Annex 4

Report of the Meeting of the Subgroup on
Acoustic Survey and Analysis Methods
(Qingdao, People’s Republic of China, 8 to 11 April 2014)

Contents

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Introduction

1.1 The 2014 meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held at the Yellow Sea Fisheries Research Institute (YSFRI), Chinese Academy of Fishery Science, Qingdao, People's Republic of China, 8 to 11 April 2014. The Co-conveners, Drs J. Watkins (UK) and X. Zhao (China), welcomed the participants (Appendix A). Dr Watkins thanked Dr Zhao for hosting the meeting at YSFRI; this was the first CCAMLR meeting hosted by China.

1.2 The Subgroup's work is currently focused on the use of fishing-vessel-based acoustic data to provide qualitative and quantifiable information on the distribution and relative abundance of Antarctic krill (*Euphausia superba*) and other pelagic species such as myctophiids and salps (SC-CAMLR-XXX, paragraphs 2.9 and 2.10; SC-CAMLR-XXXI, Annex 4). Specifically, this meeting of SG-ASAM was convened to determine protocols for collection and analysis of acoustic data collected on board fishing vessels (SC-CAMLR-XXXII, paragraph 2.14).

1.3 The meeting's provisional agenda was discussed and adopted without change (Appendix B). The Subgroup agreed to focus its discussion on Item 2.

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

1.5 This report was prepared by Drs M. Cox (Australia), S. Fielding (UK), D. Ramm, 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').

Scientific use of acoustic data collected on fishing vessels targeting krill

Overview of acoustic data submitted as part of the proof of concept

2.1 The Subgroup recalled the objectives of the proof of concept (SC-CAMLR-XXXI, Annex 4, paragraphs 2.38 and 2.39) and the subsequent intersessional work on these issues that had been facilitated by the use of the SG-ASAM e-group[1] (SC-CAMLR-XXXI, paragraphs 2.12 and 2.13).

2.2 The Subgroup noted that the proof-of-concept program, which began in 2013, had two stages and that stage 1 (implemented in 2013) was designed to determine the current setup of sonar equipment on participating vessels and to establish the feasibility of vessels collecting position- and time-referenced acoustic data. To achieve stage 1, vessels were requested to

[1] CCAMLR e-groups can be accessed from the CCAMLR homepage and are available to authorised users.

collect acoustic data over a period of 1 to 2 minutes, to complete the acoustic metadata form distributed as part of SC CIRC 13/46 and to submit the data file(s) and completed form to the Secretariat via email.

2.3 The Subgroup noted that stage 1 was an important step to provide a better understanding of the acoustic instrumentation on krill fishing vessels as well as the potential to collect the acoustic data and associated metadata required. The Subgroup also noted that, based on the number of vessels that had implemented stage 1 in 2013 and the intersessional work of the SG-ASAM e-group, the Scientific Committee had recognised that there was good momentum for ongoing work in developing protocols for stage 2 (SC-CAMLR-XXXII, paragraph 2.14).

2.4 The Subgroup welcomed the submission of stage 1 acoustic data from seven vessels (Table 1) which represented approximately 60% of the vessels engaged in the krill fishery in 2013/14. In addition, one vessel submitted images of echograms. All of the datasets submitted were collected using Simrad systems and all of the acoustic data files were submitted as '.raw' (native format) files. Of the vessels that had not supplied stage 1 data, some had Furuno echosounder systems that did not have a facility to store acoustic data. Dr S.-G. Choi (Republic of Korea) informed the Subgroup that the vessel *Insung Ho* currently had echosounders that did not allow data collection/storage but that a Simrad system would be installed on board the vessel in 2014/15.

2.5 The Subgroup agreed that the acoustic data provided has proved the concept that these data could be collected by fishing vessels.

2.6 The Subgroup reiterated its interest in receiving data from all types of echosounder under stage 1, but noted that all of the data submitted in stage 1 were from Simrad systems. As a result, discussions during this meeting focused on analysis and data collection protocols designed for Simrad systems.

2.7 During the meeting all of the acoustic data files provided for stage 1 were successfully opened and reviewed using Echoview or LSSS. The Subgroup viewed each data file, and noted that, whilst acoustic noise (ping synchronisation and background) varied between vessels, all acoustic data submitted showed that krill fishing vessels could collect acoustic data and associated metadata required to provide information on the distribution and abundance of krill.

2.8 The Subgroup acknowledged that software packages used to view and analyse acoustic data during the meeting (Echoview, LSSS and Echolab) used proprietary software and thanked those participants who had brought these licensed packages to the meeting. The Subgroup noted that the Secretariat currently does not have the facility to analyse these acoustic data files; however, a demonstration version of Echoview or LSSS could be used to open and view data. The Subgroup agreed that the requirements for the Secretariat to develop this capacity would need to be reviewed during the development of the data-analysis protocols.

Development of protocols for data collection

2.9 Given the success of stage 1, the Subgroup considered a timeline for the subsequent steps (Figure 1) in the procedure to use acoustic data from krill fishing vessels to provide information on the distribution and abundance of krill. The Subgroup agreed that the current focus should be to develop protocols for data collection that could be readily implemented on fishing vessels, and that the protocol for collecting acoustic data from transects should be developed first.

2.10 The Subgroup agreed that the development of data collection protocols, including the metadata requirements and instrument settings for acoustic data collection, should be based on existing protocols where available and should be for a particular activity type. In particular, the Subgroup recognised that existing IMOS protocols, developed for the use of ships of opportunity (SOOP) with Simrad equipment (IMOS SOOP document), provided a useful template from which to develop a specific protocol for the krill fishery.

2.11 The Subgroup agreed that there was substantial benefit in collecting data from pre-defined transects and supported the repetition of transects currently or previously undertaken as part of long-term time series for scientific research in Subareas 48.1, 48.2 and 48.3 (Figure 2). To facilitate the use of these transects by fishing vessels, the Subgroup provided the start and end waypoints (Table 2) and agreed a set of unique identifiers for each transect. The Subgroup agreed that while it would be beneficial for fishing vessels to collect data along transects (or parts of transects) currently undertaken during scientific research, new transects may be added in the future.

2.12 The Subgroup acknowledged that much of the information in a transect-specific protocol would be relevant for a fishing vessel when performing other acoustic data collection activities, including data collection from other transects.

2.13 The metadata requirements associated with acoustic data collection by a krill fishing vessel were separated into those that relate to the fixed installation of echo sounding equipment on the vessel and those that are specific to activities undertaken to collect acoustic data.

2.14 In respect of metadata concerning the fixed installation of echo sounding equipment on the vessel, the Subgroup suggested that the information in Table 3 could in future be requested as part of the notification of intention to fish for krill. The Subgroup requested the Secretariat to seek the additional information for those vessels notified for 2014/15. In particular, the Subgroup noted that providing the serial number of the transducer would allow many of the factory settings to be accessed from Simrad and would provide the basic data available for a vessel's echosounder equipment.

2.15 The Subgroup also noted that there would need to be a request made to Members engaged in the krill fishery to inform the Secretariat if the transducer specification changed in the period between the notification and the provision of acoustic data.

2.16 The key metadata requirements for acoustic data collected on transects are identified in Table 4 and the Subgroup recommended that all date and time data associated with acoustic data collection should be reported as UTC.

2.17 The Subgroup identified seven instrument settings/parameters that should be set to pre-specified values as part of the instrument setup for collecting acoustic data on transects (Table 5). While six of these parameters are vessel independent, the power setting for an individual frequency is dependent on the transducer beam width (Korneliussen et al., 2008). Vessel-specific guidance will need to be developed based on transducer type and calibration history.

2.18 The Subgroup developed draft instruction documentation on instrument setup for the 38 kHz, 7 degree beam width transducer by modifying the IMOS instructions (Appendix D). There was not sufficient time and resources to fully develop this document and it was recommended that this development be continued using the SG-ASAM e-group.

Monitoring of echosounder performance

2.19 The Subgroup agreed that the ability of any vessel to collect acoustic data and the associated metadata required to provide information on the distribution and abundance of Antarctic krill is contingent on the performance of the echosounder, both with respect to expectation (i.e. is the echosounder functioning as expected?) and with respect to a known standard (i.e. does the data from the echosounder agree with a known calibration standard?).

2.20 The Subgroup recognised that the standard sphere calibrations (e.g. as currently described by Foote et al., 1987) provided the best method by which to determine echosounder performance and provided the most accurate derived quantitative measures of krill abundance (see for example SC-CAMLR-XIX, Annex 4, Appendix G, paragraphs 3.10 to 3.12 and Tables 10 and 11).

2.21 The Subgroup noted that some fishing vessels have been calibrated using the standard sphere technique, for example, when the echosounder was installed. The Subgroup requested the results of these calibrations be made available to CCAMLR. It also encouraged the submission of any other subsequent data on calibrations performed on fishing vessel echosounders in order to better understand the variation over time and environmental conditions in echosounder performance.

2.22 The Subgroup reviewed eight years of TS gain values of the RRS *James Clark Ross* that indicated that variability in the TS gain varies within 0.5 dB at 38 kHz and 1 dB at 120 kHz, and this variability was at least partially driven by environmental (temperature) conditions during the calibration procedure.

2.23 The Subgroup noted that Brierley et al. (1998) identified markedly different (1.4 dB difference in volume backscattering strength (S_v) gain at 38 kHz) calibration gain settings determined in waters of 16.6°C compared with Antarctic waters (2.3°C). However, the Subgroup noted that a greater understanding of uncertainty driven by the effects of temperature on calibration values may allow calibration of fishing vessels in ports to be used to derive quantitative estimates in the Antarctic.

