SC-CAMLR-XXXVI

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE THIRTY-SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
16–20 OCTOBER 2017

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Chair of the Scientific Committee
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Abstract

This document presents the adopted report of the Thirty-sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 16 to 20 October 2017. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Statistics, Assessments and Modelling; Ecosystem Monitoring and Management; Fish Stock Assessment; and the Subgroup on Acoustic Survey and Analysis Methods, are appended.

1031-2889

Contents

Report of the Thirty-sixth
Meeting of the Scientific Committee
(Hobart, Australia, 16 to 20 October 2017)

Opening of the meeting

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met from 16 to 20 October 2017 at the CCAMLR Headquarters in Hobart, Tasmania, Australia. The meeting was chaired by Dr M. Belchier (UK).

1.2 The Chair welcomed to the meeting representatives from Argentina, Australia, Belgium, Brazil, Chile, People's Republic of China (China), European Union (EU), France, Germany, India, Italy, Japan, Republic of Korea, New Zealand, Norway, Poland, Russian Federation (Russia), South Africa, Spain, Ukraine, United Kingdom of Great Britain and Northern Ireland (UK), United States of America (USA) and Uruguay.

1.3 Other Contracting Parties, Bulgaria, Canada, Cook Islands, Finland, Greece, Mauritius, the Netherlands, Islamic Republic of Pakistan, Republic of Panama, Peru and Vanuatu were invited to attend the meeting as Observers, but did not attend.

1.4 The Chair also welcomed to the meeting Observers from intergovernmental organisations the Agreement on the Conservation of Albatrosses and Petrels (ACAP), the Committee for Environmental Protection (CEP), the Scientific Committee on Antarctic Research (SCAR) and the Scientific Committee on Oceanic Research (SCOR) and non-governmental organisations the Association of Responsible Krill harvesting companies (ARK), the Antarctic and Southern Ocean Coalition (ASOC), the Coalition of Legal Toothfish Operators (COLTO) and Oceanites Inc. Apologies were received from COMNAP. The Chair encouraged all Observers to participate in the meeting to the extent possible.

1.5 The List of Participants is given in Annex 1. The List of Documents considered during the meeting is given in Annex 2.

1.6 The Scientific Committee's report was prepared using the CCAMLR meetings server, which allowed rapporteurs and other meeting participants to develop and edit report text, and supported the workflow associated with the translation and production of the meeting report.

1.7 The report of the Scientific Committee was prepared by C. Darby (UK), A. Dunn (New Zealand), I. Forster (Secretariat), O.R. Godø (Norway), S. Grant (UK), E. Grilly (Secretariat), S. Hain (Germany), J. Hinke and C. Jones (USA), D. Maschette (Australia), S. Parker (New Zealand), P. Penhale (USA), K. Reid (Secretariat), C. Reiss (USA), L. Robinson (Secretariat), M. Söffker (UK), S. Somhlaba (South Africa), P. Trathan (UK), G. Watters (USA), P. Yates and P. Ziegler (Australia).

1.8 While all parts of this report provide important information for the Commission, paragraphs of the report summarising the Scientific Committee's advice to the Commission have been highlighted. Contributed statements are indicated in italics.

Adoption of the agenda

1.9 The Scientific Committee discussed the Provisional Agenda which had been circulated as SC CIRC 17/51 prior to the meeting (1 September 2017). The Agenda was adopted without change (Annex 3).

Chair's report

1.10 Dr Belchier noted the significant decisions made by the Commission in 2016, including the agreement to move to 100% scientific observer coverage in the krill fishery, the protection of newly exposed areas due to ice-shelf collapse and the establishment of the Ross Sea region (RSR) marine protected area (MPA), and hoped that the Scientific Committee would maintain this positive momentum.

Scientific Committee's work in the 2016/17 intersessional period

1.11 The following meetings had taken place:

(i) the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) met in Qingdao, China, from 15 to 19 May 2017 (Annex 4) and was convened by Dr X. Zhao (China); 19 participants from 7 Members participated, with 5 papers tabled

(ii) the Working Group on Statistics, Assessments and Modelling (WG-SAM) met in Buenos Aires, Argentina, from 26 to 30 June 2017 (Annex 5) and was convened by Dr S. Parker (New Zealand); 42 participants from 13 Members participated, with 46 papers tabled

(iii) the Working Group on Ecosystem Monitoring and Management (WG-EMM) met in Buenos Aires, Argentina, from 10 to 14 July 2017 (Annex 6) and was convened by Dr M. Korczak-Abshire (Poland); 54 participants from 18 Members participated, with 58 papers tabled

(iv) the Working Group on Fish Stock Assessment (WG-FSA) met in Hobart, Australia, from 2 to 13 October 2017 (Annex 7) and was convened by Dr D. Welsford (Australia); 47 participants from 15 Members participated, with 79 papers tabled

(v) a Workshop on the Scheme of International Scientific Observation (WS-SISO) was held in Buenos Aires, Argentina, from 3 to 7 July 2017 and was convened by Mr J. Clark (EU); 31 participants from 13 Members participated, with 13 papers tabled

(vi) a Ross Sea region MPA Research and Monitoring Plan (RMP) Workshop (WS-RMP-17) was held in Rome, Italy, from 26 to 28 April 2017 and was co-convened by Drs M. Vacchi (Italy), G. Watters (USA) and Mr A. Dunn (New Zealand); 15 Members and 6 Observers participated, with 11 papers tabled.

1.12 Dr Belchier, on behalf of the Scientific Committee, thanked the conveners of SG-ASAM, WG-SAM, WG-EMM, WG-FSA, WS-SISO and WS-RMP-17, and China, Argentina and Italy for hosting these meetings in 2017. He also thanked participants for developing the Scientific Committee's work in 2016/17 and Members for supporting these activities.

1.13 Dr Belchier also thanked the Scientific Committee Vice-chairs and working group conveners for their participation in four intersessional teleconferences during the year that had greatly assisted in intersessional prioritisation and planning. He also noted that the Report of the Second Performance Review (PR2) Panel (PR2 Report) (CCAMLR-XXXVI/01) had suggested formalising this group as a Bureau.

Advances in statistics, assessments, modelling, acoustics and survey methods

Statistics, assessments and modelling

2.1 The Scientific Committee reviewed advice from WG-SAM (Annex 5) concerning two main areas of work:

(i) the estimation of local biomass in research blocks, including the uncertainty associated with those estimates

(ii) the review of fishery research survey plans.

2.2 In addition, WG-SAM also considered papers on the development and progress of integrated assessments, future work and other business.

2.3 The Scientific Committee noted advice from WG-SAM regarding the developments towards an integrated assessment of krill in Subarea 48.1 (Annex 5, paragraphs 2.1 to 2.5) and endorsed WG-SAM's advice on improvements to toothfish (Annex 5, paragraphs 2.7 to 2.18) and icefish stock assessments (Annex 5, paragraphs 2.19 to 2.22).

2.4 The Scientific Committee noted progress on methods for the estimation of local biomass in research blocks. The Scientific Committee endorsed the proposed changes to the catch per unit effort (CPUE) by seabed area method for using:

(i) vulnerable biomass from the reference area
(ii) only the open small-scale research units (SSRUs) in the estimation of the reference Ross Sea seabed area.

2.5 The Scientific Committee noted that many issues discussed by WG-SAM, particularly regarding the review of research plans, had been taken up by WG-FSA and are further considered under subsequent agenda items and in the report of WG-FSA (Annex 7).

Acoustic survey and analysis methods

2.6 The 10th meeting of SG-ASAM was held at the Qingdao National Laboratory for Marine Science and Technology (QNLM), Qingdao, China, from 15 to 19 May 2017.

2.7 The Scientific Committee noted the body of work produced by SG-ASAM that has become critical to developing the utility of fishing vessel data for inclusion in management decision processes. The Scientific Committee also thanked the Myriax company for providing a number of 'dongles' for the use of SG-ASAM to allow for the processing and investigation of acoustic data during the SG-ASAM meeting, and noted that 19 participants from seven countries were represented at this meeting, indicating the broader engagement of Members in these issues.

2.8 The Scientific Committee recognised that CCAMLR has a well-established protocol for krill identification and biomass estimation from scientific acoustic surveys and noted the considerable success of SG-ASAM over the last several years in demonstrating the utility of fishing vessels for collecting acoustic data during fishing operations, and for regional area-based surveys.

2.9 The Scientific Committee further noted that, at present, most technical issues with respect to the collection of acoustic data from fishing vessels have been resolved, but encouraged the continued examination of other acoustic frequencies (e.g. 70 kHz) for the estimation of acoustic biomass, and the automation of this technique further demonstrates the maturity of the technical aspects of the use of these fishing data. The Scientific Committee also noted that the progress made in SG-ASAM is crucial for the development of an operational feedback management (FBM) approach.

2.10 The Scientific Committee considered the advice of SG-ASAM to use the swarm-based approach for krill density estimation from data collected by krill fishing vessels along transects, as well as during fishing operations. It noted that the collection of acoustic data by each vessel in the fishery from at least one nominated transect each month could be useful in understanding seasonal cycles in krill habitat use.

2.11 The Scientific Committee discussed the relative merits of the swarms method and the traditional echo integration method for the determination of krill biomass on fishing grounds or during the sampling of nominated transects. The Scientific Committee agreed that biomass density, which can be calculated using the swarms method, is sufficiently accurate to be used with fishing vessels in the fishing grounds, and included a number of data-processing steps to ensure that data collected and processed using automated techniques would be of high quality.

2.12 The Scientific Committee discussed issues related to the spatial and temporal scales of sampling and how that will inform the development of FBM approaches. The Scientific Committee noted the various spatial scales, from krill hotspots to large scale (i.e. the CCAMLR 2000 Krill Synoptic Survey of Area 48), over which acoustic data are collected, and the utility of these data at these scales for the provision of advice to the Commission. The Scientific Committee also discussed that further development of the use of fishing vessel data will need a more integrated and coordinated approach to the collection of that data.

2.13 The Scientific Committee agreed that the progress made by SG-ASAM is substantial and that future progress in the use of acoustic data will require that WG-EMM or the Scientific Committee deliver a management scheme for the krill fishery that could utilise the data being collected by fishing vessels. Such a scheme could include use of these data in an integrated FBM approach, but that in some cases the data may be directly useful in the interim risk assessment approach approved by CCAMLR. The Scientific Committee noted that in 2019 a joint meeting of SG-ASAM and WG-EMM is scheduled during the WG-EMM meeting to discuss issues regarding the use of the acoustic data collected by fishing vessels.

2.14 Dr S. Kasatkina (Russia) noted that acoustic surveys/observations on board fishing vessels should be aimed at obtaining reliable data on krill biomass dynamics and distribution in subareas and fishing grounds over the whole fishing season. Dr Kasatkina noted that the methodology for acoustic surveys/observations on fishing vessels (calibration of echosounders, formats for data collection) should provide maximum compatibility with the acoustic data provided by scientific research vessels. Moreover, with the lack of data from research vessels, the acoustic data collection on fishing vessels should be considered as a potential source of information on krill distribution in Subareas 48.1–48.3 for developing FBM, in particular, the proposal to use acoustic survey data on fishing vessels for assessment models for krill in Subarea 48.1 (Annex 5, paragraph 2.5).

2.15 Dr Kasatkina noted that, in her estimation, it is scientifically unfounded to focus acoustic surveys conducted on fishing vessels on estimating density indices based on krill swarms delineation. Using Echoview software for acoustic data collection and processing provides raw datasets that can be used to estimate krill density by interval and swarm indices. Dr Kasatkina suggested that data collection on krill swarms must be viewed as part of the analysis of acoustic information obtained on board fishing vessels. Dr Kasatkina also indicated that spatial and temporal variability in the types of aggregated and non-aggregated krill distributions on a fishing ground over the fishing season should be quantified.

2.16 The Scientific Committee noted that the usefulness of the swarm-based approach has been demonstrated by data collected from research vessels in Subarea 48.3 (Fielding et al., 2014) and by data collected from a fishing vessel in Subarea 48.1 (WG-EMM-17/40). The Scientific Committee endorsed the plan of SG-ASAM to conduct comparative studies between the standard interval-integration method and the swarm-based approach (Annex 4, paragraph 6.3).

Harvested species

Krill resources

3.1 The Scientific Committee noted the deliberations related to krill resources that took place at WG-EMM (Annex 6, paragraphs 2.1 to 3.110). It welcomed the wide-ranging discussions that covered important advances in a number of topics. In reviewing these discussions, the Scientific Committee focused on those issues that required a decision.

Krill fishery update

3.2 The Scientific Committee noted an error in paragraph 2.9 in the report of WG-EMM (Annex 6). It clarified that the allocation of the trigger level for Subarea 48.1 (155 000 tonnes as specified in Conservation Measure (CM) 51-07) was not reached until July 2017 (not the trigger level as presented in Annex 6).

3.3 The Scientific Committee noted that fishing for krill had occurred in Subarea 58.4 for the first time since 1996. China reported a catch of 9 tonnes in Division 58.4.1 and 504 tonnes in Division 58.4.2. The Scientific Committee noted that this represented a large change in fishery dynamics relative to recent years, where fishing has occurred exclusively in Area 48.

3.4 The Scientific Committee also noted that catches reported by China were reduced in Area 48 in relation to the previous fishing season. The Scientific Committee sought to understand the reasons for this lower catch, and whether future catches were expected to change, as well as information on what products were being developed from current catches.

3.5 Dr Zhao reported that catches during the 2016/17 season were lower than for the 2015/16 season for multiple reasons, including inherent difficulties in fishing for krill, the presence of salps on fishing grounds that restricted vessel operations, fewer vessels participating in the fishery and diversion of one vessel for exploration of fishing grounds in Subarea 58.4. He added that three Chinese vessels were expected to fish for krill in the coming year in Area 48 and Subarea 58.4. Current catches are used primarily for krill meal for animal feed, krill oil, as well as a small amount for direct human consumption.

Catch reporting for the continuous fishing system

3.6 The Scientific Committee noted the discussion at WG-EMM on catch reporting for vessels utilising the continuous fishing system (Annex 6, paragraphs 2.1 to 2.7). It recognised that the spatial/temporal accuracy of catch reporting for such vessels could be improved and noted that Norway has developed plans to address issues of accuracy (SC-CAMLR-XXXVI/11).

3.7 The Scientific Committee welcomed information from Norway (SC-CAMLR-XXXVI/11) that it intends to improve accuracy by:

(i) designing field studies to measure the delay between krill entering the net and appearing in the holding tank

(ii) calibrating holding tank volume against flow-scale measurements

(iii) investigating possibilities of attaching a quantitative echosounder that continuously measures density in the trawl mouth

(iv) reporting on these issues during WG-EMM-18 and at the Scientific Committee meeting in 2018.

3.8 The Scientific Committee also thanked Norway regarding its intention (SC-CAMLR-XXXVI/11) to analyse historical data in order to address:

(i) variability and accuracy of reported catches with particular focus on potential bias caused by the processing routines aboard the vessel

(ii) impacts on the representation of spatial distribution of catches when merging two-hour reports to four-, six-, eight- and 12-hour catches

(iii) statistical uncertainty associated with the estimated effects of the combination of catches for different time intervals

(iv) spatial displacement of catches using various time lags between the time krill enters the trawl and when the catch appears in the holding tank

(v) comparison of acoustic data recorded during fishing and catch reported by two-hour periods to understand the spatial variability associated with various delays in the reported catches.

3.9 The Scientific Committee recalled that the intent of two-hourly reporting for vessels utilising the continuous fishing system was to emulate the spatial and temporal accuracy of conventional vessels. It agreed that it was not able to identify whether Norwegian vessels utilising the continuous fishing system were compliant with CMs 21-03 and 23-06 and therefore referred the matter to the Standing Committee on Implementation and Compliance (SCIC).

Net monitoring cables

3.10 The Scientific Committee recalled that the use of net monitoring cables may be beneficial for the collection of scientific data associated with actual fishing operations (SC-CAMLR-XXXV, Annex 6, paragraph 2.24) and agreed that if Members wished to trial such systems, a full research proposal, similar to that presented by Norway (WG-FSA-16/38), would be required.

3.11 The Scientific Committee noted that due to logistical difficulties the agreed trials by Norway had not been completed (Annex 6, paragraphs 3.1 to 3.7). Nevertheless, it endorsed the recommendations of WG-EMM (Annex 6, paragraphs 3.4 and 3.6) that trials be continued under the conditions previously agreed (SC-CAMLR-XXXV, paragraphs 4.10 and 4.11).

Risk assessment for krill

3.12 The Scientific Committee welcomed the work from Australia on developing a preliminary risk assessment for the krill fishery for Divisions 58.4.1 and 58.4.2, in response to the reinitiation of commercial krill fishing in this region (Annex 6, paragraphs 3.109 and 3.110). It recognised that the risk assessment framework provided a flexible method for incorporating both quantitative and qualitative data.

3.13 The Scientific Committee noted the difference between model-based and design-based effects on analysis is an area of active discussion in statistics, and noted that the characteristics of different data layers could usefully be reviewed by WG-SAM.

Consideration of ‘swarm-based’ approach in acoustic assessments

3.14 The Scientific Committee considered aspects of the ‘swarm-based’ approach for acoustic assessments (Annex 4), in particular, whether the frequency of the echosounder used has implications for interpreting outputs from the approach.

3.15 The Scientific Committee noted that although there is a ‘dB differencing’ step in the automated procedure for the swarm-based approach, it was retained to enable future applications. At present, the default setting of the dB-difference window is very wide (–20 to 20 dB) so that it is actually ineffective. This makes the swarm-based approach more flexible, so that data from most of those commonly used echosounder frequencies have the potential to be used to provide useful information for fishery management, provided that the echosounders are functioning properly. The Scientific Committee also noted that acoustic estimation may be frequency sensitive, and the current standard frequency for krill biomass estimation is 120 kHz according to the CCAMLR protocol for acoustic surveys, although SG-ASAM is investigating the potential for using 70 kHz (Annex 4, paragraphs 2.16 and 6.6).

3.16 The Scientific Committee agreed that the swarm-based method was a useful approach and encouraged Members to continue data collection from commercial vessels. It requested that SG-ASAM consider further analyses comparing the 'conventional' and swarm-based methods in the context of how CCAMLR might use commercial vessel acoustic data to generate management advice.

Experimental approach to krill fishing

3.17 The Scientific Committee welcomed SC-CAMLR-XXXVI/09 which proposed that WG-EMM evaluate the potential for developing an experimental framework which could be implemented within coastal zones to help study how krill movement and predation interact in the presence and absence of fishing. It noted that such an approach had the potential to help inform management strategies for krill, facilitating understanding of krill retention and replenishment (krill flux). It noted that the approach had the potential to help increase understanding of functional overlap, as well as spatial overlap between krill predators and the fishery.

3.18 The Scientific Committee recognised that an experimental approach would need to consider a variety of krill predators (including seabirds, marine mammals and fish) and that multiple areas and seasons should be considered in order to ensure an ecosystem-centred approach was integral to such a study. It recognised that any experimental framework would need to have clear hypotheses established, including procedures for determining how conclusions were evaluated. The Scientific Committee agreed that any such experimental framework would need to be undertaken in the context of the precautionary approach and that it might be considered in the context of the developing risk assessment framework and FBM for krill.

3.19 The Scientific Committee agreed that acoustic data from fishing vessels can be very useful for management purposes. It noted that when using such data in the design of an experimental framework, distinct differences in the nature of the krill fishery compared with other small-pelagic fisheries that operate further north, would need to be considered.

3.20 The Scientific Committee agreed that an important consideration for WG-EMM would be the need to evaluate sites both within the traditional fishing grounds (e.g. Bransfield Strait, or to the north of Coronation Island), as well as outside these areas.

3.21 The Scientific Committee noted that a considerable amount of work relevant to krill management is under consideration by WG-EMM, including FBM, the krill risk assessment and the Domain 1 MPA proposal for spatial management. The Scientific Committee noted the need to clarify how these approaches would interact and suggested that all strategies could be consolidated into one initiative, as a way of moving forward.

3.22 The Scientific Committee discussed how detailed consideration of a consolidated approach, including an experimental approach, could be integrated into the work plan for WG-EMM, and concluded that it might be undertaken at the planned joint meeting of WG-EMM and SG-ASAM scheduled for 2019. It also recognised that ideas could be progressed during the regular meetings of WG-EMM prior to such a detailed discussion.

Additional approach to feedback management

3.23 The Scientific Committee considered SC-CAMLR-XXXVI/BG/20 which identified an additional approach to FBM for the krill fishery. The proposal focused on regulating krill fisheries, based on changes in the prey-field for land-based predators, as estimated from acoustics recorded on board fishing vessels in relation to model-based requirements of land-based predators from neighbouring colonies. The Scientific Committee welcomed the initiative, noting some similarities to the proposal previously put forward for Subarea 48.2. It therefore encouraged coordination among the various approaches in order to ensure efficient progress towards developing a practical FBM approach, particularly as it relates to the review of CM 51-07, due to expire in 2021.

3.24 The Scientific Committee also considered SC-CAMLR-XXXVI/15 and the suggestion to undertake a new large-scale synoptic survey, recognising that the last such survey was carried out in 2000. It noted the intention of Russia to contribute towards the design and implementation of such a survey, as well as its objective of ensuring such data contribute towards a practical FBM approach (paragraphs 16.1 and 16.2).

3.25 The Scientific Committee noted that the development of an FBM approach would benefit from coordination among Members to advance experimental work to improve understanding of potential impacts of fisheries and predators on krill stocks. Experimental approaches to understand such interactions may also depend on the participation of fishing vessels. The Scientific Committee noted that there is a clear need to engage with the fishery to ensure the necessary coordination to conduct such experiments. The Scientific Committee also recalled several general topics identified by WG-EMM in 2015 (e.g. SC-CAMLR-XXXIV, Annex 6, Tables 2, 3 and 4) that should be addressed to advance an FBM approach.

3.26 The Scientific Committee also recalled that development of an FBM approach could proceed in a step-wise fashion, and that advancing from simple approaches through to more fully developed approaches was appropriate as data and understanding of fishery–predator–krill interactions improve.

ASOC

3.27 The Scientific Committee welcomed a report by ASOC with suggestions for the Scientific Committee to retain a precautionary approach to managing the krill fishery. Those suggestions included:

(i) a new survey to update the CCAMLR-2000 Survey
(ii) a review of the CCAMLR Ecosystem Monitoring Program (CEMP)
(iii) a workshop, to be hosted by ASOC, to advance development of FBM
(iv) an investigation of by-catch of crystal krill (*Euphausia crystallorophias*) in the krill fishery.

3.28 The Scientific Committee thanked ASOC for the report and noted the plans for a large-scale survey (paragraph 13.6), that a review of CEMP would be useful once clear data requirements for an FBM approach were agreed, the proposal for a future workshop on FBM (paragraph 13.8) and the recommendation for expanded reporting of non-target catch in the krill fishery (Annex 6, paragraphs 2.18 and 2.19). The Scientific Committee also noted that work to develop an FBM approach was core work of the Scientific Committee and its working groups, and there would need to be consideration how the proposed ASOC FBM workshop would fit within the work of the Scientific Committee.

Fish resources

3.29 The catch limits agreed by the Scientific Committee for 2017/18 are provided in Table 1 with the details provided in the subsequent paragraphs.

Assessment of fish resources

Champsocephalus gunnari

C. gunnari in Subarea 48.3

3.30 The fishery for mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 operated in accordance with CM 42-01 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 2 074 tonnes. Fishing early in the season was conducted by one vessel using midwater trawls and the total reported catch was 66 tonnes as of 28 September 2017. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.31 The Scientific Committee noted that the updated assessment of *C. gunnari* in Subarea 48.3 was based on the random stratified bottom trawl survey, and that a bootstrap procedure was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this subarea. The bootstrap estimated the median demersal biomass at 91 531 tonnes, with a one-sided lower 95% confidence interval (CI) of 47 424 tonnes. A catch limit of 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19 would ensure at least 75% biomass escapement after a two-year projection period.

Management advice

3.32 The Scientific Committee recommended that the catch limit for *C. gunnari* be set at 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19 in Subarea 48.3.

C. gunnari at Kerguelen Islands (Division 58.5.1)

3.33 The Scientific Committee noted the discussions set out in Annex 7, paragraphs 3.7 and 3.8, relative to the assessment of *C. gunnari* in Division 58.5.1. In particular, it agreed that the CCAMLR decision rule yielded a catch limit of 3 081 tonnes for 2017/18 and 2 753 for 2018/19.

C. gunnari at Heard Island (Division 58.5.2)

3.34 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 561 tonnes. Fishing was conducted by one vessel and the total reported catch up to 28 September 2017 was 523 tonnes. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.35 The Scientific Committee noted the WG-FSA-17 discussions and recommendations set out in Annex 7, paragraphs 3.9 to 3.12. An updated short-term assessment was conducted in a generalised yield model (GYM), using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 901 tonnes of age 1+ to 3+ fish from the 2017 survey and fixed model parameters. Estimates of yield indicate that 526 tonnes of icefish could be taken in 2017/18 and 395 tonnes in 2018/19.

Management advice

3.36 The Scientific Committee recommended that the catch limit for *C. gunnari* be set in 2017/18 at 526 tonnes and at 395 tonnes in 2018/19 in Division 58.5.2.

Issues common to *C. gunnari* assessments

3.37 The Scientific Committee noted a suite of issues common to *C. gunnari* assessments in Annex 7, paragraphs 3.3 to 3.19, and endorsed the recommendation of WG-FSA that a standard set of diagnostic plots and information be included in each of the assessments of *C. gunnari* relating to the survey and assessment. These are set out in Annex 7, paragraph 3.13.

Dissostichus spp.

Dissostichus eleginoides in Subarea 48.3

3.38 The fishery for Patagonian toothfish (*Dissostichus eleginoides*) in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2016/17, the catch limit for *D. eleginoides* was 2 750 tonnes and the total reported removal was 2 192 tonnes. Fishing in the current season finished on 14 September 2017 (www.ccamlr.org/node/75667).

3.39 The Scientific Committee noted Annex 7, paragraphs 3.24 and 3.26, describing updated information used in the assessment and additional priority work on the likelihood profiles from the time series of cohorts of tagged fish.

3.40 The assessment estimated unfished spawning biomass (B_0) at 83 200 tonnes (95% CI: 79 000–88 100 tonnes), spawning stock biomass (SSB) of 42 200 tonnes (38 900−52 600 tonnes) and a stock status in 2017 of 0.51 (0.49–0.53). The long-term catch limit that satisfied the CCAMLR decision rules was 2 600 tonnes.

Management advice

3.41 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Subarea 48.3 be set at 2 600 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

Dissostichus spp. in Subarea 48.4

D. eleginoides in the South Sandwich Islands (Subarea 48.4)

3.42 The fishery for *D. eleginoides* in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. eleginoides* in Subarea 48.4 in 2016/17 was 47 tonnes and 28 tonnes were taken (www.ccamlr.org/node/75667).

3.43 The Scientific Committee noted Annex 7, paragraphs 3.29 to 3.31, describing updated information used in the assessment, migration of *D. eleginoides*, a recommendation of further review of the stock hypothesis and future work.

Management advice

3.44 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Subarea 48.4 be set at 26 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

Dissostichus mawsoni in the South Sandwich Islands (Subarea 48.4)

3.45 The fishery for Antarctic toothfish (*Dissostichus mawsoni*) in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. mawsoni* in Subarea 48.4 in 2016/17 was 38 tonnes, of which 19 tonnes were taken.

3.46 An additional upper catch limit of 18 tonnes was also allocated for an effort-limited survey (WG-FSA-16/40 Rev. 1), of which 17 tonnes were taken (www.ccamlr.org/node/75667).

Management advice

3.47 The Scientific Committee recommended that the catch limit for *D. mawsoni* in Subarea 48.4 be set at 37 tonnes for 2017/18 based on the results of the assessment.

3.48 The catch limit for the UK survey in this subarea is given in paragraph 3.98.

D. eleginoides in Division 58.5.1 inside the French EEZ

3.49 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French exclusive economic zone (EEZ). Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.50 The updated assessment model estimated B_0 at 223 980 tonnes (95% CI: 205 030−245 900 tonnes), with the biomass in 2017 at 143 700 tonnes (123 060–167 030 tonnes). Estimated SSB status was 0.64 (0.60–0.68).

3.51 The Scientific Committee agreed that the catch limit set by France of 5 050 tonnes in 2017/18, which allows for average depredation rates (313 tonnes, based on the average of the estimated depredation from the 2003/04 season to the 2015/16 season), is consistent with the CCAMLR decision rules for the model runs presented.

D. eleginoides in Division 58.5.1 outside the French EEZ

Management advice

3.52 No new information was available on the state of fish stocks in Division 58.5.1 outside areas of national jurisdiction. The Scientific Committee, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

D. eleginoides in Division 58.5.2

3.53 The fishery for *D. eleginoides* in Division 58.5.2 operated in accordance with CM 41-08 and associated measures. Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.54 The Scientific Committee noted Annex 7, paragraphs 3.45 to 3.52, describing updated information used in the assessment, changes in the assessment model structure, and a request that WG-SAM review the impact of the selectivity assumptions on the proportion of cryptic biomass, including its relation to maturity at age. The Scientific Committee further noted that the assessment now includes a parameter that accounts for movement of *D. eleginoides* between Divisions 58.5.1 and 58.5.2.

3.55 The updated assessment model led to a smaller estimate of B_0 than that obtained in 2015, with an estimate of 77 286 tonnes (95% CI: 71 492–84 210 tonnes). Estimated SSB status was 0.61 (0.58–0.64). Despite the smaller biomass, changes to the model compared to 2015, in particular its higher productivity, with the updated maturity parameters, meant that the catch limit that satisfies the CCAMLR decision rules has increased from 3 405 tonnes to 3 525 tonnes.

Management advice

3.56 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Division 58.5.2 be set at 3 525 tonnes for 2017/18 and 2018/19 based on the outcome of this assessment.

D. eleginoides in Subarea 58.6 inside the French EEZ

3.57 The fishery for *D. eleginoides* at Crozet Islands is conducted within the French EEZ and includes parts of Subarea 58.6 and Area 51 outside the Convention Area. Details of this fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.58 The updated assessment model estimated B_0 at 56 810 tonnes (95% CI: 50 750−63 060 tonnes), with the biomass in 2017 at 37 900 tonnes (32 030–44 400 tonnes). Estimated SSB status was 0.67 (0.63–0.70).

3.59 The Scientific Committee agreed that the catch limit set by France of 1 100 tonnes in 2017/18, which allows for average depredation rates (527 tonnes, based on the average of the last three years), is consistent with the CCAMLR decision rules for the model runs presented.

D. eleginoides in Subarea 58.6 outside the French EEZ

Management advice

3.60 No new information was available on the state of fish stocks in Subarea 58.6 outside areas of national jurisdiction. The Scientific Committee, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

New and exploratory finfish fisheries

Research coordination and prioritisation

3.61 The Scientific Committee recalled that PR2 identified the need to focus fish stock research in exploratory fisheries toward investigating stock distribution and productivity, and to coordinate this research within and across related management areas (CCAMLR-XXXVI/01, Recommendation 8i). The Scientific Committee also noted a lack of strategy across some areas in developing research proposals.

3.62 The Scientific Committee considered the feasibility of proposals where individual Members have notified to undertake research in multiple subareas/divisions, since they may not have the capacity to complete milestones of the research when commitments are spread across multiple research programs. It further noted that a track-record of submitting of research outputs to working groups, including data and sample analyses, is an important consideration when evaluating research proposals, in particular, where individual Members have notified to undertake research in multiple areas in the same season.

3.63 Dr Kasatkina emphasised that the priority of scientific programs should be based on their effectiveness. Therefore, clarification is needed on over how many years of the program existence its effectiveness should be assessed, and whether the continuation of the program is possible without an assessment of its effectiveness and data quality. She also noted the necessity to clarify the measure of proponent capacity to complete milestones of multiple research programs.

3.64 The Scientific Committee recommended that priority should be given to the completion of research programs already in place over new research proposals.

3.65 The Scientific Committee requested that the Commission provide advice on its consideration of the progression of activities targeting toothfish across the Convention Area, and guidance on the strategy to be followed.

3.66 Dr R. Werner (ASOC) provided the following statement:

> *'ASOC is concerned about the spread of research and exploratory fishing in the Convention Area and the failure of some research programs to deliver meaningful research outcomes.*
>
> *ASOC shares the concern of WG-SAM that research and exploratory fishing is increasing faster than the data required to evaluate the impacts on stocks. This compromises the ability of the Commission to manage impacts of these activities. The Working Group recognised limitations in the processes for developing research plans in data-poor areas and the reporting of information from this research. WG-FSA recognised that research programs proposed under CM 24-01 needed to clearly describe specific research objectives, as they may be exempt from other conservation measures.*
>
> *We are also concerned that Members conducting research fishing in new areas can reduce future options for spatial protection in these areas before conservation values have been assessed.*
>
> *ASOC welcomes WG-FSA raising the bar on research programs by developing procedures for proposals and reporting on research plans in data-poor fisheries. ASOC also supports the proposals by the USA and the Secretariat to increase the transparency and harmonise research fishing conservation measures.'*

3.67 The Scientific Committee noted CCAMLR-XXXVI/29, which proposed the establishment of an exploratory fishery in Subarea 88.3. The proposal is on the basis that fishing conducted under CM 24-01 is subject to a more limited set of compliance and mitigation requirements than fishing conducted under CM 21-02 (i.e. exploratory fisheries).

3.68 Dr Kasatkina noted that the research plan for Subarea 88.3 proposed by the Republic of Korea and New Zealand for the next three years will provide additional data relating to CM 21-01, paragraph 1, and recommended that the status of the fishery in Subarea 88.3 be revisited after consideration of the materials from this research plan.

3.69 Some Members noted that the objectives of the research and the scale of the catch proposed, as well as the fact that toothfish removals in this subarea have occurred since 1997, indicated regulation of activities under the exploratory fisheries conservation measures would be consistent with CCAMLR's regulatory framework. The Scientific Committee requested that the Commission consider this matter.

3.70 The Scientific Committee also noted CCAMLR-XXXVI/27, which proposed changes to CM 21-02 aimed at harmonising CCAMLR's approach to activities targeting toothfish. The Scientific Committee noted similarity in the objectives of fishing activities conducted under CMs 21-02 and 24-01, and that WG-SAM and WG-FSA conduct reviews of these proposals in the same way.

Evaluation of research proposals

3.71 The Scientific Committee noted that criteria based on CM 24-01, Annex 24-01/A, format 2, were applied to evaluate research proposals submitted under CMs 21-02 and 24-01 in Area 48, Area 58 and Subarea 88.3 (Annex 7, paragraph 4.7 and Tables 4 to 6).

3.72 The Scientific Committee agreed that these criteria and tables are a useful approach to evaluate and summarise research proposals in data-poor toothfish fisheries. The Scientific Committee recommended that new or modified proposals in future years should directly address these criteria.

3.73 The Scientific Committee recalled work carried out in the Ross Sea to estimate the survival and detection rates of tagged fish by vessels (Annex 7, paragraph 3.68; Mormede and Dunn, 2013) and noted that these estimates can be used as part of the evaluation process for research proposals.

3.74 The Scientific Committee noted that some research proposals were substantively revised during WG-SAM and WG-FSA meetings. It agreed that WG-SAM and WG-FSA should evaluate and provide comment on proposals submitted by the submission deadlines for these meetings. The submitted proposals, together with comments by the working groups, should then be forwarded to the Scientific Committee for consideration.

3.75 The Scientific Committee noted the ongoing discussions about gear selectivity and standardisation of effort between trotlines and Spanish longline and autoline (Annex 5, paragraphs 4.22, 4.39 and 4.41; Annex 7, paragraphs 4.19 and 4.20), and that the effect of gear type will depend on the research question asked (SC-CAMLR-XXXV, Annex 7, paragraphs 4.55 to 4.61). The Scientific Committee noted that WG-FSA-18 will include a focus topic to address the following points (Annex 7, paragraph 4.20):

(i) design-based versus model-based approaches to gear standardisation

(ii) performance of tag releases and recaptures associated with gear type

(iii) approaches to consolidate effort between different gear types for CPUE evaluations

(iv) characterisations of gear types, such as bait types or hook types and line length and number of hooks.

Catch limits in research blocks

3.76 The Scientific Committee noted that WG-FSA-17 had developed a trend analysis decision framework for setting catch limits in research blocks (Annex 7, paragraphs 4.28 to 4.38). The Scientific Committee agreed that this decision framework provides:

(i) a clear and transparent approach to setting catch limits in research blocks

(ii) a standardised mechanism for transition from catch limits based on the CPUE by seabed area biomass estimates to catch limits based on Chapman biomass estimates

(iii) feedback mechanisms to adjust catch limits in response to temporal trends in biomass estimates

(iv) reduction to potential large interannual variation in catch limits.

3.77 The Scientific Committee recommended that the following rules be applied in the calculation of catch limits (Annex 7, paragraph 4.33):

Apply a 4% exploitation rate to the Chapman and/or CPUE by seabed area biomass estimates, including up to the most recent season in which sampling has been completed for each research block (B4%):

- IF the trend was stable –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate.
- IF the trend was declining –
  - use the current catch limit × 0.8 (regardless of adequate recaptures or not).
- IF the trend was increasing –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate.
- IF the trend was too short, too variable, or trends between abundance indices are in conflict –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate
- AND constraining any changes in the proposed catch limit to be not more than a 20% increase or decrease from the current catch limit.

3.78 The Scientific Committee acknowledged that elements of the trend analysis decision framework used in calculating catch limits could be improved and further clarified and requested that WG-SAM and WG-FSA evaluate and refine these rules, by considering the following as priority work:

(i) management strategy evaluations (MSEs) underlying the establishment of the trend analysis decision framework for providing advice on catch limits (this is a priority topic for WG-SAM-18)

(ii) the method for evaluation of trends be better formalised by WG-SAM in 2018

(iii) provide stand-alone documentation of the trend analysis decision framework within working group reports and relevant Fisheries Reports

(iv) that additional work should be conducted to examine the applicability of the trend analysis decision framework when survey designs change (e.g. changes in fixed effort surveys, or changes in participating vessels).

Relationships with other management areas

3.79 The Scientific Committee noted SC-CAMLR-XXXVI/BG/18 which summarised progress on the two-year program of exploratory fishing provided for by the South Pacific Regional Fisheries Management Organisation (SPRFMO) Conservation and Management Measure (CMM) 4.14. Preliminary results from that voyage were reported to the Scientific Committee in 2016 (SC-CAMLR-XXXV/BG/32). Toothfish catch was comprised entirely of *D. mawsoni*, of which ~85% were male and in spawning or spent condition. These data were consistent with the current stock hypothesis for *D. mawsoni* growth and movement (Hanchet et al., 2008), and have provided the first direct observations of spawning *D. mawsoni* from the Ross Sea region. Information collected during the first voyage has now been shared with CCAMLR and the catch data had been used in the stock assessment of *D. mawsoni* in the Ross Sea region.

3.80 The Scientific Committee highlighted the importance of understanding stock linkages across CCAMLR and SPRFMO areas, and noted that Australia is commencing a genetic project to investigate *D. mawsoni* stock delineation and linkages throughout the CCAMLR region and adjacent management regions (Annex 7, paragraph 4.108).

Progress towards assessments

Area 48 stock hypothesis

3.81 The Scientific Committee noted the WG-FSA discussions with respect to proposals investigating *D. mawsoni* life history in Area 48, particularly in respect of the lack of a regional stock hypothesis for Area 48. Such a hypothesis will facilitate regional coordination, without which research in this area is unlikely to deliver, within a realistic timeframe, the objectives of the Commission.

3.82 The Scientific Committee noted that the multi-Member CCAMLR workshop proposed by Germany for February 2018 was considered a format that would help deliver such a stock hypothesis before the next meetings of WG-SAM and WG-EMM (paragraph 13.21).

Research proposals in Area 48

3.83 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.53 to 4.59) on the proposal by Ukraine to conduct longline research for *Dissostichus* spp. in Subarea 48.1.

3.84 Following a review using the agreed criteria (Annex 7, Table 4), WG-FSA had noted that the proposal was in need of further development. Particularly, the Scientific Committee noted that WG-FSA concluded that although some WG-SAM recommendations were implemented, details of potential stock identity, biological sampling and the types of analyses proposed were still missing.

3.85 The Scientific Committee noted the number of proposals submitted by Ukraine and enquired about the ability to carry out research and capacity to deliver outcomes by this Member.

3.86 Dr K. Demianenko (Ukraine) presented updated information on the survey proposal, in particular noting the distribution in relation to trawl surveys conducted in the area by Germany and the USA. It was noted that aiming to provide high standards of data collection, Ukraine proposes to replace a vessel in this proposal (it is planned to use the vessel *Koreiz*, which has multiannual experience in the Antarctic fishery), and a video recording of tagging procedures will be implemented. He stressed that research on toothfish in Subarea 48.1 will take into account the data-poor status of this marine area, in particular concerning toothfish. It was proposed to establish a catch limit of 40 tonnes for this research. He also noted that Ukraine would withdraw its proposals in Subareas 58.4 and 88.3 to concentrate its research efforts in Subareas 48.1 and 48.2.

Subarea 48.2

3.87 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.60 to 4.63) on a plan by Chile to continue the longline research survey for *Dissostichus* spp. in Subarea 48.2 (WG-FSA-17/27).

3.88 Following a review using the agreed criteria (Annex 7, Table 4), WG-FSA concluded that, while the proposal included a vessel that had not fished within the CCAMLR area before, it did have experience in fishing in the Chilean national toothfish fishery and that the national observer has extensive experience in the Chilean national tagging program. In addition, although the proposal has a data collection plan for by-catch, it currently did not consider the impacts of the research on by-catch species. The proposal was coordinated with Ukraine and operational agreements were reached for this season.

3.89 The Scientific Committee recommended that the Chilean survey be conducted in 2017/18, in coordination with Ukraine, which was conducting research in the same area.

3.90 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.64 to 4.67) on a plan by Ukraine to continue the longline research for *Dissostichus* spp. in Subarea 48.2 (WG-FSA-17/31).

3.91 Following a review using the agreed criteria (Annex 7, Table 4), WG-FSA concluded that, while the proposed vessel has multiple years of experience, it has also had relatively low effective tag survival rates (WG-FSA-17/36, Table 6). In addition, although the proposal has a data collection plan for by-catch, it is not currently looking at the impacts of the research on by-catch species.

3.92 The Scientific Committee recommended that the Ukrainian survey in Subarea 48.2 continue in 2017/18 in coordination with Chile, which was conducting research in the same area.

3.93 The proposals from Chile and Ukraine were coordinated with operational agreements reached for the 2017/18 season.

3.94 The Scientific Committee recommended that the existing 75 tonne catch limit be applied as the precautionary catch limit for the research proposed by Chile and Ukraine.

3.95 Chile and Ukraine noted the advice in Annex 7, paragraph 4.69.

3.96 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.64 to 4.67) on a proposal by the UK to continue research investigating the connectivity of *Dissostichus* spp. distributions between Subareas 48.2 and 48.4 (WG-FSA-17/45).

3.97 The Scientific Committee noted that the proposal met all of the agreed review criteria at WG-FSA (Annex 7, Table 4).

3.98 The Scientific Committee recommended that the survey continue in 2017/18, with research catch limits of 23 tonnes in the eastern area of Subarea 48.2 and 18 tonnes in the southern area of Subarea 48.4.

3.99 Following its advice from 2016, based on the stock hypothesis that the established fishery in Subarea 48.4 is likely to be the northern component of a larger stock of *D. mawsoni* distributed across Subareas 48.2 and 48.4, the Scientific Committee recommended that the catch limit for this survey area should be considered separate from the catch limit in the established fishery for *D. mawsoni* in Subarea 48.4.

Subarea 48.5

3.100 The Scientific Committee noted a Russian proposal for a three-year longline survey in the eastern region of the Weddell Sea (WG-FSA-17/25). The survey proposed to collect biological data and undertake tagging to estimate the stock status of *D. mawsoni* in Subarea 48.5.

