Report of the Meeting of the Subgroup on Acoustic Survey and Analysis Methods

(La Jolla, USA, 21 to 25 March 2016)

Contents

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Introduction

1.1 The 2016 meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held at the Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration (NOAA), La Jolla, USA, from 21 to 25 March 2016, and was convened by Dr C. Reiss (USA). Dr X. Zhao (People's Republic of China) is Co-convener of the Subgroup; however, he was unable to attend the meeting. Dr G. Watters, Director of NOAA's Antarctic Marine Living Resources Program, and Dr Reiss welcomed the participants (Appendix A).

1.2 The Subgroup has been developing methods to use fishing-vessel-based acoustic data to provide qualitative and quantifiable information on the distribution and relative abundance of Antarctic krill (*Euphausia superba*). The 2016 meeting focused on (SC-CAMLR-XXXIV, paragraph 2.24):

- analysis to generate validated acoustic data suitable for further analyses
- analysis to produce specific products from those validated acoustic data.

1.3 The Subgroup recognised that a range of factors, including the timescale between SG-ASAM requesting transect data and the timing of the krill fishery, meant that the only data available from a fishing vessel was collected by the *Saga Sea* as part of the South Orkney survey. As a result of this, the Subgroup agreed to postpone discussion of Agenda Item 3 and to focus on the development of elements of Agenda Item 5, including the understanding of uncertainty in acoustic biomass estimates. The meeting's agenda was adopted (Appendix B).

1.4 The Subgroup recommended that the Secretariat liaise with Members currently fishing and intending to undertake krill fishing activities, shortly after their notifications to participate in the fishery are received, to remind them of the request to collect acoustic data along the nominated transects, if possible. It would also be possible for the Secretariat to contact vessels as they enter a subarea.

1.5 The Subgroup noted that it may be useful to explore mechanisms to incentivise the broad-scale participation in the collection of acoustic data in the krill fishery, for example by allowing extra catch to be available to those vessels that voluntarily undertake surveys or repeated transects.

1.6 Documents submitted to the meeting are listed in Appendix C. The Subgroup thanked the authors of papers for their valuable contributions to the work presented to the meeting.

1.7 This report was prepared by M. Cox (Australia), C. Jones (USA), D. Ramm and K. Reid (Secretariat) and G. Skaret (Norway). Sections of the report dealing with advice to the Scientific Committee are highlighted (see also 'Advice to the Scientific Committee and other working groups').

Protocols for the collection and analysis of krill acoustic data from fishing vessels, with emphasis on Simrad echosounders (EK60, ES60/70)

2.1 The Subgroup noted that no acoustic data for the nominated transects from the fishery for the previous season was made available to the Subgroup, and it was unclear as to whether any vessels have occupied these transects.

2.2 It was noted that there is the potential to more easily collect data on an opportunistic basis along transects outside those set out in SC-CAMLR-XXXIV, Annex 4, Appendix D, Figure 1, by fishing vessels during the course of transiting to/from krill fishing grounds. The Subgroup agreed that is it most desirable for data to be collected from the nominated transect lines, but there is potentially useful information that could be collected from other repeated transects. The Subgroup underlined that, while the dedicated transects serve assessment and distribution purposes, other transects serve only the latter.

Availability of standard sphere calibration to krill fishing vessels

2.3 The Subgroup noted that funding has been made available through the Association for Responsible Krill harvesting companies (ARK) for two full calibration kits for use by ARK members participating in the krill fishery. The Subgroup noted that it may be advantageous for these calibration kits to be kept at a base or station near the krill fishing grounds, such as within Admiralty Bay, or on board a supply vessel where a krill fishing vessel could quickly retrieve the kit for in situ calibration.

2.4 The Subgroup acknowledged this important contribution from ARK and welcomed the engagement of industry in furthering the collection of high-quality acoustic data. The Subgroup also encouraged ARK to investigate ways in which non-ARK members may be able to access the acoustic calibration equipment.