2.24 The Subgroup agreed that, in order for acoustic data to be used to produce a quantitative estimate of krill biomass, a measure of echosounder system performance over time was required. These measures include internal testing as well as by reference to external standards, noting that each would have a different level of uncertainty (Table 6). The

Subgroup discussed a range of approaches to assess echosounder performance and encouraged Members to submit analyses that would investigate uncertainties around these methods.

2.25 The Subgroup agreed that appropriate processes for performing internal validation of the system should, at a minimum, be undertaken at the beginning and end of a fishing trip (Table 6).

2.26 The Subgroup noted that general functionality of a split-beam transducer can be checked by examining the single target distribution in the acoustic beam. For a properly functioning transducer, detected single targets should be distributed randomly across the acoustic beam (Figure 3a). If one or more quadrants of the transducer are malfunctioning, detected single targets may be distributed abnormally in the beam (Figure 3b).

2.27 The Subgroup agreed that the development of alternative methods of calibration was an important aspect of using krill fishing vessels to provide information on the distribution and abundance of Antarctic krill.

2.28 The Subgroup agreed that the seabed S_v along known or repeated transects has the potential to confirm system performance and provide inter-vessel comparisons, including between calibrated and uncalibrated vessels. Data available from the acoustic transects and calibration sites in Figure 2 could be examined for variability in seabed S_v and the Subgroup encouraged Members to undertake such investigations. Furthermore, the Subgroup encouraged the collection of data from these transects and calibration sites by vessels with and without standard sphere calibrated echosounders to provide a means to establish the uncertainty in this method.

2.29 Dr X. Wang (China) presented a segment of flat seabed data at 38 kHz collected on board the *Fu Rong Hai* using a Simrad EK60 echosounder. The seabed S_v was integrated over a grid size of 20 pings, and from the software-detected bottom line to 10 m below. The seabed S_v over ~2 000 pings showed a unimodal distribution ranging from –35.9 to –17.8 dB.

2.30 Dr Cox presented an analysis of seabed S_v from 2 km of calibrated 38 kHz EK60 line transect data exported on a 10-ping by 2 m grid. The echo integration results comprised of 477 cells that fell within the isolated seabed region. The cells had a range of –65.7 to –5.5 dB re 1 m^{-1} and had a bimodal distribution (Appendix E).

2.31 Dr Fielding presented the empirical cumulative distribution function (CDF) of seabed S_v (surface to 4 m below) from all of transect 3.1 of the British Antarctic Survey western core box (transect T5 in Figure 2c) time series from 2012, 2013 and 2014 (Figure 4), and there was a difference between the distributions.

2.32 Dr Skaret presented the preliminary results from a trial carried out by the fishing vessel *Juvel* in 2012. A 2 n mile section of relatively flat bottom close to the main fishing ground north of the South Orkney Islands was crossed three times repeatedly at ca. 10 knots even speed using a ping rate of 2.5 sec^{-1}. Bottom integration from detected bottom down to 5 m below the bottom was compared at frequencies of 38, 70 and 120 kHz from three repeated runs and indicated close agreement on all frequencies (Figure 5).

2.33 The Subgroup thanked those scientists who presented analyses on seabed S_v and agreed that this approach showed substantial potential and encouraged further development, including sensitivity analyses of each technique, including, inter alia, examining data from repeat transects, seabed topography (e.g. slope, flat area) and type, and integration grid dimensions.

2.34 Dr Cox also presented an analysis technique enabling the comparison of seabed acoustic returns from two vessels that may facilitate inter-vessel calibration. The technique maps the empirical cumulative distribution function from each vessel so that mean S_v values can be standardised between vessels and is based on the technique presented in Cox et al. (2010). The Subgroup agreed that this presented a promising method to inter-calibrate two vessels once a suitable seabed analysis method was identified and agreed that this process would be facilitated by vessels undertaking these transects with the parameter settings (e.g. power setting and pulse duration specific) as described in Appendix F.

2.35 The Subgroup recommended that the role of seabed as external reference target for calibration be the focus of intersessional work leading to the SG-ASAM meeting in 2015.

Acoustic data analysis protocols

Noise removal algorithms

2.36 The Subgroup recalled the previous discussion on removing interference from other acoustic instrumentation (SC-CAMLR-XXXI, Annex 4, paragraph 2.28). However, it was recognised that there may be operational requirements which prevent noise sources from being removed or switched off. Therefore, the development of noise removal algorithms is important to ensure the maximum utility of the acoustic data collected.

2.37 Dr Wang presented work on noise reduction on acoustic recordings from the fishing vessel *Fu Rong Hai*, which had severe interference noise from other acoustic instruments. Different noise reduction algorithms from the software package Echoview were used in combination for noise removal in several steps, including S_v thresholding and use of erosion, dilation and median filters. Noise occurring in several consecutive pings was particularly difficult to filter out. Dr Wang had further investigated the effect of S_v thresholding on echo integration by looking at the sensitivity in the CCAMLR S_v dB difference method for krill identification to varying S_v thresholds. While no effect was seen when using a low threshold, a higher threshold had an effect but only on the weak targets.

2.38 The Subgroup thanked Dr Wang for this interesting presentation, and Dr Cox suggested that delineation and isolation of swarms as regions in Echoview could be used to exclude the areas where noise was still present. It was also suggested that once templates for noise reduction have been established, it could be possible to work directly with manufacturers of acoustic software to implement general procedures for noise removal.

Data processing software

2.39 Dr Skaret summarised SG-ASAM-14/02 Rev. 1, which evaluated the suitability of LSSS for inspection and processing of data from krill fishing vessels. The software is designed for efficient processing of large quantities of acoustic data and may therefore be a useful tool for handling acoustic data from the krill fishing fleet.

2.40 The Subgroup noted that an efficient tool for display and easy extraction of relevant parts of a dataset would be required in future CCAMLR work on acoustic data from the fisheries. It was acknowledged that different Members are likely to use different software systems and that the comparison of these systems using common datasets should be undertaken.

2.41 The Subgroup agreed that there is a need to develop standard data analysis protocols and that this has been identified as part of the future work of the Subgroup (Figure 1).

Acoustic data from fishing vessels

2.42 Dr K. Abe (Japan) presented an analysis of the acoustic data from the Japanese-flagged fishing vessel *Fukuei Maru* during krill fishing operations in Subarea 48.1 in 2011/12 (SG-ASAM-14/03 Rev. 1). The vessel was operating a 38 kHz Simrad ES60 echosounder and data were collected for more than two months in that subarea.

2.43 The Subgroup noted that this work provided important insight into fishing activities, including movement patterns of a fishing vessel between different fishing locations (Figure 6). The Subgroup agreed that the provision of such data could potentially be used to define transects which link different fishing grounds and which could be undertaken as standard transects.

Recommendations to the Scientific Committee

3.1 The Subgroup recognised that any vessel with a functioning echosounder had the potential to collect acoustic data and associated metadata required to provide information on the distribution and abundance of krill. The Subgroup further recognised that the level of confidence that could be attached to the products derived from that data will depend on the calibration of the echosounder and the survey design used. The Subgroup agreed that vessels with calibrated echosounders conducting appropriately designed surveys and with appropriate analysis protocols provided the greatest accuracy and precision in biomass estimates, however, these surveys were typically conducted over a short time period relative to the fishery. Therefore, while the data collected from fishing vessels may be of lower precision, it may be available over greater spatial and temporal scales.

3.2 Specific advice to the Scientific Committee is summarised below, and the body of the report leading to these paragraphs should also be considered:

- proof of concept (paragraph 2.5)
- protocols for data collection (paragraph 2.9)
- echosounder performance (paragraph 2.35).

Adoption of report

4.1 The report of the meeting was adopted.

Close of the meeting

5.1 In closing the meeting, the Co-conveners thanked all participants for their contributions to the work of SG-ASAM and for the detailed discussions which had resulted in the further development of protocols for using fishing-vessel-based acoustic data. Dr Watkins also thanked Dr Zhao and Dr X. Jin (Director General, YSFRI) for the excellent meeting facilities and their generous hospitality. The Subgroup thanked Drs Watkins and Zhao for co-convening the meeting.

References

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Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan and E.J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep.*, 144: 69 pp.

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Table 1: Echosounder make and frequency, and fishing activity (to March 2014) of vessels notified to fish in the krill fishery in Subareas 48.1, 48.2, 48.3 and 48.4 in 2013/14. Participation in SG-ASAM's proof of concept and submission of acoustic data or echograms is indicated.

Notified vessel		Echosounder make	Frequency (kHz)	Activity this season (to March)	SG-ASAM proof-of-concept submission
Member	Vessel name				
Chile	*Betanzos*	Simrad ES60	38	Fishing	Data provided
	Cabo de Hornos	-		No activity reported	-
	Diego Ramírez	-		No activity reported	-
	Ila	-		No activity reported	-
China	*An Xing Hai*	Furuno FCV1200L*		Not licensed in 2013/14	-
	Fu Rong Hai	Simrad EK60	38, 70, 120	Fishing	Data provided
	Kai Li	Furuno FCV-140, MU101-C*		Fishing	-
	Kai Yu	Simrad ES60	38, 120	Fishing	-
	Lian Xing Hai	Furuno FCV1200L*		Not licensed in 2013/14	-
	Long Teng	Furuno FCV1200L*		Fishing	-
Korea, Republic of	*Adventure*	Simrad ES60	38	Replaced by *Sejong*	Data provided (2012/13)
	Sejong	Simrad ES70	38, 200	Fishing	Data provided
	Insung Ho	JRC JFV-130, Furuno FCV-161ET**	28, 50	Fishing	-
	Kwang Ja Ho	Simrad ES70	38, 120	Fishing	Data provided
Norway	*Antarctic Sea*	Simrad ES60	38, 120	Fishing	-
	Juvel	Simrad ES60	38, 70, 120	Fishing	Data provided
	Saga Sea	Simrad ES60	38, 120	Fishing	Data provided
Poland	*Alina*	-		No activity reported	-
	Sirius	-		No activity reported	-
Ukraine	*More Sodruzhestva*	Simrad ES70	70	No activity reported	Echogram provided (2012/13)

* Data storage not available. ** Data storage not available, Simrad echosounder expected to be installed in 2014/15.

