied by a very high CV (6.477 g m^{-2} with CV = 28.9% and 20.5 g m^{-2} with CV = 16%). A decrease in the density of krill by more than four times is revealed. It is not clear if this decrease in krill biomass is related to the krill stock or to the different TS model. Dr Kasatkina did not believe that the krill biomass estimate of 6.477 million tonnes, with a CV of 28.9%, represents the best available estimate for the eastern sector of Division 58.4.2.

2.26 At the time of report adoption, Dr S. Kawaguchi (Australia) noted that the comparison made by Dr Kasatkina was not of the same survey area. When comparing similar survey areas from WG-EMM-12/31 (Table 4, eastern region), the mean biomass density estimate was 18.7 g m^{-2} with a CV of 28% in 2006 compared to an estimate of 8.3 g m^{-2} with a CV of 28.9% in 2021. When CVs are considered, both surveys have an overlapping 95% confidence interval, with the 2006 survey ranging from 10.9 to 32 g m^{-2} and the 2021 survey from 4.76 to 14.45 g m^{-2}. The reduction in estimate may be a result of the 2021 survey not being able to sample sea-ice regions and shelf-break area as was done in 2006, it may also be a result of analysis methods (e.g. TS model) or krill dynamics in the region changing in the 15 years between surveys, or some combination of the above. Regardless of the cause, estimates provided within WG-ASAM-2021/12 follow the agreed CCAMLR protocols for data processing and provide the best available science for this region.

2.27 The Working Group welcomed the intention of Australia to design regular repeated smaller-scale surveys in Division 58.4.2 based on the 2021 survey as outlined in online discussions in 2020.

2.28 The Working Group noted the experimental work conducted during the survey to determine the acoustic properties of several species of zooplankton, and appreciated that the methodology developed could be potentially widely applied across vessels.

2.29 The Working Group noted that this is the first time that the krill biomass density results from the Division 58.4.2 survey, conducted in February and March 2021, had been presented to WG-ASAM, therefore, there had been limited consideration of the survey design and analysis methods.

2.30 The Working Group advised the Scientific Committee that the krill biomass estimate of 6.477 million tonnes, with a CV of 28.9%, represented the best available estimate for the eastern sector of Division 58.4.2.

2.31 The Working Group commented that consideration needed to be given on how results from the Division 58.4.1 and Division 58.4.2 acoustic surveys are potentially used given differences between the latest survey results and historic surveys conducted in the same regions.

Future work for krill biomass survey estimates

2.32 The Working Group requested that the Scientific Committee consider developing a standardised procedure analogous to the review of finfish stock assessments, to ensure that all future acoustic survey results and analysis methods contributing areal krill density biomass estimates to the management of the fishery can be checked and verified by the Scientific Committee and its working groups.

Survey design for future routine biomass estimates

Krill length frequency impacts

3.1 WG-ASAM-2021/02 considered biases in acoustic biomass density estimates related to using length frequency distributions from different sources.

3.2 The Working Group noted the implications on the uncertainty of biomass estimates resulting from the different sampling methods (commercial vessels, research vessels and predators) and their behaviours (e.g. commercial vessels target aggregations, predators select larger krill than small scientific nets, land-based predators have limited foraging areas) that influence the length composition of krill in samples.

3.3 WG-ASAM-2021/03 examined krill length compositions from catches obtained by the Russian research vessel *Atlantida* and commercial midwater trawls from several fishing vessels operating in the same fishing ground. Results indicated differences in sampled length compositions between research and commercial trawls as well as between commercial trawls. In particular, the under-representation of recruits (<36 mm) in commercial samples was highlighted and attributed to differences in gear construction and fishing method.

3.4 The Working Group noted the importance of this research and discussed the potential implications of the spatial mismatch between the research vessel and the commercial vessels used in this comparison.

3.5 WG-ASAM-2021/10 considered the effects of sampled length frequency distributions on the derivation of biomass estimates of Antarctic krill from acoustic data.

3.6 The Working Group noted the importance of the krill sampling methodology, including the impact of spatial variability and the choice of nets, as well as the way length frequency distributions were computed (e.g. unweighted, weighted by catch or normalised by volume filtered).