2.5 The Subgroup encouraged Members to develop proposals for funding additional calibration kits through the Antarctic Wildlife Research Fund or other funding bodies.

2.6 It was noted that, while standard spheres or other calibration equipment is essential, consideration should also be given to having a technician train crew members in proper calibration protocols. This sort of training could be arranged while the vessels are in port, or at a base/station where the kits would be kept. Alternatively, there could be one technician who could be available to calibrate the ships if they went to one area at a specific time. It was also noted that CCAMLR could develop a guide and other training material for calibrating acoustics, following other guides such as the ICES calibration protocols for Simrad acoustic systems (Demer et al., 2015). The Subgroup also noted the need to designate a Member point of contact for technical assistance during calibration.

2.7 The Subgroup discussed the relative merits of conducting standard sphere calibrations of fishing vessels in the Antarctic (optimal) versus calibrating vessels in other locations such as the port of departure. The Subgroup noted that changing environmental conditions (water temperature, salinity, or water column backscatter) could all influence the calibrations for the estimation of biomass, and so such possible variability should be minimised whenever possible. In order to develop flexible approaches to where and how frequently standard sphere calibrations are conducted, the Subgroup encouraged Members to investigate transducer sensitivity to changes in condition (e.g. temperature).

Data storage and management

2.8 The Subgroup discussed storage and management of acoustic data, including calibration data, raw data, processed data, summary (output) data and associated metadata. The issue of what level and type of data should be archived at the Secretariat was highlighted as an area for future work.

2.9 The Subgroup tasked the Secretariat with reviewing acoustic data models and portals from other organisations, including Southern Ocean Network of Acoustics (SONA) and Integrated Marine Observing System (IMOS), and assessing how they may be used, adapted and/or accessed by CCAMLR to manage acoustic data.

Analysis of data collected from fishing vessels

Sampling depth

3.1 Although the CCAMLR protocol specifies the depth range over which acoustic sampling should be conducted is down to a maximum of 500 m, the Subgroup acknowledged that the actual depth range of krill monitoring using acoustics, according to the CCAMLR protocol, is typically no more than 250 m due to restrictions in the signal-to-noise ratio (SNR) at greater depths, as a result of signal attenuation with range, on the higher acoustic frequencies.

3.2 The Subgroup noted that median fishing depth in the krill fishery in Subareas 48.1, 48.2 and 48.3 between 2005 and 2015 was approximately 65 m, and 95% of the hauls were made in depths shallower than 200 m (Figure 1). The Subgroup also noted that the depth region in which predator diving depths, krill distribution depths estimated from surveys and trawl depths overlapped and was less than 100 m.

3.3 The Subgroup also noted that there may be seasonal and spatial variability in the depth of fishing that would need to be accounted for in order to determine that this did not bias measures of intra-annual variability.

Survey design

4.1 The Subgroup recalled that in 2015 there were a number of nominated transects for the collection, processing and analysis of acoustic data from the commercial fishery in Subareas 48.1, 48.2 and 48.3 (SC-CAMLR-XXXIV, Annex 4, Appendix D, Table 1 and Figure 1). Collecting data from these transects over differing time periods within a season allows the opportunity to evaluate potentially important within-season features in krill density distribution.

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4.2 SG-ASAM-16/04 presented an analysis of the US AMLR time series of acoustic survey data from Subarea 48.1 to examine the utility of acoustic data collected by fishing vessels along predefined transects. The survey data included in the analysis cover four areas within Subarea 48.1 and cover both early and late summer in the years 1996–2011.

4.3 The biomasses between areas were highly correlated as were those within areas and between survey stages. The patterns over time when comparing the biomass estimated from two random transects to the one based on all transects was similar.