Table 2: Positions (dd mm.00) of the start and end of acoustic transects in Subareas 48.1, 48.2 and 48.3. See also Figure 2.

Subarea	Transect	Start position		End position	
		Longitude	Latitude	Longitude	Latitude
48.1	T1	63°00.00'W	62°15.00'S	62°00.00'W	62°45.00'S
	T2	62°30.00'W	62°00.00'S	61°30.00'W	62°30.00'S
	T3	62°00.00'W	61°45.00'S	61°00.00'W	62°15.00'S
	T4	61°30.00'W	61°30.00'S	60°00.00'W	62°15.00'S
	T5	61°00.00'W	61°15.00'S	59°30.00'W	62°00.00'S
	T6	60°30.00'W	61°00.00'S	59°00.00'W	61°45.00'S
	T7	58°30.00'W	60°00.00'S	58°30.00'W	61°30.00'S
	T8	57°30.00'W	60°00.00'S	57°30.00'W	61°45.00'S
	T9	57°00.00'W	60°00.00'S	57°00.00'W	61°45.00'S
	T10	56°30.00'W	60°00.00'S	56°30.00'W	61°45.00'S
	T11	55°45.00'W	60°00.00'S	55°45.00'W	61°45.00'S
	T12	55°00.00'W	60°00.00'S	55°00.00'W	61°03.00'S
	T13	54°30.00'W	60°00.00'S	54°30.00'W	61°45.00'S
	T14	54°00.00'W	60°00.00'S	54°00.00'W	61°03.00'S
	T15	61°30.00'W	63°00.00'S	60°30.00'W	63°30.00'S
	T16	60°30.00'W	63°00.00'S	59°30.00'W	63°30.00'S
	T17	60°00.00'W	62°45.00'S	59°00.00'W	63°15.00'S
	T18	59°30.00'W	62°30.00'S	58°30.00'W	63°00.00'S
	T19	58°30.00'W	62°30.00'S	57°30.00'W	63°00.00'S
	T20	58°00.00'W	62°15.00'S	57°00.00'W	62°45.00'S
	T21	57°24.00'W	62°00.00'S	56°30.00'W	62°30.00'S
	T22	56°00.00'W	62°00.00'S	56°00.00'W	62°45.00'S
	T23	55°00.00'W	61°12.00'S	55°00.00'W	63°00.00'S
	T24	54°00.00'W	61°18.00'S	54°00.00'W	62°45.00'S
48.2	T1	48°30.00'W	59°40.20'S	48°30.00'W	62°00.00'S
	T2	47°30.00'W	59°40.20'S	47°30.00'W	62°00.00'S
	T3	46°30.00'W	59°40.20'S	46°30.00'W	62°00.00'S
	T4	45°45.00'W	59°40.20'S	45°45.00'W	60°28.80'S
	T5	45°00.00'W	59°40.20'S	45°00.00'W	60°36.60'S
	T6	44°00.00'W	59°40.20'S	44°00.00'W	62°00.00'S
	T7	45°45.00'W	60°42.00'S	45°45.00'W	62°00.00'S
	T8	45°00.00'W	60°58.80'S	45°00.00'W	62°00.00'S
48.3	T1	39°36.14'W	53°20.83'S	39°23.51'W	54°03.32'S
	T2	39°18.25'W	53°18.94'S	39°05.34'W	54°01.40'S
	T3	39°02.29'W	53°17.22'S	38°49.14'W	53°59.64'S
	T4	38°45.05'W	53°15.31'S	38°31.61'W	53°57.70'S
	T5	38°26.94'W	53°13.25'S	38°13.22'W	53°55.61'S
	T6	38°08.42'W	53°11.11'S	37°54.40'W	53°53.42'S
	T7	37°57.86'W	53°09.85'S	37°43.67'W	53°52.15'S
	T8	37°49.93'W	53°08.90'S	37°35.62'W	53°51.19'S
	T9	36°15.62'W	54°05.73'S	35°15.19'W	53°41.49'S
	T10	36°10.50'W	54°10.35'S	35°09.80'W	53°46.26'S
	T11	36°04.15'W	54°15.94'S	35°03.05'W	53°51.92'S
	T12	35°57.60'W	54°21.02'S	34°57.42'W	53°56.79'S
	T13	35°54.68'W	54°24.11'S	34°53.74'W	53°59.99'S
	T14	35°48.65'W	54°29.60'S	34°47.35'W	54°05.35'S
	T15	35°43.98'W	54°33.43'S	34°42.54'W	54°09.38'S
	T16	35°38.65'W	54°38.34'S	34°36.98'W	54°14.02'S
	T17	35°33.94'W	54°42.22'S	34°32.50'W	54°18.15'S
	T18	35°29.00'W	54°46.67'S	34°26.85'W	54°22.33'S

Table 3: Additional instrument information required at the time of submitting the annual fishery notification.

Vessel name	
Vessel call sign	
Transducer information	
Frequency	
Type	
Serial number	
Transducer depth	
Diagram/photograph of transducer arrangement	
Manufacturer's calibration sheet	
Logging system information	
EK60/ES60/ES70 software version	

Table 4: Metadata required when running specified transects.

Vessel name	
Vessel call sign	

Instructions
Set logging system to UTC
Set instrument settings according to vessel-specific table
Turn off all other acoustic instruments where possible
Do not vary any parameters during a transect
Ship speed stable around 10 knots

Transect number	**Start date/time (UTC)**	**End date/time (UTC)**	**CCAMLR transect identifier**	**Sea state at start of transect**	**Wind direction at start of transect**	**Other remarks**

Table 5: Instrument setting for running specified transects.

Vessel name					
Vessel call sign					
Settings to use for running specified transects					
Frequency:	kHz:	38	70	120	200
Power settings*	W	* Will change dependent on beam width			
Pulse duration	microsecond	1024	1024	1024	1024
Ping interval	second	2	2	2	2
Data collection range (min.–max.)	m	0–1000	0–1000	0–1000	0–1000
Bottom detection range (min.–max.)	m	5–1000	5–1000	5–1000	5–1000
Display range (min.–max.)	m	0–1000	0–1000	0–1000	0–1000

Table 6: At-sea processes for determining echosounder performance. Grey shading denotes that further work and specification of the method is required.

	Internal validation			External validation	
	Transceiver system test	Transducer impedance measurement	Single target detection distribution	Calibration using bottom integration	Calibration using standard sphere
Purpose	To monitor basic system performance			To calibrate against known standard	
Method	Using internal test signal available in some Simrad echosounders	Development required by Subgroup	Distribution of single targets within beam used to assess transducer functionality	Vessel calibration either stationary or under way using seabed volume backscattering strength as derived standard	Stationary vessel using suspended target spheres as known calibration standard
How often	Minimum of beginning and end of fishing season			At least once each season	When possible, required for designed surveys
References	Simrad manual, Appendix D		See paragraph 2.26	See paragraphs 2.28 to 2.35	Foote et al., 1987

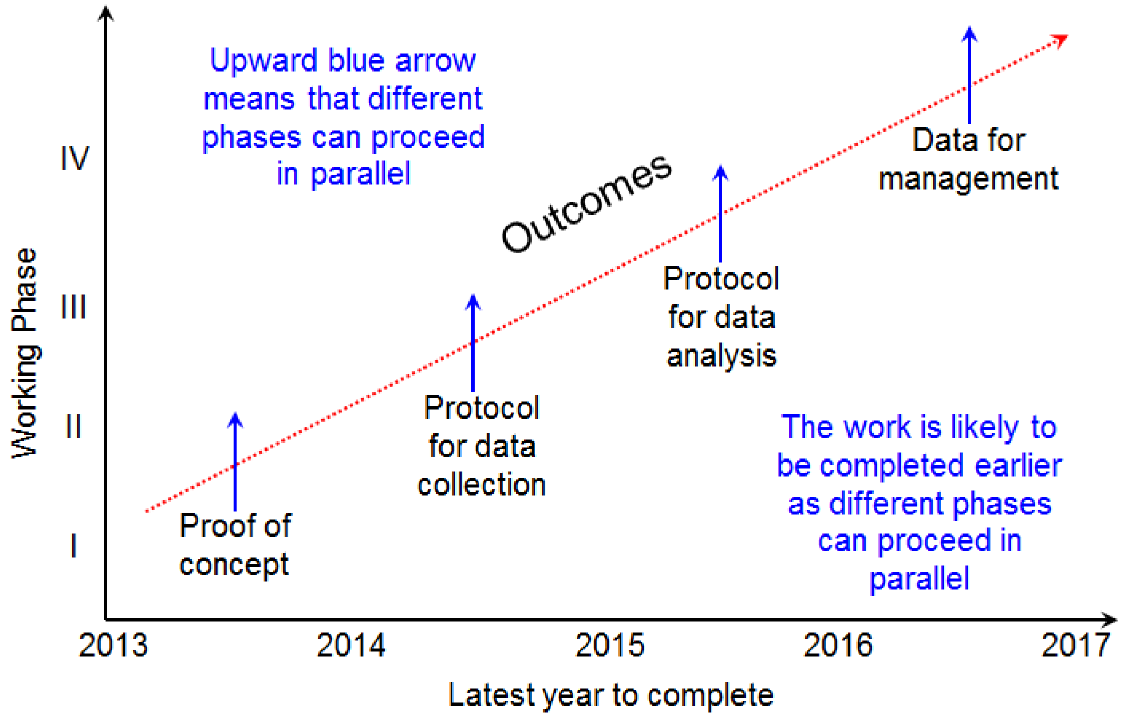

Figure 1: Road map towards the full utilisation of acoustic data collected from fishing vessels.