3.101 The Scientific Committee recalled that WG-SAM and WG-FSA had yet to have the opportunity to review analyses, previously requested by Scientific Committee (SC-CAMLR-XXXIII, paragraph 3.232; SC-CAMLR-XXXIV, paragraphs 3.271 and 3.272), on the catch rates in Subarea 48.5 from the surveys undertaken by Russia in 2013 and 2014. Consequently, WG-SAM, WG-FSA and the Scientific Committee were unable to provide advice on this proposal.

3.102 The Scientific Committee referred to its previous advice for this research recommending that the data concerned remain quarantined until such time that a complete analysis has been undertaken and submitted for consideration by WG-SAM, WG-FSA and the Scientific Committee.

Subarea 48.6

3.103 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.77 to 4.82) on a plan by Japan and South Africa to continue the longline research survey for *Dissostichus* spp. in Subarea 48.6 (WG-FSA-17/10).

3.104 The Scientific Committee noted that following a review using the agreed criteria (Annex 7, Table 4), WG-FSA concluded that while the proposed vessels have multiple years of experience, they have unknown effective tag survival rates. Furthermore, there have been ongoing issues to complete research due to either accessibility of the research block or fishing capacity, including commitments elsewhere.

3.105 The Scientific Committee noted that research in research block 486_4 had been incomplete in 2017, due to the vessel moving to research block 486_5 and raised the issue of priorities for the research block sampling.

3.106 Mr Somhlaba noted that ice conditions were such that research block 486_5 had become available for the first time in several years, and that the research block had therefore been given priority to obtain some evidence supporting the stock structure hypothesis that toothfish moves in the east–west direction along this area, over completion of the research in research block 486_4, while the ice conditions were suitable. He noted that in the 2017/18 season the vessels would be prioritising research blocks 486_4 and _5 at the start of the research and then working north to the other research areas.

3.107 The Scientific Committee noted the discussion at WG-FSA (Annex 7, paragraphs 4.83 to 4.86) on a proposal by Norway to conduct a longline research survey for *Dissostichus* spp. in Subarea 48.6 (WG-FSA-17/61).

3.108 Following a review using the agreed criteria (Annex 7, Table 4), WG-FSA concluded that, while the majority of the criteria were met by the proposal, in some form, there was insufficient detail of objectives and milestones within the proposal to determine and evaluate the likelihood of success.

3.109 The Scientific Committee noted that, based on a revised proposal, the future inclusion of an ice-strengthened vessel, in an expanded research plan for this area, would address the capacity issues that the research conducted by Japan and South Africa were experiencing.

3.110 Dr Kasatkina noted that the research proposal submitted by Norway proposed research that would be conducted using autoline gear with varying line lengths and numbers of hooks compared to the trotline gear types used by the research conducted by South Africa. In addition, she noted that the Norwegian proposal on survey design had prospecting characteristics, rather than the proposals of Japan and South Africa which targeted recapture of tagged toothfish. Consequently, she considered that the analysis of data collected by different vessels would be problematic.

3.111 The Scientific Committee noted that the Norwegian proposal was still being developed and that analysis of data collected by multiple gear types had been used successfully to provide tag-based estimates of local population biomass and also to provide advice to the Scientific Committee on stock dynamics, based on standardised CPUE analysis (WG-FSA-17/16; Annex 7, paragraphs 4.103 to 4.107).

Management advice

3.112 The Scientific Committee recommended that research by Japan and South Africa in this subarea should continue, focussing on *D. mawsoni* in research blocks 486_2 to 486_5 and that the catch limits for 2017/18 for this subarea be applied as shown in Table 1.

Area 58

Dissostichus spp. in Divisions 58.4.1 and 58.4.2

3.113 The Scientific Committee noted that WG-FSA-17 had reviewed papers on research conducted in Divisions 58.4.1 and 58.4.2 (Annex 7, paragraphs 4.88 to 4.108).

3.114 Dr Kasatkina noted that implementation of research programs in Subarea 58.4 (Divisions 58.4.1 and 58.4.2) is based on data collection by several vessels in each research block. These vessels operate using different gear types, line lengths and numbers of hooks, and these are an important consideration in relation to estimates of biomass, tagging data and stock structure and productivity parameters. Gear effect might be a critical factor for efficiency and reliability of multi-year programs in Subarea 58.4. Dr Kasatkina highlighted that it is needed to clarify efficiency of this multi-year survey and the quality of the results obtained. Such an analysis is necessary to assess the appropriateness of continuing programs and developing approaches for improving the methodology for data collection.

3.115 The Scientific Committee recalled similar discussions relating to the use of different longline gear types in research plans (Annex 7, paragraph 4.114). It noted analyses of catch rates and catch composition in which gear type and other factors have been included (Annex 7, paragraphs 4.103 to 4.105), and recommended a focus topic during WG-SAM-18 to address issues associated with gear effects.

3.116 The Scientific Committee noted that WG-FSA-17 had reviewed a joint research plan prepared by Australia, France, Japan, the Republic of Korea and Spain (WG-FSA-17/18 Rev. 1; Annex 7, paragraphs 4.112 to 4.115).

3.117 The Scientific Committee agreed that the research plan in WG-FSA-17/18 Rev. 1, and advice relating to *Macrourus* by-catch (paragraph 3.147), is appropriate to achieve the research objectives.

3.118 The Scientific Committee noted that the research proponents intended to adopt a similar approach for the initial research catch allocation to that adopted in previous years (Table 2). The Scientific Committee noted that notifying Members will confirm whether they intend to pursue research by SC CIRC by 1 January 2018. If any Member is not able to confirm that it will pursue research, its allocation will be evenly redistributed amongst the other notifying Members that have confirmed they will pursue research. If any Member has not commenced research activities by 1 February 2018, its allocation will also be evenly redistributed amongst the Members that have commenced research activities, or by another means agreed by all Members that have commenced research activities.

3.119 The Scientific Committee noted that WG-FSA-17 also evaluated a separate research plan prepared by Ukraine (WG-FSA-17/33; Annex 7, paragraphs 4.117 to 4.121). It was further noted that during the meeting Ukraine withdrew its intention to conduct research in Division 58.4.2 in the 2017/18 season.

Management advice

3.120 The Scientific Committee noted that the catch limits for research blocks in Divisions 58.4.1 and 58.4.2 were calculated using the trend analysis decision framework (paragraph 3.77) and recommended that they be applied as shown in Table 2.

D. eleginoides in Division 58.4.3a

3.121 The Scientific Committee noted that WG-FSA-17 had reviewed a joint proposal by France and Japan to continue research in Division 58.4.3a (WG-FSA-17/55; Annex 7, paragraphs 4.123 to 4.127) and agreed that this research proposal is appropriate to achieve the research objectives.

Management advice

3.122 The Scientific Committee noted that catch limits were calculated using the trend analysis decision framework (paragraph 3.77) and recommended that they be applied as shown in Table 1.

D. eleginoides Division in 58.4.4

3.123 The Scientific Committee noted that WG-FSA-17 had reviewed a joint proposal by France and Japan to continue research in Division 58.4.4b (WG-FSA-17/11; Annex 7, paragraphs 4.128 and 4.130) and agreed that it is appropriate to achieve the research objectives.

Management advice

3.124 The Scientific Committee noted that catch limits were calculated using the trend analysis decision framework (paragraph 3.77) and recommended that they be applied as shown in Table 1.

Area 88

Subarea 88.1 and SSRUs 882A–B

3.125 The Scientific Committee considered the discussions by WG-FSA on tagging performance differences among vessels and the potential effects on stock assessment (Figures 1 and 2 and Annex 7, paragraphs 3.69 to 3.73). The Scientific Committee expressed concern about the notable differences in the relative survival of tagged fish among vessels and gear types and sought additional information to understand these differences to improve the quality of tagging data.

3.126 The Scientific Committee recommended WG-SAM consider further development of the diagnostics developed in Figures 1 and 2 using methods developed by Mormede and Dunn (2013), including further investigations showing the time series of how the quality of tagging performance by individual vessels, and how the quality of tagging datasets used in assessments, have progressed through time. The Scientific Committee noted that this methodology may also be applicable to other areas where research fishing includes multiple vessels.

3.127 The Scientific Committee recommended that information be provided by Members describing the procedures used to train observers and crew to tag toothfish so that tagging practices could be reviewed. This information, as well as information requested by the 'vessel tagging notification pro forma' (Annex 8), could be provided as part of the fishery notification for new and exploratory fisheries for each vessel (CM 21-02) and for research proposals involving conducting toothfish tagging under CM 24-01.

3.128 The Scientific Committee noted that the purpose of the pro forma was for data collection and not for compliance, however, it recommended that observer reports include an indication if the tagging procedures described in the pro forma were followed in practice.

3.129 The Scientific Committee also recommended that video documentation of the tagging procedures being applied on each vessel operating under a notification under CM 21-02 or under CM 24-01 targeting toothfish with longlines be submitted to WG-FSA for review, perhaps as a standalone paper. The Scientific Committee noted that photographs of large numbers of tagged fish would not be necessary (Annex 7, paragraph 3.73).

3.130 The Scientific Committee noted that it would be important to provide training materials in the languages in use by vessel crew and observers tagging toothfish, and undertook to collect and collate this information using the tagging pro forma.

3.131 The Scientific Committee noted the discussion on management of catch limits where many vessels were competing for a relatively small catch limit, noting that an overrun of 56% occurred in SSRUs 881B, C, G in the north of the Ross Sea in 2016/17, but that it is a generic issue that could easily occur in the Ross Sea region special research zone (SRZ) or in other areas (Annex 7, paragraphs 3.94 to 3.97).

3.132 The Scientific Committee noted that effort limitation may be an option to manage small catch limits, recalling that crab fisheries within CCAMLR had imposed an effort limitation to constrain research catches in the past (CM 74/XII, paragraph 2). However, the mechanism of effort control was by agreement among participating Members.

3.133 The Scientific Committee recommended further development of robust metrics that identified vessels providing high-quality data as one option to constrain the amount of fishing effort (i.e. Annex 7, Figure 5). The Scientific Committee noted that the capacity management issue was raised as part of the CCAMLR performance review, and that the inability to manage small catch limits could impact on the ability of the Scientific Committee to provide robust management advice.

3.134 Using the north of the Ross Sea as an example, the Scientific Committee noted that additional information is available from vessels, such as their previous catch rates in the area and the number of hooks they have set but remain to be hauled (as included in daily effort reporting). The Scientific Committee recommended that this information be used to more accurately estimate the time expected to reach the catch limit (Annex 7, paragraphs 3.94 to 3.97). If this analysis was conducted for all vessels that enter the area, a closure date could be generated at the start of the fishery. Following a status summary at the predicted date, the fishery closure date could be extended until the catch limit has been reached.

3.135 The Scientific Committee considered that a more integrated approach to manage small toothfish catch limits would be useful to develop, but that current methods are designed to spread effort, prevent localised depletion and minimise bias in stock assessments.

3.136 The Scientific Committee noted two proposals by Russia and Ukraine to conduct toothfish research in the SRZ of the RSRMPA.

3.137 The Scientific Committee recommended that research proposals submitted to work in the SRZ of the RSRMPA should be clearly linked to the RMP for the area (Annex 7, paragraph 3.107). The Scientific Committee also endorsed the recommendation of WG-FSA that research catches in the SRZ should be allocated from the SRZ catch limit to ensure that the objective of limiting the exploitation rate in the SRZ is preserved (Annex 7, paragraph 3.114).

Management advice

3.138 The Scientific Committee recommended that the catch limit be set at 45 tonnes for the 2017/18 Ross Sea shelf survey and 65 tonnes for the 2018/19 Ross Sea shelf survey and that the catch limits are deducted from, and not additional to, the Ross Sea region catch limit (Table 1).

3.139 The Scientific Committee recommended that following the procedure outlined in CM 91-05, the catch limit for the Ross Sea region (Subarea 88.1 and SSRUs 882A–B) in the 2017/18 season be 3 157 tonnes, with 467 tonnes allocated to the SRZ, 591 tonnes north of 70°S, 2 054 tonnes south of 70°S and 45 tonnes for the Ross Sea shelf survey (Table 1).

SSRUs 882C–H

3.140 The Scientific Committee noted that to further progress the stock assessment in SSRUs 882C–H, better coordination was needed for at-sea operations to improve spatial overlap to recapture tagged fish, and analytical efforts to age existing otoliths from catches in specific years (Annex 7, paragraphs 3.119 to 3.126; Table 1). The Scientific Committee noted that an informal arrangement between Members would be trialled to coordinate at-sea activities, and that this would be coordinated by New Zealand with the eight Members notified to fish in the subarea.

3.141 The Scientific Committee recommended that the research plan in place for SSRUs 882C–H continue for the 2017/18 season following Scientific Committee advice from 2016 (SC-CAMLR-XXXV, Annex 7, paragraph 3.125; Table 1).

Subarea 88.3

3.142 The Scientific Committee recommended the catch limits for the Korean and New Zealand joint research plan in Subarea 88.3 be endorsed (Annex 7, paragraph 4.147; Table 1).

Fish and invertebrate by-catch

3.143 The Scientific Committee noted that in 2016/17 research undertaken by Australia and Spain in research block 5841_6 in Division 58.4.1was not completed due to exceeding the 16% by-catch limit for *Macrourus* spp.

3.144 The Scientific Committee noted that the existing move-on rule for by-catch in Division 58.4.1 should be explored to assess whether modifications in the move-on rule may help avoid or mitigate Macrourid by-catch whilst still allowing vessels to continue fishing for the purposes of research in research block 5841_6 in the future. The Scientific Committee also noted that this evaluation should include consideration of the relationship between the move-on rules and the spatial distribution of Macrourids.

3.145 The Scientific Committee noted that by-catch will be a focus topic at WG-FSA-18 and asked Members to provide analyses to that meeting that may assist in reviewing the move-on rules, including reviewing their relevance and origins.

3.146 The Scientific Committee also requested that the Secretariat provide a summary of the implementation of move-on rules to WG-FSA-18.

3.147 The Scientific Committee recommended that the by-catch limits for Macrourids in Divisions 58.4.1 and 58.4.2 be retained at 16% of the *D. mawsoni* catch limit for 2017/18 and that multi-Member research proposals should be reviewed in 2018 to account for areas of high by-catch.

3.148 To enable better avoidance and mitigation of Macrourid by-catch, the Scientific Committee recommended removal of the research grid in research block 5841_6 and proposed structuring research fishing in that block in a similar manner as in other research blocks within Division 58.4.1 without research grids. Each Member would distribute fishing effort across a range of depth strata (<1 000, 1 001–1 500, 1 501–2 000 m) with at least five longlines in each depth strata, deployed in accordance with the minimum separation distances in CM 41-01, Annex 41-01/B.

3.149 The Scientific Committee recommended updated catch limits by area for Macrourids, skates and other species in the Ross Sea region, consistent with the implementation of the RSRMPA (CM 91-05). The by-catch limits, using the recommended toothfish catch limit for the Ross Sea region of 3 157 tonnes, are shown in Annex 7, Table 8.

3.150 The Scientific Committee noted that there may need to be consequential changes as a result of the introduction of CM 91-05 (2016), and that CM 33-03, governing the limitation of by-catch in new and exploratory fisheries, may need to be reviewed. The Scientific Committee also noted the difference in the definition of management areas defined in CM 33-03 and those defined by CM 41-09. The Scientific Committee noted that this could be resolved by copying paragraphs 3, 4, 5 and 6 from CM 33-03 to CM 41-09, and the reference to CM 33-03 be removed from paragraph 6 in CM 41-09.

3.151 The Scientific Committee noted that the move-on rule defined in CM 33-03, paragraph 6, should be applied at the SSRU level for Subarea 88.1.

Incidental mortality arising from fishing operations

Incidental mortality of seabirds and marine mammals associated with fisheries

4.1 The Secretariat provided an update on incidental mortality of seabirds and marine mammals in CCAMLR fisheries during the 2016/17 season as of 10 October 2017 (WG-FSA-17/58 Rev. 2).

4.2 The Scientific Committee noted the discussions on incidental mortality associated with fishing (IMAF) in Annex 7, paragraphs 6.24 to 6.37, including consideration of current levels of seabird interactions, the use of streamer lines and methods of extrapolation of seabird mortalities from observer reports in the whole Convention Area, and the current season-extension trial in Division 58.5.2.

4.3 The Scientific Committee noted the extrapolated incidental mortality of 116 seabirds in all CCAMLR longline fisheries in 2017 was the second-lowest on record and comprised white-chinned petrel (*Procellaria aequinoctialis*, 93%), southern giant petrel (*Macronectes giganteus*, 4%) and grey petrel (*Procellaria cinerea*, 3%). The incidental mortality of three white-chinned petrel, one chinstrap penguin (*Pygoscelis antarctica*), and one unidentified bird were reported in trawl fisheries in the Convention Area in 2017. Marine mammal mortalities comprised three southern elephant seal (*Mirounga leonina*) in longline fisheries, and one Antarctic fur seal (*Arctocephalus gazella*) in finfish trawl fisheries (Table 3).

4.4 The Scientific Committee endorsed the recommendation to include the matter of seabird mortalities not associated with fishing gear as a prospective topic of mutual interest with the CEP and ACAP.

4.5 The CEP noted that at present, the issue of seabird mortality not associated with fishing gear was not a point of close consideration for the CEP, but as this is a matter of interest to the Scientific Committee, the CEP would consider how to assist in the development of this mutual topic of interest between SC-CAMLR and the CEP.

4.6 The Scientific Committee considered SC-CAMLR-XXXVI/BG/23, a proposal to modify CM 25-02 such that the instruction to longline fishing vessels to deploy streamer lines, while setting longlines, is removed for vessels that use longline weighting according to CM 24-02. The proponents highlighted the effectiveness of longline weighting (CM 24-02) in reducing seabird mortalities and suggested that this instruction in CM 25-02 was obsolete and the conservation measure should be updated.

4.7 The Scientific Committee recalled the discussion at WG-FSA (Annex 7, paragraphs 6.31 to 6.33), noting that that current best practice for mitigating seabird interactions during setting of longline gear was to use both streamer lines and longline weighting, in line with advice of ACAP. The Scientific Committee recommended that CM 25-02 should remain in place unmodified.

4.8 ACAP noted that its advice on seabird mitigation remains that in addition to other measures such as night setting, a combination of both line weight and scaring lines is most effective. The advice is based on reducing the risk area through increasing the sink rate of baited hooks, and defending the risk area through bird-scaring lines to reduce attacks on baited hooks, an approach often referred to as the 'shrink and defend' approach. The effectiveness of this approach has been demonstrated widely in both demersal and pelagic longlines.

4.9 COLTO noted that its members work towards improving seabird mitigation devices and agreed with the conclusions of WG-FSA.

Marine debris

4.10 The Scientific Committee considered WG-FSA-17/02 and SC-CAMLR-XXXVI/BG/35 summarising the marine debris monitoring program in the Convention Area and the contribution of the UK. The papers reviewed the occurrence of plastic debris on beaches and in seabird colonies, as well as entanglements of marine mammals, noting that the frequency of debris on beaches and seabird colonies is lower than previously, although still remaining an issue in the CAMLR Convention Area.

4.11 The Scientific Committee noted that marine debris data was submitted by three Members (South Africa, UK and USA), and thanked those Members that had submitted data. The Scientific Committee encouraged more Members to participate in marine debris monitoring, including developing potential links with the CEP and COMNAP in expanding engagement across more sites and national programs (see SC-CAMLR-XXXV, Annex 7, paragraph 8.38).

4.12 ASOC presented SC-CAMLR-XXXVI/BG/29:

> '*ASOC identified marine debris as a continuing threat to the Southern Ocean ecosystem and microplastics as a serious and emerging threat to the CCAMLR area. ASOC recognised the previous work of CCAMLR in the mitigation and monitoring of marine debris. However, in the past year, there has been evidence of the entanglement of seals in debris and seabird interactions with debris. There is frequent deposition of domestic and fishing-related debris on sub-Antarctic and Antarctic islands. However, where this debris comes from, how it is distributed and the impacts of ingestion or entanglement of debris on individuals and populations is virtually unknown in the CCAMLR area. ASOC proposes CCAMLR Members facilitate research beyond documenting the occurrence of marine debris onshore to identify the at-sea distribution and impacts of debris in the Southern Ocean. The trend that microplastic concentrations are higher in areas adjacent to Antarctic bases and shipping activity in the CCAMLR area is a serious and emerging problem in the Antarctic. Microplastics pose a risk to marine wildlife on all trophic levels, including zooplankton. Except for SC-CAMLR-XXXVI/BG/29, microplastics are absent in the submissions to the CCAMLR meeting this year. This is of concern for ASOC, and a collaborative approach between CCAMLR and the CEP to eliminate the microplastic pollution of the Southern Ocean from local sources is recommended. ASOC recognised that a SCAR Expert/Action Group would be a positive development, and noted that tools like the plankton recorder have taken themes of microplastics on a global scale and have been used for many years, including in the Southern Ocean. ASOC notes that the CEP did not, at present, give consideration to monitoring marine debris, and that marine debris could be documented in the CCAMLR SISO logbooks. ASOC acknowledges that longline gear loss is reported.*'

4.13 The CEP noted that, at present, the issue of monitoring marine debris in the marine environment was not a point of close consideration for the CEP, but as this is a matter of interest to the Scientific Committee, the CEP could consider how to assist, in conjunction with SCAR and COMNAP, including through information relating to marine plastics that may be derived from land-based sources and national programs and touristic activities in the Antarctic.

4.14 The Scientific Committee recalled that the facility to record marine debris is given in the new SISO CCAMLR logbooks, and that WG-FSA had recommended the inclusion of gear loss as part of the annual report on marine debris in the Convention Area. The Scientific Committee encouraged its Members conducting research fishing activities in the Convention Area to consider coordinating sampling for microplastics with their national programs.

4.15 The Scientific Committee further noted that on the question of microplastics, the continuous plankton recorder has been deployed within the Convention Area for many years by several Members and is likely to provide an important contribution to studies on microplastics globally and providing a baseline of microplastic levels in the Southern Ocean.

Spatial management of impacts on the Antarctic ecosystem

Bottom fishing and vulnerable marine ecosystems

5.1 Nine Members (Australia, France, Japan, Republic of Korea, New Zealand, Norway, Russia, Ukraine and Uruguay) submitted preliminary assessments of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems (VMEs).

5.2 The Scientific Committee recalled that CM 22-06 requires Members to submit preliminary bottom fishing assessments for all fishing activities. Consistent with CM 22-06, paragraph 7(iv), a preliminary assessment does not need to be submitted if a preliminary assessment has already been submitted for the vessel and the associated gear configurations for a prior fishing season, and the information submitted in the preliminary assessment would continue to apply in the upcoming fishing season. CM 22-06 also requires that Members submit preliminary bottom fishing assessments for review by the Scientific Committee at least three months prior to the annual meeting of the Commission. For the 2017/18 fishing season, three Members (France, Korea and Ukraine) submitted their assessments after this deadline.

5.3 The Scientific Committee is required to advise the Commission on whether proposed bottom fishing activities would contribute to having significant adverse impacts on VMEs (CM 22-06, paragraph 7ii). However, neither the Scientific Committee nor WG-FSA had sufficient time to review Members' preliminary assessments for the 2017/18 fishing season. Therefore, the Scientific Committee agreed that:

(i) preliminary bottom fishing assessments remain valuable for tracking changes in the cumulative footprint of bottom fishing activities

(ii) its processes to review and comment on preliminary bottom fishing assessments should be improved and automated where possible

(iii) time to develop such improvements and evaluate preliminary bottom fishing assessments should be included in future agendas of WG-FSA.

Marine protected areas

Domains 3 and 4 – Weddell Sea

5.4 The Scientific Committee considered four papers under this topic: SC-CAMLR-XXXVI/10, BG/24, BG/25 and BG/28. It also noted discussions related to the Weddell Sea MPA that took place at WG-EMM (Annex 6, paragraphs 5.1 to 5.14).

5.5 Germany presented updates to the scientific background and development of the Weddell Sea MPA proposal (SC-CAMLR-XXXVI/BG/28), which include updated analyses of relevant data layers, an updated *D. mawsoni* habitat model, further explanation of the influence of the cost layer and testing of the robustness of Marxan analyses through a range of protection-level scenarios. SC-CAMLR-XXXVI/BG/28 also indicated that data layers had been re-projected into an equal-area projection, and a simpler (non-recursive) Marxan approach would replace the previous Marxan approach used, however, these recommendations were not yet included in the document. Germany noted that 75 new data maps (including maps depicting data availability) had been circulated via the Weddell Sea MPA e-group.

5.6 The Scientific Committee welcomed these updates, noting the considerable progress made during the past year. It noted that the proponents had been responsive to Members' questions and commentary, particularly in relation to recommendations made by WG-EMM, WG-SAM and WG-FSA. It agreed that the continued engagement of interested Members, particularly on contributing relevant datasets, is critical to further progress the proposal.

5.7 The Scientific Committee agreed that the proposed CCAMLR Workshop for the Development of a *D. mawsoni* Population Hypothesis for Area 48 (paragraph 13.22), to be held in Berlin, Germany (February 2018), would make an important contribution to the MPA planning process for the Weddell Sea and encouraged Members to participate.

5.8 The discussion of SC-CAMLR-XXXVI/10, BG/24 and BG/25 focused on the following issues:

(i) consistency of approaches for data-rich and data-poor areas, and suitability of Marxan for use across both data-rich and data-poor areas within one analysis

(ii) availability of data for areas east of the prime meridian in the Weddell Sea MPA planning area, taking into account the new maps (made available via the Weddell Sea MPA e-group) showing the spatial distribution of additional ecological and environmental data considered in the Weddell Sea MPA planning process

(iii) consideration of ecological north–south connections, including the migration of higher-trophic level predators

(iv) further discussion and agreement of protection target figures for toothfish habitat

(v) consideration of sea-ice, and accessibility of areas for monitoring

(vi) consideration of the commercial potential of dominant fish species

(vii) analysis of potential threats to ecosystems and biodiversity, including from climate change.

5.9 The Scientific Committee noted that some of these issues could be addressed during the 2018 Workshop on Spatial Management (SC-CAMLR-XXXVI/BG/40).

5.10 Dr Kasatkina noted that there are populations of dominant fish species in the Weddell Sea that are of commercial importance or potential commercial importance: *D. mawsoni*, spiny icefish (*Chaenodraco wilsoni*), *P. antarctica* and Antarctic rockcod (*Trematomus eulepidotus*) (SC-CAMLR-XXXVI/BG/24). Research programs are needed in order to further determine the commercial potential of these fish species, as well as to assess their stocks and future rational use. She noted that a proposal for the establishment of an MPA in the Weddell Sea should be complemented by these materials. Dr Kasatkina also noted that MPA boundaries should be clarified in compliance with sea-ice conditions for vessel navigation being a fundamental factor for the successful completion of assigned research tasks in designated areas (SC-CAMLR-XXXVI/BG/25).

5.11 Regarding consistency between MPA proposals, the Scientific Committee recognised that Members may have different objectives and approaches in relation to MPAs, but that CM 91-04 and the Convention itself provide a framework for ensuring basic consistency in the foundations for MPAs.

5.12 Regarding methodologies, the Scientific Committee also recalled the advice of the Commission that Marxan, a decision support tool, is endorsed as one feasible method for undertaking systematic conservation planning (CCAMLR-XXVII, paragraph 7.2).

5.13 The Scientific Committee recalled that bioregionalisation can be used as a basis for designing representative MPAs (CCAMLR-XXVII, paragraph 7.2) in order to achieve specific conservation objectives.

5.14 The proponents thanked Members for the views expressed during discussions on the development of the Weddell Sea MPA proposal, and will continue to engage with all Members to further discuss and clarify these issues.

South Orkney Islands southern shelf MPA

5.15 The Scientific Committee considered SC-CAMLR-XXXVI/BG/26, which commented on scientific and legal aspects of the South Orkney Islands southern shelf (SOISS) MPA and the harmonisation of CM 91-03 with the requirements of CM 91-04.

5.16 The UK noted that new research, including a benthic survey, predator tracking studies and acoustic surveys, had been initiated across the South Orkney Islands region during the last review period, and that results from this research had been submitted to WG-EMM, with further results to be submitted when available. Argentina highlighted three cruises that had been undertaken in the SOISS MPA region relating to key ecosystem processes, including variations in early stage krill larva abundance, the results of which had been submitted to WG-EMM, and its intention to continue developing these studies.

5.17 Regarding harmonisation with CM 91-04, the UK noted that the intention was to develop a management plan and an RMP as part of the review process scheduled for 2019.

5.18 Some Members recalled that the MPA checklist developed by Japan could provide useful guidance in preparing and reviewing MPA proposals.

Domain 1

5.19 The Scientific Committee considered nine documents relevant to the development of an MPA in Planning Domain 1: CCAMLR-XXXVI/17, XXXVI/18, XXXVI/19, BG/10, BG/11, BG/12, BG/21, BG/22 and BG/27.

5.20 Argentina and Chile introduced a preliminary proposal to establish an MPA in Planning Domain 1 (hereafter identified as the D1MPA). The proposal is the outcome of an inclusive, multinational process that started in 2012 and included three international meetings plus discussions by WG-EMM (Annex 6, paragraphs 4.1 to 4.24). The collaborative effort produced large volumes of data and information that were compiled and analysed to develop the D1MPA proposal, which is based on 143 spatial data layers and associated conservation targets.

5.21 The proposed D1MPA aims to conserve biodiversity by achieving eight specific conservation objectives. These specific objectives are consistent with the general objectives for CCAMLR MPAs stipulated in CM 91-04 and comprise protection of:

(i) representative examples of benthic habitats
(ii) representative examples of pelagic habitats
(iii) important benthic processes
(iv) large-scale pelagic ecosystem processes
(v) important areas for bird and mammal life cycles
(vi) important areas for fish life cycles
(vii) important areas for zooplankton life cycles
(viii) rare or unique habitats.

5.22 The proponents used Marxan to identify priority areas for conservation (PACs, Figure 3) in Planning Domain 1. The PACs occur in three ecoregions: southwestern Antarctic Peninsula (SWAP), northwestern Antarctic Peninsula (NWAP) and South Orkney Islands (SOI). Argentina and Chile noted that the consideration of appropriate protection for the PACs will be important to achieving the conservation of marine living resources. The ecological importance of the PACs is highlighted independent of any fishing activities that occur in the planning domain.

5.23 Argentina and Chile proposed preliminary boundaries for the D1MPA that are designed to protect PACs in each ecoregion and to take account of the potential threats posed by climate change and the krill fishery (Figure 4). Protection of PACs in the SWAP would primarily aim to mitigate the impacts of climate change, while protection of PACs in the NWAP and SOI would mostly aim to minimise the risk that krill fishing might negatively affect the marine ecosystem.

5.24 The preliminary D1MPA proposal includes a combination of General Protection Zones (GPZs, no-take zones in which research fishing would be permitted but commercial fishing would be prohibited) and Special Fishery Management Zones (SFMZs, zones in which commercial fishing would be permitted). The proponents developed these zones by considering spatial variability across the three ecoregions, and the zones comprise a spatial strategy to balance protection priorities with the development of a sustainable krill fishery. The proponents stressed that important coastal areas for birds, mammals, fishes and zooplankton life cycles are included in GPZs named 'NWAP-Foraging grounds' and 'SOI-Benthic.'

5.25 The proponents of the D1MPA clarified that they had introduced their preliminary proposal in the absence of a draft conservation measure to allow more Members and Observers to become involved in the planning process. Argentina and Chile thus invited Members and Observers to discuss the proposal and help improve the D1MPA with an aim towards drafting a conservation measure in the near future.

5.26 The Scientific Committee thanked Argentina and Chile for completing a large volume of work and agreed that the proponents made substantial and useful progress to develop an MPA in Planning Domain 1. The primary architects of the proposed D1MPA were recipients of CCAMLR scholarships, and the Scientific Committee noted their efforts exemplified the success of the scholarship scheme. Other Members also contributed to the proposal (e.g. by providing data, analyses and useful ideas), and the Scientific Committee recognised these efforts as well.

5.27 With respect to the D1MPA proposal, the Scientific Committee recognised that:

(i) the proposal was developed in an inclusive and transparent manner

(ii) the scientific background for the proposal was comprehensive and appropriate

(iii) the PACs identified from Marxan analyses undertaken by the proponents were justified by data and appropriate

(iv) in the context of climate change, it is important to have PACs along the latitudinal gradient with a duplication of ecoregional features between them integrating the different environmental gradients

(v) further consideration of fishing activities (e.g. either by applying a cost layer in Marxan sharing the experiences with other users (Annex 6, paragraph 5.12); or by evaluating the potential displacement of fishing effort; or by identifying areas where displaced fishing activities might otherwise occur) (Annex 6, paragraph 4.8) is needed to develop an agreed set of boundaries

(vi) further consultation with industry experts and non-governmental organisation (NGO) representatives would likely improve the proposal.

5.28 The Scientific Committee endorsed the advice of WG-EMM (Annex 6, paragraph 4.16) and agreed that there is a need to coordinate the various existing and proposed fishery-management approaches in Planning Domain 1. The D1MPA should be coordinated with the SOISS MPA (CM 91-03), krill catch limits at regional (Subareas 48.1 to 48.4) and subarea scales (CMs 51-01 and 51-07 respectively), protection for areas exposed by ice-shelf retreat (CM 24-04), the prohibition on fishing for most finfish (CM 32-02) and the development of FBM (CM 51-07).

5.29 Several other issues relevant to the D1MPA proposal require additional consideration. These include:

(i) rationalising the size of the proposed MPA with achievement of its specific conservation objectives and Members' other interests such as fishing

(ii) estimating the contemporary distribution and biomass of krill throughout Planning Domain 1

(iii) providing additional evidence that the proposed MPA can mitigate the effects of climate change or that the proposed MPA includes reference areas that are useful to study such effects

(iv) providing additional evidence that the proposed MPA could decrease the risks of krill fishing having a negative impact on the ecosystem

(v) considering further data layers and conservation targets related to fishes

(vi) developing priorities for a research and monitoring plan to accompany the proposed MPA.

5.30 Dr Kasatkina noted that the MPA proposal for Domain 1 did not provide any evidence of threats from the fishery and climate changing to marine living resources or biodiversity of the Domain 1 region which require the protection and urgency of providing this protection. Moreover, potential threats from human activities regulated by effective conservation measures on the base of the precautionary and ecosystem approaches are very low, and protection against climate change cannot be achieved by MPA.

5.31 Dr E. Marschoff (Argentina) explained that fishery considerations were not included at the stage of definition of objectives to maintain the transparency of the process, as well as that the precautionary principle does not require demonstration of perceived threats in order to be applied.

5.32 Argentina and Chile acknowledged that further work remains to more thoroughly consider fishing within the context of the D1MPA, coordinate development of the D1MPA with efforts to assess the risks of krill fishing and advance FBM, and develop priorities for an RMP. The proponents of the D1MPA thus proposed that the Scientific Committee form an expert group (via an e-group) to advance such work while taking account of Members' varying interests. It was proposed that this expert group be convened by representatives from Argentina and Chile and be composed of two representatives from each interested Member, two experts representing the fishing industry and two experts from NGOs.

5.33 Argentina and Chile further proposed that the expert group operate under three terms of reference listed in SC-CAMLR-XXXVI/19. The expert group would facilitate coordination and communication related to the D1MPA, identify a clear workflow to address several topics of work (e.g. to address specific concerns and issues raised by WG-EMM) and report on work and progress to the Scientific Committee and its working groups.

5.34 The Scientific Committee agreed to establish the Domain 1 Expert Group (with leadership and representation as proposed by Argentina and Chile) and endorsed the terms of reference and associated topics of work outlined in SC-CAMLR-XXXVI/19. The Scientific Committee also agreed that, as needed, experts from the usual Observers to the Scientific Committee should be invited to participate in the work of the group.

5.35 Many Members indicated their interest in participating in the Domain 1 Expert Group, and the representatives from Argentina and Chile thanked Members, ASOC and ARK for the constructive dialog and willingness to engage in further discussions and work to develop the D1MPA.

5.36 Ukraine presented background information on efforts to develop an MPA near Vernadsky Station. Ukrainian scientists are actively characterising and mapping biodiversity around the Argentine Islands (in an area of approximately 1 800 km^2) and are planning to submit data and analyses summarising their findings to a forthcoming meeting of WG-EMM.

5.37 The Scientific Committee was pleased to learn about Ukraine's efforts to study biodiversity around Vernadsky Station and noted that it looked forward to receiving the results of their work. The Scientific Committee further noted that it may be useful to coordinate spatial planning efforts around the Argentine Islands with those efforts supporting development of the D1MPA.

5.38 ASOC introduced SC-CAMLR-XXXVI/BG/32, 'Toward a System of Marine Protected Areas in the Southern Ocean' where it commended CCAMLR for its historic decision to designate a large-scale MPA in the Ross Sea region.

> *'To realise their 2009 commitment and the ambition of CM 91-04, ASOC called on CCAMLR Members to designate an MPA in East Antarctica this year, followed by MPAs in the Weddell Sea and in the Antarctic Peninsula region.*
>
> *ASOC welcomed the changes to the proposal made by the EU and Australia, and thanked them for their continued commitment to reaching consensus, despite several years of negotiations by CCAMLR Members. ASOC called on CCAMLR Members to adopt the East Antarctic MPA at this meeting and urged them to incorporate the elements described in this paper.*
>
> *On the Weddell Sea MPA proposal, ASOC is pleased that the proposed 1.8 million square kilometres includes areas of significance for conservation, and commended the EU for its intersessional work with other CCAMLR Members in considering the best available science.*
>
> *ASOC noted that the boundaries of the Fisheries Research Zone should be adjusted to minimise impact to conservation features, such as Maud Rise and Astrid Ridge. Furthermore, ASOC is opposed to any reduction in size or protection of the General Protection Zone, and noted that special protection zones could be expanded to be more precautionary.*
>
> *ASOC congratulated Argentina and Chile for ongoing work on the development of the D1MPA proposal, which complements the existing South Orkney Islands southern shelf MPA. ASOC also commended the proponents for the degree of transparency and collaboration displayed during development of the proposal. The Western Antarctic Peninsula–South Scotia Arc region is one of the most productive areas of the Southern Ocean, but this region has experienced significant warming, with resulting changes to sea-ice dynamics. The effects of such changes on the distribution of Antarctic krill are unknown. Thus, in the context of spatial planning for this area, it is important to consider both current and future habitats for krill. ASOC stated that an effective additional MPA in Domain 1 must be large, include no-take areas, and safeguard krill habitat as well as foraging ranges for predators such as penguins, seals and whales. The establishment of the General Protection Zones as described in the D1MPA proposal and the development of risk assessments and FBM strategies in the Special Fisheries Management Zones provide opportunities to harmonise the proposed MPA with the management of the krill fishery in Planning Domain 1.'*

Ross Sea region MPA

5.39 A Workshop on the Ross Sea region MPA Research and Monitoring Plan (WS-RMP-17) was held at the Italian Ministry of Foreign Affairs and International Co-operation in Rome, Italy (26 to 28 April 2017). The Scientific Committee extended its thanks to the Workshop Co-conveners, Mr Dunn and Drs Vacchi and Watters, to all of the Workshop participants for their constructive engagement and to Italy for hosting a very successful Workshop.

5.40 The Scientific Committee welcomed the WS-RMP-17 Co-conveners' Report (SC-CAMLR-XXXVI/07), and the outputs of subsequent discussions at WG-SAM, WG-EMM and the Ross Sea MPA Implementation e-group (SC-CAMLR-XXXVI/20), as well as at WG-FSA (Annex 7, paragraphs 8.14 to 8.18). It noted that the RMP was required to be introduced to the Scientific Committee and the Commission this year, following adoption of the RSRMPA (CM 91-05) in 2016.

5.41 The RSRMPA RMP provides a research framework for evaluating whether the objectives of the RSRMPA, which fall into three categories (threat mitigation, representativeness and scientific reference areas), are being achieved. The RSRMPA RMP poses a fundamental question relevant to each category.

(i) Threat mitigation – Does the MPA protect the region from threats?

(ii) Representativeness – Does the MPA protect an adequate proportion of the marine environments in the region?

(iii) Scientific reference areas – Are there enough areas with little or no fishing to understand how intact marine ecosystems work?

5.42 The RSRMPA RMP (SC-CAMLR-XXXVI/20) identified research topics and described the process for CCAMLR Members to collaborate and report on research. It encouraged collaboration and close coordination between Members conducting research in the Ross Sea region. It required that research undertaken to support the RSRMPA is open and transparent, and that the underlying research data should be available to all Members. The RMP described baseline data, preliminary indicators of scientific effort and preliminary indicators that describe ecosystem outcomes and services. The RMP is intended to be flexible and to be a 'living' document that will develop over time and through the MPA review process, as information is collected, new questions are raised and new techniques developed.

5.43 Research and monitoring undertaken in accordance with the RSRMPA RMP should seek to address four questions (CM 91-05, Annex 91-05/C, paragraph 1):

(i) Do the boundaries of the RSRMPA continue to adequately encompass the priority populations, features and areas?

(ii) What are the ecosystem roles of the identified habitats, processes, populations, life-history stages, or other priority features?

(iii) How are the priority features potentially affected by fishing, climate change, environmental variability, or other impacts?

(iv) Does the structure and function of the marine ecosystem differ between areas inside and outside the RSRMPA?

5.44 A list of projects will be developed as an integral component of the RSRMPA RMP. These projects will be searchable by Members and the Secretariat, using a project website that facilitates scientific transparency and collaboration, automates the provision of effort indicators and provides links to a RSRMPA data repository. The data repository will primarily identify locations where relevant data are deposited in open-access data catalogues (for example external data repositories). The data repository will also house data that cannot be found elsewhere. The RSRMPA data repository will be accessible to all Members.

5.45 The Scientific Committee endorsed the RSRMPA RMP and agreed that:

(i) the requirement to introduce the RMP to the Scientific Committee and Commission this year (CM 91-05, paragraph 14) had been fulfilled

(ii) the list of research and monitoring topics included in the RMP is comprehensive and usefully linked to the specific objectives of the RSRMPA (e.g. by including clear maps)

(iii) the RMP should be a living document that is regularly reviewed and updated as appropriate by the Scientific Committee in accordance with CM 91-05

(iv) initial updates to the RMP should consider –

(a) research efforts extending beyond 'key species' to include the full ecosystem

(b) studies of key species extending beyond their core distributions to include their full life-cycle distributions

(c) studies adjacent to, and outside, the boundaries of the RSRMPA, including studies undertaken by fishing vessels, are needed to fully evaluate the MPA

(d) indicators of ecosystem services and outcomes are linked to the specific objectives of the RSRMPA

(v) additional updates to the RMP should aim to include –

(a) additional detail to specify baselines that are currently known (e.g. recent estimates of the abundance of key species)

(b) standards for data collection, where appropriate

(c) criteria that are referenced to the indicators of ecosystem services and outcomes and which might be used to evaluate the effectiveness of the RSRMPA

(vi) the new data management group (DMG) (paragraphs 14.7 to 14.10) should include consideration of data related to the RSRMPA in its deliberations and attempt to build relevant strong links with external data sources and warehouses (e.g. the Southern Ocean Observing System (SOOS)).

5.46 The Scientific Committee recommended that the Secretariat host a project website that allows Members to interact with the RSRMPA RMP (including the Project List), facilitates automated tracking of indicators that quantify scientific effort and provides links and access to baseline data and associated datasets. It was also recommended that the Secretariat provide the Scientific Committee with an annual summary of activities related to the RMP. For example, the Secretariat could identify projects added to the Project List (including who, where and when those projects will be executed), summarise submitted baseline data (including where and how such data can be accessed) and update indicators of scientific effort and progress.

5.47 Additionally, the Scientific Committee recommended that its Bureau and Members further consider how the RSRMPA RMP might practically be maintained over the long term. Options include establishment of a standing or ad hoc Working Group on MPAs, holding regular workshops or focus topics within WG-EMM and adding an additional staff member, with primary responsibilities for administrating and facilitating developments related to the RSRMPA RMP, to the Secretariat.