4.4 The Subgroup agreed that the analysis undertaken was very informative about the utility of fishery acoustic data sampling. The Subgroup noted that these results highlighted that occupation of the prescribed repeat transects in Subarea 48.1 is sufficiently robust that an index of krill could be generated to provide information about the seasonal patterns of krill. In addition, these repeat transects provide information over a broader time scale that may well enhance the utility and interpretation of data collected in temporally restricted broad-scale biomass surveys.

4.5 The Subgroup underscored that the value of such data from the fishing vessels as suggested in SG-ASAM-16/04 would not be restricted to potential use in a future feedback management, but could also add greatly to the understanding of dynamics in krill biomass and distribution, in particular intra-annual variability of which there is presently little available information.

Other issues

Data processing procedure for krill density estimation

5.1 SG-ASAM noted the WG-EMM-15 discussion (SC-CAMLR-XXXIV, Annex 6, paragraph 2.59) that highlighted difficulties following the CCAMLR biomass estimation procedure because information was distributed over several years of SG-ASAM meetings. The Subgroup agreed that the CCAMLR biomass estimation procedure should be described in a single document. The Subgroup also agreed that this document should be available online in a form that can be updated to include future developments. The Subgroup identified that version control was going to be important.

5.2 Dr S. Fielding (UK) presented an overview of the method used to calculate B_0 in the 2010 SG-ASAM meeting (SG-ASAM-16/02). The Subgroup discussed the CCAMLR biomass estimate under the following headings: survey design; data collection; acoustic data processing, including target identification; echo integration; conversion of acoustic backscatter to area biomass; and estimation of total biomass. The content of SG-ASAM-16/01, 16/02 and 16/03 informed on the discussion below.

5.3 The Subgroup recognised that, while elements of the procedure are standard methods, such as calculating the nautical area scattering coefficient (NASC) to density conversion factor, there are components of the CCAMLR biomass estimation procedure that can be subjective such as elements of the data processing. The Subgroup recognised that data processing must be sufficiently flexible to account for vessel-specific data characteristics, such as electrical noise.

5.4 The Subgroup noted that there have been numerous advances in acoustic data processing that are relevant to working with data collected from both commercial fishing and research vessels. For example, procedures are now available to estimate SNR, identify surface noise and eliminate multiple seabed echoes. The Subgroup agreed that these advances offer opportunities to improve data quality, reduce data processing time and enable reproducible data processing. The Subgroup agreed that data processing procedures should be compared in order to understand the differences in methods or that the Subgroup needs to develop standardised agreed procedures. The Subgroup agreed that changes need not be applied retrospectively until these differences are understood.

5.5 The Subgroup agreed that an investigation into potential for observation bias caused by diel and seasonal changes in vertical distribution should be carried out and the Subgroup noted that it is important to assess this potential bias as the fishery will collect data continuously.

5.6 The Subgroup noted that there has not been any change to the recommended survey design (e.g. random design coupled to a design-based analysis). However, other elements of survey design may need to be considered to accommodate data from other sources such as fishing vessels.

5.7 SG-ASAM noted that the overall approach outlined in Hewitt et al., 2004 to collect and process data is the current CCAMLR approach, except for one addition where the echosounder transmitted power setting should be set for each frequency to avoid non-linear effects (Korneliussen et al., 2008).

5.8 The Subgroup noted the discussion of WG-EMM-15/17 Rev. 1 (SC-CAMLR-XXXIV, Annex 6, paragraphs 2.53 to 2.58) and the request therein for clarification of the correct orientation parameters identified and that there has been confusion in the implementation of the stochastic distorted-wave Born approximation (SDWBA) to target identification and biomass estimation. The Subgroup recognised that the analysis undertaken in 2010 (SC-CAMLR-XXIX, Annex 5, paragraphs 2.12 to 2.19) represented the current parameterisation of the SDWBA (including *g* and *h* taken from Foote (1990), a fatness correction of 40% applied to the krill shape, and the orientation of krill as a wrapped Gaussian (normal) distribution of orientations ($N(\bar{\theta} = x^\circ$, s.d. $= y^\circ$) of $N(-20^\circ, 28^\circ)$)). Specifically, the Subgroup identified that in the absence of in situ observations, the krill target strengths (TS) calculated during SG-ASAM-10 should be used.