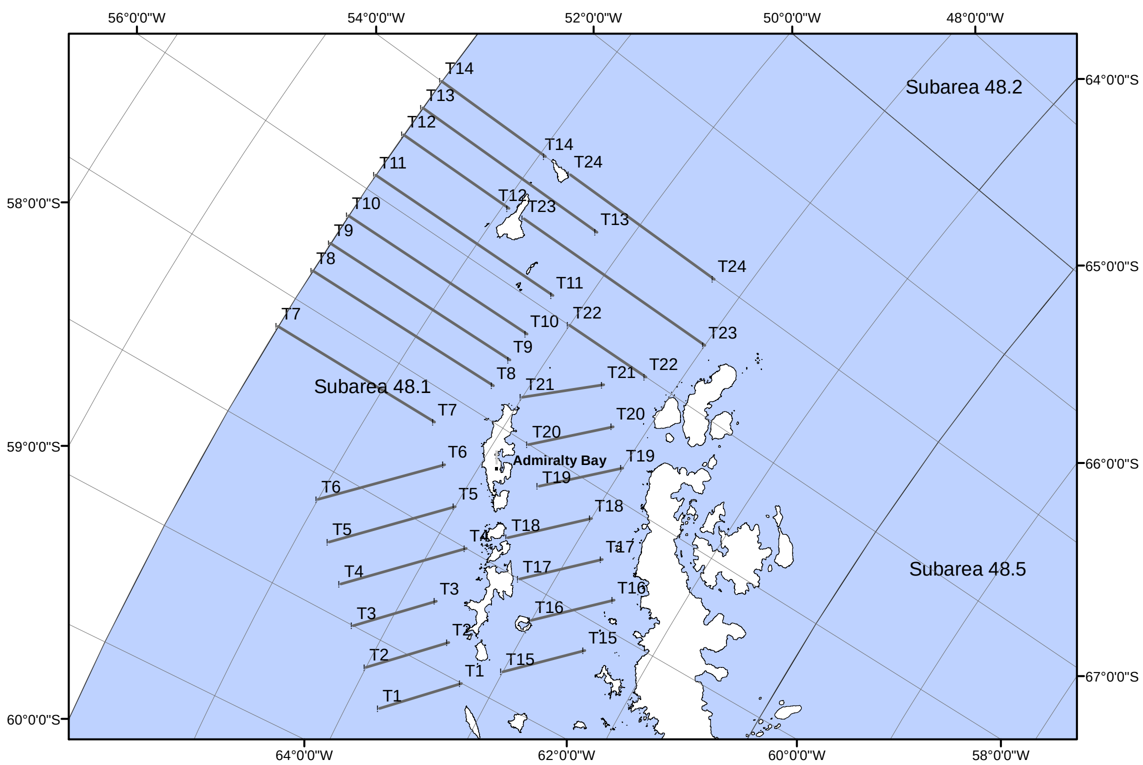

Figure 2(a): Location of acoustic transects (T1 to T24) and the calibration site (Admiralty Bay) at the South Shetland Islands (Subarea 48.1). The positions of the start and end of the transects are listed in Table 1.

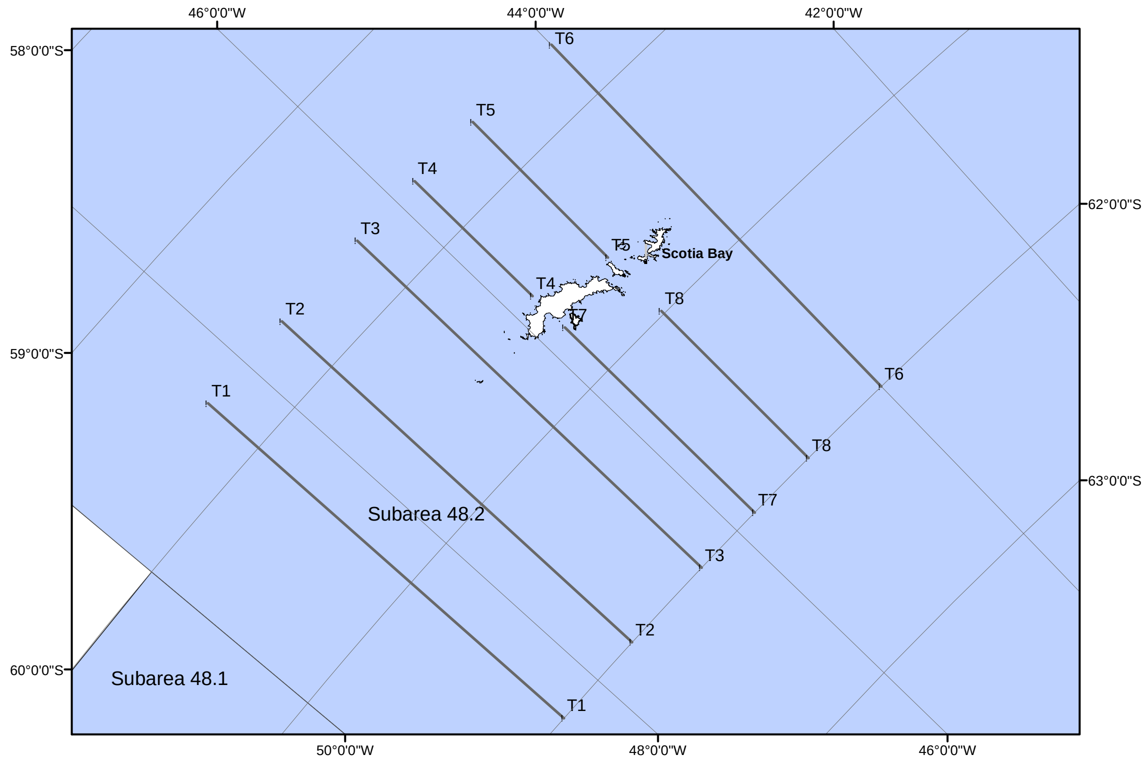

Figure 2(b): Location of acoustic transects (T1 to T8) and the calibration site (Scotia Bay) at the South Orkney Islands (Subarea 48.2). The positions of the start and end of the transects are listed in Table 1.

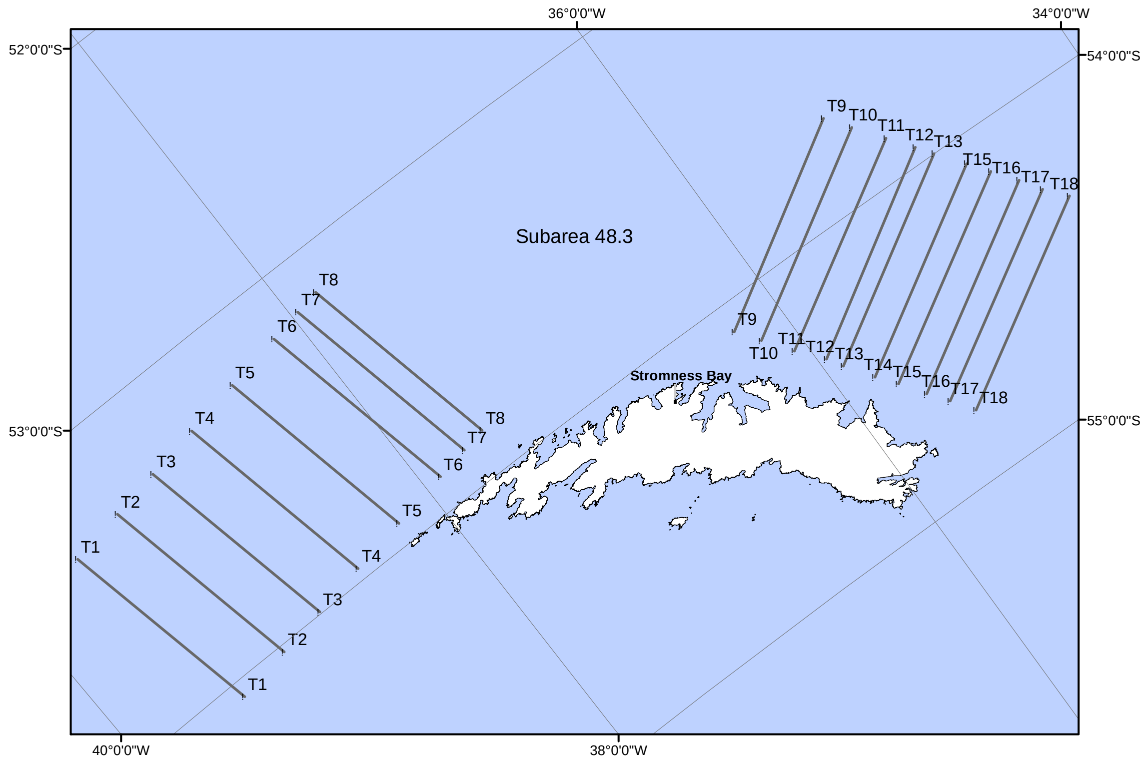

Figure 2(c): Location of acoustic transects (T1 to T18) and the calibration site (Stromness Bay) at South Georgia (Subarea 48.3). The positions of the start and end of the transects are listed in Table 1.