5.48 The Republic of Korea summarised SC-CAMLR-XXXVI/BG/17, which outlines plans for a new research program that aims to improve understanding of the structure and function of the marine ecosystem in the Ross Sea region, particularly of how environmental change might impact the ecosystem. The new research program is specifically intended to contribute towards the RSRMPA RMP and includes monitoring of populations and ecosystem processes explicitly identified in the RMP (e.g. CEMP monitoring of Adélie penguins at Cape Hallett and of the dynamics of coastal polynyas).

5.49 The Scientific Committee welcomed Korea's new research program and agreed that it would make a substantive contribution to the RSRMPA RMP. The Scientific Committee looked forward to receiving results from Korea's new research program, appreciated that the program included research approaches that are not typically considered by its working groups (e.g. biomagnification of pollutants) and noted the results of the research are likely to improve understanding of ecosystem dynamics in the RSR.

5.50 Italy, New Zealand and Australia notified the Scientific Committee of additional efforts to contribute to the RSRMPA RMP. Italy and New Zealand are developing funding streams to support new research in the RSR, and Italy shall launch a call for future proposals and emphasise international cooperation. In this context, Italy may support long-term collaborative monitoring at Cape Hallett with Korea. New Zealand is planning two research cruises to the Ross Sea region on board the RV *Tangaroa*, and Australia is planning a research cruise to study the role of krill and whales in iron cycling in the Krill Research Zone. The Scientific Committee welcomed all these efforts.

5.51 ASOC introduced SC-CAMLR-XXXVI/BG/30, titled 'Strengthening the Ross Sea Research and Monitoring Plan to deliver effective, measurable, and robust management.' ASOC thanked the conveners and participants of WS-RMP-17. ASOC noted the importance of research to assess the effectiveness of the MPA, and welcomed the commitments made by the Republic of Korea and New Zealand to undertake new research in the Ross Sea. Noting that the RMP is a living document that will be refined over time, ASOC suggested that the RMP should highlight more strongly the importance of developing indicators and defining baselines; the linkages between research, monitoring priorities and the overall objectives of the RSRMPA should be clarified as the plan evolves; and the use of geographic terms and references within CM 91-05 and the RMP should be standardised.

MPA Special Fund

5.52 The Scientific Committee welcomed SC-CAMLR-XXXVI/12 on proposed updates to the terms of reference and guidelines for the CCAMLR MPA Special Fund, recognising that recent progress by CCAMLR on the proposal and implementation of MPAs has extended the scope of activities that could be supported by the Fund. It agreed that the updated MPA Special Fund terms of reference, guidelines for use (including an application pro forma) and Management Group terms of reference (as set out in SC-CAMLR-XXXVI/12) should be made available in the Members' area of the CCAMLR website.

5.53 The Scientific Committee encouraged the development of proposals for use of the MPA Special Fund, noting that initiatives in areas not currently the subject of MPA planning efforts (e.g. Domain 9 – Amundsen–Bellingshausen Seas) could be a focus.

5.54 In this context, the Scientific Committee welcomed the development of coordinated research efforts by Australia, France, Norway and South Africa around sub-Antarctic islands in the Indian Ocean sector (Domains 5 and 6) and at Bouvet Island (Domain 4), noting particularly the importance of understanding environmental change and the effects of climate change in these ecosystems at the edge of the Convention Area. The Scientific Committee also looked forward to the results of the Symposium on Fisheries in the Kerguelen Plateau, being held shortly after this meeting, which will generate a collected volume of papers, including on marine conservation in this region.

Advice to the Commission

5.55 The Scientific Committee considered SC-CAMLR-XXXVI/02, which reported on the loss of a 5 800 km^2 section of floating ice from the Larsen C Ice Shelf in Subarea 48.5 on 12 July 2017. Members had been notified via SC CIRC 17/53 that the area of ice loss is equivalent to 12.1% of the baseline extent of the Larsen C Ice Shelf, thus meeting the criteria for designation of a Special Area for Scientific Study set out in CM 24-04, paragraph 2. Coordinates for the baseline extent of the Larsen C Ice Shelf and the Special Area for Scientific Study have been made available in the CCAMLR GIS.

5.56 The Scientific Committee recognised the scientific importance of this area and welcomed plans for research to be undertaken in the coming seasons by the British Antarctic Survey (February/March 2018), the Alfred Wegener Institute (2018/19) and others. It recommended that the initial Stage 1 Special Area for Scientific Study should be extended to a Stage 2 Special Area, designated for a period of 10 years.

IUU fishing in the Convention Area

6.1 The Scientific Committee noted the presentation by the Secretariat on CCAMLR-XXXVI/28 Rev. 2 and endorsed the commentary by WG-FSA (Annex 7, paragraphs 2.14 to 2.18) regarding the unprecedented availability of catch data from illegal, unreported and unregulated (IUU) vessels operating in Division 58.4.1. The Scientific Committee noted that the presence of authorised vessels in the region of IUU activity did not appear to deter the IUU fleet and that the significant quantity of removals by the IUU fleet may have potentially impacted on previous research conducted in the region.

6.2 The Scientific Committee noted and welcomed the offer from Australia to work with the Secretariat to coordinate the analysis of IUU data from Division 58.4.1 (Annex 7, paragraph 2.17) and looked forward to seeing the result of these analyses.

6.3 The Scientific Committee questioned whether the synthetic aperture radar imagery proposal detailed in CCAMLR-XXXVI/08 could be expanded to include 2014, as this would cover the period during which IUU fishing vessels were known to be operating in Area 58.

6.4 The Scientific Committee welcomed the advice from Germany regarding the authorisation of its Antarctic research vessels and aircraft to engage suspected IUU vessels for the purpose of obtaining photographs and other relevant information on suspected IUU activities.

CCAMLR Scheme of International Scientific Observation

7.1 The Scientific Committee considered the WS-SISO Convener's report (SC-CAMLR-XXXVI/08). The Scientific Committee commented favourably on the success of the Workshop, thanked all the participants for the large volume of work that was covered and expressed appreciation to all SISO observers for their work in providing high-quality data which enables the Scientific Committee to conduct its work.

7.2 The Scientific Committee discussed the recommendations that were referred by WS-SISO to WG-EMM (Annex 6, paragraphs 2.11 to 2.29) and provided the following commentary:

(i) The Scientific Committee endorsed the recommendation to remove the need for further subsampling of the 25 kg observer by-catch samples.

(ii) The Scientific Committee considered the addition of krill carapace measurements to observer sampling requirements, noting the paper presented by China on the effect of sample size on the observed length distribution of krill (SC-CAMLR-XXXVI/21) that was undertaken in response to the request from WG-EMM (Annex 6, paragraph 2.16). The Scientific Committee noted that this work reached a similar conclusion to previous work that had been presented to WG-SAM (WG-SAM-16/39) which used slightly different approaches on different datasets. The Scientific Committee noted the importance of analyses investigating variability in krill growth rates on both inter-seasonal and interannual time scales, and how carapace measurements may assist in these analyses, however, the Scientific Committee requested that WG-SAM and WG-EMM undertake further work to ensure that an appropriate level of krill sampling was undertaken by observers for addressing current scientific objectives.

(iii) The Scientific Committee also noted that it is important to evaluate the sampling requirements in the krill fishery by observers regularly to ensure an adequate level of sampling is taking place.

(iv) The Scientific Committee supported the reduction in warp strike observations by observers on krill vessels, subject to the evaluation of an appropriate observation frequency, and requested Members undertake this task noting that electronic monitoring could be an effective replacement in many circumstances.

(v) The Scientific Committee agreed that observers may be able to provide important data on interactions with air-breathing predators, during both commercial krill fishing operations and survey transects. However, there needed to be further consideration on what specific scientific questions required answering, to ensure data collection requirements were robustly designed.

(vi) The Scientific Committee agreed that there was potential value to expanding the collection of by-catch data from the krill fishery to include invertebrates. It noted that current guides on invertebrate by-catch associated with krill fisheries need updating and encouraged Members to submit any invertebrate guides they may have that can be compiled by the Secretariat and made available in the SISO section of the website.

7.3 The Scientific Committee endorsed the recommendations that were referred by WS-SISO to WG-FSA (Annex 7, paragraphs 5.6 to 5.8).

7.4 The Scientific Committee also noted that the current *Scientific Observers Manual* has not been updated since 2011 and omits many needed topics (SC-CAMLR-XXXVI/08, paragraph 2.2). It endorsed the development of a new CCAMLR observer manual for all fisheries, which is underway through the request of Member-submitted observer data collection documentation and e-group discussion. The new manual will include sampling requirements and protocols as well as robust instructions for completing forms.

7.5 The Scientific Committee recommended metadata clearly stating the version(s) of the observer manual and data collection forms used be included in data extracts received by Members.

7.6 The Scientific Committee considered the recommendations referred by WS-SISO to the Scientific Committee and the Commission and provided the following advice:

(i) The requirement for observers to submit their data and report within one month of returning to home port should be retained. It recommended that an email requesting the timeline for submission of data be sent from the Secretariat to the relevant technical coordinator after the vessel exited the Convention Area, as this would provide better clarity for when data would be available for use by CCAMLR Members.

(ii) Requested the Commission consider recommendations listed in Table 4, which are still outstanding from the 2013 SISO Review (SC-CAMLR-XXXII/07 Rev. 1).

(iii) Recommended changes to the text of SISO listed in Annex 4 of the WS-SISO report (SC-CAMLR-XXXVI/08).

(iv) Recommended that in order to provide clarity on the reporting requirement of join lines in observer and commercial data, the Commission adopt the fishing gear specifications set out in CM 33-02, footnote 1, for all CCAMLR fisheries.

(v) Recommended the addition of data fields containing the freezing capacity in kilowatts, and the maximum production rate of the vessels (expressed in tonnes per day) to the vessel notification details.

(vi) Recommended that set and haul start and end times be specified as times that the first anchor enters the water to the time that the final anchor is brought aboard the vessel, and clear instructions to this effect be specified in the C2 data forms.

(vii) Recommended that relevant Flag States improve catch reporting for krill vessels using the continuous fishing system, in terms of accurately recording the weight of catch taken during the two-hour haul period.

7.7 The Scientific Committee considered the paper presented by Russia on a CCAMLR observer training workshop for Russian SISO observers (SC-CAMLR-XXXVI/14). The Scientific Committee thanked Russia for the information and noted that it has encouraged Members to submit their observer training information, and the CCAMLR Observer Training Program Accreditation Scheme (COTPAS) provides a comprehensive framework and mechanism for providing feedback to Members on observer training programs.

Climate change

8.1 CCAMLR-XXXVI/20 presented a draft Climate Change Response Work Program (CCRWP) addressing the remaining terms of reference of the climate change intersessional correspondence group (ICG) to develop approaches for integrating considerations of the impacts of climate change into the work of CCAMLR. The ICG sought feedback on the draft work program, specifically, advice on issues, information gaps identified, proposed actions and relevant activities already underway, as well as advice on appropriate timeframes for responding to research activities. The paper recommended that Members agree to adopt the CCRWP and the terms of reference for an ICG to support its implementation, as presented in CCAMLR-XXXVI/20, Attachments A and B respectively. In presenting CCAMLR-XXXVI/20, the Scientific Committee emphasised that the work plan was intended to be a living document, with close ties to the working groups and outside bodies such as the CEP, SCAR and other groups involved in climate change activities.

8.2 The Scientific Committee noted that WG-EMM supported the proposed CCRWP and recognised that the important elements of climate change-related work are found in almost all the working groups' work. It noted that there was a need to ensure that the program was kept up to date and relevant (Annex 6, paragraphs 6.21 to 6.23).

8.3 The Scientific Committee noted that WG-FSA recognised that many activities identified in the plan were already part of the five-year plan for the Scientific Committee. The Working Group recommended bringing climate change science and the potential impacts on finfish in the Southern Ocean into the work of WG-FSA. Specific mention of toothfish was recommended by WG-FSA, and it was noted that there were considerable opportunities for fishing vessels to participate in the collection of oceanographic data relevant to climate change studies (Annex 7, paragraphs 8.6 to 8.10).

8.4 Both working groups called attention to the Marine Ecosystem Assessment for the Southern Ocean (MEASO) conference and the preceding Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) workshop to be held in April 2018 (www.measo2018.aq) in Hobart, Australia. This conference aims to progress many of the issues raised in the CCRWP, including assessing and managing the impacts of climate change on Southern Ocean ecosystems and Antarctic marine living resources.

8.5 The Scientific Committee thanked Australia and Norway for their leadership of the ICG and noted the importance of the CCRWP being flexible in order to respond to new knowledge and the needs identified by the Scientific Committee and working groups. Some Members noted that climate change was a core part of the Scientific Committee's work; thus, the plan should maintain its current autonomy and remain a separate agenda item. Having a separate intersessional working group to coordinate activities was viewed as important to keep the plan up to date, avoid unnecessary duplication of effort and ensure effective coordination with external organisations.

8.6 Other Members felt that a separate agenda item was not needed, and that because the Scientific Committee has a coordination group, a separate implementation group may not be necessary. Regardless of organisational structure within the Scientific Committee, the need for cooperation and coordination with bodies such as the CEP, SCAR, SOOS, ICED, the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) etc. was critical to the success of efforts.

8.7 Dr Zhao expressed his appreciation to the climate change ICG for its excellent work. He expressed the opinion that many of the elements in relation to climate change can be embedded in the existing agenda item of the Scientific Committee and thus keep the agenda item of climate change itself to a minimum.

8.8 In the following discussion, a specific issue related to climate change impacts on penguin populations in the Antarctic Peninsula was raised. While papers in the scientific literature address both upward and downward trends in population numbers of various penguin species, it was noted that this topic has not been addressed directly in the Scientific Committee, even though penguins are a CEMP indicator species. Members noted that this is a challenging topic, involving not only climate change impact to penguins, but also the recovery of marine mammal species, and competition for resources. A current summary of penguin population changes in the Antarctic Peninsula can be found in the Antarctic Environmental Portal at www.environments.aq/emerging-issues/changes-in-penguin-distribution-over-the-antarctic-peninsula-and-scotia-arc.

8.9 The Scientific Committee noted that the use of reference areas as part of CCAMLR's system of MPAs and experimental fishing methods were designed to control for factors such as the level of fishing to better understand and account for climate change in the Scientific Committee's advice. It was noted that the topic of status and trends of Antarctic marine living resources was addressed in PR2, Question 5.

8.10 Dr Y. Lei (China) noted that the proposed CCRWP is based on the work of the working groups of the Scientific Committee, which demonstrated that it is highly related to the Scientific Committee, and made the following suggestions:

(i) as the draft CCRWP is a work plan of CCAMLR, the work of other external organisations in this regard, such as CEP, SCAR, ICED and SOOS, should be appropriately regarded by CCAMLR but better be listed in a separate column as external source of information

(ii) to include in the CCRWP that, in the future three years, the development of a mechanism to enable the appropriate use and examination of data from external organisations, and the development of a clear overall strategy including the aim and method to provide climate-related information and recommendations to the Commission, as demonstrated in *CCAMLR's Management of the Antarctic* in 2000, on the basis of assessment on the status and trends of the Antarctic marine living resources and the ecosystem suggested by PR2. Such work could be conducted in parallel with other work contained in the CCRWP

(iii) that every five years may be more appropriate than an annual review, to distinguish the annual variation from the mid- or long-term change.

8.11 The Chair of the CEP described the activities of the Committee in the area of climate change in the Antarctic Treaty area. The CEP identified understanding and addressing the environmental implications of climate change in the Antarctic Treaty area as a high priority. In 2015, the CEP adopted a CCRWP. The CEP and ATCM in 2017 agreed to established a formal subsidiary group of the CEP to support the implementation of the CCRWP. The Subsidiary Group on Climate Change Response facilitates coordination among stakeholders, supports tasks identified in the work plan and provides advice to the CEP on recommended management, research and monitoring actions. The aim is to ensure that the work plan is an up-to-date and living tool that reflects the current state of knowledge on climate change and associated environmental implications.

8.12 The CEP Chair noted the successful 2016 Joint CEP–SC-CAMLR Workshop on Climate Change and Monitoring which demonstrated that the two committees have a range of shared needs and responsibilities regarding the implications of climate change for the protection and conservation of the Antarctic region. The CEP CCRWP identifies the need for communication and coordination with SC-CAMLR and other stakeholders, including to address the recommendations from the 2016 workshop. The CEP Chair noted the establishment of a CCRWP by the Scientific Committee would present an opportunity for continued cooperation to advance shared interests and responsibilities.

8.13 The Scientific Committee recommended that the Commission adopt the CCRWP and support the continuation of an ICG to support implementation of the work program.

8.14 In CCAMLR-XXXVI/BG/27, ASOC strongly supported the adoption of a CCRWP and the establishment of an ICG to support its implementation, with the aim of incorporating climate change considerations in CCAMLR's decision-making process. ASOC provided the ICG with recommendations to ensure a smooth and effective implementation of the plan. Recommendations included planning activities to achieve measurable results, establishing time frames for action (including high-priority tasks which can be achieved in the short term) and working toward the aim of including implication statements in Fishery Reports, Scientific Committee and Commission papers where relevant.

8.15 SC-CAMLR-XXXVI/BG/16 presented an update of climate change science, based on the SCAR Antarctic Climate Change and the Environment (ACCE) Report. This is the first such report to the Scientific Committee; annual reports have been presented to the CEP for several years. This paper described the results of selected research projects which exemplify significant recent advances in the understanding of climate change across the Antarctic continent and the Southern Ocean, and the impacts on the terrestrial and marine biota. A recent development has been that the original ACCE report and the updated key points have been made available online as a wiki at http://acce.scar.org/wiki/Antarctic_Climate_ Change_and_the_Environment. This online document is being progressively updated over time.

8.16 SC-CAMLR-XXXVI/BG/19 described progress made by Oceanites in its work to distinguish effects of climate change, human activity and other factors in the warmed Antarctic Peninsula. A recent development has been a formal agreement with Aker BioMarine AS (Norway), which will allow the company's historic fishing data to be analysed against the long-term penguin databases Oceanites maintains. Excellent progress was achieved through the Mapping Application for Penguin Population and Projected Dynamics (MAPPPD), which was used to produce the continent-wide State of Antarctic Penguins 2017 report. The program includes new analytical tools for work with continent-wide penguin population data; these include predictive models for gentoo (*Pygoscelis papua*) and chinstrap penguins, and advance search capabilities.

8.17 The Scientific Committee expressed interest in the MAPPPD application and noted improvements over the past year which could make the application useful to the work of the Scientific Committee and its working groups. It was noted that if results from MAPPPD were to be used for management advice, the application should be reviewed by WG-SAM.

Scientific research exemption

Chilean survey

9.1 The Scientific Committee noted the proposed research plan from Chile to conduct a bottom trawl survey of the distribution, abundance and biological characteristics of Antarctic demersal fish communities in the 2017/18 season along the shelf areas of Subareas 48.1 and 48.2.

9.2 The Scientific Committee agreed that the proposed survey should proceed following the survey design outlined in Annex 7, paragraph 4.150, and it further agreed with the catch limit of 50 tonnes for Subarea 48.1 and 50 tonnes for Subarea 48.2.

Australian survey

9.3 The Scientific Committee noted that Australia intends to conduct its annual randomised stratified trawl survey in Division 58.5.2 in 2018.

Cooperation with other organisations

10.1 The Scientific Committee noted the arrangements for cooperation with regional fisheries management organisations (RFMOs) in areas adjacent to the CCAMLR area (CCAMLR-XXXVI/10 Rev. 1) and the update from the Secretariat that there is ongoing discussion between the relative Secretariats, including on the subject of toothfish tagging programs in order to avoid duplication of effort and ensure compatibility of data collection and research.

Cooperation with the Antarctic Treaty System

CEP

10.2 The CEP Observer to SC-CAMLR (Dr Penhale) informed the Scientific Committee that the 20th meeting of the CEP was held from 22 to 26 May 2017 in Beijing, China. Five topics of mutual interest to both the CEP and SC-CAMLR were presented in the CEP 2017 Annual Report to the Scientific Committee (SC-CAMLR-XXXVI/BG/08).

10.3 The Scientific Committee noted that the CEP has made progress regarding the CEP Climate Change Response Work Plan and established an intersessional subsidiary group to review and manage the work plan. Clear communication and cooperation with CEP members, observers, experts and the ATCM will be a focus of this group. Specifically, working more closely with SC-CAMLR and SCAR on climate change issues is an important goal of the group.

10.4 The Scientific Committee also noted that the CEP welcomed a report by Argentina and Chile on progress made on the development of an MPA in Domain 1. The CEP noted that future discussions should include means and opportunities to look at the connectivity between ocean and land, and if and how complementary measures within the framework of the Environmental Protocol could support and strengthen marine protection initiatives.

SCAR

10.5 The SCAR Observer (Prof. M. Hindell) presented the SCAR Annual Report 2016/17 (SC-CAMLR-XXXVI/BG/13) and noted that SCAR and CCAMLR have a long history of cooperation and that representatives of the two organisations continue to meet regularly to maintain and develop the relationship by identifying current areas of mutual interest. This was reaffirmed during PR2, in which SCAR actively participated, and at the 2017 meeting of WG-EMM, where several SCAR subsidiary bodies and affiliated groups presented papers. The Chief Officer of the SCAR Standing Committee on the Antarctic Treaty System and the Chair of SC-CAMLR continue to maintain regular communication regarding priority areas of research and key issues which would benefit from scientific advice from SCAR.

10.6 SC-CAMLR-XXXVI/BG/13 contained a diverse range of research highlights of interest and relevance to SC-CAMLR. In relation to the focus issue 1 on large-scale population cycles in Antarctic krill (*Euphausia superba*), SCAR highlighted a recent study that provided insights into the drivers of krill cycles, with important implications for the prediction and assessment of krill population dynamics with particular relevance to whole of ecosystem studies. Regarding focus issue 2 on emperor penguin (*Aptenodytes forsteri*) population structure, SCAR provided information on several recent studies, which are important for predicting population trajectories and a better understanding of the role of emperor penguins as key predators in the Southern Ocean ecosystem. With respect to the physical environment (focus issue 3 on ice-sheet mass changes and effects on sea-level rise), SCAR reported on recent research, which suggests that melting ice sheets will have the most impact on ecosystems, fish stocks and habitat availability across Subareas 48.1, 48.5 and 88.3.

10.7 SC-CAMLR-XXXVI/BG/13 also referred to several upcoming activities of interest to the Scientific Committee, including the MEASO 2018 conference and the associated workshops/meetings to be held in Hobart, Australia, in April 2018.

10.8 The Scientific Committee thanked SCAR for its annual report and recognised the important role that it plays in bringing important science to CCAMLR. In that regard, the Scientific Committee noted the recommendation in the PR2 Report (CCAMLR-XXXVI/01) on strengthening engagement between the Scientific Committee and SCAR in order to improve mechanisms for science delivery.

10.9 The Scientific Committee noted that in June 2017 the world's leading krill scientists met at the Third International Symposium on Krill held in St Andrews, UK, and identified a number of key research topics on krill, many of which are of importance to CCAMLR. In order to take these topics forward and to address the recommendations in CCAMLR-XXXVI/01, the Scientific Committee requested that SCAR consider the establishment of a krill expert group to bring together those scientists working on krill and to have a linkage to CCAMLR as a key element of that group. The development of such a group would provide a mechanism to improve the coordination of krill research and also the delivery of those elements of that research that are of relevance to CCAMLR.

10.10 Dr A. Terauds (SCAR) agreed that a krill specialist group within SCAR with a strong linkage to CCAMLR would be a positive development and encouraged SC-CAMLR to engage with SCAR's Life Sciences Group to determine how best to proceed with this.

10.11 Welcoming the offer from Germany to nominate a krill expert for taking forward the process and discussions with respect to the establishment of a krill specialist group within SCAR, the Scientific Committee agreed that Prof. B. Meyer (Germany) will liaise on behalf of the Scientific Committee with SCAR's Life Sciences Group on this issue and provide an update to WG-EMM-18.

Reports of Observers from other international organisations

SCOR

10.12 The SCOR Observer (Dr L. Newman) introduced SC-CAMLR-XXXVI/BG/14 and made a presentation on the recent activities and products developed under SOOS relevant to the work of CCAMLR. The information provided contained, inter alia, key data, coordination products and upcoming activities of relevance to the Scientific Committee. The SCOR Observer also updated the Scientific Committee on progress and invited collaboration towards delivery of SOOS networks and tools that would benefit both communities. Dr Newman highlighted the work of the Regional SOOS Working Groups (three have been established, two more are in preparation) and encouraged CCAMLR delegates to communicate with, and be involved in, these coordination networks.

10.13 The SOOS report in SC-CAMLR-XXXVI/BG/14 contained three items for the Scientific Committee to discuss and consider:

(i) CCAMLR contributions to the Database of Upcoming Expeditions to the Southern Ocean ('DueSouth') through agreement to include proposed areas of operation by fishing vessels into DueSouth, such as the already public Fisheries Notifications. If agreed, SOOS will require some additional basic information in the notifications, such as:

(a) details of a contact person for that vessel or trip

(b) ship departure and arrival port from which, for example, cruise transects to the central latitude/longitude of the stated fishing zone can be drawn

(c) approximate dates of travel to within three months, rather than 12 months

(ii) potential data layers that CCAMLR can provide to the integrated interactive web tool developed under SOOS ('SOOSmap') or other non-CCAMLR data layers that may be useful to the CCAMLR community for inclusion in SOOSmap

(iii) for a data expert from the CCAMLR Secretariat to become a member of the SOOS Data Management Sub-Committee to avoid duplication and support the efforts of CCAMLR in identifying key data repositories.

10.14 The Scientific Committee thanked SCOR for the information provided on SOOS. The data, products and tools gathered and developed under SOOS were very useful for the various work carried out under CCAMLR, including marine spatial planning, research and monitoring and climate change response.

10.15 The Scientific Committee noted that in their research proposals, CCAMLR Members increasingly include the deployment of miniature conductivity temperature depth probes (CTDs) from fishing vessels. The data provided by these devices could contribute to the data layers in SOOSmap and also be used for calibration purposes. The Scientific Committee also noted that in light of the SOOS invitation, a data expert from the CCAMLR Secretariat will in future become a member of the SOOS Data Management Sub-Committee.

10.16 The SCOR Observer presented SC-CAMLR-XXXVI/BG/15 on the proposal for a joint workshop between representatives of SOOS and CCAMLR to identify mechanisms for greater collaboration and coordination on issues of joint interest.

10.17 The Scientific Committee noted that there was a workshop scheduled as part of the MEASO conference and associated meetings that would provide an opportunity for CCAMLR scientists and SOOS to meet (paragraph 10.7). The Scientific Committee welcomed this proposal and noted that such a joint SOOS–SC-CAMLR workshop would further strengthen the interaction between both bodies.

ARK

10.18 The Observer from ARK (Ms C. Holmes Indahl) presented SC-CAMLR-XXXVI/BG/33 and made the following statement:

> *'ARK has been formally invited as an observer to the Scientific Committee since 2012, and this invitation was renewed in 2017 for which ARK thanks the Commission. The aim of ARK is to assist the krill fishing industry to work with CCAMLR to ensure the sustainable management of the fishery. ARK now has five member companies: Aker BioMarine, Rimfrost, Insung Corporation, China National Fisheries Corporation (CNFC) and Deris S.A (Pesca Chile), with more companies currently considering invitations to join ARK. Over 80% of the current krill catch is being taken by ARK members.*

In the past year, ARK has had continued dialogue with the International Association of Antarctica Tour Operators (IAATO) with the aim of furthering understanding between the fishing and the tourism industries. ARK and IAATO are preparing book content that IAATO can provide to its member companies which provide information on the krill fishery and its management.

ARK notes that CCAMLR Conservation Measure 51-07 will expire in 2021 unless a more permanent solution to the problem of spreading out the krill catch in Area 48 has been developed. Such a solution needs to be developed as a matter of urgency. Any solution needs to involve cooperation with the krill fishing industry and ARK anticipates working constructively with the Scientific Committee to achieve a lasting outcome that will achieve the aims of Article II of the CAMLR Convention.

At its 2017 meeting, WG-EMM highlighted the importance of the development of acoustic transects by scientific research vessels and fishing vessels. ARK recognises the importance of this work and is open to discussions that might progress the development of fishing vessel acoustic transects in the Antarctic Peninsula region. To assist with this process, ARK has deployed one acoustic calibration kit, purchased by Aker BioMarine, for use by its members participating in the krill fishery.

ARK notes the suggestion for the creation of an Expert Group on Domain 1 MPA development that would include members of the fishing industry. ARK believes that any further development of MPA proposals for the Peninsula region needs to involve considerable discussion with the krill fishing industry and ARK members are available to assist.

ARK hosted a successful workshop at the Third International Krill Symposium in St Andrews, Scotland. The aim of this workshop was to bring together scientists from the wider krill community and the fishing industry to explore topics of mutual interest. The meeting indicated the huge potential for research collaborations between the fishing industry and scientists.

ARK notes Recommendation 24 of the second CCAMLR performance review (CCAMLR-XXXVI/01) on mechanisms to be considered and implemented for the participation of experts and observers in the work of the subsidiary bodies of the Commission and the Scientific Committee. ARK suggests that in the development of future management procedures for the krill fishery, expert input from the krill fishing industry to WG-EMM will be essential. ARK is in a good position to provide such expertise.

ARK thanks CCAMLR for the opportunity to observe during the 2017 annual meetings of the Scientific Committee and the Commission and looks forward to working with CCAMLR in the intersessional period.'

10.19 The Scientific Committee thanked ARK for the information provided and noted that fishing vessels are valuable tools for gaining data in areas which are otherwise not accessed.

ASOC

10.20 The Observer from ASOC (Dr Werner) informed the Scientific Committee that ASOC had submitted background papers relevant to the work of the Scientific Committee on a large variety of issues addressed by CCAMLR, for example on the development of CCAMLR MPAs in Domain 1 and East Antarctica, on krill management, on microplastics, on CCAMLR's climate change program and on the recommendations from PR2.

10.21 The ASOC Observer informed the Scientific Committee that in January and February 2018 Greenpeace (an ASOC member) will undertake an expedition with the ice-strengthened vessel *Arctic Sunrise* in Antarctic waters. The focus of this expedition is to strengthen and support proposals to establish new MPAs in the Weddell Sea and the Antarctic Peninsula. Using a manned submersible, Greenpeace will work with independent scientists to conduct video surveys of seafloor areas. Data on VMEs documented during the expedition will be shared with CCAMLR.

10.22 The ASOC Observer also provided the Scientific Committee with an update on the Antarctic Wildlife Research Fund (AWR). AWR was launched in February 2015 to facilitate and promote research on the Antarctic ecosystem. AWR's founding partners are representatives from ASOC, the World Wide Fund for Nature (WWF)-Norway and Aker BioMarine. The third call for AWR proposals opened in March 2017 and closed in June 2017. The final decision on funding individual proposals was made by the board of AWR on 19 September 2017. Three projects were selected, covering the following issues: (i) the rapid unsupervised automated krill density estimation from fishing vessels, (ii) the reconstruction of mesopelagic fish populations, and (iii) the concurrent assessment of baleen whale and krill distribution along the West Antarctic Peninsula. The selected projects are in line with the important information gaps and sources of uncertainty in the management of the krill fishery that have been identified by the Scientific Committee.

10.23 The Scientific Committee thanked ASOC for the overview on the various ASOC activities related to the work of CCAMLR and noted that Aker BioMarine had kindly agreed to continue its support of the AWR with an annual contribution of US$200 000.

FAO

10.24 The Scientific Committee noted a report on a Food and Agriculture Organization of the United Nations (FAO) Workshop on Potential Impacts of Climate Change on Deep-sea Ecosystems and Fisheries held on 26 August 2017 at Woods Hole, USA. This workshop was attended by Dr Jones, who had been nominated to represent the CCAMLR Scientific Committee at this workshop following SC CIRC 17/46. Discussions at the workshop focussed on the topics identified in presentations made by selected scientists, including climate-relevant oceanographic features, deep-ocean climate change projections, finfish use of VME habitats and benthopelagic coupling, the potential influence of climate change and benthopelagic linkages on VMEs, habitat suitability models/species distribution models, and progress made towards vulnerability modelling. The outcomes of the workshop will be captured in a peer-reviewed FAO Technical Report drafted by participants, which is scheduled for mid-December 2017.

COLTO

10.25 The Observer from COLTO (Mr R. Ball) informed the Scientific Committee that, once again, COLTO was delighted to be able to promote collaboration between the fishing industry and science by sponsoring the CCAMLR tag-return lottery. He announced the winners of the tag lottery for the 2016/17 fishing season, which had been randomly drawn by the Secretariat from tag returns in new and exploratory fisheries:

(i) first prize went to the Korean-flagged vessel *Kingstar*, tagging an Antarctic toothfish in Division 58.4.1 on 19 February 2015, which was recaptured 15 km away by the same vessel on 9 March 2017 (749 days later), still in the same research block

(ii) second prize went to the Japanese-flagged vessel *Shinsei Maru No. 3*, tagging an Antarctic toothfish in Subarea 48.6 on 9 January 2016, which was recaptured 6 km away by the same vessel on 26 March 2017 (442 days later), still in the same research block

(iii) third prize went to the South African-flagged vessel *Koryo Maru No. 11*, tagging an Antarctic toothfish in Subarea 48.6 on 19 January 2016, which was recaptured 3 km away by the same vessel on 9 March 2017 (371 days later), still in the same research block.

10.26 COLTO reiterated its support for the tagging program in CCAMLR fisheries, thanked the crews of vessels for their efforts in the tag and release programs, and congratulated the winners.

10.27 The Scientific Committee thanked COLTO for continuing this very useful initiative and noted that all tagged fish were recaptured very close to the original release location. This confirms that toothfish in general does not move very much, however, other tag returns show that some individuals undertake long-distance migrations over many thousands of kilometres.

ACAP

10.28 The ACAP Observer (Dr M. Favero) thanked CCAMLR for the invitation to attend the Scientific Committee meeting. ACAP appreciates the work done by the Scientific Committee in maintaining an effective implementation of conservation measures concerning seabirds. CCAMLR has been, and still is, considered by ACAP as a model in these matters, to be followed by other fora. Many albatross and petrel species listed in Annex 1 of ACAP and present in the CAMLR Convention Area are also distributed in adjacent waters. ACAP continues its work in these areas to promote the adoption and implementation of seabird conservation measures, as well as to better understand the nature and magnitude of by-catch. During the Tenth Meeting of the ACAP Advisory Committee (held in September 2017 in Wellington, New Zealand) the Agreement's Seabird Bycatch Working Group updated the Best Practice Advice for demersal longline fisheries regarding specifications for bird scaring lines for fishing vessels < 24 m. The ACAP Best Practice Advice still considers the combined use of an appropriate line weighting regime, bird scaring lines and night setting constitutes the most effective measures to reduce incidental take of seabirds in demersal longline fisheries. No changes were made to the advice for trawl fisheries. The ACAP Secretariat wished to reaffirm its commitment to work with the CCAMLR Secretariat in the implementation of the Memorandum of Understanding between ACAP and CCAMLR, which was renewed in 2015.

Reports of representatives at meetings of other international organisations

IWC

10.29 The Scientific Committee noted the deliberations at WG-EMM-17 with respect to the cooperation between CCAMLR and the International Whaling Commission (IWC) (Annex 6, paragraphs 5.20 to 5.23).

10.30 Regarding the interests and potential for a second Joint SC-CAMLR–IWC Workshop on the development of multi-species ecosystem models of interest to both organisations, the Scientific Committee would welcome a document by IWC, so that such a joint workshop could be discussed in the context of the overarching cooperation between IWC and CCAMLR. The Scientific Committee noted that such a joint workshop would have financial implications and would have to be considered in the context of the agreed priorities in the Scientific Committee five-year plan.

10.31 ASOC welcomed that the Scientific Committee continues to pursue collaborations with the Scientific Committee of the IWC, especially in the light that scientists have begun in recent years to understand more about the roles of large whales in marine ecosystems. Whales can contribute nutrients to the environment, thus enhancing ecosystem productivity. ASOC therefore believed that CCAMLR must begin to pay more attention to large baleen whales (primarily blue, fin, humpback and minke whales) and their role in Antarctic food webs, particularly in an era of climate change. ASOC recommended an increased cooperation and knowledge sharing between CCAMLR and IWC scientists at the IWC Scientific Meeting in 2018. ASOC supported the proposed joint SC-CAMLR–IWC Workshop in 2018 and hoped that this will result in further study, cooperation and data sharing in the Southern Ocean to allow for the inclusion of whales in CEMP.

Future cooperation

10.32 The Scientific Committee thanked the Secretariat for preparing SC-CAMLR-XXXVI/BG/09 that provides an annual update on meetings of interest to the Scientific Committee. The Scientific Committee agreed that this paper was no longer required given the improved dissemination of details of meetings and also that the group comprising the Scientific Committee Bureau (paragraph 16.8) could deal with intersessional requests for representatives from CCAMLR to attend scientific meetings.

Budget for 2018 and advice to SCAF

11.1 The Scientific Committee recalled that the provision of technical and logistical support for meetings of the Scientific Committee and its working groups is part of the central role of the Secretariat and, as such, is funded from the Commission's General Fund (SC-CAMLR-XXX, paragraph 12.1).

11.2 The Scientific Committee agreed to fund two scientific scholarships (paragraphs 13.9 to 13.18) with a combined commitment of AU$54 500 over two years resourced from the General Science Capacity Fund.

11.3 The Scientific Committee also requested SCAF to consider:

(i) the proposal for an independent review of CCAMLR assessments (Annex 7, Appendix D)

(ii) the importance of the role of Members hosting working group meetings in developing scientific capacity in SCAF's discussion of a mechanism to fund the attendance of working group conveners and the Scientific Committee Chair.

11.4 The Scientific Committee welcomed the recommendation from SCAF to support funding for the assessment review and also the recognition of the essential capacity building and scientific engagement role of continuing the current practice of Members hosting working group meetings.

Advice to SCIC

12.1 On behalf of the Scientific Committee, the Chair transmitted the Scientific Committee's advice to SCIC. SCIC requested advice from the Scientific Committee Chair on IUU fishing, preliminary assessments for bottom fishing under CM 22-06, of the criteria to assess the suitability of toothfish tagging, fishery forecasting and closure mechanisms, shark by-catch in the Convention Area and catch reporting in the krill fishery.

Scientific Committee activities

Priorities for the work of the Scientific Committee and its working groups

13.1 The Chair of the Scientific Committee presented SC-CAMLR-XXXVI/BG/40, development of a five-year work plan for the CCAMLR Scientific Committee, noting that it had incorporated the advice of the working groups during 2017. Dr Belchier considered the document to be a living document that would change as items were added, removed, or when tasks were completed. Additionally, Dr Belchier noted that changes might occur to accommodate changes in priorities and that the plan was based on themes and topics, rather than by working groups, as different themes may require input from different sources.

13.2 The Scientific Committee noted that climate change is a coherent thread throughout the work plan and is clearly a topic that is essential to the work of the Scientific Committee. Given the ubiquitous nature of the climate change theme, Dr Belchier suggested that climate change should be addressed as a standing item at each working group or sub-group meeting and that the relevant outcomes be collated to provide a summary of the status of climate change-related studies and prevailing conditions in the CCAMLR area.

13.3 The Scientific Committee agreed that the table format and structure of SC-CAMLR-XXXVI/BG/40 was useful for tracking and streamlining the work of the Scientific Committee and its working groups and subgroups. Members requested that the Secretariat make the table into a public webpage so that Members and parties interested in the work of the Scientific Committee would be able to see the work plan. The Scientific Committee also indicated that such an outward-looking web presence could increase transparency of its work.

13.4 The Scientific Committee indicated that owing to the number of items that were part of the work plan and the number of additions that may be necessary, the web-based workplan should be updated regularly. The Chair of the Scientific Committee indicated that he would update the priorities table webpage when necessary, including following each intersessional meeting.

13.5 Dr Kasatkina noted that the issues outlined in SC-CAMLR-XXXVI/15 had been discussed at some length during previous meetings, but reiterated several points. First, Dr Kasatkina noted that managing the krill resource was a critical issue for the Scientific Committee; second that FBM is seen as the basis for evaluating CM 51-07 in four years and progress on this item will need to be made; and options for the spatial allocation of catch will need to be formulated. Dr Kasatkina also reiterated that the absence of monitoring data in Area 48 meant that there is a need to continue to progress the use of fishing vessels to collect acoustic data for the assessment of krill biomass across Area 48. Moreover, Dr Kasatkina noted that the long gap, 17 years, since the last synoptic krill acoustic survey was conducted, coupled with the ongoing climate change over that time, suggested that such a broad-scale synoptic survey would be critical to conduct in order to understand the distribution of krill.

13.6 Dr Godø informed the Scientific Committee that Norway would be conducting an acoustic survey with its new research vessel in austral summer 2019. Norway was developing a multinational industry and science plan to repeat the survey. It had formed a correspondence group and will be using the existing 2016 Multi-Member Research e-group to organise the work. Norway invited other Members to contribute to the planning and suggested that, despite the short time for planning, it would be possible to successfully complete this multi-sector survey. The Scientific Committee suggested that planning of this survey be added as an agenda item to the meetings of SG-ASAM and WG-EMM in 2018.

13.7 The Scientific Committee noted the full agendas for the working group meetings and considered whether it would be appropriate to delay the development of the terms of reference of the proposed Joint IWC–SC-CAMLR Workshop. The Committee recognised that a delay for at least two years would be appropriate but noted that there were sufficient informal contacts between members of the IWC and the Scientific Committee that information could still be shared.

13.8 ASOC offered to provide financial assistance for an intersessional workshop to advance technical discussions related to FBM which would be open to any interested CCAMLR Member or observer. Drs Watters and Trathan have been approached to develop appropriate terms of reference, through collaboration with interested scientists from CCAMLR Members, and to convene the workshop. Possible dates and a venue will be notified in due course. Outputs from the workshop will be presented through a working paper to WG-EMM-19 (paragraph 3.28).

CCAMLR Scientific Scholarships Scheme

13.9 The Chair of the Scientific Scholarship Review Panel, Dr Somhlaba, senior Vice-Chair of the Scientific Committee, announced the recipients of the 2017 CCAMLR scholarship. He noted that once again two high-quality proposals were received and sufficient funds were available to provide a scholarship to both applicants.

13.10 Two scholarships were awarded, Mr Davide Di Blasi of Italy was awarded a scholarship to develop non-invasive techniques for the study of fishes in the Ross Sea, including toothfish and silverfish. The second scholarship was awarded to Ms Elisa Seyboth of Brazil who will be working on understanding the relationship between the recent increase in fin whales around the Antarctic Peninsula and their relationship to Antarctic krill around the South Shetland Islands.

13.11 Ms Seyboth thanked the scholarship panel, the Scientific Committee and the Commission for the award. She also thanked Dr Watters, her mentor in the US AMLR Program. Ms Seyboth noted that she hoped this award would help with the re-engagement of Brazil in CCAMLR and especially in the working groups.

13.12 The Scientific Committee noted that the award of a CCAMLR Scholarship to Ms Seyboth of Brazil to study whales underscored the ongoing commitment to better understand their importance to the work of CCAMLR (paragraph 13.7).

13.13 Dr Vacchi thanked the Scientific Committee for the scholarship award to Mr Di Blasi on his behalf. Dr Vacchi noted that Mr Di Blasi is working on his PhD with the Italian National Antarctic program and is working with other Members, including New Zealand, during this study.

13.14 The Scientific Committee congratulated both scholarship awardees and New Zealand noted that Mr Di Blasi participated on the recent winter cruise to the Ross Sea in 2015 that was the first to find eggs and larvae of *D. mawsoni*.

13.15 Dr Korczak-Abshire, the Convener of WG-EMM, congratulated both recipients on their awards and also looked forward to an increased engagement by Brazil at WG-EMM and within the Commission through this award.

13.16 Dr M. Santos and Ms A. Capurro of Argentina, both previous scholarship recipients, offered their congratulations to both recipients. As female recipients of the awards, they further indicated their support and were happy to see an additional woman receive this award. Dr Santos looked forward to the re-engagement of Brazil within the working groups.

13.17 The Chair of the review panel thanked the members of the panel for their work in reviewing current applications and, in particular, he thanked those members of the panel from Italy and the USA who had recused themselves from the discussion of applications in which they had an interest.