5.9 The Subgroup recommended further work be carried out on the independent observation of in situ tilt angle distribution and noted that much progress has been made in this regard by Kubilius et al., 2015.

5.10 The Subgroup agreed that the three-frequency krill identification is currently the method employed for the CCAMLR 2000 Krill Synoptic Survey of Area 48 with 120–38 kHz and 200–120 kHz frequency pairs used with length-frequency specific dB difference identification windows.

5.11 The Subgroup acknowledged that an empirical validation of the two-frequency (120−38 kHz) dB identification technique exists (Madureira et al., 1993; Watkins and Brierley, 2002), and in the absence of three-frequency data provides a valid target identification protocol and method to estimate krill density.

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5.12 The Subgroup identified that other frequency combinations should be examined for their efficacy in identifying krill targets in acoustic data, and assess their suitability.

5.13 The Subgroup recalled the WG-EMM-15 discussion of the time-series of krill acoustic estimates from the South Orkney Islands (SC-CAMLR-XXXIV, Annex 6, paragraph 2.223) in which the frequencies varied by vessel and year such that there was no single frequency that could be used in every year to generate a coherent series of krill biomass estimates. The Subgroup agreed that the development of approaches to use a greater range of frequencies would allow the data that has been collected to be used to generate the time-series of krill biomass estimates.

5.14 The Subgroup documented TS for krill lengths between 10 and 65 mm (at 1 mm intervals) for five frequencies (Table 1) so that they can be used to calculate *C* and the dB identification windows.

5.15 The Subgroup recommended an assessment of the utility of wideband (frequency modulated echosounders) for krill identification and density estimation.

5.16 The Subgroup noted that the current protocol estimates krill from the 120 kHz integration results. The Subgroup identified that other frequencies, particularly 70 kHz, may be more suitable and further investigation is required to validate this.

5.17 The Subgroup identified that a SNR could be a more appropriate measure to use to determine the maximum observation range for each acoustic frequency. The Subgroup identified that the SNR calculations of De Robertis and Higginbottom (2007) on a 50-ping by 5 m grid may be an appropriate method and encourages Members to develop and validate procedures for determining the minimum SNR.

Recommendations for future work

5.18 SG-ASAM noted that:

(i) the full implementation of the SDWBA is used to estimate krill TS which in turn is used to calculate the identification windows and the conversion factor to convert NASC to krill density

(ii) in the absence of more information regarding parameterisation of the SDWBA, SG-ASAM agreed that the model output (calculated for a length-frequency range from 10 to 65 mm, and at 38, 120 and 200 kHz frequencies) from the 2010 SG-ASAM analysis should be used (Table 1). In particular, SG-ASAM agreed that the orientation distribution calculated during SG-ASAM-10 (mean, SD) *N*(–20°, 28°), should be used in the absence of any other independent measures of orientation

(iii) SG-ASAM recommended that the integration depth be changed to 250 m or 5 m above the seabed, whichever is shallower

(iv) SG-ASAM noted that the current protocol estimates krill biomass from the 120 kHz frequency integration results.

5.19 The Subgroup endorsed the approach of using R markdown to document the procedure and recommended that each step in the procedure contain the following: (i) descriptive text; (ii) example R code, and (iii) a worked example. Dr Cox undertook to continue the development of the R markdown template SG-ASAM-16/01 and work with Mr A. Cossio (USA) and Drs Fielding and Skaret to provide an updated version of the R markdown document for submission to WG-EMM-16.