3.7 Recognising the importance of length frequency data on the estimation of TS and krill weight for acoustic estimates, the Working Group agreed to continue these important discussions within a dedicated e-group led by Dr M. Cox (Australia) and Dr Wang during the intersessional period and report to the next WG-ASAM meeting, which will:

(i) review the available sources of krill length frequency distribution that can be used to estimate the conversion factor (*C*) used to convert acoustic scattering coefficient data (NASC) to krill biomass density (Equation 1):

$$C = \frac{\sum f_i \times w(l_i)}{\sum f_i \times \sigma_{sp}(l_i)} \qquad \text{(Equation 1)}$$

where f_i is the frequency of occurrence of the i^{th} class of krill length l_i, $w(l_i)$ [g] the mass of a krill of length l_i, and $\sigma_{sp}(l_i)$ [m^2] the spherical scattering cross-section of a krill of length l_i. *C* therefore has units of g m^{-2}, noting that the m^{-2} term refers to acoustic scatter

(ii) review the methods used to reconstruct length frequency distributions

(iii) identify the impact of different sources of length frequency data to generate the conversion factor and the uncertainty

(iv) examine the sensitivity of biomass estimates to the use of multiple length frequency data, derived from a range of sources and sampling methodologies

(v) establish recommendations for future best practices.

3.8 The Working Group noted that krill length frequency distributions are used in other components of the krill management strategy (e.g. to estimate proportional recruitment for the Grym) and there may be wider discussions related to krill length frequency distributions of interest to other working groups.

Noise removal

3.9 WG-ASAM-2021/07 presented an analysis indicating echogram noise removal can erroneously remove significant amounts of krill backscatter. Resolving this produced a 16% increase in the biomass estimate from the large-scale 2019 Area Survey.

3.10 The Working Group discussed the importance of the findings presented and how best to incorporate them in future noise removal protocols, including careful consideration of individual survey noise thresholds on a case-by-case basis and semi-automated approaches to detect high-intensity spikes. The Working Group noted that in light of these results, the current default –40dB upper threshold used in the EchoView template was biased towards lower biomass estimates and constituted a precautionary approach. The Working Group agreed that future work for the group should include the development of further guidance for adjusting thresholds.

Acoustic observations of krill to inform spatial and temporal dynamics of krill

Spatial and temporal variability

4.1 WG-ASAM-2021/05 Rev. 1 presented an analysis of acoustic data collected on the *Atlantida* in 2020 in Subareas 48.1 and 48.2, examining spatial and temporal variability of krill distribution from repeated transects. The paper noted that the observed variability of krill distribution is potentially a consequence of the influence of the krill flux by the current. Analysis of the structure and dynamics of water masses in Subareas 48.1 and 48.2 and krill distribution at different spatial scales will be presented to WG-EMM-2021.

4.2 The Working Group congratulated the authors for the great amount of work leading to this paper and noted the similarity of observations within the one month surveyed, in particular, regarding the spatial distribution of krill, where the consistency of some aggregations was noticeable. The Working Group further noted that the factors (e.g. growth and flux) impacting the change in length frequency distributions over the relatively short period of time were complicated and encouraged Members to collaborate to further investigate these processes.

4.3 The Working Group recalled that WG-EMM had discussed flux in the past (e.g. WG-EMM-2019, paragraph 2.58; SC-CAMLR-39/BG/16) and recognised its importance to krill dynamics. The Working Group also recalled that due to the complexity of mathematically incorporating oceanic fluxes into management strategies, the endorsed krill management strategy (CCAMLR-38, paragraph 5.17) may progress with a staged approach in which flux would be put aside at first. As scientific understanding increases, the management strategy could incorporate krill flux in a future stage.

4.4 The Working Group agreed on the importance of continuing to work to understand flux and discussed potential future international collaboration to investigate flux dynamics and the incorporation of these results in management strategies.

4.5 Dr Kasatkina noted that krill flux should be included in the development of management options and did not agree with the development of the first stage in which flux would be put aside. Integration of krill flux into management schemes will require a comprehensive analysis of the available information and the development of appropriate mathematical models.

Fishing vessels data

4.6 WG-ASAM-2021/01 summarised the repository of acoustic data collected by fishing vessels held by the CCAMLR Secretariat.

4.7 The Working Group welcomed this contribution and indicated that additional metadata should be included in the repository, in line with Table 1 of WG-ASAM-2021/15. The Working Group supported the suggestion to use the Secretariat as a central repository for acoustic data collected by fishing vessels along nominated transects (WG-ASAM-2021/01). It noted that this would benefit collaboration and that Members could contribute their data through their Scientific Committee Representative. The Working Group noted the need for data validation prior to submission.

4.8 WG-ASAM-2021/11 presented an analysis of monthly variation of Antarctic krill biomass in a main fishing ground in the Bransfield Strait based on three years of fishing vessel acoustic data collected during routine fishing operations. The results showed that krill stock in the fishery hotspot is rather dynamic, with very high biomass towards the end of the fishery, implying flux must have played an important role that needed to be addressed in the future.