13.18 The Scientific Committee agreed that the CCAMLR Scientific Scholarships Scheme was a very successful mechanism for developing capacity in CCAMLR, both in the working groups and in the Scientific Committee.

Invitation of experts and observers to meetings of working groups

13.19 The Scientific Committee agreed that all Observers invited to the 2017 meeting would be invited to participate in SC-CAMLR-XXXVII.

Next meeting

13.20 The next meeting of the Scientific Committee will be held at the CCAMLR Headquarters building (181 Macquarie Street) in Hobart, Australia from 22 to 26 October 2018.

Intersessional activities

13.21 The Scientific Committee endorsed the recommendation from WG-FSA to hold an Independent review of integrated stock assessment methods (Annex 7, paragraphs 7.11 to 7.15) recognising the importance of such a review to improve the quality and transparency of CCAMLR's work. It agreed the terms of reference for this workshop (Annex 9) and welcomed the nomination of Dr Reiss as the Convener of the workshop.

13.22 The Scientific Committee welcomed the offer from Germany to host a CCAMLR Workshop for the Development of a *D. mawsoni* Population Hypothesis for Area 48 (see paragraph 5.7) and agreed the terms of reference (Annex 10) and welcomed the nomination of Drs Jones and Darby as the Co-conveners of the Workshop.

13.23 The Scientific Committee warmly welcomed the offer from the Chile, Germany and the UK to host the workshop/working group meetings in 2018 and agreed to the following meetings:

(i) toothfish life history workshop, Berlin, Germany, February (Co-conveners: Drs Darby and Jones)

(ii) SG-ASAM, Punta Arenas, Chile, April/May (Convener: Dr Zhao)

(iii) WG-SAM, Norwich, UK, June (Convener: Dr Parker)

(iv) independent review of assessments, Norwich, UK, June (Convener: Dr Reiss)

(v) spatial management workshop, Cambridge, UK, July (Co-conveners: Drs Korczak-Abshire and Grant)

(vi) WG-EMM, Cambridge, UK, July (Convener: Drs Korczak-Abshire)

(vii) WG-FSA, Secretariat, Hobart, Australia, October (Convener: Dr Welsford).

Secretariat supported activities

Secretariat information and data systems

14.1 The Executive Secretary reported on a restructuring for Secretariat data and information technology services that had been undertaken during 2017. He noted that the overarching goal was to strengthen the Secretariat's information systems and data services to Members. The restructure resulted in the merging of the previous Data Services with Information and Communications Technology and the transfer of fishery monitoring responsibilities to Fishery Monitoring and Compliance. He anticipated that the restructure would lead to improved efficiencies in the Secretariat and increased rigor around strategic planning to support information and data processes, including in relation to data quality, data products, web-based data services, data documentation and user requirements.

14.2 The Executive Secretary noted that the restructure had led to the departure of Dr David Ramm who had made a valuable contribution to CCAMLR over 21 years. On behalf of all CCAMLR Members, the Executive Secretary expressed appreciation to Dr Ramm for his extensive contribution to CCAMLR.

14.3 The Scientific Committee thanked the Executive Secretary for the presentation and also thanked Dr Ramm for his contribution to the Scientific Committee and its working groups over many years.

14.4 The Scientific Committee noted the importance of maintaining data quality and that this should not be seen as subsidiary to the development of data management architecture. It looked forward to greater clarity in the plans for the future development of information and data services in the Secretariat and agreed that the proposed DMG should have an important role in providing strategic and technical advice to CCAMLR information and data services.

14.5 The Executive Secretary confirmed that data services remain at the core of the Secretariat services to Members and that further details of the changes to the Secretariat staff structure associated with the restructuring exercise for Secretariat data services were provided in CCAMLR-XXXVI/05. He welcomed further suggestions and engagement from Members in developing the Secretariat data and information services.

14.6 The Scientific Committee noted the developments in Information Systems and Data Services during 2017 set out in SC-CAMLR-XXXVI/BG/38 Rev. 1 (Annex 7, paragraphs 2.7 to 2.13). These included automated data loads and the resulting improvements in efficiencies of data processing for catch and effort and observer data submissions and the planned development for C1 and C2 data processing (see also Annex 7, paragraph 2.10) as well as the development of analytical tools (e.g. CCAMLR RGIS) to assist Members in the interactions with CCAMLR data.

14.7 The Scientific Committee noted the discussions in WG-FSA on development of the DMG to provide an enhanced mechanism for communication between the Secretariat and data providers and data users in order to align the workplan of the Secretariat and the expectation of Members with respect to information and data management services.

14.8 The Scientific Committee acknowledged the scope and breadth of information and data services undertaken by the Secretariat. It included fisheries, SISO, MPAs, acoustic data and

CEMP as well as the development of data exchange and interoperability processes to allow data and information requirements for MPA RMPs to be addressed, all of which would benefit from a broad level of engagement in the DMG.

14.9 The Scientific Committee endorsed the advice of WG-FSA in relation to the need for documentation to explain to data users what additional data quality measures are being implemented as part of the data loading process and the potential impacts of these as they are applied to the historical data (Annex 7, paragraph 2.38).

14.10 The Scientific Committee agreed the terms of reference for the DMG (Annex 11) and accepted the nomination of Dr Reiss as the Convener of this group.

Election of the Chair and Junior Vice-Chair

15.1 The Scientific Committee noted SC-CAMLR-XXXVI/13 that specified the Russian Federation's view that, in accordance with the Rules of Procedure of the Scientific Committee, specifically Rule 8, 'Chairman and Vice-Chairmen', the procedures and terms are set for electing the Chair and Vice-Chairs, and limits are prescribed on the election of the Chair for more than one term.

15.2 In SC-CAMLR-XXXVI/13 the Russian Federation sought clarification from the CCAMLR Executive Secretary on the matter of the procedure for re-election of the previous Chair of the Scientific Committee for his second term and called for compliance with the procedure for electing the Chair and Vice-Chairs of the Scientific Committee for the next term of 2018–2019 by organising transparent elections of the Chair of the Scientific Committee in accordance with the Scientific Committee's procedure.

15.3 In respect of the procedure for the election of the previous Chair of the Scientific Committee, the Secretariat noted that the Russian translation of Rule 8 of the Rules of Procedure of the Scientific Committee on the CCAMLR website differed in respect of the penultimate sentence of that rule. The penultimate sentence in the English version states that 'The Chairman and Vice-Chairmen shall not be re-elected to their post for more than one term', however, a direct translation to English of the Russian version states 'The Chairman and Vice-Chairmen shall not be elected to their post for more than one term'.

15.4 The Secretariat informed the Scientific Committee that this inconsistency was not present in the original Rules of Procedure source document but was introduced into the version on the website. The Russian Federation thanked the Secretariat for recognising this inconsistency and requested that the Russian translation of the Rule of Procedure be made consistent with the original text.

15.5 The Scientific Committee thanked the Secretariat and the Russian Federation for identifying this inconsistency and their openness to work with Members to find a solution. It requested that the Secretariat implement a system to ensure consistency between translations, especially for prescriptive texts such as Rules of Procedure and conservation measures. The Scientific Committee recommended that this issue be brought to the attention of the Commission.

15.6 The Scientific Committee noted that the Senior Vice-Chair, Mr Somhlaba, had followed the Rules of Procedure regarding the coordination of nominations for the Chair and Junior Vice-Chair positions, consulting all Scientific Committee representatives with full transparency.

15.7 Mr Somhlaba was pleased to announce that Dr Santos had been unanimously elected to the position of Junior Vice-Chair for a term of two regular meetings (2018 and 2019). This nomination was firstly recognised by Mr Dunn and was seconded by Dr Zhao. A very warm welcome was extended to the incoming Junior Vice-Chair who thanked the Scientific Committee for its confidence in her nomination.

15.8 Mr Somhlaba also announced that all Scientific Committee representatives were very happy with Dr Belchier's work as Scientific Committee Chair and, consequently, supported his re-election for one more term as Chair of the Scientific Committee. Dr Belchier thanked the Scientific Committee for its ongoing support.

15.9 The Scientific Committee acknowledged that Mr Somhlaba would be moving on from his role as Vice-Chair and welcomed Mr R. Sarralde Vizuete (Spain), the previous Junior Vice-Chair, into the Senior Vice-Chair position.

15.10 The Scientific Committee thanked Mr Somhlaba for his excellent work as Vice-Chair and for coordinating this year's election.

Other business

Synoptic krill survey 2019

16.1 Norway informed the Scientific Committee of intersessional work by several Members to develop a multinational plan to complete a synoptic krill survey in 2018/19. Norway noted that several delegations are working to develop an initial survey design that will be presented to SG-ASAM in 2018 for consideration, which will be followed by a more refined multinational plan combining ship- and land-based work to be presented at WG-EMM in 2018. This research will facilitate the development of FBM and the MPA planning process in Domain 1. Norway notified the Scientific Committee that an e-group, '2019 Multinational cruise', is being used as a platform for intersessional communication between interested parties.

16.2 The Scientific Committee noted that this proposed survey would be an excellent opportunity for a productive fishing industry and science collaboration and suggested the preliminary design of the survey would be an appropriate item for SG-ASAM to consider.

Proposal for Global Environment Facility funding

16.3 Dr A. Makhado (South Africa), on behalf of the Global Environment Facility (GEF) Eligible CCAMLR Member Countries (GECMCs), provided an update on the status of the proposal for GEF funding (CCAMLR-XXXVI/02). The proposal, in the format of a GEF project identification form (PIF), was approved by the GEF Council at its meeting in May 2017. The proponents of the proposal, Chile, India, Namibia, South Africa and Ukraine, have requested consideration by the Scientific Committee to endorse this proposal, to provide feedback on the timeline to develop the Project Document over the next 12 months and to seek further guidance on the role of the project in the work of CCAMLR. It was further noted that the project is financed by GEF, with financial support of US$6 192 694 requested, and will be executed by CCAMLR over the duration of four years.

16.4 The Scientific Committee thanked the GECMCs for the update on this proposal and noted the discussions at WG-FSA (Annex 7, paragraphs 8.11 to 8.13) and WG-EMM (Annex 6, paragraphs 5.30 to 5.33) regarding this project. The Scientific Committee welcomed the proposal and agreed that it would contribute significantly to building capacity within CCAMLR among GECMCs by promoting engagement and activity among these nations.

16.5 Dr Godø extended an invitation for the project to affiliate with the proposed 2019 multinational synoptic krill survey, suggesting that there is significant opportunity for ongoing engagement of the five GECMCs with the survey initiative over several years.

16.6 The Scientific Committee congratulated the five GECMCs and noted that many Members were well positioned to provide assistance to this type of capacity-building initiative, as well as other initiatives for capacity building, such as development of a mentoring program.

16.7 The Scientific Committee expressed strong support for capacity building in general, noting that the specifics of this proposal would be considered by the Commission.

Second Performance Review

16.8 The Scientific Committee considered the PR2 Report (CCAMLR-XXXVI/01) and endorsed Recommendation 19 that the current practice of managing the business of the Scientific Committee through an informal executive group be institutionalised as a Scientific Committee Bureau, in order to formalise good practices to improve the efficiency and conduct of business in the Scientific Committee and its working groups. The Scientific Committee agreed the terms of reference for the Scientific Committee Bureau (Annex 12), and agreed that it would comprise the Scientific Committee Chair, Vice-Chairs and working group and subgroup conveners and the Convener of the DMG.

16.9 The Scientific Committee agreed that the Scientific Committee Bureau be tasked with working intersessionally to develop a process to address the recommendations of the PR2 Report, as they relate to the Scientific Committee, for consideration at SC-CAMLR-XXXVII. The Scientific Committee noted that discussions on the development of this work should be open to all Members and identified that an e-group would be the appropriate mechanism for these intersessional discussions.

Proposal to amend the Rules of Procedure

16.10 The EU introduced a proposal to amend the rules of procedure of the Commission and the Scientific Committee to enable public access to Commission and Scientific Committee documents on the CCAMLR website (CCAMLR-XXXVI/13). Under this proposal, Members could choose to have their respective documents posted and available to the public at the close of the respective meeting.

16.11 Several Members expressed their support for this proposal, noting that it would increase transparency around the work completed by the Scientific Committee and the Commission and develop public awareness.

16.12 Some Members consider that the sensitivity around some of these meeting documents, noting that many are not peer-reviewed articles and there was concern on how the public would interpret and utilise the subject material, merited further consideration of the EU proposal.

CCAMLR communication strategy

16.13 The Scientific Committee expressed its support for the recommendation from WG-EMM on the development of a CCAMLR communications strategy, that integrates across different types of communications media and allows CCAMLR to promote its various activities, successes and actions over time (Annex 6, paragraph 5.29). The Scientific Committee noted the amount of research and information that could be used to inform a wide audience on events around the Southern Ocean and to increase awareness of CCAMLR activities.

16.14 The Scientific Committee agreed that the communication strategy should focus on the activities of the Scientific Committee and Commission as a whole, rather than individual Members' activities and achievements.

16.15 The Scientific Committee suggested that the Secretariat work intersessionally with working groups and individuals outside of CCAMLR to develop an appropriate communication strategy, including consideration of the future of *CCAMLR Science*.

16.16 The Scientific Committee noted that the 'Recent News' stream on the CCAMLR website (www.ccamlr.org/en/news) could be used to include news items relating to the Scientific Committee, such as notifications when public reports are made available.

CCAMLR Science

16.17 The Scientific Committee considered SC-CAMLR-XXXVI/16 that introduced a proposal for a special volume to promote the science done in CCAMLR in support of MPAs, noting that many of the background papers presented as part of the MPA process contained extremely valuable science that might not be amenable to publication in other journals.

16.18 The Scientific Committee agreed that this offered a good potential approach to providing a mechanism to publicise the large volume of excellent science in support of MPAs in CCAMLR in addition to the material already hosted on the CCAMLR website.

16.19 The Science Manager, as Editor of *CCAMLR Science*, recalled that in 2015 the Scientific Committee considered the future options for *CCAMLR Science* (SC-CAMLR-XXXIV, paragraphs 14.1 to 14.6). He also noted that while there were over 200 papers considered by the working groups in 2017, only five papers were submitted for consideration by *CCAMLR Science*.

16.20 The Scientific Committee acknowledged that with this level of submission there was a need to change the future direction of *CCAMLR Science* and recommended that this should be considered as part of the communication strategy for the Scientific Committee (paragraphs 16.3 to 16.6).

Adoption of the report

17.1 The report of the Thirty-sixth meeting of the Scientific Committee was adopted.

Close of the meeting

18.1 Dr Belchier concluded the Thirty-sixth meeting of the Scientific Committee and thanked participants for their patience and contributions throughout the week. He thanked all involved in supporting the work of the Scientific Committee and noted that the efficient convivial manner in which the meeting proceeded reflected the high level of productivity at intersessional meetings this past year.

18.2 On behalf of the Scientific Committee, Dr Darby thanked Dr Belchier for his excellent chairing of the Scientific Committee and extended thanks to the Secretariat and others for their support that had allowed the meeting to reach a successful conclusion.

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Mormede, S. and A. Dunn. 2013. Quantifying vessel performance in the CCAMLR tagging program: spatially and temporally controlled measures of tag-detection rates. *CCAMLR Science*, 20: 73–80.

Table 1: Catch limits (in tonnes) agreed by the Scientific Committee for 2017/18 (the catch limits for Antarctic krill are included for completeness but were not considered during the Scientific Committee meeting. CM – conservation measure; A, B, C – management areas in Subarea 48.3; N – north; S – south; E – east; W – west; SSRU – small-scale research unit; N70 – north of 70°S; S70 – south of 70°S; SRZ – special research zone; P – proposed research block.

Subarea/ division	SSRU	Area	Species	Catch limit 2016/17	Agreed catch limit 2017/18	Additional information	Conservation measure containing catch limit
48.3		Total	*D. eleginoides*	2 750	2 600	2018/19 limit 2 600 tonnes	CM 41-02
		A (0%)		0	0	2018/19 limit 0 tonnes	
		B (30%)		825	780	2018/19 limit 780 tonnes	
		C (70%)		1 925	1 820	2018/19 limit 1 820 tonnes	
48.3			*C. gunnari*	2 074	4 733	2018/19 limit 3 269 tonnes	CM 42-01
48.4			*D. eleginoides*	47	26	2018/19 limit 26 tonnes	CM 41-03
48.4			*D. mawsoni*	38	37		
58.5.2			*D. eleginoides*	3 405	3 525	2018/19 limit 3 525 tonnes	CM 41-08
58.5.2			*C. gunnari*	357	526	2018/19 limit 395 tonnes	CM 42-02
48.2	n/a	N and S	*D. mawsoni*	75	75	Ukraine and Chile joint research proposal	No CM
	n/a	E	*D. mawsoni* and *D. eleginoides*	23	23	UK research program	No CM
48.4	n/a	S	*D. mawsoni* and *D. eleginoides*	18	18	UK research program	No CM
48.6	n/a	486_2	*D. mawsoni*	170	169	Japan and South Africa joint research proposal	CM 41-04
48.6	n/a	486_3	*D. mawsoni*	50	40	Japan and South Africa joint research proposal	CM 41-04
48.6	n/a	486_4	*D. mawsoni*	100	120	Japan and South Africa joint research proposal	CM 41-04
48.6	n/a	486_5	*D. mawsoni*	190	228	Japan and South Africa joint research proposal	CM 41-04
58.4.1	C	5841_1	*D. mawsoni*	80	96	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.1	C	5841_2	*D. mawsoni*	81	97	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.1	E	5841_3	*D. mawsoni*	233	186	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.1	E	5841_4	*D. mawsoni*	13	16	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.1	G	5841_5	*D. mawsoni*	35	42	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.1	G	5841_6	*D. mawsoni*	90	108	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-11
58.4.2	E	5842_1	*D. mawsoni*	35	42	Australia, France, Japan, Republic of Korea and Spain joint research proposal	CM 41-05

(continued)

Table 1 (continued)

Subarea/ division	SSRU	Area	Species	Catch limit 2016/17	Agreed catch limit 2017/18	Additional information	Conservation measure containing catch limit
58.4.4b	n/a	5844b_1	*D. eleginoides*	25	20	France and Japan joint research proposal	No CM
58.4.4b	n/a	5844b_2	*D. eleginoides*	35	28	France and Japan joint research proposal	No CM
58.4.3a	n/a	5843a_1	*D. eleginoides*	32	38	France and Japan joint research proposal	CM 41-06
88.1	All SSRUs in 88.1 and SSRUs 882A–B	Total	*D. mawsoni*	2 870	3 157		CM 41-09
		N70	*D. mawsoni*	n/a	591		CM 41-09
		S70	*D. mawsoni*	n/a	2 054		CM 41-09
		SRZ	*D. mawsoni*	n/a	467		CM 41-09
		Shelf survey	*D. mawsoni*	40	45	2018/19 limit 65 tonnes	CM 41-09
88.2	D, E, F, G	882_1	*D. mawsoni*	200	200	With overall limit of 419 tonnes SSRUs C, D, E, F and G with no more than 200 tonnes in any research block	CM 41-10
88.2	C, D, E, F, G	882_2	*D. mawsoni*	200	200	With overall limit of 419 tonnes SSRUs C, D, E, F and G with no more than 200 tonnes in any research block	CM 41-10
88.2	C, D, E, F, G	882_3	*D. mawsoni*	200	200	With overall limit of 419 tonnes SSRUs C, D, E, F and G with no more than 200 tonnes in any research block	CM 41-10
88.2	C, D, E, F, G	882_4	*D. mawsoni*	200	200	With overall limit of 419 tonnes SSRUs C, D, E, F and G with no more than 200 tonnes in any research block	CM 41-10
88.2	H		*D. mawsoni*	200	200		CM 41-10
88.3	n/a	883_1	*D. mawsoni*	21	20	New Zealand and Republic of Korea joint research proposal	No CM

(continued)

Table 1 (continued)

Subarea/ division	SSRU	Area	Species	Catch limit 2016/17	Agreed catch limit 2017/18	Additional information	Conservation measure containing catch limit
88.3	n/a	883_2	*D. mawsoni*	29	25	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	883_3	*D. mawsoni*	31	50	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	P_6	*D. mawsoni*	n/a	30	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	P_8	*D. mawsoni*	n/a	10	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	883_4	*D. mawsoni*	52	50	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	P_7	*D. mawsoni*	n/a	30	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	P_9	*D. mawsoni*	n/a	10	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	883_5	*D. mawsoni*	38	10	New Zealand and Republic of Korea joint research proposal	No CM
88.3	n/a	P_10	*D. mawsoni*	n/a	10	New Zealand and Republic of Korea joint research proposal	No CM
58.4.1	n/a	W	*E. superba*	277 000	277 000		CM 51-02
58.4.1	n/a	E	*E. superba*	163 000	163 000		CM 51-02
58.4.2	n/a	W	*E. superba*	260 000	260 000		CM 51-03
58.4.2	n/a	E	*E. superba*	192 000	192 000		CM 51-03
48.1	n/a		*E. superba*	155 000	155 000		CM 51-07
48.2	n/a		*E. superba*	279 000	279 000		CM 51-07
48.3	n/a		*E. superba*	279 000	279 000		CM 51-07
48.4	n/a		*E. superba*	93 000	93 000		CM 51-07

Table 2: Catch limit (in tonnes) and initial allocations among Members for *Dissostichus mawsoni* in research blocks in Divisions 58.4.1 and 58.4.2 for the 2017/18 fishing season. AUS – Australia; ESP – Spain; FRA – France; JPN – Japan; KOR – Republic of Korea.

Research block	Catch limit in 2017/18	AUS	ESP	FRA	JPN	KOR	Total
5841_1	96	0	0	32	32	32	96
5841_2	97	48	49	0	0	0	97
5841_3	186	24	24	48	60	30	186
5841_4	16	16	0	0	0	0	16
5841_5	42	0	0	0	0	42	42
5841_6	108	54	54	0	0	0	108
5842_1	42	28	0	14	0	0	42
Total	587	170	127	94	92	104	587

Table 3: Numbers of incidental mortalities of seabirds and marine mammals (IMAF) in 2016/17 received through vessel and observer data. Data source 'Obs. tally period' is the haul observation period conducted by observers, and the mortalities recorded during this period are used to calculate the extrapolated total (scaled by the percentage of hooks observed) for seabird mortalities. 'Obs. total' is the total number of mortalities reported by observers (includes incidental mortalities reported from outside the haul observation/tally period). 'Catch and effort' are summary catch and effort data reported at 1-, 5- or 10-day intervals depending on the fishery. C1 and C2 data are haul-by-haul vessel data reported to the Secretariat at monthly intervals. Subareas and divisions[1] that are marked with an asterisk have incomplete datasets and fields marked with a dash have no fishing activity present, or data is not submitted to the Secretariat.

	Data source	Subarea					Division		Total
		48.1*	48.2*	48.3*	48.4	58.6 (French EEZ)	58.5.1 (French EEZ)	58.5.2*	
Longline									
Seabirds	Obs. tally period	-	0	12	1	4	14	2	33
	Obs. total	-	0	21	1	-	-	2	24
	Extrapolated total	-	0	37	3	16	56	4	116
	Catch and effort	-	0	24	1	-	-	2	27
	C2	-	0	20	1	-	-	2	23
Marine mammals	Vessel	-	0	0	0	-	-	6	6
	Observer	-	0	0	0	0	0	3	3
Finfish trawl									
Seabirds	Observer	-	-	3	-	-	-	0	3
	Catch and effort	-	-	3	-	-	-	0	3
	C1	-	-	3	-	-	-	0	3
Marine mammals	Vessel	-	-	0	-	-	-	0	0
	Observer	-	-	1	-	-	-	0	1
Krill trawl									
Seabirds	Observer	0	0	0	-	-	-	-	0
	Catch and effort	1	1	0	-	-	-	-	2
	C1	1	1	0	-	-	-	-	2
Marine mammals	Vessel	0	0	0	-	-	-	-	0
	Observer	0	0	0	-	-	-	-	0

[1] Subareas and divisions not listed in this table had no reported mortalities during 2016/17 or no fishing activities were undertaken.

Table 4: Scientific Committee and Commission recommendations outstanding from the 2013 Review of the CCAMLR Scheme of International Scientific Observation (SISO) and considered by the Workshop on the Scheme of International Scientific Observation (WS-SISO).

Review recommendation	CCAMLR group(s)	WS-SISO outcome and comments
Bilateral arrangements		
CCAMLR examines ways of increasing the diversity of Designating and Receiving Member arrangements.	Commission	WS-SISO noted this was still outstanding and requested the Scientific Committee refer for further consideration by the Commission
The process by which observers are assigned to vessels should be reviewed, to ensure that the vessel's input into the selection of a specific observer is minimal or prevented.	Commission	
Revising the text of the scheme in paragraphs D.a(iii) and D.b(i), to 'meals **or** accommodations ~~or salary when~~ provided by the vessel'	Commission	WS-SISO requested the Scientific Committee recommend wording should reflect no direct payment from the vessel representatives, officers or crew to the observer.
Provide an independent mechanism for observers to provide feedback on concerns regarding reporting of contentious or compliance-related issues (see recommendation for standardised CCAMLR debriefing format).	Standing Committee on Implementation and Compliance (SCIC)	WS-SISO requested the Scientific Committee recommend SCIC consider how any feedback reporting mechanism would best be detailed.
Observer tasking and workload		
All additional sampling requirements be agreed by all parties prior to embarkation of an observer and that a summary of this additional sampling should be highlighted in the Cruise Report. There is also a need to clearly define the roles, responsibilities and priorities of the observer with respect to data collection.	Commission	WS-SISO requested the Scientific Committee recommend that wording should reflect that additional tasks should not impact on the SISO data collection requirements, and that a summary of tasks be listed in the Cruise Report.
Deploying observers		
Reviewing the requirement in paragraph A.d of the text of the scheme that requires that the observer should be able to speak the language of the Flag State; consider either its mandatory nature or a requirement that the common language should be agreed by the two parties and not necessarily restricted to be that of the vessel.	Commission	WS-SISO requested the Scientific Committee approve this recommendation.

(continued)

Table 4 (continued)

Review recommendation	CCAMLR group(s)	WS-SISO outcome and comments
Strengthening observers' 'right to refuse' deployment on a vessel by requiring a standard safety check to be performed and passed prior to boarding. The safety check should be submitted to CCAMLR via the Designating Member and summarised for SCIC each year.	Commission	WS-SISO requested the Scientific Committee recommend that the Commission consider how a code of best practice could be developed to ensure observer safety on CCAMLR vessels, and for safety equipment details to be reported as part of the vessel notification details.
Harmonising training requirements		
CCAMLR finds a mechanism to increase engagement in the CCAMLR Observer Training Program Accreditation Scheme (COTPAS), including allocation of funding to assist Designating Members to undertake the accreditation process	Commission	WS-SISO requested the Scientific Committee consider that the recommendations for COTPAS engagement could be revisited by the Commission, taking into account the concerns of some Members that the accreditation process become mandatory, as this would lead to better understanding of Members' observer programs.
All Designating States accredited in three years and that after a three-year window all observers deployed should only be from accredited Designating States.	Commission	
Designating Members that are not accredited should only deploy observers that have been through training with an accredited Designating State.	Commission	
All Designating Members undertake a COTPAS self-assessment in 2014 and that the results are provided to the Secretariat for review.	Commission	
Review mandatory health and safety requirements for the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW95) training and the inclusion of a requirement for helicopter rescue training.	Commission	
Feedback/debriefing of observers.		
In order assist the observers in identifying unknown or IUU vessels Members include their vessels' automatic identification system (AIS) and maritime mobile service identity (MMSI) number in their vessel details supplied in notifications to the Secretariat.	Commission/SCIC	WS-SISO requested the Scientific Committee refer this recommendation to SCIC.
The CCAMLR Scheme of International Scientific Observation – the future		
The expectation of the observers in providing 'vessel independent catch data' should be reviewed to provide clarity on what is expected/required to deliver this particular objective.	Commission	WS-SISO requested the Scientific Committee approve this recommendation and noted that the latest version of the krill logbook did not require the collection of catch data, and is under review for finfish trawl fisheries.

(continued)

Table 4 (continued)

Review recommendation	CCAMLR group(s)	WS-SISO outcome and comments
Harmonisation of training programs, and other factors that might influence the decisions of both parties in the in the placement of observers, should be addressed prior to a re-examination of the administrative processes for bilateral arrangements.	Commission	WS-SISO requested the Scientific Committee consider that the recommendations for COTPAS engagement could be revisited by the Commission, taking into account the concerns of some Members that the accreditation process become mandatory, as this would lead to better understanding of Members' observer programs.
The implementation of COTPAS in three years should be followed by two years of consolidation prior to a second review of the implementation (including the diversity of bilateral deployments) in 2018.	Commission	

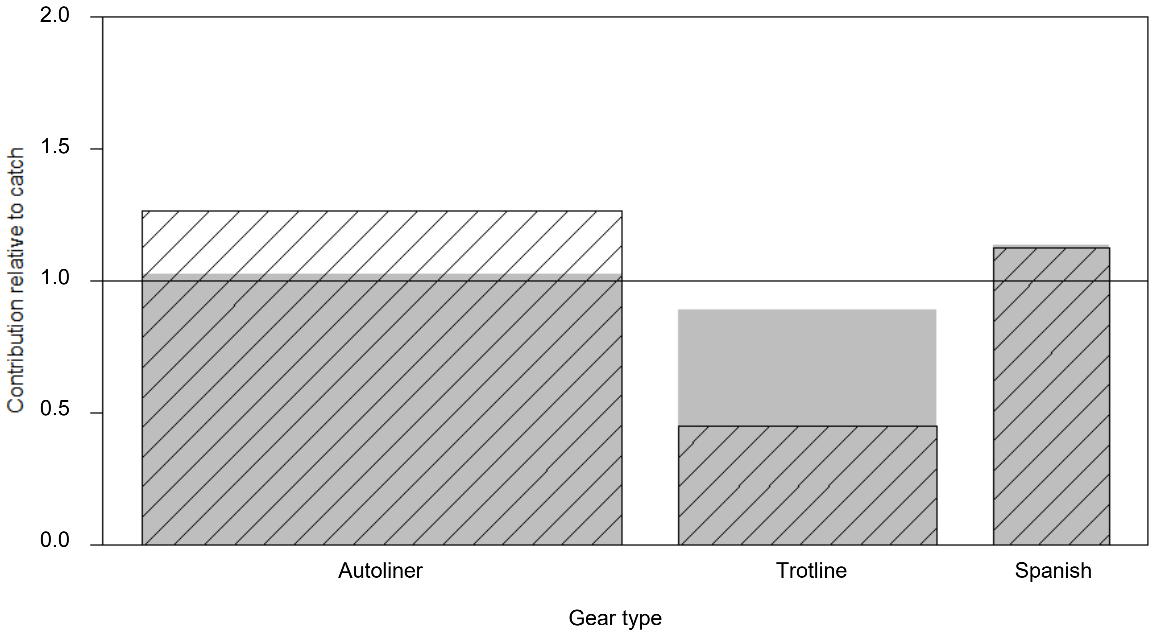

Figure 1: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by gear type, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each gear type and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each gear type and used within the Ross Sea region assessment model. Gear types are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36.

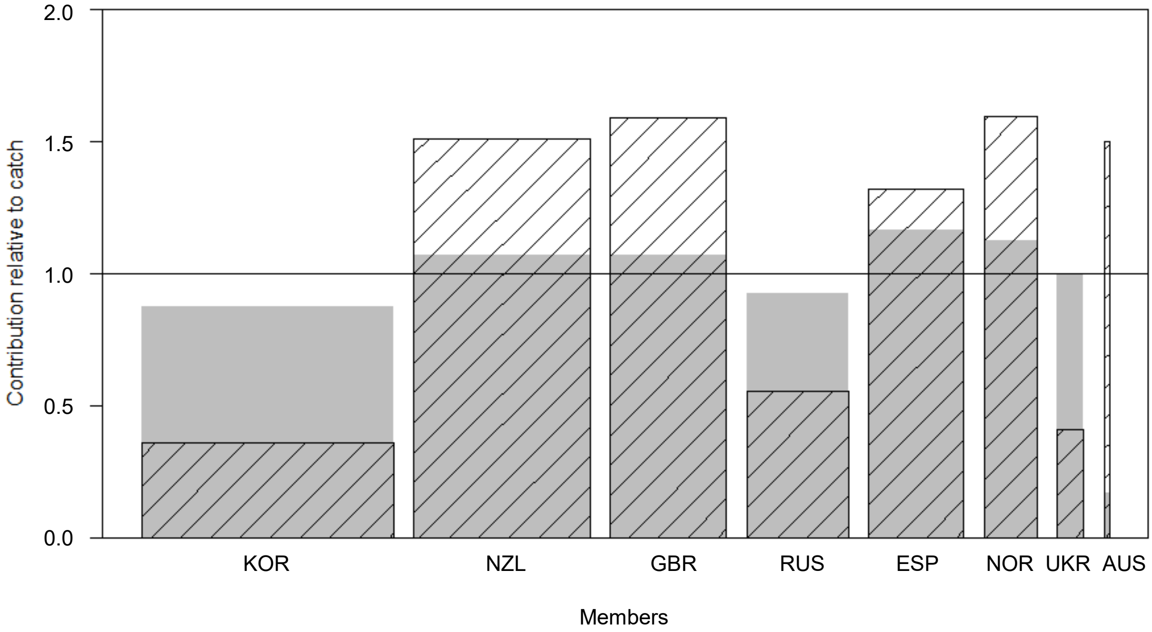

Figure 2: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by Member, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each Member and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each Member and used within the Ross Sea region assessment model. Members are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36. KOR – Republic of Korea; NZL – New Zealand; GBR – United Kingdom; RUS – Russia; ESP – Spain; NOR – Norway; UKR – Ukraine; AUS – Australia.

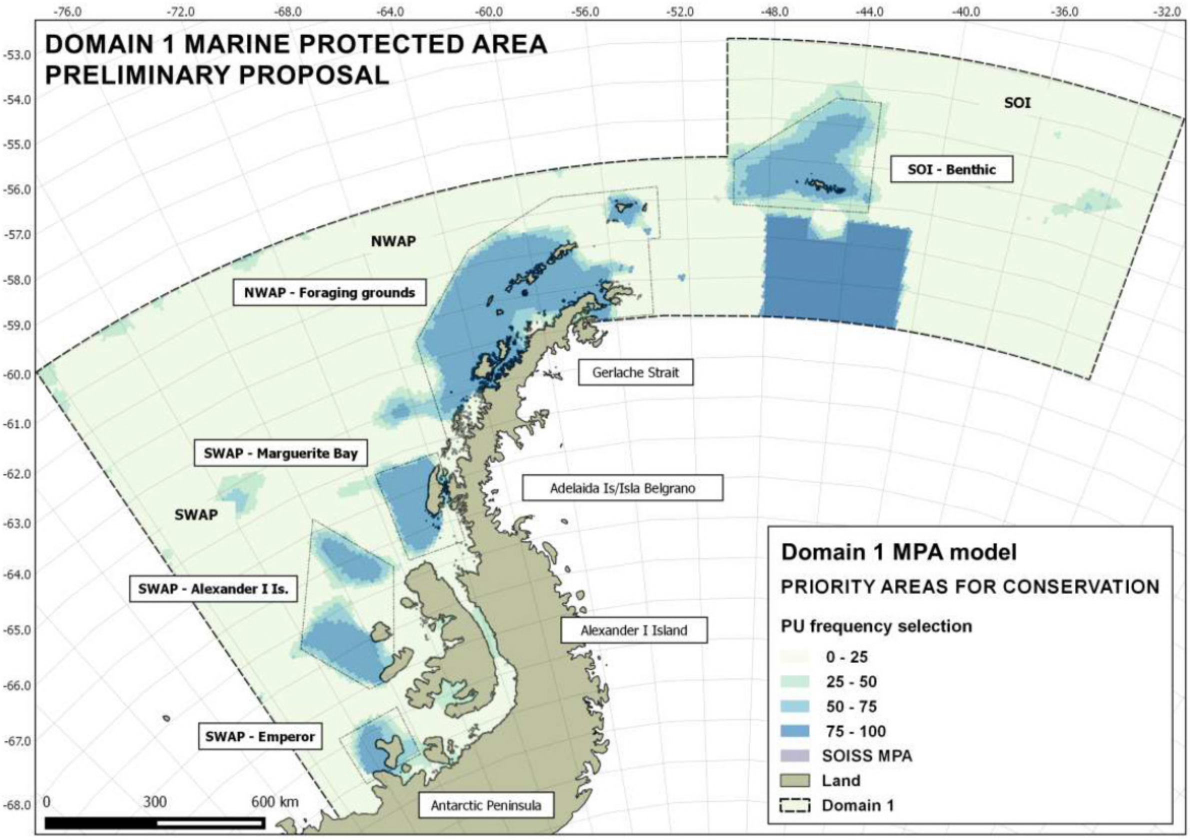

Figure 3: Priority areas for conservation (PACs) in Planning Domain 1. Planning unit (PU) selection frequency indicates the number of times each pixel in the map was 'selected' from 100 repeat runs of Marxan. Pixels coloured in darker shades of blue indicate locations with relatively higher conservation value. The PACs are named with reference to the ecoregion in which they occur (SWAP – southwestern Antarctic Peninsula; NWAP – northwestern Antarctic Peninsula; and SOI – South Orkney Islands).

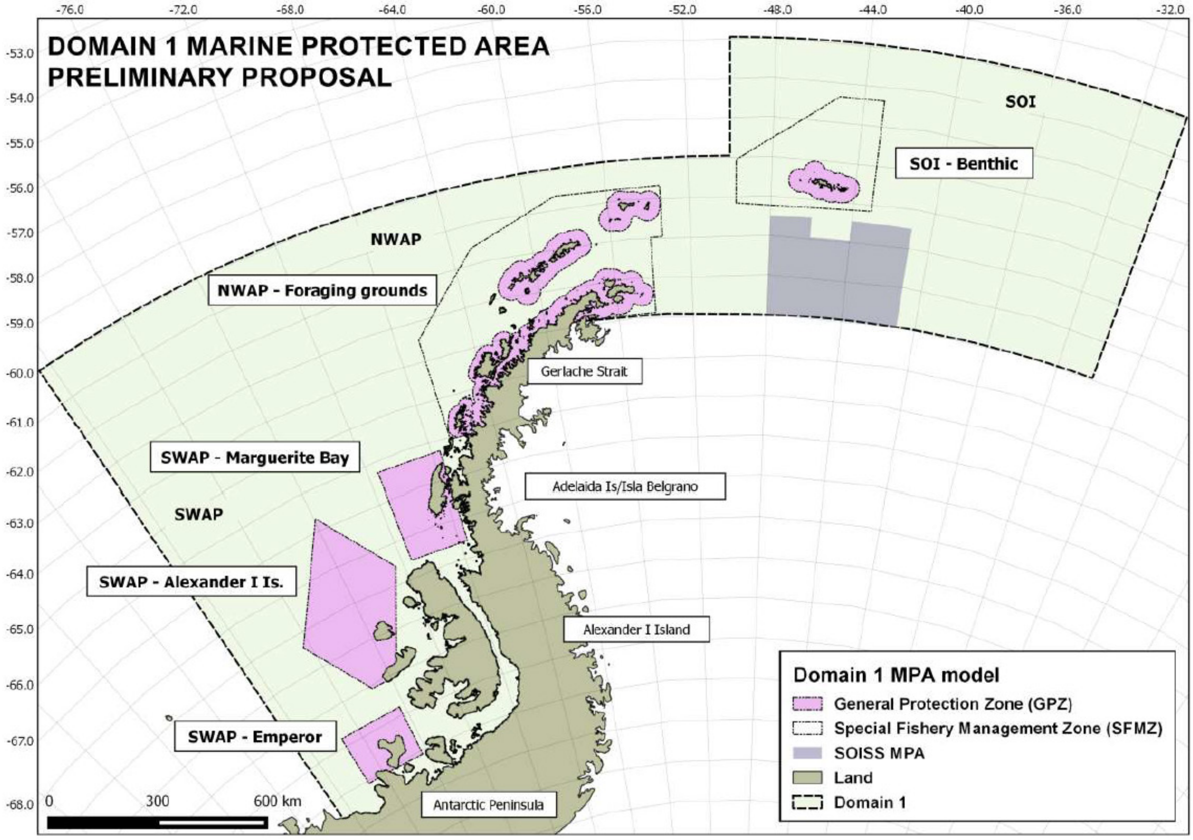

Figure 4: Preliminary boundaries proposed for the Domain 1 marine protected area (MPA). Commercial fishing would be prohibited in the General Protection Zones but permitted in the Special Fishery Management Zones.