Development of methods for the evaluation of uncertainty
in acoustic estimates of krill biomass

5.20 The Subgroup identified the following as general areas of uncertainty:

(i) measurement uncertainty (e.g. calibration, speed of sound/absorption coefficient)

(ii) processing uncertainty (e.g. variability between methods of noise removal, SNR calculation)

(iii) target identification uncertainty (e.g. parameterisation of the SDWBA, particularly orientation, length frequency etc.)

(iv) conversion to biomass uncertainty (e.g. parameterisation of the SDWBA, length-frequency representation of population)

(v) survey uncertainty (e.g. Jolly and Hampton style calculation versus geostatistical).

5.21 The Subgroup acknowledged that issues with data quality will potentially apply to any set of acoustic data collected at sea whether collected on board research or fishing vessels and whether collected with or without scientific supervision.

5.22 The Subgroup noted that guidelines for processing of acoustic data from different platforms are generic, and that the processing steps of such data involve a range of user-dependent decisions, and potentially vary between software. The Subgroup acknowledged that differences in acoustic data processing, particularly addressing issues of noise removal, may potentially have huge influence on the output from the data. The Subgroup further noted that details of individual data processing steps for the removal of noise, integration depth and other aspects of the data processing need to be documented much the same way that both the instrument setup and the acoustic biomass estimation are documented to fully comprehend the decisions made.

5.23 The Subgroup agreed to look at data collected by the Norwegian fishing vessel *Saga Sea* in 2016 during the annual South Orkney Island acoustic biomass survey for a simple comparison of data processing among individuals within the Subgroup. The Subgroup noted that these data were collected as part of a supervised survey.

5.24 The Subgroup undertook a simple comparison of the effect of different processing techniques from different individuals processing the same dataset. Sixteen hours of survey data from the 2016 annual survey off the South Orkney Islands with the *Saga Sea* was distributed among Members to process and integrate down to 500 m (as required in the CCAMLR protocol) and to 250 m and at a horizontal resolution of 1 n mile. Three Members (Australia, UK and USA) used the software Echoview and one Member (Norway) the LSSS.

5.25 Among Members that analysed these data, all noted that they would not normally integrate to 500 m as they did not feel that the 120 kHz had sufficient SNR below 250 m.

5.26 Dr Skaret highlighted that LSSS requires a threshold to be applied to the data for export, and that exported echo integration values from LSSS by default only include full vessel log distance intervals at the selected resolution (in this case 1 n mile). Hence, in this particular case, a large krill swarm at the end of the transect was not included in the Norwegian export, but was included in all the others.

5.27 The Subgroup noted that NASC integrated to 250 m (NASC250m) was of a similar order of magnitude across the suite of methods, but still noted that the different processing methods (Table 2) (whilst undertaking the same descriptive steps) outputted different results, potentially unpredictably.

5.28 Whilst there are marked differences between the four processing results, the Subgroup recognised that the data presented here are from a single frequency, 120 kHz. Also, when identifying krill, it is common practice to use the 'dB difference' to both identify krill and to provide further data screening to remove seabed and sea surface returns. Nevertheless, the Subgroup noted that the significant differences in these processing results highlight the importance of a consistent approach to processing acoustic data.

5.29 The Subgroup recommended a single processing approach is developed and applied to data collected by all fishing vessels. The processing approach should include data quality measures such as SNR, and the proportion of bad and missing data.

5.30 The Subgroup agreed that metrics of acoustic data quality should be developed. The Subgroup encouraged the development of processes to estimate proportion of bad and missing data and the SNR. The Subgroup identified the need to assess statistical techniques that adequately represent uncertainty in data processing decisions and the Subgroup encouraged engagement with appropriate experts to advise on suitable techniques.

5.31 The Subgroup recognised that, while it was essential that the current approach was appropriately documented, CCAMLR needs a review process to ensure that technological and methodological advances in acoustics are incorporated throughout its work where the results are to be used in management.