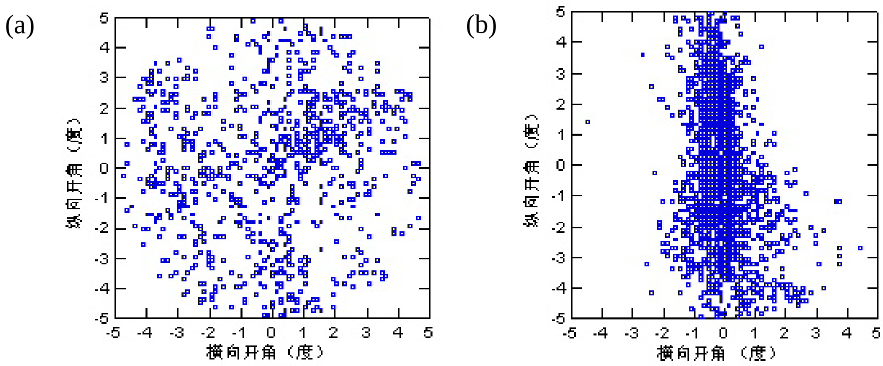

Figure 3: Distribution of detected single targets in the acoustic beam. X-axis: athwartship off-axis angle (°); y-axis: alongship off-axis angle (°); (a): from a properly functioning transducer, (b): from a malfunctioning transducer.

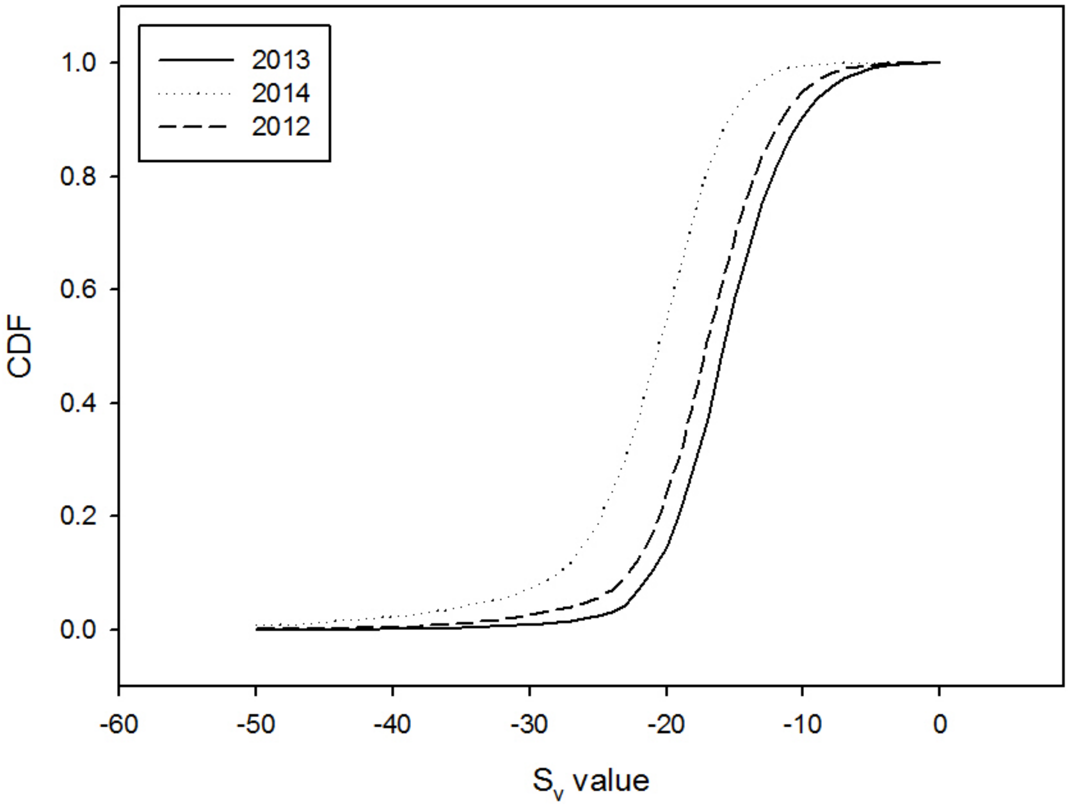

Figure 4: Cumulative distribution function of seabed S_v (dB) from Transect 3.1 of the British Antarctic Survey western core box (transect T5 in Figure 2c) time series (2012, 2013, 2014).

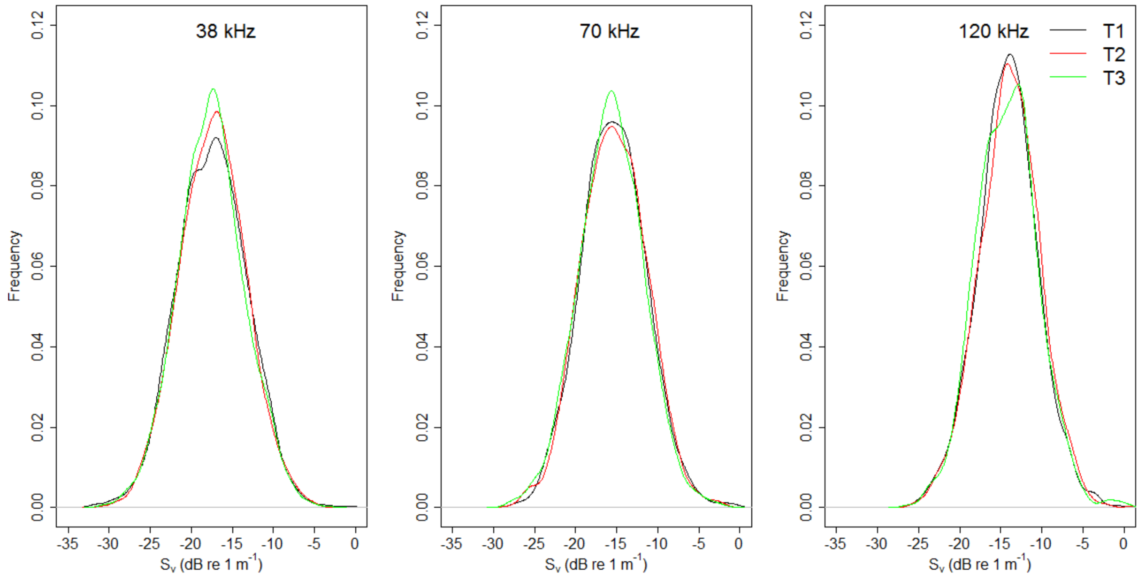

Figure 5: Distribution of acoustic volume backscattering strength (S_v) from bottom integration using repeat transect data from the fishing vessel *Juvel* running three frequencies (38, 70 and 120 kHz). The PDF plots are based on single pings (N~1700) and three repetitions (T1, T2 and T3) of a ca. 2 n mile transect over a relatively flat bottom.

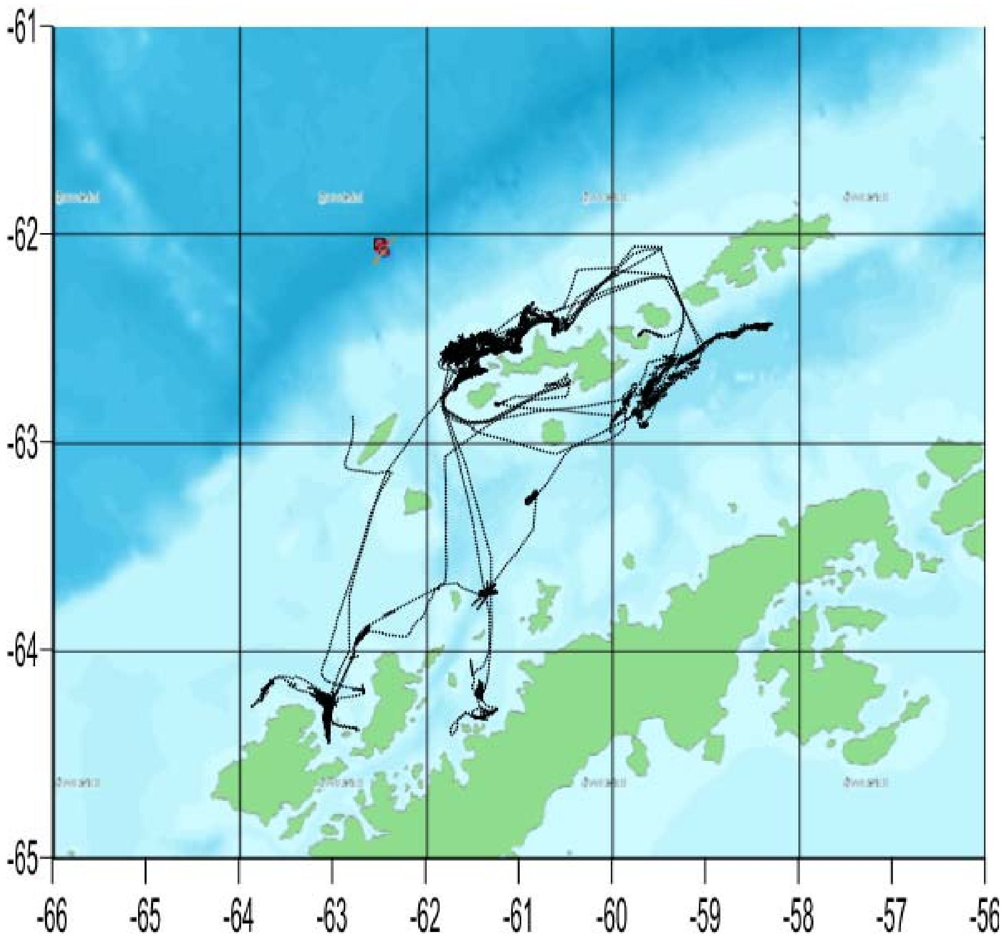

Figure 6: Location of the fishing vessel *Fukuei Maru* during krill fishing and collection of acoustic data in Subarea 48.1 in 2011/12.