Annex 1

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List of Participants

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Ms Silvia Martinez
Dr Marc Orlando
Ms Rebeca Paredes Nieto
Assoc. Prof. Ludmila Stern
Mr Philippe Tanguy
Ms Irene Ulman

Annex 2

List of Documents

List of Documents

SC-CAMLR-XXXVI/01	Vacant
SC-CAMLR-XXXVI/02	Proposed designation of newly-exposed marine area (adjacent to Larsen C Ice Shelf, Subarea 48.5) as a Special Area for Scientific Study Delegation of the United Kingdom
SC-CAMLR-XXXVI/03	Report of the Working Group on Ecosystem Monitoring and Management (Buenos Aires, Argentina, 10 to 14 July 2017)
SC-CAMLR-XXXVI/04	Report of the Working Group on Fish Stock Assessment (Hobart, Australia, 2 to 13 October 2017)
SC-CAMLR-XXXVI/05	Report of the Working Group on Statistics, Assessments and Modelling (Buenos Aires, Argentina, 26 to 30 June 2017)
SC-CAMLR-XXXVI/06	Report of the Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Qingdao, People's Republic of China, 15 to 19 May 2017)
SC-CAMLR-XXXVI/07	Report of the Co-conveners of the CCAMLR Workshop on the Ross Sea region Marine Protected Area Research and Monitoring Plan Co-conveners (A. Dunn, M. Vacchi and G. Watters)
SC-CAMLR-XXXVI/08	Convener's Report of the Workshop on the CCAMLR Scheme of International Scientific Observation (WS-SISO) (Buenos Aires, Argentina, 3 to 7 July 2017) WS-SISO Convener (J. Moir Clark (EU))
SC-CAMLR-XXXVI/09	Developing an experimental approach to help resolve the relative roles of predation and flux on krill distribution and improve the assessment of potential fisheries impacts on predators Delegation of the United Kingdom
SC-CAMLR-XXXVI/10	The Weddell Sea MPA revisited and wider implications for CCAMLR MPA planning Delegation of Norway
SC-CAMLR-XXXVI/11	Quality of positioning and estimates of green weight of krill when using the continuous fishing system Delegation of Norway

SC-CAMLR-XXXVI/12	Proposed update to the terms of reference and guidelines for the CCAMLR MPA Special Fund Delegations of the United Kingdom and the United States, on behalf of the MPA Special Fund Correspondence Group
SC-CAMLR-XXXVI/13	Election of the Chair and Vice-Chairs of the Scientific Committee Delegation of the Russian Federation
SC-CAMLR-XXXVI/14	Information about a workshop for training CCAMLR scientific observers and inspectors Delegation of the Russian Federation
SC-CAMLR-XXXVI/15	Development of procedures for ecosystem-based management of the krill fishery: proposals and comments concerning the CCAMLR Scientific Committee's five-year work plan Delegation of the Russian Federation
SC-CAMLR-XXXVI/16	Proposal for a *CCAMLR Science* Special Volume Delegations of Argentina and Chile
SC-CAMLR-XXXVI/17	Domain 1 Marine Protected Area Preliminary Proposal PART A-1: Priority Areas for Conservation Delegations of Argentina and Chile
SC-CAMLR-XXXVI/18	Domain 1 Marine Protected Area Preliminary Proposal PART A-2: MPA Model Delegations of Argentina and Chile
SC-CAMLR-XXXVI/19	Proposal for the creation of a Domain 1 MPA Expert Group Delegations of Argentina and Chile
SC-CAMLR-XXXVI/20	The Ross Sea region Marine Protected Area Research and Monitoring Plan A. Dunn, M. Vacchi and G. Watters (Co-conveners)
SC-CAMLR-XXXVI/21	The effect of sample size on the observed length distribution of Antarctic krill Delegation of China

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SC-CAMLR-XXXVI/BG/01 Rev. 1	Catches of target species in the Convention Area Secretariat

SC-CAMLR-XXXVI/BG/02	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of Australia
SC-CAMLR-XXXVI/BG/03	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of Uruguay
SC-CAMLR-XXXVI/BG/04	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of Norway
SC-CAMLR-XXXVI/BG/05	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of Japan
SC-CAMLR-XXXVI/BG/06	Форма для представления предварительных оценок возможности того, что предложенный донный промысел будет иметь существенное негативное воздействие на уязвимые морские экосистемы (УМЭ) [Pro forma for submitting preliminary assessments of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems (VMEs)] Делегация Российской Федерации [Delegation of the Russian Federation]
SC-CAMLR-XXXVI/BG/07 Rev. 1	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of New Zealand
SC-CAMLR-XXXVI/BG/08	Committee for Environmental Protection: 2017 Annual Report to the Scientific Committee of CCAMLR CEP Observer to SC-CAMLR (Dr P. Penhale, USA)
SC-CAMLR-XXXVI/BG/09	Calendar of meetings of relevance to the Scientific Committee in 2016/17 Secretariat
SC-CAMLR-XXXVI/BG/10	Soft-sediment macrozoobenthos from Domain 1 (Antarctica): A preliminary report using community parameters and proxies Delegation of Chile

SC-CAMLR-XXXVI/BG/11	The benthic realm in Domain 1: a review Delegation of Chile
SC-CAMLR-XXXVI/BG/12	Simulating nursery areas for Antarctic krill along the western Antarctic Peninsula with relevance for the Domain 1 MPA Planning process Delegations of Argentina and Chile
SC-CAMLR-XXXVI/BG/13	The Scientific Committee on Antarctic Research (SCAR) Annual Report 2016/17 Submitted by SCAR
SC-CAMLR-XXXVI/BG/14	Report on 2017 Activities of the Southern Ocean Observing System (SOOS), relevant to the work of CCAMLR Submitted by SCOR
SC-CAMLR-XXXVI/BG/15	Proposal for a joint workshop between the Southern Ocean Observing System and the Scientific Committee for the Conservation of Antarctic Marine Living Resources Submitted by SCOR
SC-CAMLR-XXXVI/BG/16	Antarctic Climate Change and the Environment – 2017 Update Submitted by SCAR
SC-CAMLR-XXXVI/BG/17	Korean research project on the ecosystem structure and function of the Ross Sea region MPA (2017–2022) Delegation of the Republic of Korea
SC-CAMLR-XXXVI/BG/18	New Zealand's exploratory fishery for toothfish within the SPRFMO Convention Area: update and future directions M. Cryer, A. Dunn and J. Fenaughty
SC-CAMLR-XXXVI/BG/19	Antarctic Site Inventory/MAPPPD/Climate Challenge Analyses: Report to CCAMLR by Oceanites, Inc. Submitted by Oceanites, Inc.
SC-CAMLR-XXXVI/BG/20	An approach to feedback management (FBM) of the krill fishery based on routine acoustic data collection and intermittent land-based predator studies Delegations of Norway, China and Chile
SC-CAMLR-XXXVI/BG/21	Domain 1 Marine Protected Area Preliminary Proposal PART C: Biodiversity Analysis by MPA zones Delegations of Argentina and Chile

SC-CAMLR-XXXVI/BG/22	Domain 1 Marine Protected Area Preliminary Proposal PART B: Conservation Objectives Delegations of Argentina and Chile
SC-CAMLR-XXXVI/BG/23	Proposal to modify Conservation Measure 24-02 regarding the use of a streamer line Delegation of the Russian Federation
SC-CAMLR-XXXVI/BG/24	Materials on the biodiversity of areas of possible introduction Delegation of the Russian Federation
SC-CAMLR-XXXVI/BG/25	Designation of the Weddell Sea MPA (comments and questions) Delegation of the Russian Federation
SC-CAMLR-XXXVI/BG/26	Comments regarding a Marine Protected Area on the Southern Shelf Delegation of the Russian Federation
SC-CAMLR-XXXVI/BG/27	Model-based, ecosystem risk assessments of MPA scenarios in Planning Domain 1 Delegation of the USA
SC-CAMLR-XXXVI/BG/28	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2017 – Reflection of the recommendations by WG-EMM-16 and SC-CAMLR-XXXV Delegation of Germany
SC-CAMLR-XXXVI/BG/29	Marine debris: a persistent and emerging threat to Antarctic ecosystems Submitted by ASOC
SC-CAMLR-XXXVI/BG/30	Strengthening the Ross Sea Research and Monitoring Plan to deliver effective, measurable, and robust management Submitted by ASOC
SC-CAMLR-XXXVI/BG/31	Progressing towards responsible, science-based and highly precautionary krill fisheries management Submitted by ASOC
SC-CAMLR-XXXVI/BG/32	Toward a system of marine protected areas in the Southern Ocean Submitted by ASOC

SC-CAMLR-XXXVI/BG/33	Report to the Scientific Committee of CCAMLR by the Association of Responsible Krill Harvesting Companies (ARK) Submitted by ARK
SC-CAMLR-XXXVI/BG/34	CEMP Fund cameras and satellite transmitter projects in areas of Ukraine responsibility: state and preliminary results D. Lutsenko, G. Milinevsky, O. Savitsky, A. Simon, I. Dykyy, M. Telipska, V. Lytvynov and L. Pshenichnov
SC-CAMLR-XXXVI/BG/35	Marine debris and entanglements at Bird Island and King Edward Point, South Georgia, Signy Island, South Orkneys and Goudier Island, Antarctic Peninsula 2016/17 C. Waluda
SC-CAMLR-XXXVI/BG/36	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of the Republic of Korea
SC-CAMLR-XXXVI/BG/37	Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems Delegation of Ukraine
SC-CAMLR-XXXVI/BG/38 Rev. 1	CCAMLR information and data systems update Secretariat
SC-CAMLR-XXXVI/BG/39	Évaluation préliminaire du risque d'impact négatif significatif des activités de pêche de fond proposées sur les écosystèmes marins vulnérables (VME) [Preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on vulnerable marine ecosystems] Délégation française [Delegation of France]
SC-CAMLR-XXXVI/BG/40	Development of a five-year work plan for the CCAMLR Scientific Committee Mark Belchier (Chair of SC-CAMLR)

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Other Documents

CCAMLR-XXXVI/01	Second Performance Review of CCAMLR Final Report of the Panel Performance Review Panel
CCAMLR-XXXVI/02	Proposal for GEF (Global Environment Facility) funding to support capacity building in the GEF-eligible CCAMLR Members Delegations of Chile, India, Namibia, South Africa, Ukraine and the CCAMLR Secretariat
CCAMLR-XXXVI/10 Rev. 1	Relations with other organisations: Cooperation with RFMOs Secretariat
CCAMLR-XXXVI/13	EU proposal to amend the Rules of Procedure of the Commission and the Scientific Committee Delegation of the European Union
CCAMLR-XXXVI/20	Proposal for a Climate Change Response Work Program for CCAMLR Delegations of Australia and Norway on behalf the Climate Change Intersessional Correspondence Group
CCAMLR-XXXVI/22	Proposal to increase transparency related to fishing for research purposes targeting *Dissostichus* spp. conducted pursuant to Conservation Measure 24-01 Delegation of the USA
CCAMLR-XXXVI/27	Harmonising CCAMLR's approach to activities targeting toothfish Secretariat
CCAMLR-XXXVI/29	Establishment of an exploratory fishery for *Dissostichus mawsoni* in Statistical Subarea 88.3 Delegations of Australia and New Zealand
CCAMLR-XXXVI/BG/02 Rev. 2	Fishery notifications 2017/18 Secretariat
CCAMLR-XXXVI/BG/25 Rev. 2	A representative system of CCAMLR MPAs: taking stock and moving forward Submitted by ASOC
CCAMLR-XXXVI/BG/27	Adopting and implementing a climate change response work plan Submitted by ASOC

WG-FSA-17/02	Report on the CCAMLR marine debris monitoring program Secretariat
WG-FSA-17/35	Ukrainian research proposal for the 2017/18 season in Subarea 88.1 Delegation of Ukraine

Annex 3

Agenda for the Thirty-sixth Meeting
of the Scientific Committee

Agenda for the Thirty-sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources

1. Opening of the meeting

    1.1 Adoption of the agenda
    1.2 Chair's report

2. Advances in statistics, assessments, modelling, acoustics and survey methods

    2.1 Statistics, assessments and modelling
        2.1.1 Advice to the Commission

    2.2 Acoustic survey and analysis methods
        2.2.1 Advice to the Commission

3. Harvested species

    3.1 Krill resources
        3.1.1 Status and trends
        3.1.2 Ecosystem effects of krill fishing
        3.1.3 Advice to the Commission

    3.2 Fish resources
        3.2.1 Status and trends
        3.2.2 Assessment of fish resources
            3.2.2.1 Advice to the Commission

        3.2.3 New and exploratory finfish fisheries
            3.2.3.1 Progress towards assessments
            3.2.3.2 Advice to the Commission

    3.3 Fish and invertebrate by-catch
        3.3.1 Status and trends
        3.3.2 WG-FSA advice
        3.3.3 Advice to the Commission

4. Incidental mortality arising from fishing operations

    4.1 Incidental mortality of seabirds and marine mammals associated with fisheries
    4.2 Marine debris
    4.3 Advice to the Commission

5. Spatial management of impacts on the Antarctic ecosystem

    5.1 Bottom fishing and vulnerable marine ecosystems
        5.1.1 Status and trends
        5.1.2 Advice to Commission

5.2 Marine protected areas
   5.2.1 Scientific analysis of proposals for MPAs
   5.2.2 Advice to the Commission

6. IUU fishing in the Convention Area

7. CCAMLR Scheme of International Scientific Observation

   7.1 Scientific observations
   7.2 Advice to the Commission

8. Climate change

   8.1 Advice to the Commission

9. Scientific research exemption

   9.1 Advice to the Commission

10. Cooperation with other organisations

   10.1 Cooperation within the Antarctic Treaty System
      10.1.1 Committee for Environmental Protection
      10.1.2 Scientific Committee for Antarctic Research

   10.2 Reports of observers from other international organisations

   10.3 Reports of representatives at meetings of other international organisations

   10.4 Future cooperation

11. Budget for 2017/18

12. Advice to SCIC and SCAF

13. Scientific Committee activities

   13.1 Priorities for work of the Scientific Committee and its working groups
   13.2 CCAMLR Scientific Scholarships Scheme
   13.3 Invitation of experts and observers to meetings of working groups
   13.4 Next meeting

14. Secretariat supported activities

15. Election of Chair and Vice-Chair

16. Other business

17. Adoption of report of the Thirty-sixth Meeting

18. Close of meeting.

Annex 4

Report of the Meeting of the Subgroup
on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 15 to 19 May 2017)

Contents

Report of the Subgroup on
Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 15 to 19 May 2017)

Introduction

1.1 The 2017 meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held at the Qingdao National Laboratory for Marine Science and Technology (QNLM), Qingdao, China, from 15 to 19 May 2017. The Convener, Dr X. Zhao (China) welcomed the participants (Appendix A) and noted that this was the 10th meeting of the Subgroup. The Co-convener, Dr C. Reiss (USA), was unable to attend the meeting.

1.2 Mr Z. Wang (Executive Director of the QNML) welcomed the participants. He described how the 42 hectare site of the QNML brought together five Chinese universities and institutes to create a collaborative and coordinated centre of excellence for marine research. Mr Wang recalled that Antarctic research and resource management was an important element of marine research at QNML and he wished the meeting participants a successful and productive meeting and a pleasant stay in Qingdao.

1.3 The meeting's provisional agenda was discussed, and the Subgroup adopted the proposed agenda without any changes. The meeting agenda is in Appendix B.

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

1.5 This report was prepared by A. Cossio (USA), M. Cox (Australia), K. Reid (Secretariat) and G. Skaret (Norway). In this report, paragraphs that provide advice to the Scientific Committee and WG-EMM have been highlighted; these paragraphs are listed in Item 7.

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 agreed that the priority area of work was to establish an automated method for processing acoustic data collected by commercial krill fishing vessels to support CCAMLR's management of the krill fishery, including the feedback management (FBM) strategy.

2.2 The Subgroup also recalled that an important element of this was to develop the methodology and protocols that enable CCAMLR to reliably reflect changes in krill availability in the areas in which the fishery operates throughout the fishing season. Acoustic data from both dedicated transects and data collected during fishing operations can provide useful information, however, the current priority was focused on transect data (SC-CAMLR-XXXV, Annex 4, paragraph 2.2).

2.3 The Subgroup recognised that CCAMLR has a well-established protocol for krill identification and biomass estimation from scientific acoustic surveys. However, the fundamental differences between the current priority and scientific surveys require a different approach to the design and protocols for data processing routines, including krill identification and biomass assessment.

Analysis of acoustic data collected from fishing vessels

2.4 Prof. K. Lee (Republic of Korea) presented SG-ASAM-17/04 that described a survey to estimate the density and biomass of krill around the South Shetland Islands from the surveys conducted on the krill fishing vessels *Kwang Ja Ho* in April 2016 and *Sejong Ho* in March 2017. The analysis included a comparison of dB difference values between the integrated cell (50 ping × 5 m) of krill swarms from krill target sampling and the recommended range values by sampled krill size (SC-CAMLR-XXIX, Annex 5). The density estimates from the surveys were consistent with scientific surveys conducted in this subarea in previous years. The authors of SG-ASAM-17/04 are planning to analyse the data from the two surveys following the swarm-based approach developed at this meeting.

2.5 The authors of SG-ASAM-17/04 noted that the sea-surface temperature (SST) in 2017 was 1–1.5°C warmer than in 2016 and that there was an increase in the frequency of salps in scientific and commercial catches in 2017. They also described evidence for vertical size stratification of krill in 2016 with larger krill being found at greater depths.

2.6 The Subgroup warmly welcomed the details of these two surveys conducted by Korean scientists that represented a significant advance in the use of krill fishing vessels to conduct surveys in this subarea. The Subgroup encouraged the authors to submit the updated results and discussion to WG-EMM.

2.7 Dr Cox presented SG-ASAM-17/02 that compared swarm integration and interval integration based on data from a transect-based survey in a 65 km × 60 km area off Mawson research station, East Antarctica. The data were processed and analysed following CCAMLR standard protocols for noise removal, krill identification and biomass estimation. Echoview v 8.0.7 was used for data processing and the SHAPES module within that software for swarm identification and delineation. Mean areal krill density and associated variance was estimated using the random sampling theory estimator of Jolly and Hampton (1990). There was a 61% overlap between the variance estimates for conventional grid-based and swarm-based krill density. The processing time of the swarm-based approach was half that of the standard grid-based technique.

Echosounder calibration using seabed as reference target

2.8 Dr S.-G. Choi (Republic of Korea) introduced SG-ASAM-17/P01 which described the difference between the bottom backscattering strength of the commercial echosounder (i.e. ES70) and a standard sphere calibrated scientific echosounder (i.e. EK60) on board the Korean fishing vessel *Kwang Ja Ho* during a krill survey conducted in Subarea 48.1 in April 2016. The vessel was equipped with ES70 echosounders with operating frequencies of 38 and 120 kHz, but the ES70 General Purpose Transceivers (GPTs) were replaced with EK60 GPTs for the period of the survey for the purpose of krill monitoring and estimation of krill biomass. The system set up with EK60 GPTs was calibrated according to the standard sphere method. In order to calibrate the ES70 system, two transect lines were completed twice, first using the calibrated system with EK60 GPTs, then using the system connected to ES70 GPTs. Seabed echo along the transects were integrated using both systems and the gain settings of the ES70 system were adjusted based on the relative difference in seabed echo intensity with the EK60 system. Using the uncalibrated ES70, only 26.95% of the krill swarm signals were in the 2–12 dB range, however, 92.04% of the krill swarm signals were in the 2–12 dB range with the calibrated ES70 data.

2.9 The Subgroup thanked the authors of SG-ASAM-17/P01 for this work and recalled that the approach of using seabed integration for echosounder calibration had been addressed previously in SG-ASAM as an alternative method to standard sphere calibration. Previous work had shown that integration values are sensitive to changes in bottom features and sensitive to slight changes in vessel track and direction when the bottom is not entirely homogenous and flat. Ideally, a hard and flat stretch of seabed should be used for calibration. For comparison of two or more GPTs connected to the same transducer, a multiplexer can allow for alternate pinging with the two GPTs and a ping-by-ping comparison of integration results. In this case, an inter-calibration on a krill layer or large swarm might be preferable.

2.10 The Subgroup encouraged Members to go through existing acoustic data from surveys and fisheries acquired in the Bransfield Strait area in order to look for candidate locations with appropriate depth and flat bottom for carrying out bottom calibration on different frequencies. In general, the Subgroup encouraged the use of the standard sphere calibration also for ES70 as described in 2015 (SC-CAMLR-XXXIV, Annex 4, paragraph 3.24).

Noise reduction

2.11 Mr X. Wang (China) presented SG-ASAM-17/03 using data from two krill fishing vessels, the *Fu Rong Hai* (China) and the *Saga Sea* (Norway) to evaluate the quality of the acoustic data collected from krill fishing vessels and to validate various spike noise mitigation techniques on such data. Noise spikes from instrument cross-talk was the most important source of noise during normal fishing operations and totally dominated the backscatter on the 38 kHz in the *Fu Rong Hai* data and partly on the 120 kHz in the *Saga Sea* data. Background noise was prominent and changed rapidly with time in the *Saga Sea* data. Other issues causing reduced data quality were ‘false bottom’ noise, missing bottom detection and inclusion of bottom echo in the integrated regions, surface bubble noise and missing pings under bad weather conditions. Background noise was estimated based on data from a transect survey conducted around the South Shetland Islands with the *Fu Rong Hai* using the method described in de Robertis and Higginbottom (2007). The results showed that the background noise level increased with increasing vessel speed, and the background noise was shown to limit the effective acoustic sample range for a given frequency and vessel speed.

2.12 Four spike noise removal algorithms were tested on a presumed clean dataset from a scientific survey on the *Saga Sea*; the outputs after filtering were compared to the unfiltered output to assess potential bias introduced by the filters (assuming the unfiltered data to be unbiased). All the spike noise removal methods reduced both mean and standard deviation of the nautical area scattering coefficient (NASC). When using the swarm integration, instead of the full dataset integration, on presumed clean data, all algorithms reduced NASC when compared to the unfiltered data, but none of them reduced this by more than 10%. Also, for the noisy data collected during fishing operations, there was less difference between filtered and unfiltered data when using swarm integration than interval integration, presumably because noisy segments of the data were excluded by using the swarm integration approach.

2.13 The Subgroup acknowledged the comprehensive evaluation of spike noise reduction algorithms for acoustic data presented in SG-ASAM-17/03, and agreed that both background noise removal and spike noise removal should be incorporated as parts of the standard processing of transect data from krill fishing vessels. It was agreed that the results and conclusions from SG-ASAM-17/03 should be used to guide the recommendation of the Subgroup on choice of noise removal algorithms.

Day/night variability in krill backscatter and optimal frequency for krill abundance estimation

2.14 Dr O.R. Godø (Norway) presented preliminary results from acoustic observations of krill swarms during a survey on the R/V *James Clark Ross* off the South Orkney Islands in 2016. Data collected on the frequencies 38, 70, 120 and 200 kHz both during daytime and night-time were available for analysis. The data showed large variation in frequency response ($NASC_i/NASC_{38kHz}$) over day and night and within and between swarms likely due to diel differences in krill behaviour. He underlined that the CCAMLR protocol for data collection and biomass estimation from acoustic surveys was developed based on the CCAMLR-2000 Survey for data collected during daytime in austral summer conditions only, whereas the protocol when applied to fishing vessel transect data should also consider different conditions for data collection.

2.15 The data presented by Dr Godø also indicated that 70 kHz was the optimal frequency for krill monitoring of those available on the *James Clark Ross*. With the broadband technique, 70 kHz will cover the most dynamic frequency range for krill and is likely to produce optimal data for target identification for krill biomass estimation as it is less sensitive to variability in behaviour and tilt angle of krill compared to 120 kHz, and less susceptible to issues with false bottom detection and low backscatter of krill at 38 kHz.

2.16 The Subgroup recalled that 70 kHz had been acknowledged as the optimal frequency for krill biomass estimation by the Subgroup several times before. The continued use of 120 kHz as *de facto* frequency for krill biomass estimation is likely a consequence of the presently limited number of 70 kHz echosounders installed for data collection. However, as more vessels now have 70 kHz echosounders, including three Chinese krill fishing vessels, the Subgroup recommended continued effort to facilitate the implementation of 70 kHz for krill monitoring. The Subgroup noted that no empirical validation of the stochastic distorted-wave Born approximation (SDWBA) model parameter settings for target strength estimation for 70 kHz data has been carried out like it has for 38 and 120 kHz (Demer and Conti, 2005).

Analysis of data collected from fishing vessels

Data analysis using the swarm-based approach

3.1 The Subgroup acknowledged that SG-ASAM-17/02, 17/03 and 17/04 indicated that the krill density estimation is sensitive to the dB difference window technique for krill identification. However, krill identification based on swarm detection and delineation can be used without or with a very wide dB difference window if the risk associated with identifying all detected swarms as krill swarms is acceptable.

3.2 The Subgroup acknowledged several potential advantages of the swarm-based method compared to interval integration when applied to data collected from fishing vessels:

(i) it is not dependent on data from a specific set of acoustic frequencies which is required when setting the dB difference window for krill identification following the CCAMLR protocol

(ii) it reduces the risk of integrating noise-contaminated segments of the data

(iii) it provides potentially interesting information about swarm dynamics and swarm characteristics which would not be available from standard interval integration

(iv) it potentially reduces data processing time.

3.3 The Subgroup recommended that the swarm-based approach should be used for krill density estimation from data collected along transects by krill fishing vessels following the procedure agreed below (paragraphs 3.4 to 3.18).

Echoview template for automatic data processing

3.4 Dr Cox presented the Echoview template 'CCAMLR_SWARM.EV' that was uploaded on the SG-ASAM e-group. This template was developed to support the automation of acoustic data processing. He described and demonstrated the function of each acoustic variable in the template.

3.5 The Subgroup noted that the template is currently designed for 38 and 120 kHz data and that the template is designed to output integrated 120 kHz krill swarm data in 250 m depth × 1 n mile intervals for either NASC or krill density.

3.6 The Subgroup recommended that the template be used with calibrated data, but recognised that schools detection can be performed on uncalibrated data, although echo integration cannot. The Subgroup noted that estimates of swarm characteristics from uncalibrated data might provide useful information in support of assessments from calibrated data. Furthermore, the template can be adapted for use with different frequencies, but currently this must be carried out manually.

3.7 The Subgroup tested the Echoview template using calibrated 38 and 120 kHz data collected by the *Saga Sea* from 13 to 15 February 2016 in Subarea 48.2 to detect krill swarms and integrate krill echoes to obtain NASC values; in all tests (n = 5) identical results were obtained. The Subgroup wrote a manual for the use of the template (Appendix D).

3.8 The final Echoview template incorporated the following data processing steps:

(i) spike noise removal
(ii) background noise removal
(iii) automated seabed detection

(iv) krill swarm detection
(v) dB differencing
(vi) integration and export of NASC attributed to krill and krill areal density.

Default parameters for the template are given in Table 1.

Spike noise removal

3.9 The spike noise removal algorithm of Wang et al. (2016), presented in SG-ASAM-17/03 was included in the Echoview template. The Wang et al. (2016) algorithm was selected because it has been tested on acoustic data collected using krill fishing vessels in the Antarctic and only requires two parameters (minimum and maximum data S_v threshold; Table 1). The Subgroup recommended that the same minimum data S_v threshold should be applied to the spike noise removal and to the schools detection.

Background noise removal

3.10 The Subgroup agreed to use the method of de Robertis and Higginbottom (2007) to remove background noise. The Subgroup noted that, with the exception of the maximum noise parameter, values of the background noise removal parameter settings were taken from de Robertis and Higginbottom (2007). Maximum noise parameter settings were –105 dB and −135 dB for the 38 and 120 kHz frequencies respectively. The maximum noise parameter values were determined from analysis of the data presented in SG-ASAM-17/02.

Automated seabed detection

3.11 The Subgroup agreed to use the 38 kHz frequency for seabed detection and to use the ‘best bottom candidate line pick’ algorithm implemented in Echoview. The Subgroup noted that refinement of the best bottom candidate line pick parameters might be necessary and recognised two ways to aid in bottom detection:

(i) that bottom depths from the transect lines be provided to the Secretariat from previous surveys

(ii) to implement the seabed detection approach of Renfree and Demer (2015).

Krill swarm detection parameters

3.12 The sensitivity of mean areal krill density estimates to the swarm detection parameters was investigated using the 38 and 120 kHz EK60 data collected from the Australian research vessel, the *Aurora Australis*, in East Antarctica (SG-ASAM-17/02). Dr Cox used schools detection parameters taken from SG-ASAM-17/02 and 17/03; Cox et al., 2011; Tarling et al., 2009; Woodd-Walker et al., 2003 (Table 2) and estimated mean real krill density (Figure 1). The Subgroup agreed that the different schools parameters are not sensitive with dB differencing removed.

3.13 The Subgroup noted that, in future, schools parameters could be adjusted to account for ping interval and vessel speed. The Subgroup noted that SG-ASAM had suggested survey settings, assuming a vessel speed of 10 knots, to be used by fishing vessels during line transect surveys in earlier meetings.

dB differencing

3.14 The Subgroup noted that the template has 'dB differencing' for 38 kHz – 120 kHz. The Echoview template default settings have a –20 to 20 dB difference range. The Subgroup recognised that this wide default dB difference range will avoid krill being excluded but may potentially also include non-krill echoes. However, the Subgroup agreed that the swarm detection step in the template is sufficient to delineate krill from other organisms and avoid the inclusion of the majority of non-krill echoes.

3.15 The dB difference option is retained in the template to enable future research to be carried out on the sensitivity of swarm-based approaches to krill length-frequency data. To support this future work, Dr Cox agreed to edit the R Markdown file used in SG-ASAM-16/01 to set the dB difference (38 – 120 kHz) and convert NASC to areal krill density using the conversion factor (C), as described in WG-EMM-16/38, automatically and to provide this to the SG-ASAM e-group.

Integration and export

3.16 The template has two output variables for 120 kHz. One variable 'Krill NASC from mean Sv', produces an output of NASC (m^2 n $mile^{-2}$) at 250 m depth × 1 n mile interval. The other variable 'krill areal density' produces an output of density (g m^{-2}) at 250 m depth × 1 n mile interval. The default value for the conversion factor (C) used to produce krill areal density is set to 0. This can be changed once a conversion factor is calculated.

Automation of data processing

3.17 Dr Cox presented EchoviewR, an R software package used to help automate acoustic data processing using Echoview. The software package is currently located on the Github website (https://github.com/AustralianAntarcticDivision/EchoviewR). The Subgroup agreed that EchoviewR was a powerful tool that could be used with Echoview to help automate processing of large datasets and to conduct sensitivity analyses. The Subgroup agreed that using EchoviewR will enable acoustic data processing to be conducted in a reproducible manner, and when run using R Markdown documents will enable data processing steps to be version-controlled.

3.18 The Subgroup requested that the Secretariat hold a 'forked' copy of EchoviewR on its Github site in order to ensure appropriate version control and documentation. The Subgroup also requested that the Secretariat maintain the Echoview template in a version-controlled information management system to ensure transparency in the future use and modification of the template.

Survey design

4.1 The Subgroup reiterated its request for krill fishing vessels to collect acoustic data along the nominated transects (SC-CAMLR-XXXV, Annex 4, paragraphs 2.1 and 2.2). The Subgroup agreed that the collection of acoustic data by each vessel in the fishery from at least one nominated transect each month would contribute greatly to understanding temporal variability in krill abundance, distribution and swarm characteristics.

4.2 The Subgroup noted that, while acoustic data was being collected by krill fishing vessels as part of dedicated surveys (e.g. SG-ASAM-17/04), there has been relatively little repeated collection of acoustic data from the nominated transects reported to the Secretariat. The Subgroup recalled its advice from last year that it may be potentially beneficial to examine mechanisms to provide incentives for vessels to collect acoustic data along the nominated transects (SC-CAMLR-XXXV, Annex 4, paragraph 1.5).

4.3 The Subgroup encouraged the evaluation of potential alternative locations for new transects that could be occupied repeatedly, especially where these transect locations might achieve a greater degree of overlap with areas of fishing operations.

Other business

Japanese dedicated krill survey proposal

5.1 Dr H. Murase (Japan) presented SG-ASAM-17/01 that described a proposal for a dedicated krill survey in Division 58.4.1 in 2018/19. The plan proposed to repeat the BROKE survey in order provide an updated estimation of krill biomass to provide a revised estimate of B_0 used by CCAMLR for setting catch limits in this area and also to collect oceanographic observations to detect long-term changes.

5.2 The Subgroup noted that SG-ASAM-17/01 was based on a proposal for a dedicated krill survey that was originally presented in WG-EMM-15/43 and the Subgroup thanked Dr Murase for his very comprehensive presentation on the design and planned implementation of the survey that used the CCAMLR-agreed protocol for the estimation of krill biomass. The Subgroup recalled the invitation from Japan for scientists to participate in the survey (COMM CIRC 17/33–SC CIRC 17/26) and was delighted to hear that discussions between Subgroup participants were ongoing in this regard.

5.3 The Subgroup noted that Japan was proposing to use broadband acoustics during the survey, including 70 kHz, and that this would likely provide a useful contribution to the evaluation of the use of this frequency in the collection of acoustic data by fishing vessels (see paragraph 6.6). The Subgroup encouraged the presentation of details of density contrast and sound-speed contrast measurement methods to SG-ASAM-18.

US AMLR Program

5.4 Mr Cossio provided an update on the proposal to revise at-sea research within the US AMLR Program to better address questions necessary for understanding the consequences of overlap among krill, predators and the krill fishery. This includes the movement away from ship-based research to an instrument-based (moorings and gliders) program of oceanographic and ecological observations and research to support the US commitment to CCAMLR and ecosystem science in the Southern Ocean.

Location of next SG-ASAM meeting

5.5 In encouraging Members to consider hosting future meetings of SG-ASAM, the Subgroup recognised the great value of increased attendance and engagement in the work of CCAMLR that was provided to acousticians from the Member hosting the meeting. This had been particularly evident in the current meeting and also in the meeting hosted by the Republic of Korea in 2015.

Future work

6.1 The Subgroup reviewed the default settings for the swarm-based Echoview template and highlighted the following areas of future work:

(i) Spike noise reduction parameters –

 (a) review the reduction in NASC as a result of application of the spike noise algorithm to clean data, i.e. data with no spike noise

 (b) evaluation of the impact of the maximum S_v threshold value on a case-by-case basis for specific noise signals and vessel-specific noise characteristics

 (c) review the impact of frequency dependent spike noise removal on the dB difference method.

(ii) Background noise removal parameters –

 (a) measure background noise of a vessel, including by using passive mode, to optimise the background noise removal parameters for an individual vessel.

(iii) Swarm detection parameters –

 (a) frequencies other than 120 kHz (for example 70 kHz) should be evaluated for swarm detection and the associated parameters evaluated.

(iv) 38 – 120 kHz dB difference parameters –

 (a) krill length-frequency data can be used to refine the dB difference parameters (see paragraph 6.2)

 (b) frequencies other than 38 – 120 kHz (for example 70 kHz) should be evaluated for target identification.

(v) 1 n mile × 250 m export parameters –

 (a) krill length-frequency data can be used to determine the conversion factor from NASC to density (see paragraph 6.2).

Krill length-frequency data

6.2 Data on the length frequency of krill is relevant to the dB difference and the conversion factor and the Subgroup recommended that an evaluation of the use of observer-collected length-frequency data be undertaken to determine the appropriate spatial and temporal scale over which length samples of krill should be pooled to characterise the length frequency of the krill population in the acoustic survey (and individual transects). The Subgroup noted that the selectivity of some commercial krill trawls has been studied and the selection curve estimated (Krag et al., 2014). Such selection curves can be useful in future work studying the potential impacts of net selectivity on length-frequency data used in the estimates of conversion factors and dB differences.

Evaluation of the use of the swarm-based approach rather than gridded data

6.3 The Subgroup recommended that the differences in biomass estimates from the scientific acoustic surveys using the CCAMLR-agreed method and the swarm-based approach should be evaluated for existing data from Subareas 48.1 and 48.2, noting that this comparison has been undertaken for the surveys in Subarea 48.3 (Fielding et al., 2014).

Other noise reduction algorithms

6.4 The recommended Echoview template for processing of transect data collected by fishing vessels presently includes algorithms to automatically handle background noise and spike noise. Methods to evaluate the implications of other issues reducing the quality and biasing the output of the processing step (SG-ASAM-17/03), including missed bottom detection and inclusion of bottom echo in integrated region, false bottom echo, variable background noise level, surface bubble noise and missing pings due to bad weather condition, should be developed in the future.

Survey design

6.5 In addition to the suggestion to evaluate potential alternative locations for new transects that could be occupied repeatedly (see paragraph 4.3), the Subgroup also noted the potential to carry out a combined trawl acoustic survey in selected areas with the objective of developing and checking existing methods as well as to assess local krill density.

New echosounders and frequencies

6.6 The current approaches to the estimation of krill biomass from krill fishing vessels are focused on the use of 38 and 120 kHz with Simrad ES60 echosounders. However, other frequencies, such as 70 kHz, are now becoming more routinely available and new echosounders, such as the EK80 and ES80, are being installed on research and fishing vessels. Therefore, there is a need to evaluate the use of these developments in the estimation of krill biomass used in CCAMLR.

Automated data processing

6.7 The Subgroup noted that it is possible for fishing vessels to use the template and send the NASC outputs to the Secretariat and recommended that an implementation plan be prepared to allow NASC and/or raw data to be processed either on vessels, by Member scientists or by the Secretariat.

Advice to the Scientific Committee and WG-EMM

7.1 The Subgroup recommended that the swarm-based approach should be used for krill density estimation from data collected along transects by krill fishing vessels (paragraph 3.3) following the procedure set out in paragraphs 3.4 to 3.18.

7.2 The Subgroup agreed on the value of the collection of acoustic data by each vessel in the fishery from at least one nominated transect each month (paragraph 4.1) and the benefit of examining mechanisms to provide incentives for vessels to collect acoustic data along the nominated transects (paragraph 4.2).

Adoption of the report and close of the meeting

8.1 The report of the meeting was adopted.

8.2 At the close of the meeting Dr Zhao thanked all participants for their patient, painstaking and productive contributions to the work of SG-ASAM. Dr Zhao also thanked the Secretariat for its efficient support to the meeting, both those attending the meeting and, in particular, those providing support from Hobart.

8.3 On behalf of the Subgroup, Dr Godø thanked Dr Zhao for his efficient and hard work in convening the meeting and also for the very efficient hospitality in hosting SG-ASAM-17 that had led to this meeting making great progress in the use of fisheries acoustics data.

8.4 The Subgroup noted its gratitude to Echoview for generously loaning five licence ‘dongles’ to the Secretariat for use at the meeting; these had greatly enhanced the productivity of the meeting.

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De Robertis, A. and I. Higginbottom. 2007. A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. *ICES J. Mar. Sci.*, 64 (6): 1282–1291.

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Renfree, J.S. and D.A. Demer. 2016. Optimizing transmit interval and logging range while avoiding aliased seabed echoes. *ICES J. Mar. Sci*, 73 (8): 1955–1964.

Tarling, G.A., T. Klevjer, S. Fielding, J. Watkins, A. Atkinson, E. Murphy, R. Korb, M. Whitehouse and R. Leaper. 2009. Variability and predictability of Antarctic krill swarm structure. *Deep-Sea Res. I*, 56 (11): 1994–2012.

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Woodd-Walker, R.S., J.L. Watkins and A.S. Brierley. 2003. Identification of Southern Ocean acoustic targets using aggregation backscatter and shape characteristics. *ICES J. Mar. Sci.*, 60 (3): 641–649.

Table 1: Default settings for the swarm-based Echoview template. NB all dB values re 1 m^{-1}.

Spike noise reduction parameters (Wang et al., 2016)		
	38 kHz	120 kHz
Minimum data threshold (S_v)	–80 dB	–70 dB
Maximum data threshold (S_v)	–50 dB	–40 dB
Background Noise removal parameters (de Robertis and Higginbottom, 2007)		
	38 kHz	120 kHz
Horizontal extent (pings)	20	20
Vertical extent (samples)	5	5
Vertical overlap	0%	0%
Maximum noise	–105 dB	–135 dB
Minimum signal to noise (SNR)	12 dB	12 dB
Seabed detection parameters		
Run on unprocessed 38 kHz data (the 'fisheries: Sv raw pings T1' virtual variable in the Echoview template)		
	38 kHz	
Start depth	20 m	
Stop depth	1 000 m	
Minimum S_v for good pick	–60 dB	
Apply backstep:		
Discrimination level	–70 dB	
Backstep range	15 m	
Peak threshold	–50 dB	
Maximum dropouts	2 samples	
Window radius	50 samples	
Minimum peak asymmetry	–1	
Swarm detection parameters		
Run on 120 kHz 3 × 3 dilation that has been through the spike and background noise reduction processes above (the '120 Dilation filter 3×3 (detect schools here)' virtual variable in the Echoview template)		
	Parameter value	
Minimum candidate length	15 m	
Minimum candidate height	3 m	
Maximum horizontal linking distance	15 m	
Maximum vertical linking distance	5 m	
Minimum total length	15 m	
Minimum total height	3 m	
Minimum data threshold	–70 dB	
38 – 120 kHz 'dB difference' parameters		
Minimum dB difference	–20 dB	
Maximum dB difference	20 dB	
1 n mile × 250 m export parameters		
Minimum data threshold (S_v)	none	
Conversion factor (NASC to areal density)	0	

Table 2: Schools detection parameters used in the sensitivity analysis of mean areal krill density.

Schools detection parameter	Woodd-Walker et al. (2003)	Tarling et al. (2009)	Cox et al. (2011)	SG-ASAM-17/02	SG-ASAM-17/03	SG-ASAM-17 meeting settings
Maximum horizontal linking distance (m)	15	15	30	15	15	15
Maximum vertical linking distance (m)	3	5	10	3	5	5
Minimum candidate height (m)	3	1	10	3	1	3
Minimum candidate length (m)	10	10	30	10	10	10
Minimum school height (m)	3	2	10	3	2	3
Minimum school length (m)	15	15	30	15	15	15
Minimum data S_v threshold (dB re 1 m^{-1})	–80	–70	–80	–65	–70	–70
Estimated inter ping distance (m)	12.5	7.5	12.5	10	Undefined	Undefined
Image processing acoustic variable type	None – as observed	Convolution 7 × 7	Convolution 3 × 3	Dilation 3 × 3	None – as observed	Dilation 3 × 3

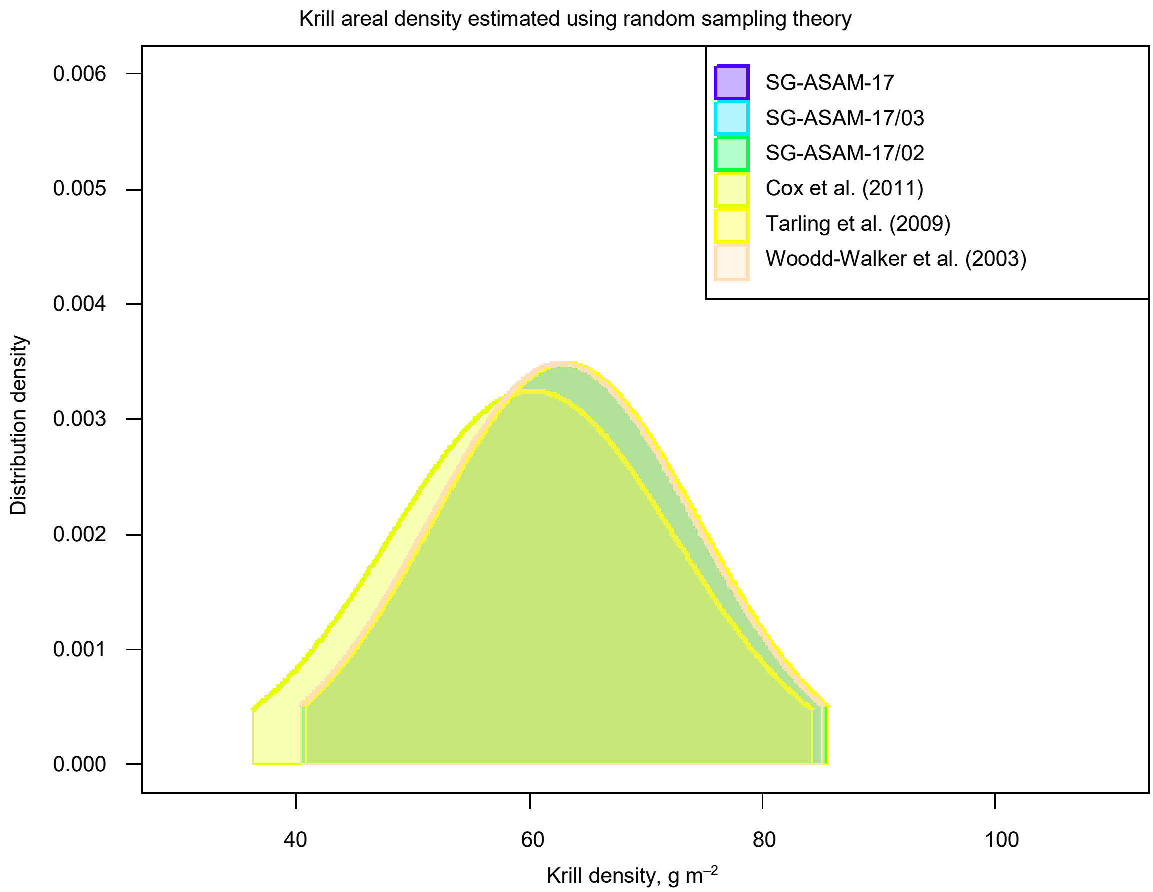

Figure 1: The sensitivity of mean krill density estimates to varying school detection parameters with no dB differencing applied. The figure legend references are: SG-ASAM-17 – school detection parameters selected during SG-ASAM-17; SG-ASAM-17/02 and 17/03 – working group papers; Cox et al. (2011), Tarling et al. (2009) and Woodd-Walker et al. (2003) are cited in the reference section.

Appendix A

List of Participants

Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 15 to 19 May 2017)

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Appendix B

Agenda

Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 15 to 19 May 2017)

1. Opening of the meeting

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

3. Analysis of data collected from fishing vessels

4. Survey design

5. Other business

6. Advice to the Scientific Committee

7. Adoption of report and close of meeting.

Appendix C

List of Documents

Subgroup on Acoustic Survey and Analysis Methods
(Qingdao, People's Republic of China, 15 to 19 May 2017)

SG-ASAM-17/01	An outline of the proposed dedicated krill survey for CCAMLR Division 58.4.1 during 2018/19 season by the Japanese survey vessel, *Kaiyo-maru* H. Murase, K. Abe, T. Ichii and A. Kawabata
SG-ASAM-17/02	Describing krill: swarms or integration intervals? M.J. Cox
SG-ASAM-17/03	Evaluation of some processing techniques applied to acoustic recordings from two krill fishing vessels X. Wang, G. Skaret and O.R. Godø
SG-ASAM-17/04	Density and biomass of Antarctic krill around South Shetland Islands using by 2-dB difference method S.-G. Choi, K. Lee and D. An
	***************
SG-ASAM-17/P01	A study on calibration for commercial echosounder using bottom backscattering strength in Antarctic S.-G. Choi, H. Lee, K. Lee and J. Lee *Fisheries Technology in Korea*

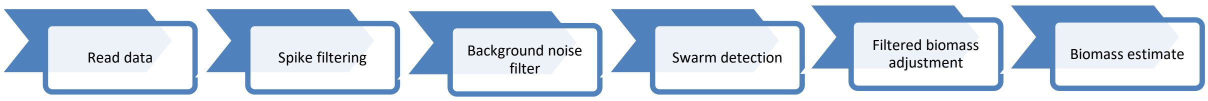
Appendix D

Swarm-based Echoview template user manual

Version 1 May 2017

Background

The Echoview swarm template is developed to pursue an alternative approach to the CCAMLR procedure for biomass estimation from transect line acoustic surveys. All available information indicates that a very high percentage of the krill will be concentrated in swarms which are almost exclusively krill. The basis of the method is, therefore, to identify the swarms and assess their biomass after cleaning the data for various types of noise. To prepare the acoustic data from fishing vessels for assessment purposes, a sequential data automatic data processing routine is developed in Echoview (see figure below).