Advice to the Scientific Committee and other working groups

6.1 The Subgroup agreed that much of the advice in the report was directed towards those Members that were actually engaged in the krill fishery and encouraged those Members and the Secretariat (paragraph 1.4) to communicate the relevant outcomes of the Subgroup meeting to those engaged in the krill fishery.

6.2 Advice to the Scientific Committee on how acoustic data collected by fishing vessels might contribute to FBM would be guided by discussions in WG-EMM.

Adoption of report

7.1 The report of the meeting was adopted.

Close of the meeting

8.1 In closing the meeting, the Convener thanked all participants for their contributions to the work of SG-ASAM and for developing acoustic protocols during the intersessional period. The Subgroup recognised the importance of industry participation in the meeting and thanked Mr H. Leithe (Norway) for participating in the meeting and for his insight into the krill fishing industry. The Subgroup thanked the AMLR team, in particular Jen Walsh, and the Southwest Fisheries Science Center for the excellent support and generous hospitality during the meeting. Dr Jones, on behalf of the Subgroup, thanked Dr Reiss for convening the meeting.

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Table 1: Krill target strength values for five acoustic frequencies for krill lengths of 10 to 65 mm. All target strength model parameters were as specified in SG-ASAM-10 (SC-CAMLR-XXIX, Annex 5).

Krill length (mm)	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
10.00	–114.21	–104.73	–97.34	–90.30	–85.96
11.00	–111.84	–102.54	–95.32	–88.48	–84.72
12.00	–109.70	–100.55	–93.45	–86.88	–83.78
13.00	–107.74	–98.75	–91.77	–85.46	–83.10
14.00	–105.95	–97.10	–90.27	–84.22	–82.67
15.00	–104.27	–95.57	–88.85	–83.11	–82.49
16.00	–102.74	–94.18	–87.56	–82.13	–82.56
17.00	–101.30	–92.86	–86.36	–81.28	–82.84
18.00	–99.96	–91.61	–85.23	–80.53	–83.31
19.00	–98.71	–90.45	–84.20	–79.88	–83.89
20.00	–97.53	–89.38	–83.27	–79.35	–84.40
21.00	–96.40	–88.36	–82.33	–78.91	–84.56
22.00	–95.36	–87.39	–81.49	–78.55	–84.17
23.00	–94.36	–86.43	–80.72	–78.29	–83.24
24.00	–93.39	–85.56	–79.96	–78.11	–82.05
25.00	–92.48	–84.73	–79.31	–78.02	–80.82
26.00	–91.62	–83.93	–78.66	–78.01	–79.71
27.00	–90.79	–83.18	–78.06	–78.10	–78.77
28.00	–90.00	–82.46	–77.53	–78.26	–78.02
29.00	–89.23	–81.77	–77.01	–78.47	–77.46
30.00	–88.50	–81.08	–76.52	–78.77	–77.09
31.00	–87.76	–80.47	–76.06	–79.07	–76.88
32.00	–87.06	–79.87	–75.68	–79.38	–76.82
33.00	–86.41	–79.27	–75.28	–79.68	–76.89
34.00	–85.77	–78.71	–74.97	–79.86	–77.05
35.00	–85.16	–78.19	–74.65	–79.88	–77.23
36.00	–84.57	–77.66	–74.40	–79.73	–77.40
37.00	–83.97	–77.16	–74.11	–79.37	–77.47
38.00	–83.41	–76.68	–73.90	–78.81	–77.38
39.00	–82.86	–76.23	–73.70	–78.18	–77.12
40.00	–82.35	–75.77	–73.60	–77.46	–76.72
41.00	–81.83	–75.34	–73.46	–76.73	–76.23
42.00	–81.32	–74.95	–73.29	–76.03	–75.72
43.00	–80.82	–74.55	–73.26	–75.37	–75.24
44.00	–80.36	–74.20	–73.18	–74.78	–74.82
45.00	–79.91	–73.83	–73.18	–74.24	–74.48
46.00	–79.45	–73.48	–73.15	–73.76	–74.22
47.00	–79.02	–73.17	–73.15	–73.38	–74.05
48.00	–78.58	–72.84	–73.17	–73.03	–73.93
49.00	–78.18	–72.53	–73.19	–72.77	–73.86
50.00	–77.79	–72.25	–73.28	–72.56	–73.82
51.00	–77.37	–71.96	–73.32	–72.40	–73.77
52.00	–76.99	–71.70	–73.41	–72.32	–73.71
53.00	–76.58	–71.43	–73.53	–72.27	–73.60
54.00	–76.24	–71.16	–73.63	–72.28	–73.46
55.00	–75.88	–70.97	–73.67	–72.34	–73.28
56.00	–75.53	–70.74	–73.75	–72.43	–73.10
57.00	–75.19	–70.55	–73.78	–72.52	–72.88
58.00	–74.89	–70.33	–73.89	–72.61	–72.70
59.00	–74.53	–70.16	–73.82	–72.74	–72.52