List of Participants

Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 8 to 11 April 2014)

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Appendix B

Agenda

Meeting of the Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 8 to 11 April 2014)

1. Introduction

2. The scientific use of acoustic data collected on fishing vessels targeting krill

   2.1 Review acoustic data submitted from fishing vessels as part of the Proof of Concept
      - 2.1.1 What data have been submitted? – recalling the request for digital data geo-referenced and time-referenced with associated instrument metadata suitable for evaluation of data quality

   2.2 Development of protocols for data screening and analysis of acoustic data collected from fishing vessels
      - 2.2.1 Comparison of noise removal algorithms
      - 2.2.2 Degree of specification and standardisation required in noise removal and other processing steps
      - 2.2.3 What acoustic analysis protocols are needed to be put in place?
      - 2.2.4 Consider, and develop if required, a standard protocol (templates) for packages such as Echoview and LSSS (are there open-source options?)
      - 2.2.5 Survey statistics

   2.3 Routine data analysis, management and storage (CCAMLR, SONA, IMOS)

3. Assessment of the effectiveness of current CCAMLR acoustic analysis protocol

   3.1 How well is this working, is it being applied consistently and correctly?
   3.2 Is there a need for any updates or modifications?

4. Consideration of new methods or procedures submitted to SG-ASAM

5. Recommendations to the Scientific Committee

6. Adoption of report

7. Close of meeting.

Appendix C

List of Documents

Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 8 to 11 April 2014)

SG-ASAM-14/01	Collection, processing and potential use of sonar data from krill fishing vessels G. Skaret (Norway) and M.J. Cox (Australia)
SG-ASAM-14/02 Rev. 1	Background for evaluation of the suitability of the software suite Large Scale Survey System (LSSS) for inspection and processing of acoustic data from krill fishing vessels G. Skaret and R.J. Korneliussen (Norway)
SG-ASAM-14/03 Rev. 1	Report of acoustic survey of Antarctic krill using FV *FUKUEI-MARU* K. Abe, Y. Takao and T. Ichii (Japan)

Appendix D

Draft instruction documentation on instrument setup
Simrad ES60 Open-ocean data logging

This set of instructions describes how to set up the Simrad ES60 38 kHz 7° beamwidth echosounder to record data during acoustic transects.

System requirements

- Simrad ES60 running software versions 1.4.xx or higher
- USB external hard drive
- Keyboard with Windows button (only very old keyboards would not have this key)
- Mouse attached to ES60 PC
- GPS connected to the ES60

System settings

- Set data to log to a folder on the external USB hard drive
- Set power to 2 000 W; Pulse length to 1.024 ms
- Set display range: 0–1 000 m
- Set bottom detection range from 5 to 1 000 m
- Set ES60 PC clock to UTC and reset against GPS time source
- Log data from port to port

If you are unsure how to adjust any of these settings, details on how to set them up are given below in steps 1 to 6.

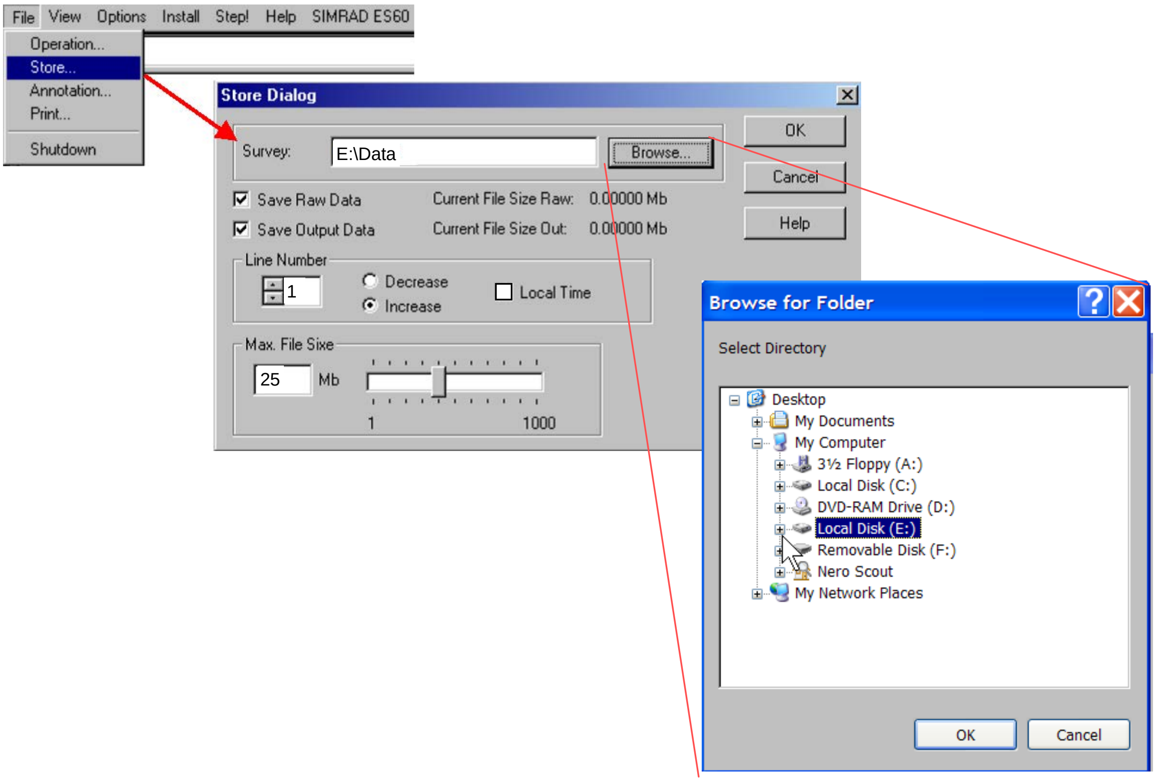
A word of thanks

The areas that fishing vessels work in, and the transits to get there, give a unique opportunity to collect data. The information collected is forming part of a valuable dataset that is helping us to better understand the krill fishery.

Thank you for taking the time to record this data.

1. Set logging directory

On the very top left-hand side of the ES60 screen, click File/Store and then the Browse button to navigate to the externally attached hard drive and select a suitable folder for the logged data. Set the file size to 25 MB and uncheck the box that says ‘Local time’.



Tip: USB drive letter will not be C and is unlikely to be D, and is probably E on most installations. Supplied drives will most likely have a folder \Data. If so, log to this folder, i.e. E:\Data*.

Tip: If you need to set up a logging directory, hold down the Windows button on the keyboard ( ) and press E. This will bring up Windows Explorer. You can then find your way to the USB hard drive and create a folder to log to.

Tip: Hold down the alt-key and press the Tab button. This will take you back to the ES60 software.

* For ES70 and EK60 recommend that the vessel use the call sign as file suffix to the recorded data.

2. Set Echosounder power and pulse duration

On the top of the ES60 screen, right click on the text ‘38 kHz’ to bring up the transceiver settings dialog. Set the power to **2 000 W** and the pulse length to **1 024 microseconds** and click OK.

3. Set display range

Set the display range from 0 to 1 000 m by right clicking on the right-hand side of the ES60 screen.

4. Set bottom detection range

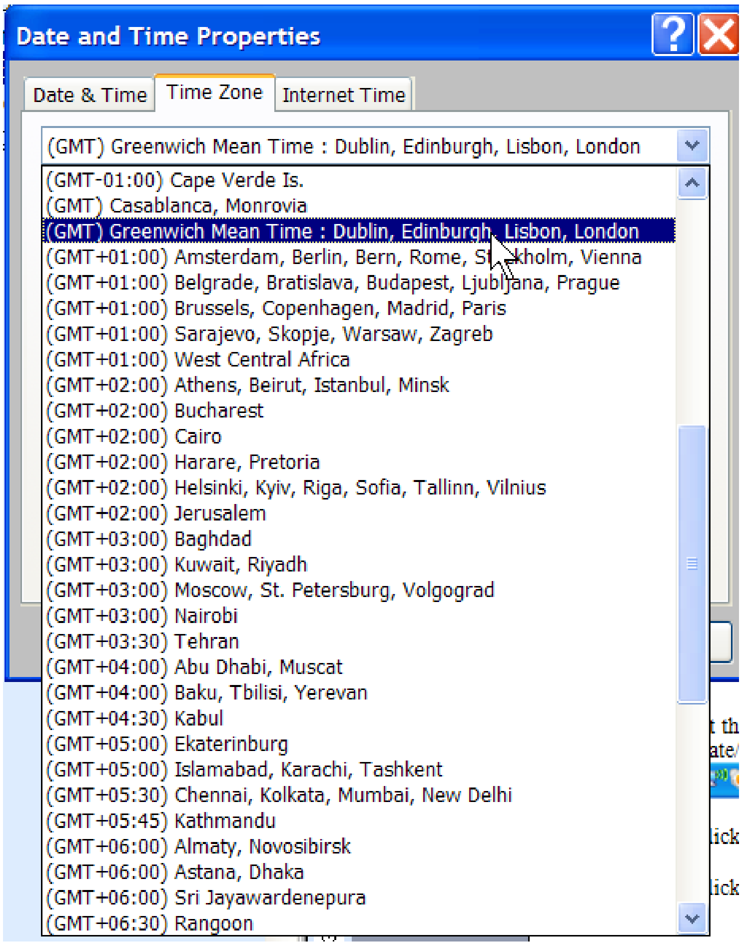
Set the bottom detection to start at 5 m and finish at 1 000 m. Note: if this reading is needed for navigational purposes, the depth setting should be reset.