4.9 The Working Group welcomed the contribution and noted the potentials of such analysis in the study of krill flux.

4.10 The Working Group noted that in addition to flux, krill behaviour or predation from penguins and whales might also contribute to the dynamics of krill stocks.

4.11 WG-ASAM-2021/15 presented an analysis of acoustic transects undertaken by fishing vessels at South Georgia in winter.

4.12 The Working Group welcomed the successful collaboration between scientists and the fishing industry and encouraged the continuation and expansion of these valuable partnerships. The Working Group noted the need to establish clear sampling guidelines to enhance the standardisation of the resulting data, when scientists are not on board the vessel. It noted this should include krill size composition data, a subject that would fit within the scope of the length frequency data e-group (paragraph 3.7).

Autonomous vehicles data

4.13 WG-ASAM-2021/08 presented an analysis on the use of unmanned surface vehicles to monitor krill density during fishing and obtain regular updates of pre-exploitation biomass.

4.14 The Working Group welcomed the new emerging technologies which will prove helpful in understanding krill dynamics, including during wintertime, and also noted the contribution from WG-ASAM-2021/P01 on this topic.

Advice to the Scientific Committee and future work

5.1 The Working Group identified the following items relevant to providing advice to the Scientific Committee and its future work:

(i) the formation of an e-group to summarise acoustic survey results, with the intent to provide advice to WG-SAM-2021 and WG-EMM-2021 (paragraphs 2.16 and 2.17)

(ii) krill biomass estimate in Division 58.4.1 (paragraph 2.23)

(iii) krill biomass estimate in the eastern sector of Division 58.4.2 (paragraph 2.30)

(iv) the development of a standardised procedure to enable the checking and verification of acoustic survey results by CCAMLR (paragraph 2.32)

(v) the formation of an e-group to establish recommendations for the use of krill length frequency data on the estimation of target strength, and krill weight for acoustic estimates (paragraph 3.7)

(vi) the addition of survey data and the inclusion of metadata by Members in the repository of acoustic surveys held by the Secretariat (paragraph 4.7).

Adoption of the report and close of the meeting

6.1 The report of the meeting was adopted.

6.2 At the close of the meeting Dr Fielding and Dr Wang thanked all the participants for their hard work and collaboration that had contributed greatly to the successful outcomes from WG-ASAM this year, and to the Secretariat for their support.

6.3 On behalf of the Working Group, Dr X. Zhao (China) thanked Dr Fielding and Dr Wang for their guidance during the meeting and noted that WG-ASAM-2021 had the highest-ever number of participants for this Working Group, which had greatly contributed to successful meeting outcomes.

Table 1: Draft template for summary of acoustic survey estimates. AMLR – Antarctic marine living resources; Grym – generalised R yield model.

	Most recent three years	Most recent five years	Since adoption of CM 51-07 (2009)	All data in metadata table
Season (December, January, February)	n, xbar, var(x), med(x)			
AMLR Stratum				
West				
South				
Joinville				
Elephant Island				
Season (March, April, May)				
AMLR Stratum				
West				
South				
Joinville				
Elephant Island				
Summed biomass to AMLR study area (125 000 km^2)				
Season (December, January, February)				
Season (March, April, May)				
Subarea (Area 48.1) scaled mean biomass and variability for total allocation for Grym				
CV for biomass estimates				
Season (December, January, February)				
Season (March, April, May)				

Appendix A

List of Registered Participants

Working Group on Acoustic Survey and Analysis Methods
(Virtual Meeting, 31 May to 4 June 2021)

Co-conveners

Dr Sophie Fielding
British Antarctic Survey
sof@bas.ac.uk

Dr Xinliang Wang
Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science
wangxl@ysfri.ac.cn

Australia

Dr Martin Cox
Australian Antarctic Division, Department of the Environment
martin.cox@awe.gov.au

Dr So Kawaguchi
Australian Antarctic Division, Department of the Environment and Energy
so.kawaguchi@awe.gov.au

Dr Natalie Kelly
Australian Antarctic Division, Department of the Environment and Energy
natalie.kelly@awe.gov.au

Mr Dale Maschette
Australian Antarctic Division, Department of the Environment and Energy
dale.maschette@awe.gov.au

Ms Abigail Smith
University of Tasmania
abigail.smith@utas.edu.au

Dr Philippe Ziegler
Australian Antarctic Division, Department of Agriculture, Water and the Environment
philippe.ziegler@awe.gov.au