(continued)

Table 1 (continued)

Krill length (mm)	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
60.00	–74.20	–69.97	–73.84	–72.80	–72.35
61.00	–73.89	–69.83	–73.75	–72.86	–72.21
62.00	–73.57	–69.65	–73.61	–72.85	–72.07
63.00	–73.29	–69.52	–73.52	–72.78	–71.93
64.00	–72.99	–69.37	–73.39	–72.66	–71.76
65.00	–72.71	–69.26	–73.06	–72.47	–71.56

Table 2: Australian, Norwegian, UK and US data processing of a transect from the *Saga Sea* survey 2016. Integrated nautical area scattering coefficient (NASC) at 120 kHz mean (quantile range and skewness).

	Australia	Norway	UK	USA
Integrated to 250 m	275	122	381	390
Threshold (dB)	–80	–86	none	none
2.5 percentile	1	27	1	14
97.5 percentile	665	465	1661	1659
Skewness	8.48	10.08	6.80	8.49

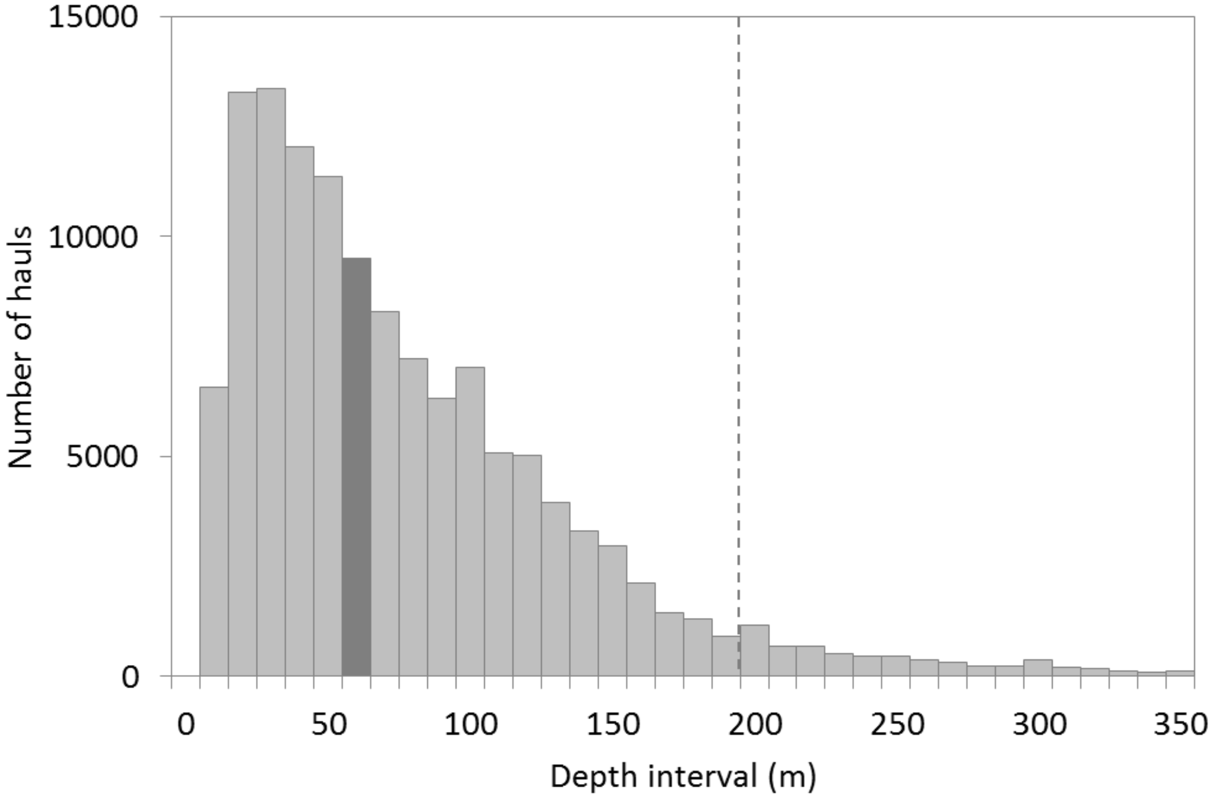

Figure 1: Fishing depth (10-metre interval) of hauls in the krill fishery in Subareas 48.1, 48.2 and 48.3 between 2005 and 2015. Dark bar: median depth; dash line: 95% percentile. Source: C1 effort data.

Appendix A

List of Participants

Subgroup on Acoustic Survey and Analysis Methods
(La Jolla, USA, 21 to 25 March 2016)

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Appendix B

Agenda

Subgroup on Acoustic Survey and Analysis Methods
(La Jolla, USA, 21 to 25 March 2016)

1. Introduction

   1.1 Opening of the meeting
   1.2 Adoption of the agenda

2. Protocols for the collection and analysis of krill acoustic data from fishing vessels, with emphasis on Simrad echosounders (EK60, ES60/70)

   2.1 Protocols for data collection
      2.1.1 Validation of acoustic instrument performance
         2.1.1.1 Methods to improve internal instrument testing