The following template provides guidance on how the developed protocols can be applied and adjusted.

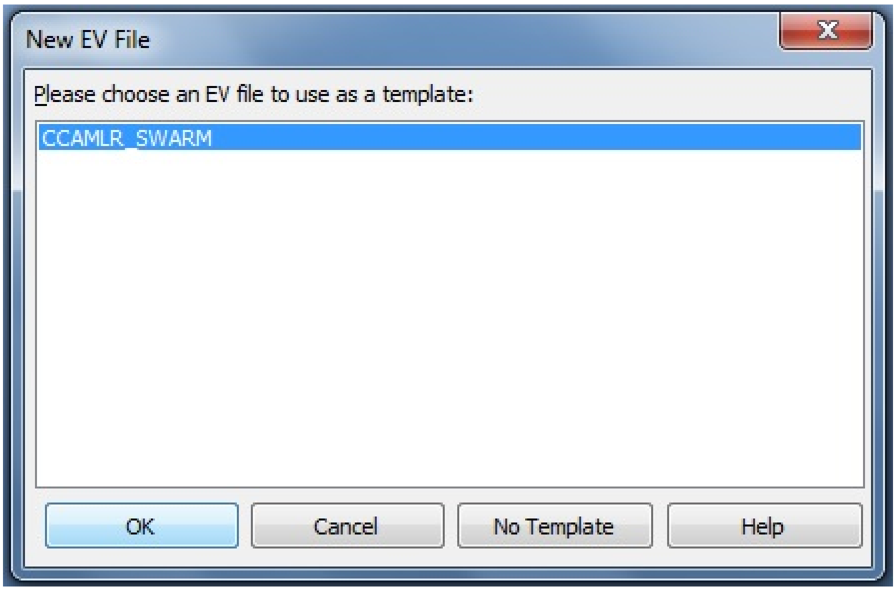
The following template is designed for use with 38 and 120 kHz only. The default parameters for the template are provided in Table 1. The process for using the EchoviewR package is illustrated in the R Markdown document 'Saga Sea EchoviewR example' that was developed during SG-ASAM-17 (see Attachment 1).

How to use the swarms template

Place the 'CCAMLR_SWARM.EV' file in C:\Program Files\Echoview Software\Echoview 8.0\Echoview\Templates. Administrator permissions are needed to do this. If you cannot get access to the Templates folder, you will have to open the Echoview program first. Go to 'File' then 'Configuration'. Click the tab on the left marked 'File Locations'. On the right side, select 'Templates' under 'File Type'. Click 'Edit' and then navigate to the folder location where 'CCAMLR_SWARM.EV' is located.

Open the Echoview program.

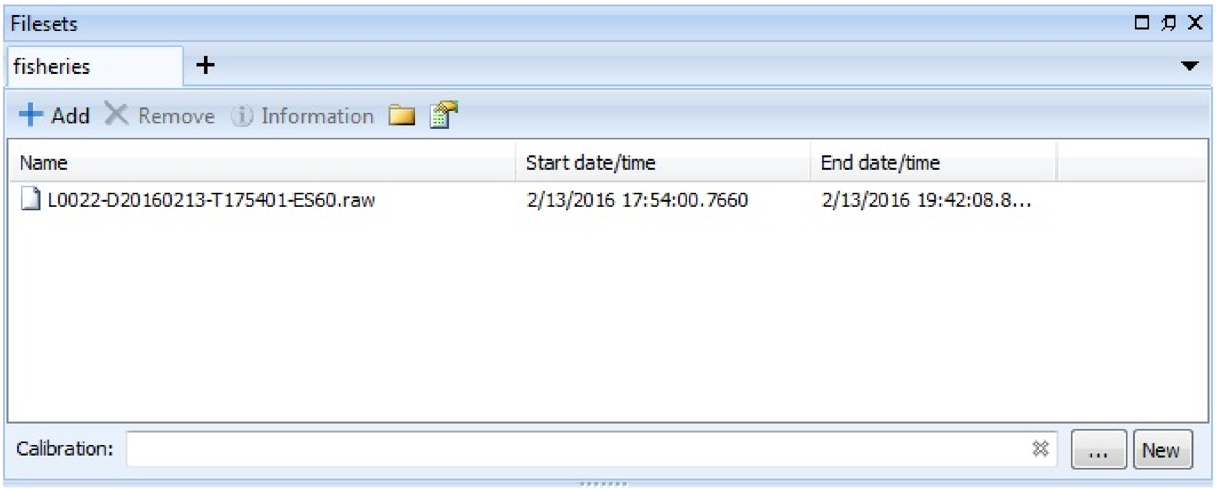
Click on 'File' and select 'New'.



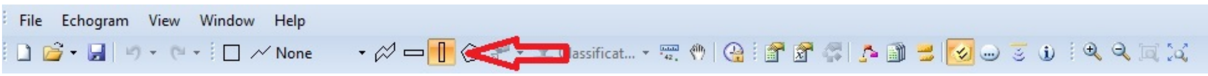
Select ‘CCAMLR_SWARM’ and press ‘Ok’.

Add your survey data to the file set. Press the ‘+Add’ button and select your acoustic data. Then press ‘Ok’.

Double-click ‘SV raw pings T1’ to visually check your data.

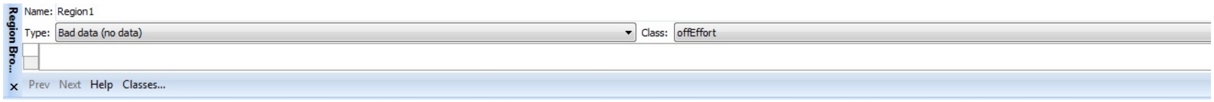


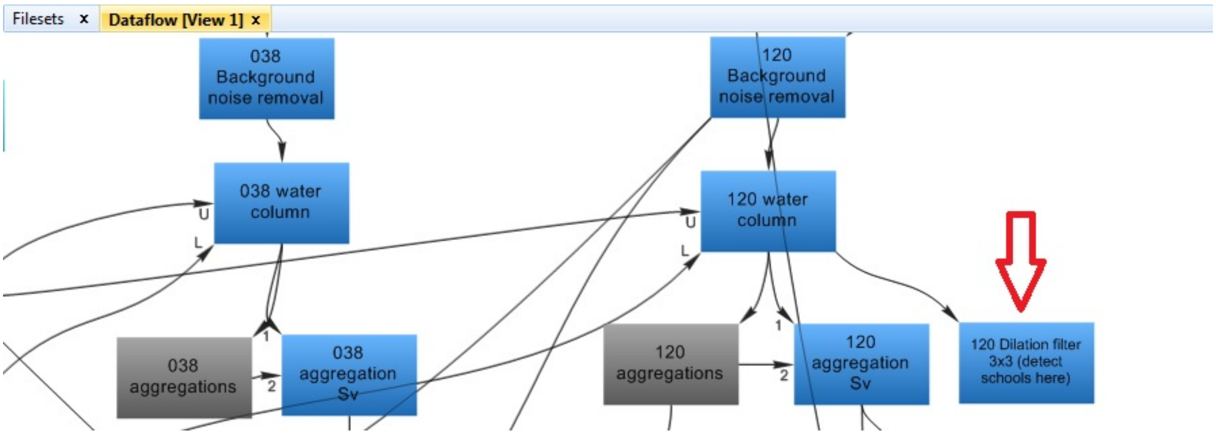
Now add the calibration file for your fishing vessel. Press ‘. . .’ and add your calibration file. If you do not have one, you can create one. To create a new calibration file, press ‘New’. Once you have named your calibration file press ‘Save’. You should now see your calibration file in the box next to ‘Calibration:’.



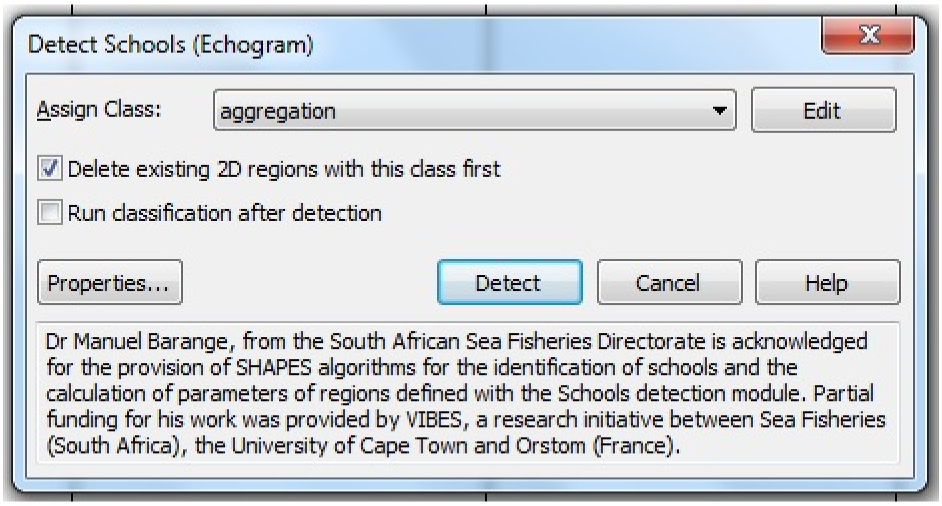
If you still have SV raw pings T1 open, select the ‘Vertical band’ tool. This can be used to select data that is not part of the transect line. Press and hold the left mouse button to size the area. Next, click the right mouse button and select ‘Define Region’. Make sure the ‘Type’ says

‘Bad Data (no data)’. The ‘Class’ should be selected to ‘offEffort’. Do this for each section of data that is not part of the transect line (i.e. turns, net tows, etc.). The area should turn purple.



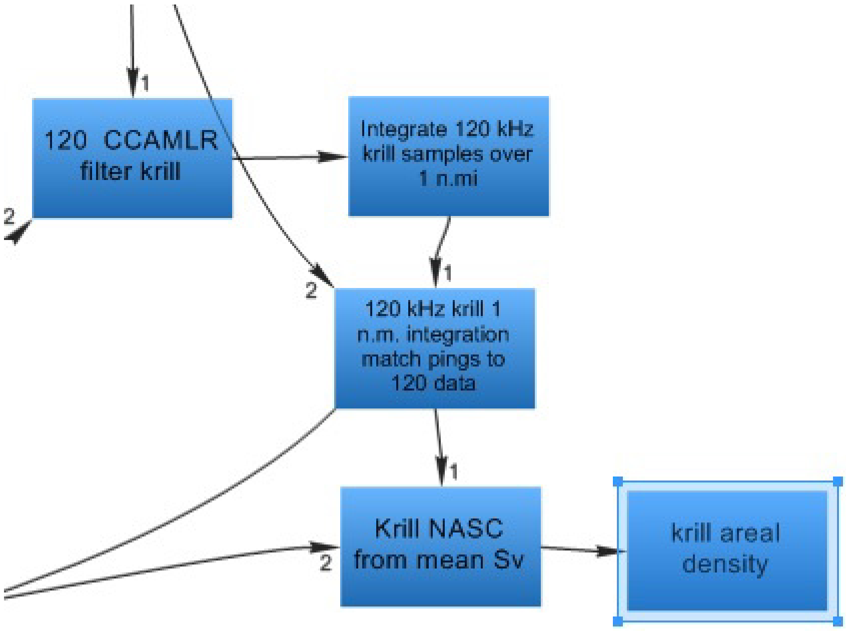


In the Dataflow window, double-click to open ‘120 Dilation filter 3×3 (detect schools here)’.



On the menu bar, select ‘Echogram’ and select ‘Detect Schools…’.

Where it says ‘Assign Class’ pull down and select ‘aggregation’. Make sure that you check ‘Delete existing 2D regions with this class first’. Then select ‘Detect’. This step will take several minutes.



For an output of nautical area scattering coefficient (NASC) values (m^2 n miles^{-2}), open the ‘Krill NASC from mean Sv’ by double-clicking the left mouse button. This step will take several minutes. On the menu bar, select ‘Echogram’ then ‘Export’ then ‘Analysis by Cells’ then ‘Integration’. Save the file as comma-separated values (csv).

For an output of density estimates (g m^{-2}), open the ‘krill areal density’ variable by double-clicking the left mouse button. This step will take several minutes. On the menu bar, select ‘Echogram’ then ‘Export’ then ‘Analysis by Cells’ then ‘Integration’. Save the file as csv. The initial settings are set at 0 until a conversion factor is put in place. To put in a conversion factor, right-click on the ‘krill areal density’ and select ‘Variable Properties’. Open the tab to ‘Constant Multiply/Divide’. Enter your conversion factor calculated from the krill length frequency.

Output

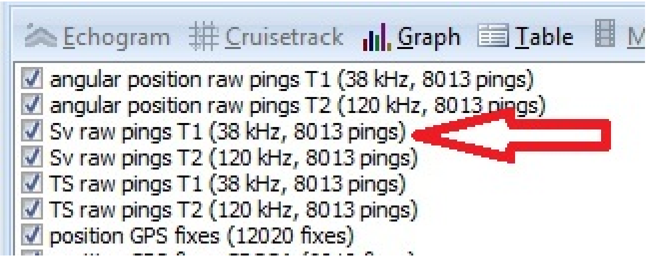
The output of both the ‘Krill NASC from mean Sv’ and the ‘krill areal density’ is in 250 m depth × 1 n mile intervals.

The fourth column of the exported csv file is labelled as ‘Sv_mean’. This is actually NASC if your output file is from ‘Krill NASC from mean Sv’, not the column titled ‘NASC’. The fourth column of the csv file from ‘krill areal density’ labelled ‘Sv_mean’ is the density output.

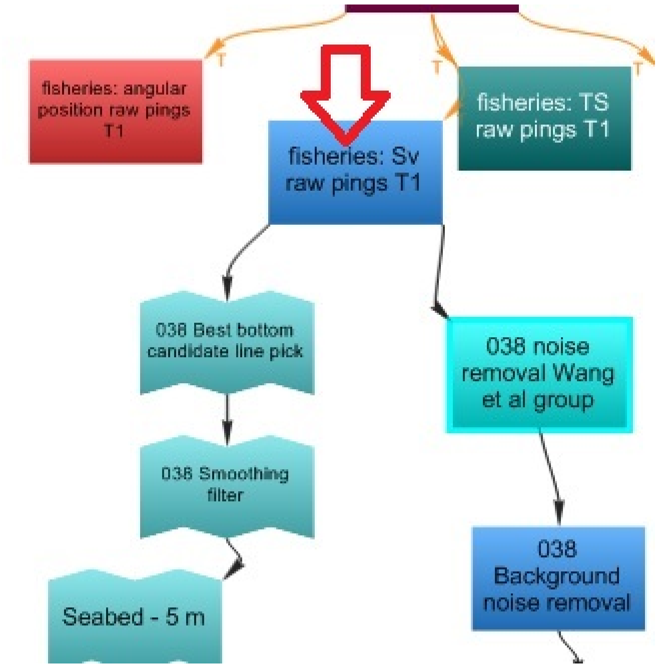
Troubleshooting

Assigned frequencies

The template is designed for S_v raw T1 to be 38 kHz and S_v raw T2 to be 120 kHz. If S_v raw T1 is not 38 kHz, you will have to manually change the variables in the Dataflow window.



You can see what frequency is assigned to T1, it will show up to the right of 'Sv raw pings T1'. This can be done for each frequency.



Schools detection

To change the schools detection parameters, open the 'Properties' button in the 'Detect Schools'.

Conversion factor

The conversion factor to transform NASC into density is documented in SG-ASAM-16/01. Length frequency of krill caught in the area that the transect lines were performed can be used to determine the conversion factor. The length frequencies collected from the observers on krill fishing vessels from the previous seven days can be aggregated.

Default settings

Default schools parameter	Default value
Maximum horizontal link	15 m
Maximum vertical link	5 m
Minimum candidate height	3 m
Minimum candidate length	10 m
Minimum school height	3 m
Minimum school length	15 m
Data threshold	–70 dB

The default settings for the noise reduction is found in Wang et al., 2015.

Default settings for 38 – 120 kHz dB difference filter are:

minimum in-range: –20 dB
maximum in-range: 20 dB.

The conversion factor found in the krill areal density is set to zero.

Table 1: Default settings for the swarm-based Echoview template. NB all dB values re 1 m^{-1}.

Spike noise reduction parameters (Wang et al., 2016)		
	38 kHz	120 kHz
Minimum data threshold (S_v)	–80 dB	–70 dB
Maximum data threshold (S_v)	–50 dB	–40 dB
Background Noise removal parameters (de Robertis and Higginbottom, 2007)		
	38 kHz	120 kHz
Horizontal extent (pings)	20	20
Vertical extent (samples)	5	5
Vertical overlap	0%	0%
Maximum noise	–105 dB	–135 dB
Minimum signal to noise (SNR)	12 dB	12 dB
Seabed detection parameters		
Run on unprocessed 38 kHz data (the 'fisheries: Sv raw pings T1' virtual variable in the Echoview template)		
	38 kHz	
Start depth	20 m	
Stop depth	1 000 m	
Minimum S_v for good pick	–60 dB	
Apply backstep:		
Discrimination level	–70 dB	
Backstep range	15 m	
Peak threshold	–50 dB	
Maximum dropouts	2 samples	
Window radius	50 samples	
Minimum peak asymmetry	–1	
Swarm detection parameters		

(continued)

Table 1 (continued)

Run on 120 kHz 3 × 3 dilation that has been through the spike and background noise reduction processes above (the ‘120 Dilation filter 3×3 (detect schools here)’ virtual variable in the Echoview template)

	Parameter value
Minimum candidate length	15 m
Minimum candidate height	3 m
Maximum horizontal linking distance	15 m
Maximum vertical linking distance	5 m
Minimum total length	15 m
Minimum total height	3 m
Minimum data threshold	–70 dB
38 – 120 kHz ‘dB difference’ parameters	
Minimum dB difference	–20 dB
Maximum dB difference	20 dB
1 n mile × 250 m export parameters	
Minimum data threshold (S_v)	none
Conversion factor (NASC to areal density)	0

Saga Sea EchoviewR example created in R markdown

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19 May 2017

Here I provide an example of how to use EchoviewR to control Echoview from R and to detect swarms and export the resulting echo integration. In this example, I use ES60 data from the Saga Sea, collected in February 2016 and provided by Norway during the 2017 SG-ASAM meeting.

At the end of this document, I provide an example of how to automate this approach by controlling Echoview within a loop.

Data locations

To run this example, you will need to set the ES60 RAW data directory and The data directory that is specific to your own computer. The directory in the `R` object, `wd` must contain the ES60.RAW files.

Find RAW files

We start by loading the RAW file locations into the `R` workspace and do this using the `R` function `list.files()`.

```
wd='C:/Users/martin_cox/Documents/ASAM/sagaSea-raw/' #Change the data dire
ctory here.
rawFiles=list.files(wd,pattern='.raw',full.names = TRUE)
```

There are `17` ES60 RAW data files in the data directory.

Calibration file directory and filename

Next, we specify the Echoview calibration (.ECS) file directory and location:

```
calFile='C:/Users/martin_cox/Documents/2017/sagaSea/raw/SimradEK60Raw.ecs'
```

Echoview template file directory and filename

Finally, I specify the location of the Echoview template file that we will use for the acoustic processing. This Echoview template was developed during SG-ASAM17 for swarm-based analysis.

```
EVtemplate='C:/Users/martin_cox/Documents/mawsonBox/CCAMLR_SWARMR06.EV'
```

Load EchoviewR library into R

Now we have specified the locations of the ES60.RAW data files, the Echoview format calibration file, and the Echoview template file we can load the `EchoviewR` package version `1.0` into the `R` workspace.

```
library(EchoviewR,quietly = TRUE)
```

Start Echoview remotely

Here, we establish a link between `R` and Echoview. If the link fails, please see the resolved issues on the `EchoviewR` git hub website.

```
EVAppObj=COMCreate('EchoviewCom.EvApplication')
```

The COM address of the Echoview program is now available in the `R` workspace and can be used to control Echoview remotely from `R`.

Load the RAW data into Echoview using EchoviewR

In this section we load the ES60 RAW data files into the template and save the template as an Echoview .EV file. We specify the output .EV file directory and name as:

```
outputDVFile=paste(wd,'SagaSeaTestWithTemplateR06.EV',sep='')
```

Now we are ready to add the ES60 RAW data files. The `EchoviewR` package has a function `EVCreateNew()` function that will let us add files. Recall, the ES60.RAW file directory and file names are stored in the `R` workspace in the `rawFiles` object. We are going to add the files in the `rawFiles` object to the fisheries Echoview fileset. We specify Echoview specify fileset allocation using the `filesetName` argument in the `EVCreateNew()` function.

```
EVFile=EVCreateNew(EVAppObj=EVAppObj,
                   templateFn=EVtemplate,
                   EVFileName=outputDVFile,
                   filesetName="fisheries",
                   dataFiles=rawFiles,
                   CloseOnSave = FALSE)$EVFile
```

After running the `EVCreateNew()` function, we have created an Echoview (.EV) file. The COM object address is now assigned to the `EVFile` object in the R workspace.

Load calibration file

Next, we add the calibration file to the Echoview file using the `EchoviewR` function `EVAddCalibrationFile()`. Again, we use the `filesetName` argument in the `EVAddCalibrationFile()` to specify the Echoview fileset to which the calibration file will be assigned.

```
EVAddCalibrationFile(EVFile=EVFile, filesetName='fisheries', calibrationFi
le=calFile)
```

Save the Echoview File

In order to retain the link to the calibration file, we now save the Echoview file.

```
EVSaveFile(EVFile=EVFile)
```

Detect krill swarms

We are now ready to carry out swarms detection. The `EchoviewR` package has a function, `EVSchoolsDetect()`, to run the SHAPES algorithm. We run the SHAPES algorithm on the Echoview virtual acoustic variable called '120 Dilation filter 3x3'. The detected swarms are allocated to the Echoview region class called 'aggregation'. This is specified using the `outputRegionClassName` argument in the `EVSchoolsDetect()` function. Remember swarms detection might take five minutes to run.

```
swarmDetResults=EVSchoolsDetect(EVFile = EVFile,
                    acoVarName='120 Dilation filter 3x3',
                    outputRegionClassName = 'aggregation',
                    deleteExistingRegions = TRUE,
                    distanceMode = "GPS distance",
                    maximumHorizontalLink = 15, #m
                    maximumVerticalLink = 5,#m
                    minimumCandidateHeight = 3, #m
                    minimumCandidateLength = 15, #m
                    minimumSchoolHeight = 3, #m
                    minimumSchoolLength = 15, #m
                    dataThreshold = -70)#dB re 1 m^-1
```

Export the data in 1 n mile x 250 m depth intervals

After swarm detection we integrate the swarms in 1 n mile x 250 m intervals. Currently, we have two options for integration export. Firstly, we integrate the swarms, export the integration results as NASC. In the example below, we export the NASC result to the file 'krillNASCfromTemplateR06.csv'.

```
exportFileName=paste(wd,'krillNASCfromTemplateR06.csv',sep='')
EVExportIntegrationByCells(EVFile= EVFile,
                           variableName='Krill NASC from mean Sv (export h
ere for NASC values)',
                    filePath=exportFileName)
```

If we know the krill length frequency distribution, we can calculate the NASC to areal density conversion factor, C (see SG-ASAM16/01) and enter the value into the Echoview virtual variable 'krill areal density (enter conversion factor before export)'. We can export mean areal krill density, gm^{-2}, over 1 n mile x 250 m intervals to the file 'krillArealDensityfromTemplateR06.csv'

```
exportFileName=paste(wd,'krillArealDensityfromTemplateR06.csv',sep='')
EVExportIntegrationByCells(EVFile= EVFile,
                           variableName='krill areal density (enter conver
sion factor before export)',
                    filePath=exportFileName)
```

Creating multiple Echoview (.EV) files using a loop

We can also use `EchoviewR` within a loop to create multiple Echoview files. For example, we could create one Echoview .EV file per transect. The *Saga Sea* example data has two transects, so in the example below, we will create two Echoview .EV files.

Here, we assign ES60.RAW files from working directory `C:/Users/martin_cox/Documents/ASAM/sagaSea-raw/` to one of two transects:

```
fileDataFrame=data.frame(fileName=rawFiles,transect=1)
#manually add transect 2:
fileDataFrame$transect[6:14]=2
```

Next, we make a variable that holds the unique transect numbers.

```
uniqueTransect=unique(fileDataFrame$transect)
```

We will loop over the `1, 2` object and create an Echoview EV file containing transect specific ES60.RAW data and the Echoview format calibration (.ECS) file.

At the start of each iteration we assign transect-specific ES60 RAW file directory and names to the `R` object `TMPtransect`.

With the exception of the `EVFileName` argument, the `R` code in the loop follows the example code given in the examples above. The `EVFileName` argument is changed to create a unique .EV file name for each transect.

```
for(i in 1:length(uniqueTransect))
{
  TMPtransect=as.character(fileDF$fn[fileDF$transect==uniqueTransect[i]])
  EVFile=EVCreateNew(EVAppObj=EVAppObj,
                     templateFn=EVtemplate,
                     EVFileName=
                       paste(wd,'SagaSeaTestWithTemplateR06-transect',uniqueTr
ansect[i],'.EV',sep=''),
                     filesetName="fisheries",
                     dataFiles=TMPtransect,
                     CloseOnSave = TRUE)$EVFile
  EVAddCalibrationFile(EVFile=EVFile, filesetName='fisheries', calibration
File = calibrationFile=calFile)
  EVSaveFile(EVFile=EVFile)
}
```

Annex 5

Report of the Working Group on Statistics, Assessments and Modelling
(Buenos Aires, Argentina, 26 to 30 June 2017)

Contents

Report of the Working Group on
Statistics, Assessments and Modelling
(Buenos Aires, Argentina, 26 to 30 June 2017)

Introduction

Opening of the meeting

1.1 The 2017 meeting of WG-SAM was held in the Palacio San Martín, Buenos Aires, Argentina, from 26 to 30 June 2017. The meeting Convener, Dr S. Parker (New Zealand), welcomed participants (Appendix A). The Argentinian Commissioner to CCAMLR (Mr Maximo Gowland) welcomed the participants to the historic palace and wished the participants every success in their meeting and an enjoyable stay in Buenos Aires.

Adoption of the agenda and organisation of the meeting

1.2 Dr Parker recalled the terms of reference for WG-SAM and noted that the priorities identified by the Scientific Committee in 2016 for the work of WG-SAM this year were the estimation of local biomass in research blocks, including the uncertainty associated with those estimates, and the review of fishery research survey plans (SC-CAMLR-XXXV, Table 1). The meeting agenda was adopted (Appendix B).

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

1.4 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been indicated in grey. A summary of these paragraphs is provided in Item 7.

1.5 The Working Group used the Secretariat's online meeting server to support its work and facilitate the preparation of the meeting report.

1.6 The report was prepared by M. Belchier and C. Darby (UK), A. Dunn (New Zealand), T. Earl (UK), C. Jones and D. Kinzey (USA), K. Reid and L. Robinson (Secretariat), M. Söffker (UK), S. Somhlaba (South Africa) and D. Welsford and P. Ziegler (Australia).

Development and progress of integrated assessments

Krill

2.1 WG-SAM-17/31 described recent developments towards an integrated stock assessment for krill in Subarea 48.1. The work identified that not all parameters in the model could be successfully estimated, and investigated approaches for estimating parameters in stages.

2.2 The diagnostics presented in the paper focused on the performance of the optimiser used in the model and retrospective fits, rather than the fit of the model to the data. The Working Group suggested that further diagnostics showing the fit of the model to the survey data and likelihood profiling would be required to evaluate the suitability of the model. In particular, the Working Group considered that it was important to test sensitivities to the assumption that the survey has a catchability of 1 at the oldest age.

2.3 The Working Group noted that when natural mortality was estimated, the value was 2−3 times higher than had previously been assumed. When age-varying natural mortality was estimated, it varied without trend between ages. This estimation of high and variable mortality may be the result of emigration or other violated assumptions within the model. Some Members considered that quantifying the flux of krill through Subarea 48.1 from the Weddell Sea and Bellingshausen Sea would be important for managing the stock, quantifying the stock–recruit relationship and understanding the age structure of the assessment unit. Other Members considered that over management timescales, this flux could be neglected.

2.4 WG-SAM-17/32 responded to a request from WG-SAM-16 to describe how the process of model development had incorporated, and responded to, the recommendations of previous working groups. The review highlighted the significant work and degree of model development that has taken place.

2.5 The Working Group noted that there are no plans for further US AMLR surveys in the same form as in previous years. These are currently used as an important source of data within the model, and so the Working Group noted the importance of making the best use possible of data from surveys by commercial fishing vessels, such as the transects identified by SG-ASAM that cover the US AMLR survey area. The following transects in Subarea 48.1 overlap the area covered by the US AMLR survey: 7 to 14 and 22 to 24 (SC-CAMLR-XXXIV, Annex 4, Appendix D, Figure 2a).

Toothfish

2.6 The Working Group considered four papers on toothfish population integrated assessments and management advice relating to research on: (i) the sensitivity of assessments to migration from and to the stock area (WG-SAM-17/11), (ii) the sensitivity of the CASAL model estimates to the number of years at liberty of released tags (WG-SAM-17/35), (iii) a simulation study of the data required to achieve a stock assessment of the Amundsen Sea region (WG-SAM-17/40) and (iv) the proposed assessment approach to accommodate the impact of the Ross Sea region marine protected area (MPA) implementation on the assessment of the Ross Sea region (WG-SAM-17/41).

Divisions 58.5.1 and 58.5.2

2.7 WG-SAM-17/11 evaluated the sensitivity of the CASAL tag-based toothfish stock assessments to migration of fish in and out of the assessed area and estimated annual migration between Divisions 58.5.1 and 58.5.2. Both emigration and immigration to the stock can violate the single stock assumptions of the tag-recapture models used in the assessments. This study used a fisheries simulation model to evaluate the impacts of migration on biomass estimates and sustainable catch limits, demonstrating that emigration of tagged fish out of the assessed area results in initial and current spawning biomass and stock status being overestimated.

2.8 Annual migration rates of toothfish from Division 58.5.2 to Division 58.5.1 were estimated to be 1.1% using longline releases from 2007 to 2014 and 0.7% using longline releases from 2009 to 2014. The annual migration rate from Division 58.5.1 to Division 58.5.2 was estimated to be 0.4% and was insensitive to the time period of longline tag releases used. There was insufficient tagging data to distinguish whether the migration was related to maturity or sex, although it did include tags from across a large range of sizes.

2.9 Annual migration rates of up to 1%, consistent with those estimated between Divisions 58.5.2 and 58.5.1 on the Kerguelen Plateau, resulted in simulated bias in spawning biomass estimates of <2%. The authors demonstrated that the bias can be corrected by increasing the tag-shedding parameter in CASAL, providing a simple approach to correct for the effects of emigration. They recommended that for tag-based assessments for stocks where emigration occurs, the tag-shedding parameter should be increased by the estimated emigration rate to adjust for migration-related bias.

2.10 The Working Group recommended that the authors examine the development of a simple diagnostic to quantify the effects of migration in the next toothfish stock assessment. The Working Group also asked the authors to evaluate an alternative approach to representing emigration, by including an additional fishery that would impact the population of tagged and untagged fish, rather than through increasing tag loss, which only applies to tagged fish.

Subareas 48.3 and 48.4

2.11 WG-SAM-17/35 evaluated the sensitivity of the CASAL toothfish assessment estimates for Subareas 48.3 and 48.4 to the number of years at liberty that recaptures were included in the model. The assessment in Subarea 48.3 currently uses recaptures within four years of their release as input data, whereas the assessment in Subarea 48.4 uses all available recapture data (excluding within-year recaptures). Truncation to four years at liberty in the Subarea 48.3 assessment is used to prevent bias in the assessment estimates resulting from a mismatch between the CASAL model formulation for tag loss of single-tagged fish, while tag loss is estimated from double-tagged fish. Sensitivity tests on both stocks show that this bias occurs in practice and that truncation to four years is appropriate for the assessments.

2.12 The Working Group noted that two studies by Candy (WG-SAM-11/12) and Dunn (WG-SAM-11/18) had also examined bias resulting from tag loss and reached similar conclusions, noting that differences in the analytical approaches used to date may be useful to explore. The Working Group agreed that the number of years of tag liberty in the Subarea 48.4 assessment should be reduced to four.

Subarea 88.2

2.13 WG-SAM-17/40 presented a simulation study of the two-area stock assessment of the Amundsen Sea region. The authors concluded that the current research plan is providing tag recaptures in the south and north as intended and should yield sufficient data to allow a robust assessment of the toothfish stock in the Amundsen Sea region (ASR) in future years. They further showed that at the current level of tag release, there is a low probability that tagged fish will be caught after having moved from the south to the north or vice versa.

2.14 The Working Group noted that local biomass estimates for the north and south using the tagging information available would be required for WG-FSA-17 in order to help evaluate whether the current catch limits were precautionary and for WG-FSA to be able to provide additional advice on the continuation of the research plan. Due to the low probability of recapture of tags moving between the north and the south, the Working Group urged Members to consider other mechanisms that may help to determine population linkages, such as using pop-up satellite archival tags (PSATs) or otolith microchemistry to investigate toothfish movements in the ASR and other areas.

Subarea 88.1

2.15 WG-SAM-17/41 presented a proposed approach to updating the stock assessment in 2017 of the Ross Sea region in light of the implementation of the Ross Sea region MPA (Conservation Measure (CM) 91-05). The authors concluded that CM 91-05 would not impact on the 2017 assessment of stock status, but would impact on the forward projections and setting catch limits using the 2017 assessment. They further noted that the implementation of CM 91-05 would require further work to address potential bias in the assessment resulting from the redistribution of effort resulting from the MPA. This would be particularly important in the provision of advice on regional catch allocations as the assessment develops in the future.

2.16 The Working Group recommended that the 2017 stock assessment of toothfish in the Ross Sea region be an update of the 2015 assessment, with sensitivity analyses carried out on the allocation of catch limits used in projections.

2.17 WG-SAM-17/41 noted that additional options should be developed for catch splits between the shelf, slope and north areas of the Ross Sea region prior to the 2019 assessment. Dr S. Kasatkina (Russia) suggested that it would be important to clarify the methods used for developing these options prior to the 2019 assessment, taking into account the changes in fishing grounds and areas of toothfish habitats accessible to the fishery arising from the coming into force of the Ross Sea region MPA.

2.18 The Working Group recommended that the WG-SAM and WG-FSA strategic programs of work include a priority for reviewing and evaluating the potential bias in the assessment and advice due to changes in the location of catch and effort, including those in relation to the spatial distribution of tagged fish. These should be developed further, along with the scientific rationale for catch allocations to regions of Subarea 88.1, in advance of WG-FSA-21, as per CM 91-05.

Icefish

2.19 WG-SAM-17/36 compared two methods for bootstrapping the haul data from biomass surveys for icefish in Subarea 48.3. The current method (WG-FSA-96/38) resamples across data from all strata, weighted by the number of samples per unit area in each stratum. In this method, the number of samples within each stratum may differ between repetitions of the bootstrap. In the rescaled bootstrap, the number of samples in each stratum is consistent with the data for every repetition.

2.20 The estimated percentiles of the mean biomass density were nearly identical between the two methods. The largest difference between the methods was when sample sizes were low (fewer than two haul samples per stratum).

2.21 The current method of bootstrapping is used for icefish assessments in both Subarea 48.3 and Division 58.5.2. In Division 58.5.2, the method is applied to both biomass and the length distribution, whereas in Subarea 48.3 the length distribution is calculated deterministically. The Working Group noted previous work (Hillary et al., 2010) suggesting that the rescaled bootstrap is less suitable for length distributions due to the potential for small sample sizes in individual length classes in some strata.

2.22 For consistency between the areas, the Working Group recommended retaining the existing approach in Subarea 48.3 rather than the rescaled bootstrap.

Biomass estimation, including estimation of uncertainty

3.1 The Working Group noted that the Scientific Committee referred discussion of the most appropriate analytical methods to be used to generate local biomass estimates with different levels of information available, as well as uncertainty in those estimates, to WG-SAM for recommendations (SC-CAMLR-XXXV, paragraph 13.17).

3.2 The Working Group noted WG-SAM-17/12, which developed a bootstrap method to estimate the uncertainty around both the Chapman and catch per unit effort (CPUE) by seabed area analogy biomass estimates. This work was developed in response to the request to develop such approaches from the Scientific Committee (SC-CAMLR-XXXV, paragraph 3.187ii). The paper noted that while CPUE by seabed area and Chapman bootstrapped confidence intervals generally overlapped for research blocks where Patagonian toothfish (*Dissostichus eleginoides*) are dominant, they generally did not overlap in research blocks where Antarctic toothfish (*D. mawsoni*) were dominant. The Working Group agreed that comparisons of confidence intervals around biomass estimates in the same research blocks derived from different methods were a useful indicator of whether the independent methods were appropriate.

3.3 The Working Group noted that in instances where the two confidence intervals around the estimates did not overlap, this suggested that there were issues with the underlying data, parameter values, and/or a violation of methodological assumptions (such as post-release mortality, spatial overlap of release and recapture effort, or different catchability between the reference and research areas) that warranted further investigation.

3.4 The Working Group noted WG-SAM-17/13, which described a simulation study to investigate the implications of realised tag recaptures being different to the expectation in a tag-release and recapture experiment. It noted that the Chapman biomass estimates were unbiased when large numbers of tagged fish are available for recapture, however, in instances when observed recaptures are lower or higher than the expected number, biomass estimates were asymmetrically distributed. The simulations showed that in a best-case scenario, when tagging mortality, tag shedding and natural mortality parameters used in the Chapman estimator reflect what is occurring in the population, the recapture of fewer than expected tagged fish results in biomass estimates that can be several times the actual biomass. This effect was more pronounced when the number of tag recoveries is much lower than expected in any one season.

3.5 The Working Group noted that the effects of lower than expected numbers of recaptures (WG-SAM-17/13) may, in part, explain the observed large variations in Chapman biomass estimates between seasons, and the difference between CPUE by seabed area and Chapman biomass estimate in some research blocks (see WG-SAM-17/12). It agreed that these analyses further emphasised the need for an evaluation of fishing and tagging effort in research plans to increase the number of tagged fish recovered to a point where the chance of large biases is reduced. This could be achieved through increased tag-release rates, increased tag-detection rates and increased numbers of scanned fish.

3.6 The Working Group noted WG-SAM-17/37, which reviewed the derivation of the CPUE by seabed area biomass estimation method, and highlighted the large differences between point estimates of biomass derived using the CPUE by seabed area method relative to those derived using the Chapman mark-recapture method. The Working Group recalled that the CPUE by seabed area method assumes a proportional relationship between CPUE and toothfish density (SC-CAMLR-XXXV, Annex 5, paragraph 2.28), and noted that a regression of Chapman-estimated biomass and CPUE in 100 × 100 km cells from the Ross Sea region fishery showed a significant relationship, which provided support for the CPUE by seabed area method to provide an interim biomass estimate for research plans.

3.7 The Working Group noted that the estimated relationship between CPUE and density was likely to be sensitive to the choice of cell size, movement of tagged fish, fish size distribution, gear type and functional relationship. However, it noted that the CPUE by seabed area analysis presented in WG-SAM-17/37, provided finer-scale and a more habitat-specific reference area than the Ross Sea region assessment, and could be useful in future analyses.

3.8 The Working Group also noted that the sum of the Chapman biomass estimates provided in WG-SAM-17/37 in the shelf/slope and northern seamount areas approximated the vulnerable biomass estimate from the integrated assessment, which provided some confidence that this method was producing reasonable density estimates. Consequently, the Working Group recognised that the proposed changes to the reference areas had the potential to improve the accuracy of CPUE by seabed area estimates in research blocks that currently used the entire Ross Sea region as the reference area.

3.9 The Working Group requested that additional analysis on how the cell-by-cell density estimates are translated to an overall CPUE-to-biomass density relationship be considered by WG-FSA before the separate shelf/slope and northern seamount reference area estimates are used to estimate biomass in research blocks. The additional details to be considered would include issues such as the interannual variability in the spatial distribution of catch and effort and vessel-specific variability in tag-recovery rates and how uncertainty could be best estimated for the resulting biomass estimates.

3.10 The Working Group recalled its advice from WG-SAM-16 that current biomass should be used from the reference area for CPUE by seabed area calculations, and noted that this had been interpreted as the current spawning stock biomass. The Working Group noted that the gear used in toothfish fisheries typically select immature as well as mature fish, and that the estimated biomass using the CPUE by seabed area would be for the part of the stock vulnerable to fishing. Consequently, the current vulnerable biomass from a reference area should be used in the CPUE by seabed area calculations. The Working Group agreed that the vulnerable biomass for the relevant reference area should be used to update CPUE by seabed area biomass estimates.

3.11 The Working Group noted that the seabed areas used from the Ross Sea region in CPUE by seabed area calculations had used the entire fishable area from all the Ross Sea region. It agreed that the fishable area within the open small-scale research units (SSRUs) in the Ross Sea region should be used, rather than the fishable area for all of Subarea 88.1 and SSRUs 882A–B, in revised calculations where the Ross Sea region is the reference area. It requested that the Secretariat provide revised CPUE by seabed area biomass estimates for exploratory fisheries in research blocks based on the revised parameter values, to be presented at WG-FSA-17.

3.12 The Working Group noted that WG-SAM-17/37 proposed a method of combining Chapman and CPUE by seabed area biomass estimates by using a Bayesian analysis where the CPUE by seabed area distribution is used as a prior that was updated by the tag release and recapture observations. The Working Group noted that this concept had potential to resolve the issue of choosing a 'best' estimate where CPUE by seabed area and tag release and recapture data were both available, and requested that Members work in the intersessional period to develop this method.

Review of research plan proposals and results

General issues on research proposals in data-poor exploratory fisheries and closed areas

Harmonising conservation measures related to conducting research on toothfish

4.1 The Working Group noted that toothfish exploratory fisheries such as those in Subarea 48.6 and Division 58.4.1 are conducted under CM 21-02, while research fishing in Subareas 48.1, 48.2 or 88.3 is conducted under CM 24-01. Despite the different conservation measure, these fishing activities are often at different stages of working towards similar objectives. However, activities conducted under CM 24-01 have a much more limited set of restrictions for fishing, e.g. no by-catch limits or move-on rules, no requirement for the use of bird exclusion devices at the hauling station.

4.2 To harmonise research fishing activities in exploratory fisheries and research exemptions under CM 24-01, the Working Group recommended (i) an evaluation of CM 24-01 and its application of exemptions from other conservation measures to research fishing targeting toothfish where catch limits are similar to those in exploratory fisheries, and (ii) the consideration by the Scientific Committee and the Commission of a conservation measure or measures for research fishing targeting toothfish not already included within other conservation measures.

Streamlining the review of research plans

4.3 The Working Group noted that the efficiency of its work has been impacted where research proposals in the same area had been submitted by individual Members and encouraged the development of single coordinated multi-Member proposals and progress reports be submitted for review by working groups.

4.4 The Working Group recalled that Members who submit a multi-Member and multi-vessel research proposal could identify a coordination process or group for a given research area to facilitate coordination of research proposals, operations at sea and data analyses. It was further recalled that such multi-Member multi-vessel research proposals (WG-SAM-17/08) include outlining milestones, operational contingency plans and progress made (SC-CAMLR-XXXV, Annex 5, paragraphs 4.76 and 4.77).