5. Set the ES60 PC clock to UTC

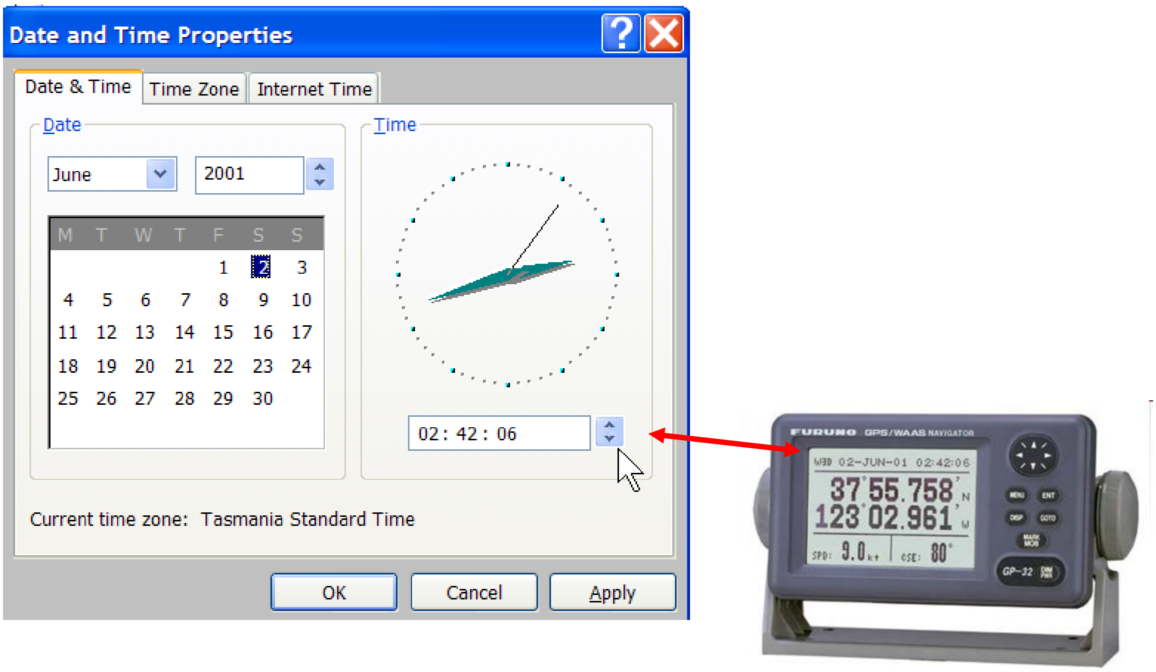
Hold the Windows button ( ) and press M to get to the ES60 PC's desktop.

At the bottom right-hand side of the screen, double click on the time readout to bring up the Date/Time dialog.

Click on the Time Zone tab. Select GMT from the pick list and click OK.

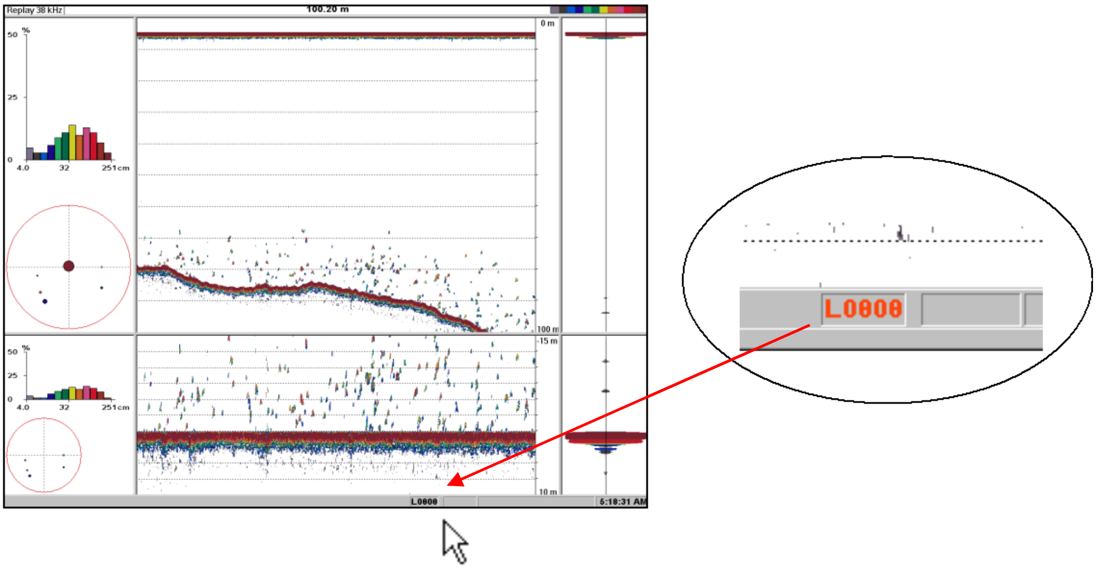


Click on the Date & Time tab. Reset the time to match the UTC time from a GPS readout.



6. Commence logging

Alt-Tab back to the ES60 software. At the bottom right-hand side, click on the text ‘L000..’. This should turn from black to red to indicate logging has commenced.



Turn off other sounders when logging in transects to avoid unwanted interference.

Tip: Log from port to port. This avoids the risk of forgetting to turn logging on when reaching deep water.

An example of determining echosounder system performance by seabed comparison

When the seabed falls within the echosounder sampling range, seabed mean volume backscattering strength can be determined (S_v, UNITS: dB re 1 m^{-1}). In Figure A1, an integration grid has been set up with 10 ping along transect and 2 m vertical cell dimensions. The ‘maximum S_v line pick’ in Echoview v5.4 (Myriax, Australia) was used to find the seabed boundary (Figure E1, seabed line) and offset a second line by 10 m from the seabed boundary line (Figure E1, offset seabed line). The integration grid was referenced to the seabed boundary line.

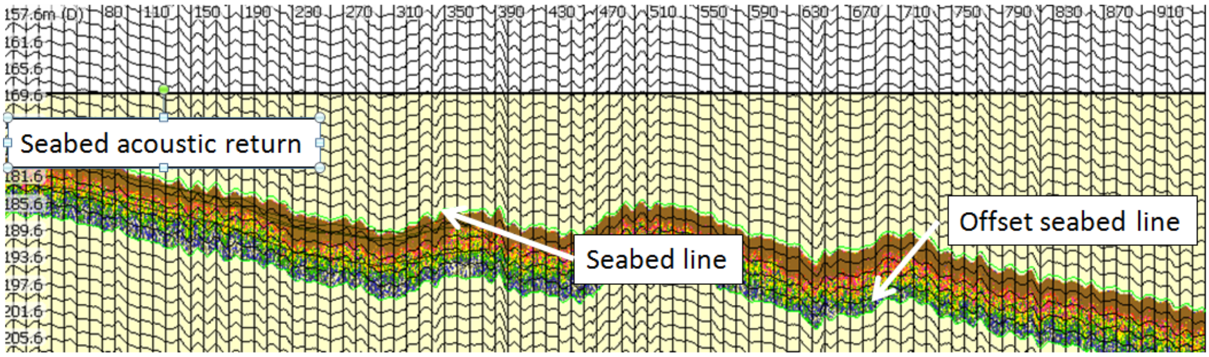


Figure E1: Example seabed echogram from a calibrated EK60 scientific echosounder operating at 38 kHz with a 10 ping by 2 m grid referenced to the seabed line. The echogram display threshold was –80 dB re 1 m^{-1}.

The echo integration results comprised of 477 cells that fell within the isolated seabed region. The cells had a range of –65.7 to –5.5 dB re 1 m^{-1} and had a bimodal distribution (Figure E2).

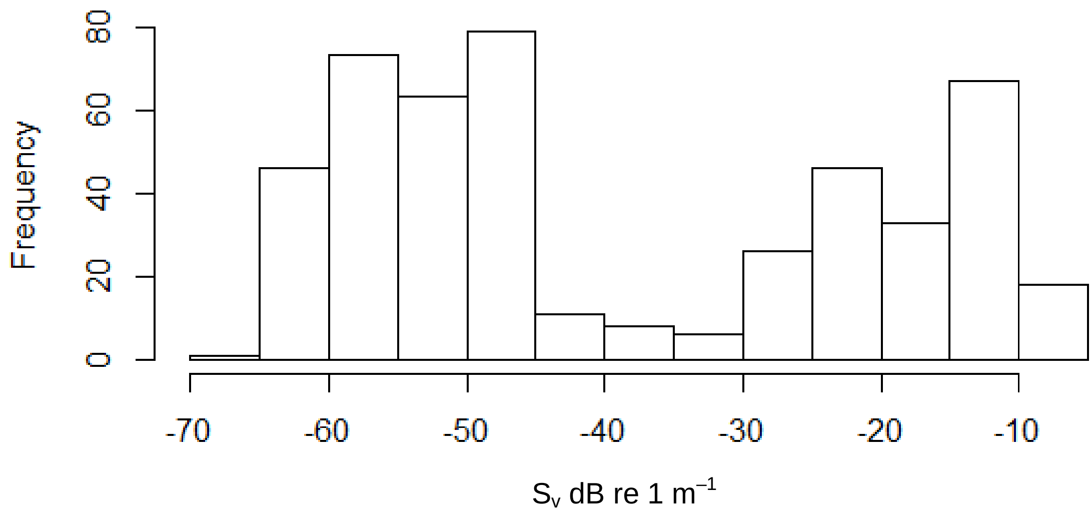


Figure E2: Echo integration results that fell in the seabed region in Figure A1.