         2.1.1.2 Availability of standard sphere calibration to krill fishing vessels
         2.1.1.3 Other calibration approaches

      2.1.2 Operational instructions for data collection
         2.1.2.1 Review and refine the existing data collection approaches

   2.2 Protocol for data screening and analysis
      2.2.1 Review noise removal algorithms
      2.2.2 Development of automated data processing/analysis algorithm/code
      2.2.3 Data storage and management

3. Analysis of data collected from fishing vessels

   3.1 Analysis to generate validated acoustic data suitable for further analyses
   3.2 Analysis to produce specific products from that validated acoustic data
   3.3 Analysis method for data collected during fishing operations

4. Survey design

5. Other issues

   5.1 Review and clarify the current documentation and instruction protocols for the implementation of the full SDWBA model
   5.2 Development of methods for the evaluation of uncertainty in acoustic estimates of krill biomass

6. Recommendations to the Scientific Committee

7. Adoption of report

8. Close of meeting.

Appendix C

List of Documents

Subgroup on Acoustic Survey and Analysis Methods
(La Jolla, USA, 21 to 25 March 2016)

SG-ASAM-16/01	A procedure for krill density estimation M.J. Cox, S. Fielding and A. Constable
SG-ASAM-16/02	CCAMLR protocol for krill biomass estimation S. Fielding, A. Cossio, M. Cox, C. Reiss and G. Skaret
SG-ASAM-16/03	Matlab code for calculating krill biomass in a survey area A. Cossio, J. Renfree and C. Reiss
SG-ASAM-16/04	Information from repeat acoustic transects to inform feedback management strategies: data for SG-ASAM 2016 C.S. Reiss