4.5 The Working Group noted the large number of newly proposed research blocks this year, and, when combined with the existing research blocks, this generates a significant number of areas for the Working Group to track and manage, as well as high demands on proponents to develop stock assessments in these areas (Figure 1). The Working Group expressed concern that the proliferation of research blocks could increase the development of research activities involving fishing faster than the data required to evaluate the impacts on stocks.

CCAMLR strategy on research plans in data-poor fishery areas

4.6 The Working Group recognised that the uncertainty in the processes for developing research plans targeting the development of toothfish stock assessments in data-poor areas created difficulties in the review of research plans in the evaluation of progress in ongoing research.

4.7 The Working Group recalled that over the past few years it had identified a number of requirements for research on toothfish and that bringing these agreements and review criteria together in a single document would greatly facilitate the future review of progress in research, both by proponents and the Working Group.

4.8 The Conveners of WG-SAM and WG-FSA undertook to provide an overview document to WG-FSA-17 that brought together the relevant advice and process on developing, and reviewing progress on, research plans related to toothfish. Such a review is intended to provide suggestions for the redesign of the research proposal form so that equal emphasis is placed on the non-fishing elements of the research plan, such as research into available data from a region, otolith ageing, model development, etc.

4.9 The Working Group agreed that presenting summary results of activities by individual research blocks would assist in evaluating whether the research design as implemented is achieving its objectives and requested that the Conveners of WG-FSA and WG-SAM include this consideration in their review.

4.10 The Working Group recommended that, prior to consideration of the establishment of new research blocks, proposals should include, inter alia, a:

(i) summary of work that has been undertaken in the proposed areas

(ii) preliminary or revised stock hypothesis and how the research helps develop management advice

(iii) scientific rationale and objectives as to how the research will lead to an assessment in these areas or other objectives beyond basic collection of data

(iv) rigorous experimental design that optimally meets CCAMLR research objectives

(v) sea-ice analysis of the proposed area.

4.11 The Working Group agreed that there are often significant questions and clarification required when evaluating submissions where new research in a closed area, or the intention to participate in an existing multi-Member or multi-vessel research activity in the Convention Area, is proposed. As such, the Working Group encouraged that relevant scientists from the Member submitting the proposal participate in the meetings of WG-SAM and WG-FSA.

Stock assessment development in areas with IUU fishing

4.12 Based on the discussions around research plans in regions with historic illegal, unreported and unregulated (IUU) fishing, the Working Group considered how to assess stocks and provide management advice in such areas. The Working Group recalled that the 4% exploitation rate (Welsford, 2011) was introduced as a conservative and precautionary limit to not prevent recovery in stocks that may have been overfished by IUU fishing. Research plans in regions with large potential IUU fishing would need to consider how to address this issue in assessments and in developing advice, as without that information it is difficult to evaluate whether the research design is adequate to achieve its objectives.

4.13 The Working Group discussed whether there were any options in the short-term to improve the understanding of IUU fishing affecting estimations of B_{current}, such as using CASAL to estimate B_{current} without back-calculating to B_0, based solely on size distribution and tag recaptures. While that is not directly possible, there is scope to explore whether CASAL can be used to determine harvest strategies similar to a constant F, which would complement the estimation of B_{current} (e.g. through Chapman or CPUE by seabed area). The Working Group recalled that previous work has used CASAL to provide a model to estimate IUU fishing year by year (paragraph 4.53 and WG-FSA-15/22 and 15/23).

4.14 The Working Group recalled that this issue has been identified on several occasions before, and that this subject was already recommended as a focus topic to WG-SAM (SC-CAMLR-XXXV, Annex 5, paragraph 3.262). The Working Group acknowledged that the issue of historic and current IUU fishing, its estimation and inclusion in biomass estimations and resulting management advice is difficult and complex, and that, in the current format where the agenda of WG-SAM is driven by submissions, it is challenging to dedicate the necessary time. Going forward, the Working Group suggested that with the change of priorities and work plans of the working groups (WG-EMM-17/02) there is an opportunity for defining this as a focus topic under future work (paragraph 5.2). The Working Group encouraged its members to intersessionally consider how to progress this issue, including contributions to a dedicated agenda item for WG-SAM.

Geographic information system (GIS) and spatial information

4.15 The Working Group welcomed the updates to the CCAMLR GIS R package (WG-SAM-17/47) that now allowed the generation of polygon data that can either be used directly in R, or exported for use in other programs. The Working Group encouraged Members to engage with the CCAMLR GitHub repositories. The authors thanked Dr M. Sumner from the AAD for contributing to the CCAMLR GIS R package.

4.16 The Working Group requested that proponents of research plans with research blocks provide coordinates for the research block boundaries to the Secretariat both with fishery notifications and with the submission of research plans to the CCAMLR working groups, and that geographical figures in research plans provide the projection used. The Working Group recommended that the Secretariat prepare a map with existing and proposed research blocks for its working groups each year (Figure 1). The Working Group noted that the CCAMLR GIS R package was a good tool for that purpose.

Proposals and research results from Subarea 48.6

4.17 The Working Group considered five papers relating to research plans and results of research conducted in Subarea 48.6, including a summary of by-catch results from research fishing carried out by Japan and South Africa (WG-SAM-17/44), an updated analysis of sea-ice concentration in the south of Subarea 48.6 (WG-SAM-17/10), a proposal to extend the spatial extent of research block 486_2 (WG-SAM-17/09), an updated joint proposal to continue research fishing in Subarea 48.6 submitted by Japan and South Africa (WG-SAM-17/03) and a proposal for a prospecting phase effort-limited research fishing by Norway for the 2017/18 season (WG-SAM-17/06).

4.18 The Working Group welcomed the joint progress report on research fishing from South Africa and Japan (WG-SAM-17/03) and noted the updated Chapman estimations of biomass using tagr (WG-SAM-17/13) that provided the expected number of tags from the research. The Working Group also welcomed the provision of research milestones in the paper which included a summary of research progress to date and an overview of future research, including an indication of how various components of the research would be shared between the proponents (WG-SAM-17/03, Table 8). The Working Group noted that the proposal from South Africa and Japan was largely unchanged from the existing plan.

4.19 The Working Group noted that the research fishing was now into its fifth year and that over this period most fishing had taken place in research blocks 486_2–4, and in 486_5 for the first time in five years. The Working Group noted that an inability of vessels to consistently return every year to a research block to deploy or catch tagged fish remained a major constraint on the development of an assessment.

4.20 The Working Group recalled its advice from WG-SAM-16 that the lack of a robust stock hypothesis was impacting on the ability to develop an integrated stock assessment for Subarea 48.6. It noted that the further development of a stock hypothesis for *D. mawsoni* in this subarea would benefit from data from the shelf region in research block 486_5 but access had previously been limited by sea-ice.

4.21 The Working Group welcomed the sea-ice analysis carried out by Japan (WG-SAM-17/10) which examined accessibility of research blocks 486_4 and 486_5 in the southern region of Subarea 48.6 over the period 2002–2017 using satellite-derived data, and noted that the latter research block had been fished in 2016/17 given the low sea-ice concentration. The paper also noted that these data showed that there appeared to be a strong negative correlation between the levels of sea-ice and the sea-surface temperature anomaly. The Working Group noted that further analyses could be conducted that investigate correlations between sea-ice coverage and to wider global weather phenomena such as El Niño/El Niño Southern Oscillation or rising temperatures/increased variability in observed temperatures such as may be expected from climate change.

4.22 WG-SAM-17/44 presented a preliminary analysis of by-catch from the C2 data in the research fishery for *Dissostichus* spp. in Subarea 48.6. The Working Group noted that the report showed that *Macrourus* spp. and blue Antimora (*Antimora rostrata*) were the most common by-catch in the fishery which were caught in all the research blocks. Channichthyidae was also a common by-catch species, but mainly found in research blocks 486_4 and 486_5. The Working Group suggested that additional analyses on the by-catch could be undertaken to help explain the interannual and spatial variability, including alternative statistical methods and analyses of the observer data. In addition, the Working Group noted that the effect of different fishing gear on by-catch ratios and by-catch variability is not yet fully understood in the region, and such analyses could be undertaken in any future updated paper.

4.23 WG-SAM-17/46 presented a preliminary analysis of the movement of tagged fish recaptured in Subarea 48.6. The paper showed that both *D. eleginoides* and *D. mawsoni* are typically recaptured close to where they were released; typically, 90% and 97% of each species respectively were recaptured within 50 km of their release location. The Working Group agreed that the focus of research should continue to be on efforts to resolve the movements of fish between research blocks and to improve the tag-recapture rate. The Working Group noted that the few movements of tagged fish that had been observed to date were typically east–west and between subareas, and not north–south between the southern and northern research blocks within Subarea 48.6. The Working Group noted that additional work on the stock hypothesis of *D. mawsoni* in Subarea 48.6 would support the research proposal.

4.24 The Working Group considered WG-SAM-17/09 by Japan that proposed a possible future extension to the spatial extent of research block 486_2. The rationale for the extension to the research block was that it is adjacent to an area of higher *D. mawsoni* density within the existing research block which could increase the possibility of the catch limit for the research block being taken. There would be no increase in catch for this research block but it would come from the limit for the existing research block 486_2. The Working Group noted the proposal for the addition of a future research block in Division 58.4.2 (WG-SAM-17/10) and agreed that little information was presented to link this new area to the stock hypothesis for the region. This proposed research block also overlapped with another research plan proposal (WG-SAM-17/07).

4.25 The Working Group noted that the expansion of research blocks was likely to distribute fishing effort across a larger area and, therefore, could reduce the ability of vessels to scan tagged fish and dilute tagging effort in the research block, especially given that the catch limit in research block 486_2 is typically not taken. However, the Working Group noted that tags recaptured from research block 486_2 had occurred mainly in a cluster in the south of the research block, and recommended that the proponents present a revision to the analysis that subdivided research block 486_2 to account for tagging heterogeneity.

Norwegian proposal for research fishing in Subarea 48.6

4.26 The Working Group considered a proposal by Norway to conduct research fishing in Subarea 48.6 (WG-SAM-17/06). The Working Group noted that Norway was not represented at the meeting, and that this had hampered the Working Group's ability to resolve questions it had on the proposal.

4.27 The Working Group questioned what additional scientific knowledge the research proposal would bring to the management of toothfish in the region and how this would integrate with the research proposals from South Africa and Japan. The Working Group recommended that, should Norway wish to progress its research proposal, it would require further development and Norway should coordinate its research efforts with Japan and South Africa, including by attending WG-FSA.

Proposals and research results from Subarea 58.4

Proposals and research results from Divisions 58.4.1 and 58.4.2

4.28 There were three papers relating to exploratory fishery research efforts in Divisions 58.4.1 and 58.4.2 tabled for consideration by the Working Group.

4.29 WG-SAM-17/08 provided a joint multi-Member research notification by Australia, France, Japan, Republic of Korea and Spain for continuation of the *D. mawsoni* exploratory fishery research in Divisions 58.4.1 and 58.4.2.

4.30 The Working Group noted that a similar approach to initial research catch allocation among participating Members, as was undertaken in 2016/17, was proposed, although there were some other minor changes set out in WG-SAM-17/08. Specifically:

(i) Australia could potentially include an additional vessel during the research in Division 58.4.1

(ii) the milestone pertaining to estimation of local biomass within research blocks was removed, as this is now undertaken by the Secretariat.

4.31 The Working Group noted that the catch limit of macrourids in research block 5841_6 (SSRU 5841G) for the 2016/17 season of 14 tonnes was reached on 27 January 2017, and the fishery was subsequently closed with 39 percent of the total catch limit (90 tonnes) for *D. mawsoni* remaining. It was recommended that WG-FSA explore strategies for mitigating fishing impacts on macrourids while endeavouring to meet research objectives.

4.32 WG-SAM-17/27 provided a progress report on the exploratory longline fishery by the Republic of Korea for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 during the 2016/17 season. The Working Group noted that the areas of fishing operations were specifically selected to overlap, as far as possible, with areas where tagged fish were previously released in order to increase the probability of recapture. It was also noted that only about half of the agreed catch limit was taken, which may have reduced the probability of recaptures. Dr S.-G. Choi (Republic of Korea) indicated that there were issues with heavy sea-ice in parts of the proposed research areas.

4.33 The Working Group recalled that the geographic extent of existing and proposed research blocks (Figure 1) includes additional buffer zones where research can be undertaken if the specified research block is inaccessible as a result of sea-ice (CM 41-01, Annex 41-01/B, footnote 1). It was further noted that there may be circumstances where buffer zones overlap with other research blocks. The Working Group recommended that this issue should be further explored to ensure that fishing in one research block's buffer zone does not geographically overlap with another research block.

4.34 WG-SAM-17/07 provided a research plan by Ukraine to participate in the 2017/18 exploratory longline fishery for *Dissostichus* spp. in Division 58.4.2. It was noted that there were three new research blocks proposed in the westernmost SSRUs of Division 58.4.2 (located within SSRUs 5842A and 5842B).

4.35 The Working Group noted that there were no sea-ice analysis plots provided in WG-SAM-17/07, which are important for evaluating the geographic positions of these proposed research blocks, and it was unclear as to how the positions of these research blocks were selected. The Working Group noted that the proposed research blocks substantially overlapped with the proposed research blocks detailed in WG-SAM-17/10 (paragraph 4.24).

4.36 The Working Group noted that the current endorsed catch limit for the research block within SSRU 5842E is 35 tonnes, and that WG-SAM-17/07 suggested that an appropriate combined research catch in the three proposed new research blocks is 75 tonnes. The Working Group agreed that the proposal should provide details on previous work that has been undertaken in the area, some rationale as to why the proposed research blocks were positioned where they were in relation to the objectives of the research, and details as to how the proposed research catch limit was developed.

4.37 The Working Group noted that research in this division should be coordinated with other Members that are currently undertaking research in the region.

Proposals and research results from Divisions 58.4.3 and 58.4.4

4.38 WG-SAM-17/45 summarised the results of a comprehensive by-catch analysis for the research fishery for *D. eleginoides* in Divisions 58.4.3a and 58.4.4b, as part of the progress report of the research plan. The results showed that the most common by-catch species were grenadiers and *Antimora*, and noted a clear decrease in the number of individuals over time. The model results highlighted that the fishing method and gear types may influence the observed results in by-catch patterns.

4.39 The Working Group noted the use of two different gear types on two different vessels, which operated in separate locations over time, and recommended the use of mixed models (GLMM, GAMM) to establish whether factors such as year, vessel, or fishing location drive the observed results, or whether the patterns observed were independent of the patterns in fishing activities (see also paragraphs 4.22 and 4.41).

4.40 The Working Group noted the different specificity in the use of taxonomic codes between the two Members contributing to this research, and suggested coordination of by-catch identification in the future. The Working Group further suggested to consider by-catch identification at WS-SISO, as, although responsibility for by-catch identification and reporting lies with the Flag State, the observer is often asked by the vessel operator to support the crew in species identification to ensure accuracy.

4.41 WG-SAM-17/20 formed the second part of the progress report for Division 58.4.3a, summarising the data collected to date in this division. The paper highlighted the differences in gear use, depth of fishing and spatial locations between the two vessels, and summarised the research objectives, methods and milestones of the research carried out in this division over time. In addition, WG-SAM-17/04 provided an updated research plan with a changed survey design for Division 58.4.3a, taking into account the discussion around WG-FSA-16/55 (SC-CAMLR-XXXV, Annex 5, paragraphs 4.128 to 4.134).

4.42 The Working Group noted that the two vessels fished with two different gear types, targeting different depths and locations within the same fishing season. As a result, the vessels were catching different size classes of toothfish. The Working Group discussed how to distinguish between vessel and location effects by redesigning the survey to understand this variation better. The Working Group recommended overlapping fishing locations in depth and space between the two vessels to calibrate between them.

4.43 The Working Group discussed the large variation in effort over time, noting that catches were not, or barely, taken since 2013/14. The expectation of tag availability after three years is low, and thus it is difficult to generate the necessary information to meet the research objectives without dedicated participation. Therefore, the Working Group recommended the use of the tagr package to estimate how many tagged fish are expected to remain in the population at present (as in WG-SAM-17/12). The Working Group further suggested to assemble a CPUE time series for both gear types separately, to potentially allow tracking of year classes through length distributions from the two gear types.

4.44 The authors confirmed that the new survey design included the notification of a new fishing vessel, ensuring commitment to this research going forward. The authors further noted that in the past seasons, in one year the work could not be completed due to engine failure, while in the current season there was a low CPUE and an unusual problem with sea lice, so the vessel master discontinued research fishing.

4.45 The Working Group enquired about the plan for otolith ageing from this research, noting it should form an integral part of the plan. The authors noted that the improved sampling design has the tag-recapture of toothfish as its main objective to work towards tag-based stock assessment, acknowledging that otolith ageing is also an important part of the research going forward.

4.46 The Working Group noted that WG-SAM-17/04 identified and acknowledged issues with the past survey design, and encouraged the authors to incorporate the feedback given on the survey design to achieve the objectives of the research. The Working Group recommended the spread of survey effort and the overlap between gear types/vessels over space and depth.

4.47 WG-SAM-17/02 Rev. 1 presented an updated research plan for research blocks 1 and 2 in Division 58.4.4b, proposing to continue the current research operation with the same survey design as to date, as well as proposing additional research blocks and amendments to the research design.

4.48 The Working Group discussed the details and rationale regarding the survey design in the proposed research blocks, highlighting past information available for these regions and recommending changes to the design.

4.49 Following this feedback, the proponents concluded to proceed only with the unchanged established research design, without expanding research block options or changing the survey design at this time.

4.50 The Working Group noted that the data collected on depredation, consistent with the work carried out around Kerguelen and Crozet Islands, enables this research program to get an improved understanding of the loss of biomass to depredation and thus include this in future stock assessments.

4.51 The Working Group discussed the timetable for the proposed research, which outlined a preliminary CASAL assessment for WG-FSA-17, noting that a preliminary CASAL assessment would also need to come to WG-SAM, and queried why the design of the survey is proposed to be changed now, at a point where data collected begins to contribute towards a tag-based assessment.

4.52 The authors recalled the discussions around the CASAL assessments in previous WG-FSA meetings (e.g. SC-CAMLR-XXXV, Annex 7, paragraphs 5.79 to 5.91), noting that, at present, without a good understanding of historic IUU fishing in the region, the Working Group had concluded that a CASAL assessment would be difficult to achieve. The timetable in the research plan will reflect this in the future by removing this milestone. The survey design change was proposed to investigate the movement of toothfish, which is a key question for the involved proponents, despite expected low catch rates associated with the design change (paragraphs 4.12 to 4.14).

4.53 Agreeing that completing a CASAL assessment was premature at present, the Working Group discussed how to achieve the objective of developing an assessment for this region, noting that an integrated assessment does not mean it would need to be a CASAL assessment. The data available to date provide a time series of information on this fishery, allowing to monitor CPUE and thus population trends, allowing to give management advice based on that information. The Working Group encouraged the investigation of other forms of assessment, including tag-based assessments, which may be more appropriate to the objectives of this research.

4.54 The Working Group noted that when the initial objectives of a research plan change, the direction of the research would also need to be re-evaluated to ensure that the design and sampling is compatible and appropriate. Part of this process would be the development of alternative methods and providing evidence to WG-SAM as to how questions were addressed and what solutions were found.

4.55 The Working Group noted that the development of the stock hypothesis for this region was planned towards the end of the research duration, whereas in many other regions, a stock hypothesis precedes and informs the research plan, so that the research can be improved as the hypothesis is improved. The Working Group recommended that a stock hypothesis be developed to inform the research going forward.

Review of research proposals and results from Subareas 88.1 and 88.2

4.56 The Working Group considered WG-SAM-17/23 which reported on a preliminary analysis of variability in catch rates of target and by-catch species of different longline gear types within selected SSRUs within Subareas 88.1 and 88.2. CPUE data (kg/1 000 hooks) were used to examine spatial and temporal variability in catch and by-catch rates by looking at residual deviations from the long-term average and cluster analysis on spatial heterogeneity with the Coniss method. The analysis indicated:

(i) spatial–temporal variability in, and mean estimates of, CPUE by SSRU and season

(ii) differences in toothfish length distributions (arising from small and large fish in the catches), as well as in the mean length of toothfish in the catch

(iii) catches are characterised by a wider species composition of by-catch when using the autoline system.

4.57 The Working Group noted the necessity to provide additional analysis of differences between the CPUE and length- or species compositions of catch obtained from different gear types based on the analyses presented in WG-SAM-17/23.

4.58 The Working Group recalled that during WG-SAM-16 it was noted that there was a range of additional variables that were likely to influence catch rates of target and non-target species, including depth and bait type. The Working Group noted that WG-SAM-16 and WG-FSA-16 had recommended the use of multivariate methods such as GLMMs and GAMs for the analysis of catch data in order to address this issue and recommended exploration using these statistical methods (SC-CAMLR-XXXV, Annex 7, paragraph 3.57).

4.59 The Working Group discussed the difficulty in using the number of hooks to standardise CPUE on trotlines making comparison with Spanish and autoline systems problematic. It remains uncertain as to how the unit of effort for a trotline should best be defined. The Working Group also noted that considerable differences in the reporting rate of by-catch between vessels had been highlighted during the 2016 meeting of the Scientific Committee and the influence of this on the analysis of by-catch CPUE should be considered in future GLM and GLMM analyses.

4.60 The Working Group noted that it should consider how the results of analyses of spatial, temporal and gear-specific differences in CPUE are incorporated into calculating the toothfish density used in the first stages of the development of research plans. However, it was also noted that differences in the gear type of vessels operating within fisheries as in Division 58.5.2 and Subarea 88.1 have not been a barrier to the development of integrated stock assessments for toothfish. Dr Kasatkina indicated that the results of further analyses would be reported to WG-FSA-17.

Tagging using pop-up satellite archival tags

4.61 WG-SAM-17/33 reported on the preliminary results of the use of PSATs deployed on *D. mawsoni* on the southern shelf (SSRUs 881M, J, L) and northern seamount (SSRUs 881B, C) areas of the Ross Sea region in 2016. The objectives were to characterise movement and habitat preferences, compare two different commercially available types of PSATs, and to develop methods to support research and monitoring of the Ross Sea region MPA.

4.62 Of the 15 tags deployed, 13 were scheduled to pop-up and transmit data on 1 February 2017, and two on 1 February 2018. Data were recovered from four tags, although two of these tags only provided partial data. The limited amount of data recovery may have been a result of a variety of reasons, including depth limitation to 1 800 m for one of the tag types as evidenced by diagnostics from two of these tags.

4.63 The Working Group discussed the experiences of other deep-sea tagging programs, noting that tags on toothfish are likely to be the deepest tags currently deployed. Further development of the devices and methods for deployment is required if they are to be successfully deployed on toothfish within the Convention Area. The Working Group noted that PSAT technology was developing rapidly and models were now available that were depth rated to 8 000 m that would overcome the issue of depth damage observed during the study.

4.64 Considering the cost and early stage development of deep-sea PSATs, the Working Group also considered whether the use of other data storage tags could provide some movement and environmental data given the apparent site fidelity observed in toothfish, acknowledging the trade-off between cost consideration, longer collection duration and loss in location accuracy.

4.65 The Working Group discussed the paper's recommendation that a two-day workshop involving scientists with an interest in archival tagging and PSAT manufacturers would be a useful way of advancing the use of PSATs for toothfish studies. It was agreed that such an approach could be beneficial, although concerns were raised about the additional time and financial cost associated with another intersessional meeting. To reduce costs, such a workshop could be run in conjunction with scheduled CCAMLR meetings in 2018 or in conjunction with the proposed Subarea 48.6 stock hypothesis and tagging workshop proposed by Germany for early 2018.

Ross Sea shelf survey

4.66 WG-SAM-17/01 presented the results of the sixth New Zealand Ross Sea shelf survey to monitor abundance of sub-adult *D. mawsoni* in the southern Ross Sea. The survey included numerous objectives as previously outlined in WG-SAM-15/45, with an additional objective of trialling the collection of tagged toothfish release data via an electronic data form application in collaboration with the CCAMLR Secretariat.

4.67 Operational and sea-ice constraints meant the survey commenced from Terra Nova Bay in the northwestern stratum of the survey area. High catch rates encountered in this region at the start of the survey led to the need to reduce station numbers in the southern strata to avoid exceeding the catch limit. This is likely to have contributed to higher overall variance within the survey results compared with previous years. Results suggest the Ross Sea shelf survey series is providing a reliable means of monitoring recruitment, estimating recruitment availability and year-class strength, which was not evident in the data collected from fishery operations in the wider Ross Sea region fishery.

4.68 The Working Group noted high levels of spatial variability in toothfish depredation by amphipods. Where high scavenging rates occur, it was noted that total removals might be underestimated. This issue should be referred to WG-FSA for consideration across all toothfish fisheries where scavenging by amphipods occurs.

4.69 The Working Group considered the proposal by New Zealand to continue the Ross Sea shelf survey for a further five years from 2018. It noted that the core strata would be sampled every year with the McMurdo and Terra Nova strata sampled in alternate years. Although an effort-limited survey, the different maximum catches observed in these strata would give rise to a total catch limit of 43 tonnes in 2018, 2020, 2022, and 65 tonnes in 2019 and 2021.

4.70 The Working Group noted that, to date, the survey has taken place following the commercial fishing season in areas where commercial fishing occurs. Following the adoption of CM 91-05 (Ross Sea region MPA), from 2017/18 surveys will take place within a region of the MPA where fishing activities will be otherwise prohibited. Changes to fish density in the region resulting from a reduction in fishing effort may result in higher survey catch rates in the future and the current survey catch limit may need to be reviewed.

4.71 The Working Group noted that the proposed research was for an annual survey for the next five years. However, it was recalled that unlike other toothfish research, outputs from the Ross Sea shelf survey provide direct input into the Ross Sea region integrated stock assessment and the objectives of the research are not to derive a local biomass estimate. In addition, catch limits are deducted from, and not additional to, the Ross Sea region catch limit.

4.72 Dr Kasatkina noted that it was important to determine how data on the abundance of sub-adult *D. mawsoni* obtained from previous time-series surveys are reflected in the subsequent fish length frequency in catch data in order to track strong cohorts into the adult population. This analysis will provide information on fish movement as well as on the efficacy of surveys to monitor abundance of sub-adult *D. mawsoni* in the southern Ross Sea.

Special research zone

4.73 The Working Group considered two proposals by Members to conduct toothfish research in the newly created Ross Sea region MPA special research zone (SRZ) submitted by Russia (WG-SAM-17/21) and Ukraine (WG-SAM-17/29).

4.74 The Russian proposal for research in Subarea 88.2 followed on from research that had been carried out between 2010 and 2012 and described a 10-year program of proposed research within the eastern part of the Ross Sea region over the shelf and continental slope within the SRZ would focus on providing data on toothfish stock structure, movement and life history which links to the objectives of the research and monitoring plan for the Ross Sea region MPA. Tagging was a key component of the research with a proposed tagging rate of 5 fish per tonne within the SRZ. This program provides opportunities for collaborative investigations in the SRZ by the Russian vessel and vessels from other CCAMLR Members.

4.75 The Ukrainian proposal (WG-SAM-17/29) suggested a tagging rate of 3 fish per tonne for the first 30 tonnes of catch and 1 fish per tonne thereafter and included a program of plankton sampling and the collection of acoustic and temperature data.

4.76 The Working Group noted that very little detail on the research and analysis to be conducted by Ukraine was provided in WG-SAM-17/29, which made scientific evaluation of the proposal difficult. The Working Group requested that Ukraine outline in more detail the scientific rationale for the research, the research capacity that it was intending to utilise and the types of analysis it will be conducting within the proposal and submit a revision for consideration by WG-FSA. Similar concerns were noted for research proposals by Ukraine in other regions (paragraphs 4.34 to 4.36, 4.87 and 4.88, 4.101 to 4.106).

4.77 The Working Group noted that there is no requirement within CM 91-05 for Members to submit proposals for conducting research within the SRZ. It also noted that under CM 91-05 a requirement to tag toothfish at a rate of 3 fish per tonne would not be introduced until the start of the 2020/21 season. The Working Group recalled that the overall catch limit for the SRZ has been set at 15% of the catch limit for the Ross Sea region assessment.

4.78 The Working Group noted that careful consideration should be given to the potential impact of research conducted within the SRZ upon the Ross Sea region stock assessment. As the SRZ is open to all vessels notified to fish in the Ross Sea region fishery, concern was raised that prior to the introduction of a 3 fish per tonne requirement in 2020/21, different tagging rates as indicated in the research proposals could introduce bias into the stock assessment.

4.79 The Working Group recommended that proponents of research within the SRZ should consider the impact of non-research fishing within the SRZ on their ability to conduct research. Coordination of research activities with other Members may reduce these impacts.

4.80 The Working Group noted that CM 91-05 does not prescribe how catch limits for research within the SRZ are to be allocated. The Working Group recommended that this issue should be considered by WG-FSA and the Scientific Committee. It was noted that research catches within the SRZ could be allocated from the overall Ross Sea region catch limit in an analogous manner to the Ross Sea shelf survey of sub-adult toothfish.

4.81 The Working Group agreed that there is a need to demonstrate how research conducted within the SRZ would link to the Ross Sea region MPA research and monitoring plan.

Review of research proposals and results from Subarea 88.3

4.82 The progress report for the Korean research fishing in Subarea 88.3 in 2016/17 (WG-SAM-17/28) noted that fishing commenced on 11 January 2017 and ended on 7 March 2017 with a total of 95 longlines being set and hauled. Research blocks 883_2 to 883_5 were surveyed with a total catch of 118.2 tonnes and 4 132 individual *D. mawsoni* being removed. The survey had a mean CPUE of 0.21 kg/hook and 597 individuals of *D. mawsoni* were tagged and released and the by-catch was approximately 6.2% of the total catch by weight across all research blocks. The tagging rate and tag-overlap statistics were 5.04 and 88% respectively. The length frequency of *D. mawsoni* had a single mode of 150 cm and the maturity of both male and female *D. mawsoni* were predominantly in stage 2. Biological information of *D. mawsoni*, including otolith, stomach contents, gonad and muscle were collected. Temperature and salinity data was also recorded using a conductivity temperature depth probe (CTD) at 12 stations.

4.83 In discussing the 2016/17 progress report, the Working Group noted that none of the tagged fish releases from the survey in the previous year had been recaptured. To assist with understanding why this had occurred, the Working Group recommended the proponents include a table of the number of tagged fish releases and the estimated number of tagged fish available for recapture in each research block and year in future progress reports and a plot of spatial overlap in fishing from previous seasons.

4.84 The Working Group considered the proposals from the Republic of Korea (WG-SAM-17/43), New Zealand (WG-SAM-17/38) and Ukraine (WG-SAM-17/16 and 17/19) to conduct research in Subarea 88.3 in 2017/18.

4.85 The Working Group noted that the Korean proposal would implement the third year of research fishing in the 2017/18 season with the same survey design to previous years, while New Zealand and Ukraine were proposing to initiate new surveys in the area with a number of new research blocks (Figure 1).

4.86 The Working Group noted differences in the scientific objectives between the proposals, but emphasised that when the objective was to provide robust estimates of *D. mawsoni* abundance, recapturing tagged fish was the highest priority. The Working Group noted the highest number of tagged fish releases had been in research blocks 883_3, 883_4 and 883_5. It was also noted that these research blocks were more likely to be ice free and, therefore, accessible during the proposed survey period.

4.87 The Working Group discussed the rationale behind creating new research blocks in some of the proposals in Subarea 88.3 and noted that research objectives for the purpose of estimating abundance were more likely to be achieved if a coordinated research effort was focused in the existing research blocks.

4.88 The Working Group noted that data collected from historical surveys in this area could be presented in descriptive summaries to better characterise the area and information available in future proposals. The Working Group also noted that the justification for the proposed sample size and design in WG-SAM-17/19 was unclear. Additionally, it was noted that the intention to acquire fish age data and develop an assessment model were stated, but there was no specification of how and when this would be achieved.

4.89 The Working Group recommended that the proponents collaborate to provide a single multi-Member coordinated research proposal for presentation at WG-FSA-17.

Review of research proposals and results from Subareas 48.1, 48.2 and 48.5

Subarea 48.5

4.90 WG-SAM-17/22 presented an updated proposal for the third stage of the Russian research program in the Weddell Sea. A five-year longline survey is proposed in the eastern region of the Weddell Sea, with the objectives to estimate fish distribution and abundance and assess biological parameters related to productivity in Subarea 48.5.

4.91 The Working Group noted that the situation with this survey proposal in Subarea 48.5 has not changed since 2014 (SC-CAMLR-XXXIII, paragraphs 3.230 to 3.233). The Working Group recalled that, as in previous years, the submitted proposal was based on assumptions and results of previous work carried out by Russia in Subarea 48.5 from 2012 to 2014, and that data from these activities have been quarantined by CCAMLR since 2014 (SC-CAMLR-XXXIII, paragraph 3.232).

4.92 The Working Group recalled that in 2015 the Scientific Committee had requested an update on the analyses on catch rates in Subarea 48.5 (SC-CAMLR-XXXIV, paragraphs 3.271 to 3.275), and that such an update had not been provided to WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 4.71).

4.93 A background paper on previous Russian survey activities undertaken in Subarea 48.5 was subsequently submitted to the Commission in 2016 (CCAMLR-XXXV/BG/29 Rev. 1), but the Scientific Committee noted that this report had not been presented to the Scientific Committee for consideration (SC-CAMLR-XXXV, paragraph 3.237).

4.94 Without completion of the analysis requested by WG-SAM, WG-FSA and the Scientific Committee, and therefore to be consistent with its previous advice, the Working Group was not able to evaluate the approach and proposed research in WG-SAM-17/22 (SC-CAMLR-XXXV, Annex 5, paragraph 4.71).

Subareas 48.1, 48.2 and 48.4

4.95 In WG-SAM-17/18, Chile proposed a research plan for a three-year project to study the distribution, abundance and biological characteristics of Antarctic demersal fish communities around the continental shelf of Elephant Island (Subarea 48.1) and the South Orkney Islands (Subarea 48.2). Based on the experience gained in the first phase of research in 2016 and recommendations made by WG-SAM-16 and WG-FSA-16 (SC-CAMLR-XXXV, Annex 5, paragraphs 4.62 to 4.67; SC-CAMLR-XXXV, Annex 7, paragraphs 4.149 to 4.155), a revised proposal for a random, stratified trawl survey in accordance with CM 24-01 was provided. The proposed survey will be conducted in six depth strata between 100 and 500 m using bottom trawl nets, with stations in the same approximate geographic coordinates as those used by Germany on the RV *Polarstern* around Elephant Island in 2012 and by the USA on the RV *Yuzhmorgeologiya* around the South Orkney Islands in 2009. The proposed catch limits for this research is 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2.

4.96 The Working Group agreed that repeating historic surveys in the area will provide insights into the potential recovery of mackerel icefish (*Champsocephalus gunnari*) and marbled rockcod (*Notothenia rossii*). The Working Group noted that while individual hauls may return large catches, the survey was not planning to repeatedly haul the same stations, and the overall catch should thus not exceed the catch limit. The maximum catch limit proposed was similar to that of the previous survey.

4.97 The Working Group noted that the bottom net used in the 2009 survey will be on board the fishing vessel and, if possible, used for this survey to maintain consistency in gear type.

4.98 The Working Group noted that the proposed locations for sampling stations are similar to the ones from the German and US surveys, with the exceptions of those that had previously encountered vulnerable marine ecosystems (VMEs). These locations will be replaced with stations from within the same stratum. The Working Group agreed that VMEs which have been reported frequently in the survey areas require careful consideration in the choice of alternative sampling locations, as spreading effort could spread impacts to other VMEs versus limiting impact to just those areas already impacted to some degree. The Working Group also noted that cameras, similarly, for example to the ones used in Divisions 58.4.1 and 58.4.2, attached to the trawl net can record the seafloor habitat and should be considered for this survey if feasible.

4.99 The Working Group recommended that the survey include hydro-acoustic sampling as during the first survey, since this remote sensing method could provide important estimates of the distribution and abundance of pelagic and demersal organisms.

4.100 Prof. P. Arana (Chile) confirmed that, as chief scientist of the research proposal, he will be on board the fishing vessel to ensure that the survey will be conducted as planned.

4.101 In WG-SAM-17/15 and 17/17, Ukraine proposed research fishing in accordance with CM 24-01 in a study area within the eastern part of Subarea 48.1 and the western parts of Subareas 48.2 and 48.5. Research fishing is proposed to be conducted over three years, with a possible two-year extension, with 36 hauls using Spanish longline and a total catch limit of 40 tonnes. No haul locations were specified, but hauls would be set in the first year in the depth range between 600 and 2 200 m. The main result from this initial prospecting phase would be the mapping of the spatial distribution and relative abundance of toothfish in the research area. Research blocks would then be proposed and subsequent fishing would be depth-stratified with spatial consistency in every subsequent year. The research aims to provide an estimate of the stock abundance using standard assessment methods that have been tested in other areas which have a robust stock assessment.

4.102 The Working Group noted that while the research proposal description indicated that it would be conducting research in Subarea 48.5, no fishable depths were indicated on the maps presented and the research area outlined in the presentation did not extend to Subarea 48.5. Consequently, the Working Group recommended that this area be removed from the proposal and, if subsequently agreed, the proposal concentrate on the fishable depths in Subarea 48.1.

4.103 The Working Group noted the lack of key information in this proposal, including a stock hypothesis, the locations of the proposed haul stations, a sea-ice analysis, details on biological sampling and statistical analyses, and details about how the research would contribute to the stated objectives and the management of toothfish in this area.

4.104 Given that no research fishing has occurred in this area so far, the Working Group recommended random haul locations be specified for the initial survey, rather than research blocks within which the research fishing activities would occur. Research would then be determined based on the outcomes of the initial effort-limited survey.

4.105 The Working Group noted that the area is known for heavy ice concentrations even in summer, and that it is likely to be inaccessible for many fishing seasons. A sea-ice analysis is, therefore, crucial to evaluate the ability to revisit research locations on a regular basis.

4.106 With existing research proposals by Ukraine in other parts of Subarea 48.2 and new research proposals in Subareas 88.1 and 88.3 and Division 58.4.2, the Working Group asked whether Ukraine would be able to conduct all research activities as required, including field work, laboratory analyses of biological samples such as otoliths for ageing and gonads for maturity estimation, and statistical analyses of the data in order to develop an integrated population model.

4.107 WG-SAM-17/25 provided a preliminary report of the third year of research fishing by Ukraine in Subarea 48.2. In the 2016/17 season, Ukraine fished all proposed 48 stations in the research block on the northern plateau and the four southern research blocks. Catch rates were higher in the southern research blocks, but they were found to be highly variable between fishing seasons. The effort-limited survey was completed with a total catch of 62 tonnes out of a 75 tonne catch limit. A total of 318 fish were tagged and six *D. mawsoni* were recaptured.

4.108 In WG-SAM-17/26, Ukraine proposed to continue research fishing in Subarea 48.2 in accordance with CM 24-01 for another two seasons (2017/18 and 2018/19), with the same research design for all haul locations, a 75 tonne catch limit, and tagging rate of 5 fish per tonne. The motivation for the continuation of this research was the highly variable catch rate data which prevented an estimation of *Dissostichus* spp. biomass in the area.

4.109 In WG-SAM-17/24, Chile proposed to continue its research fishing in Subarea 48.2 in accordance with CM 24-01. The survey for 2017/18 would use similar methodology and objectives as agreed in WG-FSA-16/34. During the 2015/16 season, Chile conducted the first stage of its multiannual research program (WG-FSA-15/10), but it did not fish in the 2016/17 season because of the performance of the research program in the 2015/16 season (SC-CAMLR-XXXV, Annex 7, paragraph 4.44).

4.110 The Working Group noted the commitment by Chile to improve the performance of the research program. It requested that Ukraine and Chile, with the support of the Secretariat, coordinate their fishing activities with the aim to achieve the objectives of their research, for example by fishing the same research strata with two vessels to enable a comparison of catch rates and catch composition by gear type. It also noted that the collection of oceanographic data, especially of bottom temperature, in an area where the two species of *Dissostichus* overlap, could assist in understanding the habitat preferences for biogeographic models.

4.111 The Working Group highlighted the contribution that Chilean research could make to the identification of natal origin through the microchemistry of otoliths. It looked forward to the presentation of results of such analyses at WG-FSA-17, based on samples collected in the survey of the 2015/16 season.

4.112 The Working Group noted that *D. mawsoni* constituted most of the catch and considered that future research fishing should focus on this species.

4.113 The Working Group also noted that the research has been conducted for three years by Ukraine as an effort-limited survey with an overall catch limit. Given the availability of data on catch rates and recaptures from these surveys, the Working Group recommended that the proposal be updated and that biomass could be estimated with the CPUE by seabed area method and the Chapman estimator, with the choice of reference area following that for other research blocks in which *D. mawsoni* is targeted.

4.114 The Working Group requested that an updated survey design be presented to WG-FSA, with information on how the research design accounts for the distribution of the two toothfish species. It also requested that Ukraine present further research results in the area, such as *D. mawsoni* ageing and spatial by-catch distribution, as well as to update the stock structure hypothesis and outline the development of a population assessment as indicated in the research objectives.

4.115 WG-SAM-17/34 presented preliminary results from the first year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4. The survey is located in an area where both species are caught simultaneously between predominantly single-species catches of *D. eleginoides* and *D. mawsoni* to the north and south respectively. On the 18 stations of this effort-limited survey, 12 tonnes of *Dissostichus* spp. were caught in Subarea 48.2 and 17 tonnes were caught in Subarea 48.4, both below the set catch limits of 23 tonnes and 18 tonnes respectively. A total of 151 *D. mawsoni* and one *D. eleginoides* were tagged and released, and seven tagged *D. mawsoni* were recovered in Subarea 48.4.

4.116 The Working Group noted that VME indicator taxa were reported mainly from Subarea 48.4 and discussed whether this pattern was driven by reporting differences between vessels or the volcanic geology of the habitat in Subarea 48.4.

4.117 The Working Group also noted that tissue samples were collected from this area which will be used in genetics studies on stock connectivity of toothfish. Dr Choi indicated that the Republic of Korea was conducting research fishing outside the CAMLR Convention Area to the west of Subarea 48.3 to further understand stock structure and movement of toothfish in the area outside the CAMLR Convention Area.

Future work

5.1 The Working Group considered the proposed five-year work plan for the Scientific Committee presented by its Chair in WG-EMM-17/02. The paper advances the recommendations of the Scientific Committee which were discussed and put forward by the Scientific Committee Symposium in October 2016. The paper outlined the work in themes and it also indicated a timeline by which each topic should be addressed.

5.2 The Working Group welcomed and thanked the Chair for bringing forward the work and also the conveners of the working groups for working with the Chair. The Working Group noted that a week had been set aside between the meetings of WG-SAM-18 and WG-EMM-18 in order to address some of the overlapping/common topics that are in the five-year priority list of the two working groups, as was the case with WS-SISO-17. In 2018, a spatial planning data management workshop was scheduled for this week. It was also suggested this could offer an opportunity to review and develop implementation for the Ross Sea region MPA research and monitoring plan.

5.3 The Working Group further noted that the scientific topics that are a priority will inevitably grow in number and scope as the work is being carried out in the next five years. The Scientific Committee will need to continuously reprioritise and streamline the scientific topics in order to balance the workload of the working groups. A number of strategies, such as conducting some priority tasks/topics less frequently, might be explored in order to free up time to streamline the work of the working groups.

5.4 The Working Group encouraged its participants to focus on priority topics when submitting their scientific work to be considered by WG-SAM meetings and the Working Group Convener will allocate meeting time mainly to the discussions of priority topics. The Working Group noted that the priority topics tasked by the Scientific Committee can arise quickly and displace other previous high-priority topics. Further, it noted that some topics will not be addressed in a single meeting and may require a specific workplan and contributions from Members over several years.

Other business

Ross Sea region marine protected area (MPA) research and monitoring plan

6.1 The Working Group discussed the draft Ross Sea region MPA research and monitoring plan (RMP) (WG-SAM-17/42) and noted the impressive breadth of information and research topics contained in the plan. In particular, the Working Group noted that the Co-conveners of the Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP-17) had undertaken to seek recommendations from all of the working groups in order to provide a revised RMP to the Scientific Committee for consideration.