Chile	Professor Patricio M. Arana Pontificia Universidad Catolica de Valparaíso patricio.arana@pucv.cl
	Dr César Cárdenas Instituto Antártico Chileno (INACH) ccardenas@inach.cl
	Mr Mauricio Mardones Instituto de Fomento Pesquero mauricio.mardones@ifop.cl
	Mr Francisco Santa Cruz Instituto Antartico Chileno (INACH) fsantacruz@inach.cl
	Mr Marcos Troncoso Valenzuela Subsecretaría de Pesca y Acuicultura mtroncoso@subpesca.cl
China, People's Republic of	Dr Jianfeng Tong Shanghai Ocean University jftong@shou.edu.cn
	Dr Yi-Ping Ying Yellow Sea Fisheries Research Institute yingyp@ysfri.ac.cn
	Mr Jichang Zhang Yellow Sea Fisheries Research Institute zhangjc@ysfri.ac.cn
	Dr Yunxia Zhao Yellow Sea Fisheries Research Institute zhaoyx@ysfri.ac.cn
	Dr Xianyong Zhao Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Science zhaoxy@ysfri.ac.cn
	Professor Guoping Zhu Shanghai Ocean University gpzhu@shou.edu.cn
France	Dr Marc Eléaume Muséum national d'Histoire naturelle marc.eleaume@mnhn.fr

	Dr Sara Labrousse Sorbonne Université sara.labrousse@gmail.com
Italy	Dr Andrea De Felice CNR-IRBIM andrea.defelice@cnr.it
Japan	Dr Koki Abe Japan Fisheries Research and Education Agency abec@fra.affrc.go.jp
	Dr Taro Ichii National Research Institute of Far Seas Fisheries ichii@affrc.go.jp
	Dr Hiroto Murase Tokyo University of Marine Science and Technology hmuras0@kaiyodai.ac.jp
	Dr Takehiro Okuda National Research Institute of Far Seas Fisheries okudy@affrc.go.jp
Korea, Republic of	Dr Seok-Gwan Choi National Institute of Fisheries Science (NIFS) sgchoi@korea.kr
	Dr Sangdeok Chung National Institute of Fisheries Science (NIFS) sdchung@korea.kr
	Professor Kyounghoon Lee Chonnam National University ricky1106@naver.com
	Mr Wooseok Oh Chonnam National University owsnice@gmail.com
	Mr Sang Gyu Shin National Institute of Fisheries Science (NIFS) gyuyades82@gmail.com
Norway	Dr Tor Knutsen Institute of Marine Research tor.knutsen@imr.no

Dr Rolf Korneliussen
Institute of Marine Research
rolf.korneliussen@hi.no

Dr Bjørn Krafft
Institute of Marine Research
bjorn.krafft@imr.no

Dr Andrew Lowther
Norwegian Polar Institute
andrew.lowther@npolar.no

Dr Gavin Macaulay
Institute of Marine Research
gavin.macaulay@hi.no

Dr Sebastian Menze
Institute of Marine Research
sebastian.menze@hi.no

Russian Federation

Dr Svetlana Kasatkina
AtlantNIRO
ks@atlantniro.ru

Mr Aleksandr Sytov
FSUE VNIRO
cam-69@yandex.ru

United Kingdom

Dr Chris Darby
Centre for Environment, Fisheries and Aquaculture Science (Cefas)
chris.darby@cefas.co.uk

Dr Tracey Dornan
British Antarctic Survey
tarna70@bas.ac.uk

Dr Phil Trathan
British Antarctic Survey
pnt@bas.ac.uk

United States of America

Mr Anthony Cossio
National Marine Fisheries Service
anthony.cossio@noaa.gov

Dr George Cutter
National Marine Fisheries Service, Southwest Fisheries Science Center
george.cutter@noaa.gov

Dr Christian Reiss
National Marine Fisheries Service, Southwest Fisheries Science Center
christian.reiss@noaa.gov

Dr George Watters
National Marine Fisheries Service, Southwest Fisheries Science Center
george.watters@noaa.gov

CCAMLR Secretariat

Dr David Agnew
Executive Secretary
david.agnew@ccamlr.org

Belinda Blackburn
Publications Officer
belinda.blackburn@ccamlr.org

Dane Cavanagh
Web Project Officer
dane.cavanagh@ccamlr.org

Daphnis De Pooter
Science Data Officer
daphnis.depooter@ccamlr.org

Gary Dewhurst
Data Systems Analyst
gary.dewhurst@ccamlr.org

Doro Forck
Communications Manager
doro.forck@ccamlr.org

Isaac Forster
Fisheries and Observer Reporting Coordinator
isaac.forster@ccamlr.org

Angie McMahon
Human Resources Officer
angie.mcmahon@ccamlr.org

Ian Meredith
Systems Analyst
ian.meredith@ccamlr.org

Dr Stephane Thanassekos
Fisheries and Ecosystems Analyst
stephane.thanassekos@ccamlr.org