As a preliminary investigation into the effect of integration cell size on the distribution of S_v values, the seabed was re-exported, using a 20 ping by 2 m grid. There was no significant difference between the 10 and 20 ping integration intervals (two-sample Kolmogorov-Smirnov test, $D = 0.02$, p-value = 0.9).

Inter-vessel comparison

The seabed returns from two vessels can be compared by mapping each vessel's cumulative frequency distributions onto one another. To illustrate this technique, simulated S_v data have been taken from two vessels (Figure F1). The simulated values were drawn from a normal distribution, with the simulated data from vessel x having mean = –70 dB re 1 m^{-1} and standard deviation 5 dB re 1 m^{-1}, and vessel y having mean = –50 dB re 1 m^{-1} and standard deviation 10 dB re 1 m^{-1}. The 100 random sample histograms in the top row of Figure F1 are the simulated data from each vessel, and the bottom row is the empirical cumulative distribution (ECDF) for the simulated seabed S_v data for each vessel.

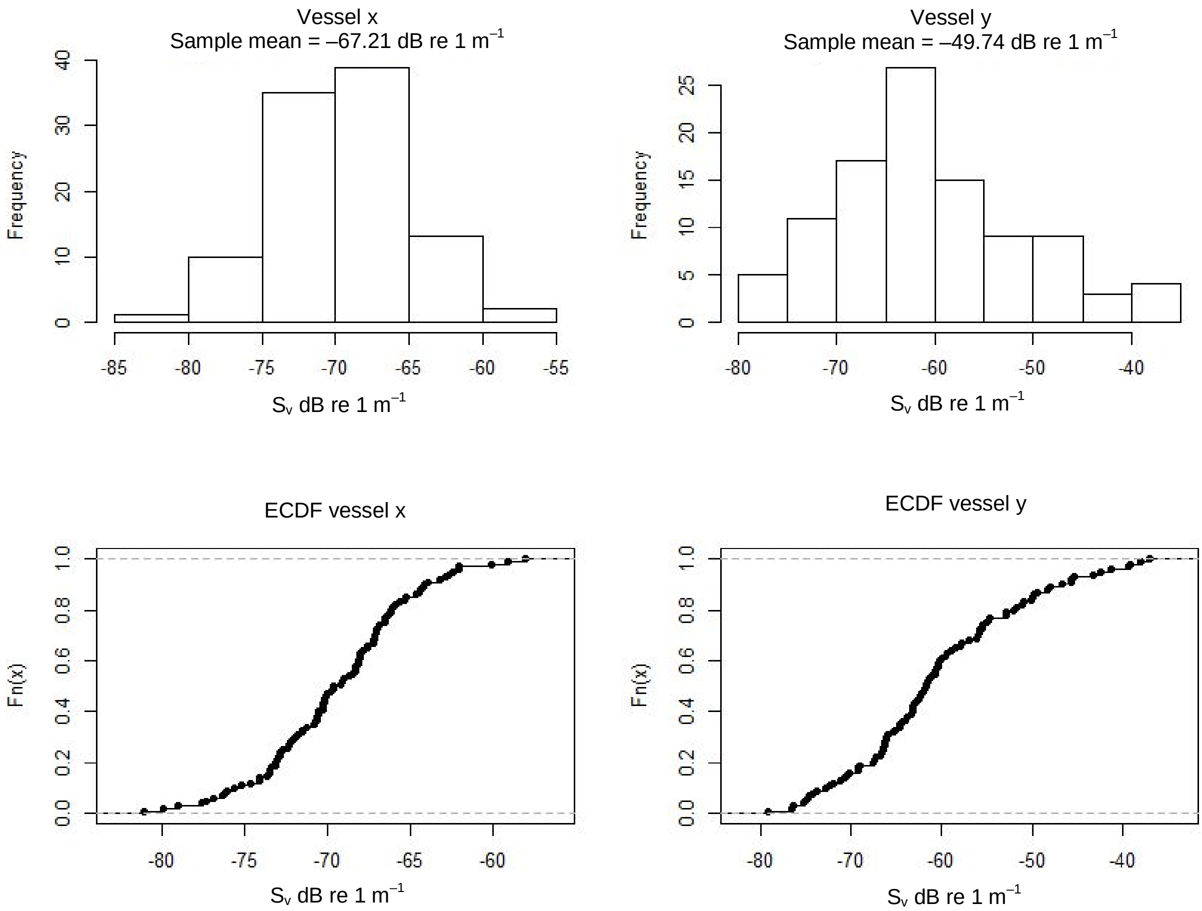


Figure F1: Inter-vessel comparison using seabed returns. Top row is the distribution of simulated S_v data from two vessels and the bottom row is empirical cumulative distribution function for each vessel.

ECDFs for each vessel are then mapped onto one another (solid black line, Figure F2). This mapped line can then be used to transfer S_v values between vessels. This procedure broadly follows that of Cox et al. (2010). Once mapped, the curve can be used to transfer S_v values between vessels. In Figure F2, S_v = –70 dB re 1 m^{-1} from vessel x is transferred to vessel y, resulting in transferred S_v = –63 dB re 1 m^{-1}. Uncertainty in the ECDF mapping can be represented by resampling the S_v values from each vessel. In Figure F2, the simulated S_v data has been resampled (with replacement) 100 times and the ECDF mapping repeated for each resample (grey lines Figure F2).

The R code to carry out the ECDF mapping has been posted on the SG-ASAM e-group.

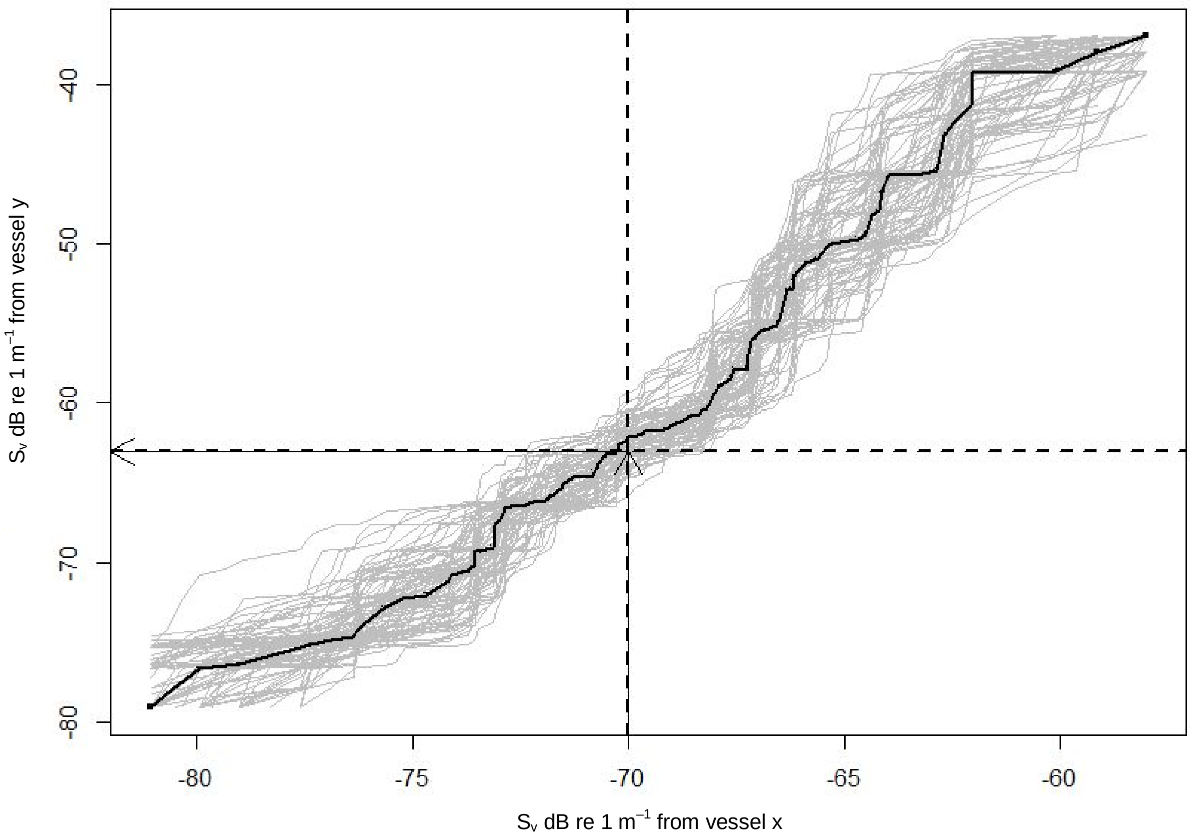


Figure F2: An example of empirical cumulative distribution function mapping. The mapped ECDFs are shown as a solid black line. The dashed lines and arrows illustrate the mapping of S_v = –70 dB re 1 m^{-1} from vessel x to vessel y. The grey lines are the results of mapping ECDF based on resampling the S_v data 100 times.