Robert Weidinger
IT Assistant
robert.weidinger@ccamlr.org

Appendix B

Agenda

Working Group on Acoustic Survey and Analysis Methods
(Virtual meeting, 31 May to 4 June 2021)

1. Opening of the meeting

2. Krill biomass survey estimates

   2.1 Area 48
      2.1.1 Subarea biomass estimates from 2019 and any other relevant survey data
      2.1.2 Local-scale biomass estimates within subareas relevant to the area of operation of the krill fishery

   2.2 Area 58
      2.2.1 Area 58 subarea estimates of krill biomass

3. Survey design for future routine biomass estimates

4. Acoustic observations of krill to inform spatial and temporal dynamics of krill

5. Advice to the Scientific Committee

6. Adoption of the report and close of the meeting.

Appendix C

List of Documents

Working Group on Acoustic Survey and Analysis Methods
(Virtual Meeting, 31 May to 4 June 2021)

WG-ASAM-2021/01	Repository of acoustic data collected by fishing vessels CCAMLR Secretariat
WG-ASAM-2021/02	Biases in acoustic biomass density estimates used for calculating catch limits C.S. Reiss, J. Hinke, A.M. Cossio, G.R. Cutter and G.M. Watters
WG-ASAM-2021/03	Comparison analysis of krill length compositions from catches obtained by research and commercial midwater trawls S. Sergeev and S. Kasatkina
WG-ASAM-2021/04 Rev. 1	Results of acoustic survey in Subarea 48.1 and 48.2 carried out by Russian RV «Atlántida» in 2020 S. Kasatkina, A. Abramov, M. Sokolov, A. Sytov and D. Kozlov
WG-ASAM-2021/05 Rev. 1	Analysis of acoustic data to examine spatial and temporal variability of krill distribution from repeated transects S. Kasatkina, A. Abramov, M. Sokolov and A. Malyshko
WG-ASAM-2021/06	A revised biomass estimation of Antarctic krill based on the up-to-date swarm based method for CCAMLR Division 58.4.1 in 2018/19 using data obtained by Japanese survey vessel, *Kaiyo-maru* K. Abe, R. Matsukura, N. Yamamoto, K. Amakasu and H. Murase
WG-ASAM-2021/07	Echogram noise removal can remove significant amounts of krill backscatter G. Macaulay, G. Skaret and B. Krafft
WG-ASAM-2021/08	Using unmanned surface vehicles to monitor krill density during fishing and obtain regular updates of pre-exploitation biomass S. Menze, A. Lowther and B.A. Krafft
WG-ASAM-2021/09	The various spatial scales available for consideration and the distribution of the krill fishery in Subarea 48.1 Y. Ying, X. Zhao, G. Fan and X. Wang

WG-ASAM-2021/10 Potential effect of the chosen length-frequency distribution on acoustic biomass estimates of Antarctic krill
X. Wang, X. Zhao and Q. Xu

WG-ASAM-2021/11 Monthly variation of Antarctic krill biomass in a main fishing ground in the Bransfield strait based on fishing vessel acoustic data collected during routine fishing operations
Y. Zhao, X. Wang, X. Zhao, Y. Ying and J. Zhang

WG-ASAM-2021/12 Biomass of Antarctic krill (*Euphausia superba*) in the eastern sector of the CCAMLR Division 58.4.2
M.J. Cox, G. Macaulay, N. Kelly, R. King, D. Maschette, J. Melvin, A. Smith, S. Wotherspoon and S. Kawaguchi

WG-ASAM-2021/13 Biomass estimates of Antarctic krill around the South Shetland Islands based on surveys conducted by a Chinese fishing vessel from 2013 to 2019
X. Wang, X. Yu, X. Zhao, J. Zhang, G. Fan, Y. Ying and J. Zhu

WG-ASAM-2021/14 Developing plausible estimates of subarea and fished area biomasses
B.A. Krafft, G. Macaulay, S. Fielding and P.N. Trathan

WG-ASAM-2021/15 Acoustic transects undertaken by fishing vessels at South Georgia
S. Fielding, J. Arata and P.N. Trathan

Other Documents

WG-ASAM-2021/P01 Glider-Based Estimates of Meso-Zooplankton Biomass Density: A Fisheries Case Study on Antarctic Krill (*Euphausia superba*) Around the Northern Antarctic Peninsula
C.S. Reiss, A.M. Cossio, J. Walsh, G.R. Cutter and G.M. Watters
Frontiers in Marine Science, 8 (2021): 1–18, doi: 10.3389/fmars.2021.604043