6.2 The Working Group noted that the draft RMP contained a description of the research requirements associated with the SRZ, but that some clarity of the requirements in the short and longer term would be desirable.

6.3 The Working Group noted that the RMP did not seek to prioritise the areas of research that had been identified but that it is advantageous to allow national Antarctic programs to select the work that they would undertake rather than for CCAMLR to seek to agree on a priority for the list of important research areas. The Working Group noted that the first five-year review would reveal gaps in the delivery to the RMP and that this would be likely to require a prioritisation to address identified gaps.

6.4 The authors of the RMP encouraged contributions and proposed revisions to the RMP via the e-group that had been established at the Workshop (WS-RMP-17).

6.5 Dr T. Ichii (Japan) suggested that although there is evidence that toothfish are prey for a number of air-breathing predator species, the current stock assessment does not take account of ecosystem impacts on dependent species and this may require further consideration.

6.6 The Working Group noted that the CCAMLR decision rules and conservation measures that mitigate against incidental mortality of seabirds and impacts on VME taxa, all contribute to CCAMLR's ecosystem approach. Furthermore, the adoption of CM 91-05, the Ross Sea region MPA, provides additional mitigation against irreversible impacts of fishing on the Ross Sea region ecosystem through spatial management.

6.7 Mr Dunn informed the Working Group that New Zealand planned a considerable amount of future research related to the ecosystem impacts of the toothfish fishery on dependent and related species in the region. The Ross Sea region MPA RMP will have a key role in driving the requirements of this research.

Weddell Sea MPA

6.8 The Working Group discussed WG-SAM-17/30 on the Weddell Sea MPA and noted the:

(i) desire for increased clarity on the interaction between the CCAMLR decision rules and the 60% protection targets for toothfish in the Weddell Sea proposal

(ii) importance of determining toothfish life-history and stock dynamics of the region, including the offer from Germany to host a workshop in early 2018 to examine toothfish dynamics and movement in the region in order to inform a working stock structure hypothesis

(iii) desirability for the authors of WG-SAM-17/30 to be present at the meeting in order to facilitate discussion of their paper.

Advice to the Scientific Committee

7.1 The Working Group's advice to the Scientific Committee and its working groups is summarised below; the body of the report leading to these paragraphs should also be considered:

(i) Development and progress of integrated assessments –

(a) Subarea 88.1 (paragraphs 2.16 and 2.18).

(ii) Review of research plan proposals and results –

(a) harmonising conservation measures related to conducting research on toothfish (paragraph 4.2)

(b) special research zone (paragraph 4.80).

Close of the meeting

8.1 In closing the meeting, Dr Parker thanked all the participants for their cooperation and productivity during the meeting.

8.2 Dr Parker noted that Dr Kenji Taki has taken a new assignment and will no longer participate in CCAMLR working groups. On behalf of the Working Group, he expressed sincere thanks for all the hard work and diligence that Dr Taki contributed to CCAMLR and its working groups and wishes him the best in his future work.

8.3 On behalf of the Working Group, Dr Belchier thanked Dr Parker for conducting the meeting in an efficient and friendly atmosphere that had allowed the efficient and effective outcomes of the meeting.

References

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Welsford, D.C. 2011. Evaluating the impact of multi-year research catch limits on overfished toothfish populations. *CCAMLR Science*, 18: 47–55.

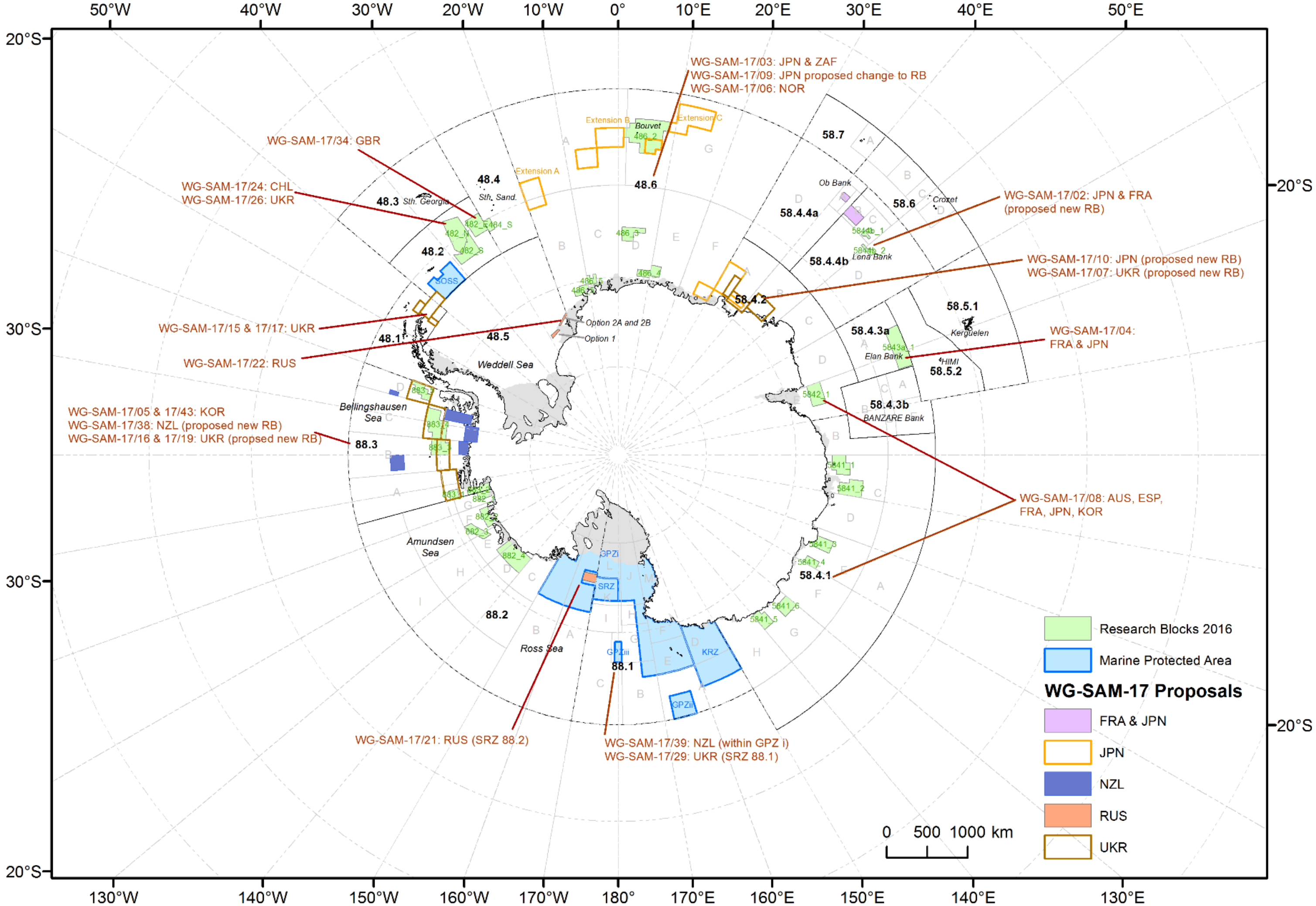

Figure 1: Map of existing and proposed research blocks for activities involving toothfish considered at WG-SAM-17. AUS – Australia, CHL – Chile, ESP – Spain, FRA – France, GBR – United Kingdom, JPN – Japan, KOR – Republic of Korea, NZL – New Zealand, NOR – Norway, RUS – Russia, UKR – Ukraine; ZAF – South Africa. RB – research block, GPZ – general protection zone, SRZ – special research zone.

Appendix A

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Appendix B

Agenda

Working Group on Statistics, Assessments and Modelling
(Buenos Aires, Argentina, 26 to 30 June 2017)

1. Introduction

   1.1 Opening of the meeting
   1.2 Adoption of the agenda and organisation of the meeting

2. Development and progress of integrated assessments

   2.1 Krill
   2.2 Toothfish
   2.3 Icefish

3. Biomass estimation, including estimation of uncertainty

4. Review of research plan proposals and results

   4.1 Proposals and research results from Subarea 48.6

   4.2 Proposals and research results from Subarea 58.4

      4.2.1 Proposals and research results from Divisions 58.4.1 and 58.4.2
      4.2.2 Proposals and research results from Divisions 58.4.3 and 58.4.4

   4.3 Review of research proposals and results for other areas

      4.3.1 Review of research proposals and results from Subarea 88.1
      4.3.2 Review of research proposals and results from Subarea 88.3
      4.3.3 Review of research proposals and results from Subareas 48.1, 48.2 and 48.5

5. Future work

6. Other business

7. Advice to the Scientific Committee

8. Adoption of report and close of meeting.

Appendix C

List of Documents

Working Group on Statistics, Assessments and Modelling
(Buenos Aires, Argentina, 26 to 30 June 2017)

WG-SAM-17/01	Results of the sixth Ross Sea shelf survey to monitor abundance of sub-adult Antarctic toothfish in the southern Ross Sea, January 2017 K. Large, L. Robinson and S. Parker
WG-SAM-17/02 Rev. 1	Research plan for the 2017/18 toothfish fishery in Division 58.4.4b by Japan and France Delegations of Japan and France
WG-SAM-17/03	Research plan for the 2017/18 exploratory longline fishery of *D. mawsoni* in Subarea 48.6 by South Africa and Japan Delegations of Japan and South Africa
WG-SAM-17/04	Continuation of multi-Member research on the *Dissostichus* spp. exploratory fishery in 2017/18 in Division 58.4.3a by France and Japan Delegations of France and Japan
WG-SAM-17/05	Vacant
WG-SAM-17/06	Proposal for a longline survey on toothfish in Statistical Subarea 48.6 in 2017/18 Delegation of Norway
WG-SAM-17/07	Research plan for the 2017/18 exploratory longline fishery of *Dissostichus* spp. in Division 58.4.2 Delegation of Ukraine
WG-SAM-17/08	Continuation of multi-Member research on the *Dissostichus* spp. exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) by Australia (notification ID 98422, 98423), France (94903, 94904), Japan (94886, 94887), Republic of Korea (94889, 94890) and Spain (94835) Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-SAM-17/09	Proposal for the extension of research block 48.6_2 T. Namba, T. Ichii and T. Okuda

WG-SAM-17/10	Update of analysis on sea-ice concentration of southern part of 48.6 and 58.4.2 for the new research block on expected spawning ground of TOA T. Namba, T. Ichii and T. Okuda
WG-SAM-17/11	Estimation and correction of migration-related bias in the tag-based stock assessment of Patagonian toothfish in Division 58.5.2 P. Burch, P. Ziegler, D. Welsford and C. Péron
WG-SAM-17/12	Estimating uncertainty in local biomass estimates of toothfish in CCAMLR in Subareas 58.4 and 48.6 research blocks L. Robinson, P. Burch and K. Reid
WG-SAM-17/13	Assessing data requirements for tag-based estimates of local biomass in data-poor and exploratory fisheries L. Robinson, P. Burch and K. Reid
WG-SAM-17/14	Vacant
WG-SAM-17/15	Format for reporting finfish research proposals of the Ukraine in Subarea 48.1 in 2018 (CM 24-01, para 3) Delegation of Ukraine
WG-SAM-17/16	Format for reporting finfish research proposals of the Ukraine in Subarea 88.3 in 2018 (CM 24-01, para 3) Delegation of Ukraine
WG-SAM-17/17	Plan of research program of the Ukraine in Subarea 48.1 in 2018 Delegation of Ukraine
WG-SAM-17/18	Demersal finfish distribution, abundance and their biological characteristics in Statistical Subareas 48.1 (northern part) and 48.2 (2018–2020) Delegation of Chile
WG-SAM-17/19	Plan of research program of Ukraine in Subarea 88.3 in 2018 Delegation of Ukraine
WG-SAM-17/20	Characterisation of the exploratory fishery on *Dissostichus* spp. between the 2004/05 and 2016/17 fishing seasons in Division 58.4.3.a J.-B. Lecomte, R. Sinegre, A. Rigaud and T. Okuda
WG-SAM-17/21	Research program to examine the life cycle and resource potential of *Dissostichus* species in the Special Research Zone within the Ross Sea region marine protected area (RSRMPA) in 2017–2027 Delegation of the Russian Federation

WG-SAM-17/22	Plan of the research program of Russian Federation in Subarea 48.5 (Weddell Sea) in season 2017/18 Delegation of the Russian Federation
WG-SAM-17/23	Analysis of the toothfish fishery indices in Subareas 88.1 and 88.2 when using different types of longline gears S. Kasatkina
WG-SAM-17/24	Research longline fishing proposal for *Dissostichus* spp. in Subarea 48.2 Delegation of Chile
WG-SAM-17/25	The preliminary report on the survey in Subarea 48.2 in 2017 (the third year of the planned 3-year-old investigations) Delegation of Ukraine
WG-SAM-17/26	Proposal for continuation of the Ukrainian research survey in Subarea 48.2 in 2017/18 and 2018/19 seasons Delegation of Ukraine
WG-SAM-17/27	Progress report on the Korean exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 in 2016/17 season S.-G. Choi, J. Lee, J. Lee and D. An
WG-SAM-17/28	Progress report on the Korean research fishing by longline fishery for *Dissostichus* spp. in Subarea 88.3 in 2016/17 season S.-G. Choi, J. Lee, J. Lee and D. An
WG-SAM-17/29	Ukrainian research proposal for the 2017/18 season in Subarea 88.1 Delegation of Ukraine
WG-SAM-17/30	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2017 – Reflection of the recommendations by WG-EMM-16 and SC-CAMLR-XXXV K. Teschke, H. Pehlke and T. Brey on behalf of the German Weddell Sea MPA (WSMPA) project team
WG-SAM-17/31	Phase-randomisation in an integrated assessment model for Antarctic krill D. Kinzey, G.M. Watters and C.S. Reiss
WG-SAM-17/32	Incorporation of science advice from the CCAMLR working groups and Scientific Committee into the krill assessment model for Subarea 48.1 D. Kinzey, G.M. Watters and C.S. Reiss

WG-SAM-17/33	Results of 2016 pop-off satellite archival tagging of Antarctic toothfish in the Ross Sea region C.D. Jones and S.J. Parker
WG-SAM-17/34	Preliminary results from the first year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4 K. Olsson, M. Belchier and M. Söffker
WG-SAM-17/35	Sensitivities in the assessment of the Patagonian toothfish (*D. eleginoides*) in Subareas 48.3 and 48.4 to truncation of tagging data T. Earl
WG-SAM-17/36	Comparison of bootstrap methods for assessment of mackerel icefish (*Champsocephalus gunnari*) in CCAMLR Statistical Subarea 48.3 based on the ground fish survey T. Earl and N. Fallon
WG-SAM-17/37	Developing robust biomass estimates and advice on catch limits in research blocks S.J. Parker, S. Mormede, A. Dunn, S.M. Hanchet and C. Marsh
WG-SAM-17/38	Notification for scientific research in 2017/18: proposal to participate in research plan for Antarctic toothfish in Subarea 88.3 Delegation of New Zealand
WG-SAM-17/39	Proposal to continue the time series of research surveys to monitor abundance of Antarctic toothfish in the southern Ross Sea, 2018–2022 S.M. Hanchet, K. Large, S.J. Parker, S. Mormede and A. Dunn
WG-SAM-17/40	Simulations to evaluate model performance for Antarctic toothfish stock assessment in the Amundsen Sea region S. Mormede and S. Parker
WG-SAM-17/41	Updating the 2017 stock assessment of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region S. Mormede and S. Parker
WG-SAM-17/42	The Ross Sea region Marine Protected Area Research and Monitoring Plan (WG-SAM 2017) A. Dunn, M. Vacchi and G. Watters
WG-SAM-17/43	Research plan for the exploratory longline fishery for *Dissostichus* spp. in Subarea 88.3 in 2017/18 Delegation of the Republic of Korea

WG-SAM-17/44	By-catch analysis as a part of progress report for the research fishery of *Dissostichus* spp. in Subarea 48.6 by Japan and South Africa during 2012/13–2016/17 T. Okuda, S. Somhlaba and T. Ichii
WG-SAM-17/45	By-catch analysis as a part of progress report for the research fishery of *Dissostichus* spp. in Divisions 58.4.3a and 58.4.4b by Japan and France during 2012/13–2016/17 T. Okuda, A. Rigaud, R. Sinegre and T. Ichii
WG-SAM-17/46	Preliminary investigation of fish movement in Subarea 48.6 S. Somhlaba, R. Leslie, T. Okuda, T. Ichii and D. Yemane
WG-SAM-17/47	An update on using the CCAMLRGIS R package to create polygon data and access data on the CCAMLR online GIS Secretariat

Other Documents

WG-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)

Annex 6

Report of the Working Group on Ecosystem Monitoring and Management
(Buenos Aires, Argentina, 10 to 14 July 2017)

Content

Report of the Working Group on Ecosystem Monitoring and Management
(Buenos Aires, Argentina, 10 to 14 July 2017)

Introduction

Opening of the meeting

1.1 The 2017 meeting of WG-EMM was held in the Palacio San Martín, Buenos Aires, Argentina, from 10 to 14 July 2017. The meeting Convener, Dr M. Korczak-Abshire (Poland), welcomed the participants (Appendix A). Mr Maximo Gowland, the Argentinian Commissioner to CCAMLR and Director of the Dirección Nacional de Política Exterior Antártica welcomed all participants to the meeting and wished them every success in their meeting and an enjoyable stay in Buenos Aires.

Adoption of the agenda and organisation of the meeting

1.2 At the invitation of Dr Korczak-Abshire, the Chair of the Scientific Committee (Dr M. Belchier, UK) provided a summary of the outcomes of the Scientific Committee Symposium, held in 2016, and the subsequent deliberations of the Scientific Committee on the priorities and work plans for the Working Group. He noted that the priorities identified by the Scientific Committee in 2016 for the work of WG-EMM this year (as outlined in SC-CAMLR-XXXV, Table 1) were:

- approaches to the operationalising of feedback management (FBM) in the krill fishery in Subarea 48.1
- data layers used in the risk assessment for krill fisheries and the Domain 1 planning process
- Domain 1 marine protected area (MPA) process, including the integration of CCAMLR Ecosystem Monitoring Program (CEMP) monitoring and monitoring as part of the Domain 1 MPA process.

1.3 Dr Belchier also noted that events that had occurred after the meeting of the Scientific Committee, such as the adoption of the Ross Sea region MPA, meant that there were additional items that required consideration. He acknowledged the reduced time available and the considerable number of papers tabled to the meeting, however, while hoping that all papers could receive appropriate consideration, he urged the Working Group to focus on the priorities provided by the Scientific Committee.

1.4 The meeting agenda was adopted (Appendix B).

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

1.6 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been indicated in grey. A summary of these paragraphs is provided in Item 7.

1.7 The Working Group used the Secretariat's online meeting server to support its work and facilitate the preparation of the meeting report.

1.8 The report was prepared by M. Belchier (Chair of the Scientific Committee), C. Cárdenas (Chile), C. Darby (UK), L. Emmerson (Australia), D. Freeman (New Zealand), O.R. Godø (Norway), S. Grant and S. Hill (UK), J. Hinke and E. Klein (USA), P. Koubbi (EU), K. Reid (Secretariat), M. Santos (Argentina), M. Söffker (UK) and D. Welsford (Australia).

The krill-centric ecosystem and issues related to management of the krill fishery

2.1 WG-EMM-17/48 described how accuracy of catch reporting at two-hourly intervals can be improved on continuous fishing system vessels, by:

(i) monitoring holding tank fullness more accurately and defining the relationship between tank fullness and krill wet weight

(ii) correcting the estimates at the end of each day with daily catch.

2.2 WG-EMM-17/48 outlined a calibration process for more accurate two-hourly catch reporting, whereby the sum of two-hourly catch estimated in the holding tank over 24 hours is compared to the actual catch measured for this period over the flow scale, and the two-hourly catch data subsequently corrected by the relationship between them:

$$C_{ic} = C_i * C_{tot}/\sum C_i$$

where C_i is the catch reported at two-hourly intervals and C_{ic} is the compensated two-hour catch, $\sum C_i$ is the sum of two-hour catches over one 24-hour period and C_{tot} is total daily reported catch for that period.

2.3 The paper presented calibration results of a trial period in May 2017, and the authors considered that fine-scale recording of catch cannot be improved beyond the improvement suggested by this paper until instrumented recording of krill influx through the trawl opening can be recorded. The Working Group requested that vessels using the continuous fishing system carry out the calibration process regularly and frequently throughout the fishing season to better understand the variability expected with this proposed way of catch reporting.

2.4 The Working Group recalled the discussions at WG-EMM-16 (SC-CAMLR-XXXV, Annex 6, paragraphs 2.18 to 2.22), noting that due to the current inability of continuous fishing system vessels to record catches accurately at the time intervals required by Conservation Measure (CM) 21-03, there is still a mismatch between where catch was taken and where it was reported. The Working Group also noted the discussions around WS-SISO-17/11, detailing how observer samples are taken on continuous fishing system vessels, and recalled that the Workshop on the Scheme of International Scientific Observation (WS-SISO) concluded that there is a need to find a way of reconciling observer samples and data with corresponding C1 data, as well as gaining accurate spatial and temporal locations for these samples.

2.5 The Working Group requested that the Scientific Committee review whether the catch and effort data submitted from the continuous fishing system is consistent with CMs 21-03 and 23-06.

2.6 The Working Group requested that Norway analyse historic catch data and catch reporting, including the following analyses to assist in the interpretation of this issue:

(i) whether there is a systematic factor in the delay of catch location and volume reporting that could further improve the accuracy of catch data, and to investigate if any such relationships could also rectify previously collected data

(ii) investigate the variability associated with the time delay from when a vessel begins fishing on a new swarm and that first catch being recorded in the holding tank

(iii) investigate the spatial uncertainty associated with historic catch reporting locations

(iv) compare acoustic data and catch reported to understand the spatial variability associated with the delay.

2.7 The Working Group noted that other means of obtaining accurate information on catch and location, such as monitoring of trawl opening and codend and pump flow rate, may potentially be available in the future and encouraged Norway to consider how these could improve catch location reporting in the future.

Krill fishery update

2.8 The Krill Fishery Report for Area 48 is available on the CCAMLR website (www.ccamlr.org/node/93212). The Working Group noted that the krill fishery had operated in Subarea 58.4 in the 2016/17 season and that it would be appropriate to provide a separate report for krill fishing in East Antarctica in the future.

2.9 The catch by subarea and month in the 2016/17 season indicated that fishing occurred later and with fewer vessels in Subarea 48.1 than in previous seasons, and the trigger level was not reached until July 2017. The Working Group noted that fishing vessels remained in Subarea 48.2 for a longer period than in recent years with a contingent delay in the movement of fishing operations to Subarea 48.1. This appeared to be a consequence of more favourable fishing conditions in Subarea 48.2 during February and March.

2.10 The Working Group reviewed notifications of intention to fish for krill in 2018 using the information on notifications, vessel and gear details that are provided on the CCAMLR website (www.ccamlr.org/en/fishery-notifications/notified/krill). The Working Group noted that following the advice of the Scientific Committee, these data are no longer presented as a summary in a paper to WG-EMM (SC-CAMLR-XXXV, paragraph 3.168). The Working Group noted that 13 vessels from five Members had notified their intention to fish for krill, and two vessels withdrew from the fishery in all areas and one vessel withdrew from Area 58. It recalled that records of withdrawn vessels remain in the notification table, as this information provides important background to understanding how interest in the krill fishery changes over time.

Scheme of scientific observation

2.11 The key recommendations from WS-SISO-17 to WG-EMM-17 were as follows:

(i) Krill sampling – krill carapace measurements

(a) WS-SISO considered the suggestion for the addition of a field in the SISO observer logbook for recording krill carapace lengths during measurement of krill: Request to WG-EMM to review the utility, methods and sample size

(b) review the number of carapace measurements and the number of total length measurements.

(ii) Fish by-catch in the krill fishery

(a) WS-SISO-17 considered an analysis of the relative number of fish found in subsamples – 98% of all fish reported came from the 25 kg samples. WS-SISO-17 recommended that subject to review by WG-EMM, the krill by-catch sampling regime undertaken by observers only requires a 25 kg sample

(b) extend by-catch monitoring to address more than fish, e.g. include other invertebrates, such as salps

(c) consider molecular approaches that may be appropriate for identifying by-catch species in krill by-catch samples, as well as visual guides that could be drawn from existing guides and information from Members.

(iii) Interactions between fishery and air-breathing krill predators

(a) WS-SISO-17 noted that in several thousand trawl-warp strike observation periods, there have been three seabird strikes since 2010, evidence of the low impact the krill fishery had on bird mortalities, and the success of mitigation measures in CCAMLR. With these mitigation measures in place, WS-SISO suggested to retain the methods and forms currently in use, but to further consider how electronic monitoring in warp strike observations could be used to allow changing the frequency of observations, which would permit observers to focus on other high-priority tasks

(b) WS-SISO-17 asked WG-EMM-17 to consider the suggested design of a sampling regime to record air-breathing predators observed around krill vessels during fishing operations and during acoustic surveys carried out by the krill fishery (Annex 4, paragraphs 4.1 and 4.2), how krill fishing vessels could be used as 'platforms of opportunity' to collect broader marine mammal and seabird abundance data, and how these data would progress the work of WG-EMM. The Working Group noted such an approach is exemplified in WG-EMM-17/05.

2.12 The Working Group considered the recommendations of WS-SISO-17 as set out below.

Carapace measurements and observer krill sample size

2.13 In addition to the recommendations from WS-SISO-17, the Working Group discussed WG-EMM-17/28 in this context. WG-EMM-17/28 examined the variability in krill length caught by different vessels fishing in the Bransfield Strait in April and May 2014 and 2015, in the context of the need for accurate observer data on krill length for stock status and fishery selectivity, for the development of FBM and as an integral part of acoustic monitoring from commercial krill vessels. The study found that while the mean krill lengths were comparable between vessels, there was a significant difference in krill length distributions caught by different vessels operating in the same area, which was not determined by the type of fishing gear. The study concluded that it is important to maintain a krill sample size that is sufficiently large to capture the whole range of krill length distribution in a sample.

2.14 The Working Group noted that there can be some variance between observers measuring the same sample (Watkins et al., 1986), but also that there can be noticeable variance in krill length distribution between swarms and different depths, and over different spatial and temporal scales. These are likely important for results found in WG-EMM-17/28, and the Working Group suggested that some of that variability could be addressed by comparing observer data on krill lengths to scientific hauls, where conditions are standardised and acoustic data is available on the same transects. The Working Group also noted that there are statistical methods available to include and address such uncertainties (Annex 5, paragraph 4.39).

2.15 The Working Group recalled that for biomass estimation from acoustic surveys, the important measure is the range of krill lengths in an associated biological sample, where the distribution between vessels was very similar.

2.16 The Working Group concluded that the measure of krill carapaces is important (Tarling et al., 2016) to understand sex-dependent growth dynamics of krill. The Working Group agreed that an optimal sampling design be developed that both captures the spatial variety observed in krill sampling (WG-SAM-16/39, WS-SISO-17/11), and provides sufficient sample size to represent krill length-frequency distribution in the catch. The Secretariat offered to support Members in the development of these methods.

By-catch in the krill fishery

2.17 The Working Group noted the discussions at WS-SISO on by-catch in the krill fishery, particularly around the successful collective development of observer guides for fish by-catch. The Working Group noted that 98% of all fish had been recovered from the 25 kg samples and agreed to the changes to the instructions to remove the need for further subsampling the 25 kg samples.

2.18 The Working Group also noted the potential value of expanding by-catch data from the krill fishery to include invertebrates and noted that, currently, the only field guide for invertebrates potentially caught in the krill fisheries is dated and relies on black and white line drawings.

2.19 The Secretariat encouraged all Members to submit any identification guides on potential invertebrate by-catch in Antarctic krill (*Euphausia superba*) fisheries to the Secretariat, who would compile the information and make it available on the SISO sections of the website, similarly to the compiled finfish by-catch guides provided by Members.

Air-breathing krill predators

Trawl warp strikes

2.20 The Working Group considered the recommendation by WS-SISO to retain the methods and forms currently in use, but to further consider how electronic monitoring in warp strike observation could be used to allow changing the frequency of observations, which would permit observers to focus on other high-priority tasks.

2.21 The Working Group recalled that while globally warp strikes in trawl fisheries are regular causes of seabird deaths caused by fisheries, the characteristics of the krill fishery within CCAMLR, combined with the mitigation measures in place, result in fishing activity of relatively low warp strike danger, with only three white-chinned petrels (*Procellaria aequinoctialis*) recorded in warp strikes during thousands of warp observation periods.

2.22 In view of this, the Working Group supported the reduction of the warp strike observation frequency, subject to evaluation of appropriate observation frequency, and encouraged the development of electronic monitoring, which could include infrared and night-vision cameras, to collect data to support this particular task.

Marine mammal and seabird distribution and abundance

2.23 The Working Group discussed the recommendation by WS-SISO to consider the suggested design of a sampling regime to record air-breathing predators observed around krill vessels during fishing operations and during acoustic surveys carried out by the krill fishery (Annex 4, paragraphs 4.1 to 4.3), and how these data would progress the work of WG-EMM. WS-SISO-17/05 was also considered in this context.

2.24 The Working Group recalled that the recommendation addressed two separate questions: the potential interactions and competition of the krill fishery with krill-dependent predators during fishing operations (SC-CAMLR-XXXV, Annex 7, paragraphs 6.14 and 8.25, see also SC-CAMLR-XXXV, paragraphs 3.84 and 3.108), and the wider ecosystem monitoring through transect and survey work, and acknowledged that these two activities would need different approaches to data collection. The Working Group discussed the utility of marine mammal and seabird observations during surveys on acoustic transects by commercial fishing vessels, noting previous initiatives to use acoustic data to evaluate marine mammal presence (WG-EMM-16/P01), and the opportunity that the current (WG-EMM-17/08) and planned acoustic transects by the commercial fleet provide to collect planned survey data on marine mammals in regions where the krill fleet operates.

2.25 The Working Group agreed that for questions such as the krill risk assessment framework, collection of predator abundance, presence and absence during fishing operations and during survey transects it was important to understand the probability of direct interaction between predators and vessels and potential competition for the same resource. The Working Group noted that the two sets of information are required for the further development of the krill risk assessment framework as well as wider ecosystem studies, and that WS-SISO had drafted two data collection methods, one for observations during fishing operations, and one for commercial vessels in survey transect mode.

2.26 The Working Group recommended that the Scientific Committee consider whether and how data collection on air-breathing predators, both during fishing operations and during survey transects carried out by the commercial krill fishery, could form part of the regular SISO duties.

Observer coverage

2.27 The Working Group discussed the different ways that observer coverage has been defined in the past (SC-CAMLR-XXXV, Annex 6, paragraphs 2.41 to 2.43), and noted that the current CM 51-06 refers to the coverage of vessels, rather than coverage of number of days or number of hauls observed.

2.28 The Working Group noted the agreement by the Commission to transition to 100% observer coverage in the krill fishery by 2020, and that this allowed the Working Group to focus its discussion on observer deployment in terms of sampling and representative data collection, which addresses specific scientific questions, rather than the coverage of vessels by observers, which is specified in the conservation measure.

2.29 The Working Group thanked all the scientific observers in the krill fishery that provided valuable data to the work of CCAMLR and this Working Group in particular.

Operationalising feedback management (FBM) in the krill fishery in Subarea 48.1

Net monitoring cables

3.1 WG-EMM-17/47 presented the challenges and some results from using a net monitoring cable to inform crew and scientists of the real-time performance of a krill trawl. The difficulties encountered when monitoring two different continuous gear types are outlined and discussed. One system requires a separate net monitoring cable, the second solves the problem of adding a third cable by attaching the net cable to other operational cables of the trawl system. The trials demonstrated the potential to observe the trawl in real time, as well as the real-time density distribution of krill entering the trawl.

3.2 Norway had intended to conduct a systematic trial on board the FV *Saga Sea* during the 2016/17 fishing season but due to logistical difficulties it was not completed. Norway is therefore seeking to extend the trial period to the 2017/18 fishing season.

3.3 The Working Group welcomed the development of the net monitoring system, noting that it would be beneficial to establish the links between the monitoring observations recorded by the vessel and the density of krill observed by the vessel acoustics. Also, as the krill entering the net would not all be selected by the gear, investigating the relationship between inflow and eventual catches would be beneficial.

3.4 The Working Group discussed the proposal and recommended that the trials be continued under the conditions agreed previously (SC-CAMLR-XXXV, paragraphs 4.10 and 4.11).

3.5 The Working Group noted that the use of net monitoring cables would also be beneficial for the collection of scientific data associated with actual fishing operations (SC-CAMLR-

XXXV, Annex 6, paragraph 2.24). The Working Group noted that the prohibition on net monitoring cables that currently also applied to the krill fishery was introduced after evidence from other fisheries was presented in CCAMLR that the cables that were thinner than trawl warps represented a high risk of bird strike.

3.6 The Working Group discussed a range of options and agreed that if Members wished to trial such systems, a full research proposal, similar to that presented by Norway (WG-FSA-16/38), would be required and requested that the Scientific Committee provide advice on the most appropriate procedure to review such proposals.

3.7 The Working Group discussed the potential use of the data from real-time monitoring of krill entering the vessel nets, noting that it would help in the determination of the density of krill in the water column which could be used to further examine the daily and seasonal migration of krill similar to the modelling reported in WG-EMM-17/41.

Data for the spatial management of krill

3.8 WG-EMM-17/50 Rev. 1 provided a review of information on openly available data and metadata that could be used as input to the krill risk assessment, developed by WG-EMM and WG-FSA in 2016, and which was used to provide management advice to the Scientific Committee and Commission. The Scientific Committee had requested that the development of the model and datasets continue (SC-CAMLR-XXXV, paragraph 3.64). The paper highlighted where gaps in the available data occur, particularly where the krill fishery is occurring but information on predators is lacking, and where the collection of additional information would help contribute to the development of the risk assessment approach in the management of the krill fishery and also CCAMLR's commitment of applying FBM.

3.9 Several participants noted that datasets currently not available through CEMP would fill some of the gaps noted, but these have not been released for general use to date, due to analyses still being conducted on them. The Working Group encouraged broad engagement in the review process.

3.10 The Working Group discussed the communication and availability of data and recommended that the Developing practical approaches to feedback management for krill e-group outline a proposal for a database setup to contain metadata for regional datasets. The database could be populated by Members collecting data within Subareas 48.1 and 48.2 and which could then be used as a reference.

3.11 Such a database would be similar to that discussed at WS-RMP-17 (WS-RMP-17/09). WS-RMP considered that for the development and monitoring of MPAs, the Secretariat could provide a transparent mechanism to catalogue and share metadata collected for providing advice. WS-RMP-17 considered that the Ross Sea region MPA data repository would be accessible to all Members under the Rules for Access and Use of CCAMLR Data.

3.12 The Working Group noted that such a repository could be used by CCAMLR Members collecting data throughout Antarctica and used for the provision of advice to the Commission by the Scientific Committee and its working groups.

3.13 The Working Group noted that in order to progress the krill risk assessment framework in Area 48 as requested by the Scientific Committee (SC-CAMLR-XXXV, paragraph 3.108), it requires:

(i) further collaborative parameterisation of the conceptual model for the region
(ii) identification of the required data components
(iii) coordination of research effort to collate and/or collect any additional data identified to progress the risk assessment framework.

3.14 The Working Group noted that the suggested schedule of working group meetings, outlined by the Chair of the Scientific Committee (WG-EMM-17/02), included a joint workshop between SG-ASAM, WG-EMM and WG-SAM to further develop FBM of the krill fishery. The Working Group recognised that:

(i) the development and population of a database of biological information

(ii) an analysis of spatial information that can be used to formulate management advice

(iii) identification of information gaps

(iv) the further development of the krill risk analysis and FBM models

would each benefit the 2019 joint meeting, as would the establishment of a steering committee, to ensure that preparatory work was conducted in the build-up to the discussions. The Working Group also noted that the work of the Southern Ocean Observing System (SOOS) and other such collaborative projects would also provide a useful input to the meeting discussions.

Krill biology, ecology and population dynamics

Swarm analysis

3.15 WG-EMM-17/40 described an analysis of abundance and distribution, as well as swarm characteristics and diel vertical migration which were studied using acoustic data from the Chinese krill fishing vessel *Fu Rong Hai* operating in the Bransfield Strait from late austral summer (February) to autumn (March to May).

3.16 The analysis indicated a major shift in krill distribution in mid-April, which included: increased biomass; increased vertical distribution of the swarms; a change in the diel vertical migration, from upward migration during daytime in February–March to downward migration during daytime in May; and also a change in the length distribution of krill. The results strongly support the hypothesis of an inshore krill migration from summer to winter (Siegel, 1988; Trathan et al., 1993) and indicate that the migration is also followed by a gradual shift in swarming behaviour. The catching efficiency of the vessel increased over the season and was positively related to both krill packing density and acoustic biomass, but negatively related to the central depth of gravity of the krill swarms.

3.17 The Working Group congratulated the authors on their research that allowed krill dynamics to be identified from the catch rates recorded by the conventional commercial trawl vessel. The findings, along with those described in WG-EMM-17/41 and 17/45, have demonstrated that the fishery data can be used to make inferences about krill seasonal dynamics and the responses in vessel behaviour. The Working Group noted that the model does not include spatial interaction terms and also that log transformations had been applied to the data. It would be useful to evaluate whether including spatial patterns and changing the distribution assumption made any differences to the analysis.

3.18 The Working Group noted the changes apparent in the krill dynamics in April, which may be related to migration and which also correspond to the time at which some krill predators leave the area. Given the high catch rates at this time, it would be useful to repeat the analysis for other years of data to establish whether this is a time when the condition of krill is good and there is less conflict with predators. The results of such studies would be useful in the development of FBM in the area.

3.19 The Working Group also noted that an extension of this work to analyse catches from other vessels in the area and other gear types would be interesting, however, given the doubts about the utility of the catch rates from the continuous fishing gears this may require further analysis before the data can be used in this approach (paragraphs 3.102 to 3.104).

3.20 The Working Group noted that analyses such as those presented in WG-EMM-17/40, 17/41 and 17/45 have shown that fishing vessel data can be used to evaluate the dynamics of krill and vessels behaving as predators, and that the work of SG-ASAM in standardising the vessel data would be critical to combining information across platforms. The Working Group also noted that data from acoustic moorings could additionally be used in interpreting the seasonal patterns. Such analyses would also be important in determining the role of the flow of krill resulting from water movements (flux) on the replenishment of the krill population, both throughout the season and as catches are removed by the fishery.

3.21 Dr S.-G. Choi (Republic of Korea) noted that Korea had been conducting standardised acoustic transects in Bransfield Strait, using the protocol set out by SG-ASAM, and would be repeating these in future years, including by month to examine the dynamics of krill.

3.22 The Working Group thanked Dr Choi, noting that it was encouraging that the ideas for utilising fishing vessels to conduct research, as set out in WG-EMM and SG-ASAM, were starting to be taken up by the industry.

KRILLBASE

3.23 WG-EMM-17/P03 described KRILLBASE, a circumpolar database of *E. superba* and salp numerical densities, from 1926 to 2016, which is now available online. The database includes fine-scale information on adult krill distribution in Subareas 48.1 and 48.2 and Divisions 58.4.1 and 58.4.2, which have been used in Domain 1 planning (paragraph 4.6) and could provide input to risk assessments for the krill fishery in the Scotia Sea and East Antarctica.

Hydrographic modelling

3.24 WG-EMM-17/30 described the development of regional models for water movements across the South Georgia and South Orkney Islands shelves and surrounding regions, and the results of preliminary analyses. The models simulate key physical processes of relevance to the local ecosystems, including tides, atmospheric forcing from reanalysis, glacial melt and with sea-ice processes incorporated using Louvain-la-Neuve sea-ice model (LIM3). The models have been used to generate 20-year hind-cast time series of oceanographic flows and water mass properties.

3.25 The model in WG-EMM-17/30 provided simulations of the underlying physical environment for detailed examinations of the controls on the distribution of krill and fish life-stage distributions around the islands, their interactions with predators and availability to fisheries. Insight from such studies will help inform WG-EMM activities aimed at developing spatial and FBM procedures. The program is currently being used to investigate the spawning and recruitment of Patagonian toothfish (*Dissostichus eleginoides*).

3.26 The Working Group noted the series of papers presented to the meeting on the dynamics of krill, as estimated from fishing vessels, particularly in the area covered by the model in WG-EMM-17/30, and suggested to combine the current predictions with observed dynamics of krill.

3.27 The Working Group noted that the model allowed predictions to be made in localised fine-scale areas, and that predictions had been evaluated using conductivity temperature depth probe (CTD) data. The model also includes freshwater input from glaciers. The sea-ice predictions show some discrepancy with satellite observations, whilst the seasonal cycle is reproduced by the model, there is a tendency for sea-ice to extend too far north and west in winter, and to retreat too far south in summer; these are thought to arise because of the open boundary forcing from the global Nucleus for European Modelling of the Ocean (NEMO) model.

Krill life-history parameters

3.28 WG-EMM-17/29 analysed Euphausiid larvae (*E. superba*, *Thysanoessa macrura* and *E. frigida*), collected during the summer of 2011 in the Weddell–Scotia confluence region, during 2012 in the western Antarctic Peninsula (WAP) and Scotia Sea and during 2014 on the South Orkney Islands. A strong decrease in the abundance of *E. superba* larvae and an increase in *T. macrura* was recorded between 2011 and 2012 with a strong increase in the abundance of *E. superba* in 2014. In 2011, *T. macrura* dominated the species composition with all stages present, and *E. superba* was found in lowest proportion of the three species. In 2012, the three species had very low numbers, but also *T. macrura* had the highest proportion. In 2014, *E. superba* dominated the sampling with calyptopis larvae stages.

3.29 The geographical distribution of krill larvae was in accordance with previously recorded data for these species, and oceanographic conditions did not show any significant differences to historical information. The analysis also reviewed possible causes of the variability of observed species density and proportions, in relation with physical variables with no clear relationships. Comparison of the data for the recent three years with the physical data obtained in 1995 indicated a decrease in salinity and an increase in the maximum and the minimum temperatures, but the values remain well within the physiological limits of Euphausiid larvae.

3.30 The Working Group thanked the authors for their paper and noted that studies of the dynamics of larval krill are an important contribution to its understanding of the species dynamics, particularly, the transition of year classes in the length distribution of larvae transitioning into, and through, the adult stock.

3.31 The authors noted that there was no linkage between the krill abundance in the fishery and the subsequent larvae abundance; measuring the length distribution of the larvae was currently being conducted.

3.32 The Working Group noted the value of research surveys providing long-term monitoring of the regional density and variability of both larval krill and physical oceanographic parameters so as to understand the possible impacts of climate change on Euphausiid life-history distributions.

Krill assessment models

3.33 No documents were presented for this agenda item. However, the Working Group noted the discussions at WG-SAM-17 (Annex 5, paragraphs 2.1 to 2.5) during which recent developments in the krill assessment model for Subarea 48.1 were considered. WG-SAM noted that there was a need to consider the population dynamics of the krill stock in the area as a whole, as there was confounding between natural mortality and emigration resulting from water flows (flux) within the model.

3.34 In addition, WG-SAM noted that there are no plans for further US AMLR surveys in the same form as in previous years (paragraphs 6.7 to 6.9). The surveys are currently used as an important source of calibration data within the model. The importance of making the best use possible of data from other science surveys and that provided by commercial fishing vessels, such as the transects identified by SG-ASAM, needs to be developed as a high priority in order to allow WG-SAM, WG-EMM, WG-FSA and the Scientific Committee to provide future advice on the trends in stock dynamics of the krill stock covered by the US AMLR surveys (Annex 5, paragraph 2.5).

3.35 The Working Group noted that defining the temporal and spatial scale of the krill assessment process is key to determining the requirements for data that would be used to provide management advice, particularly in relation to the importance of flux. Assessments conducted at a fine scale, which evaluate the localised impact of catches on a small-scale area over a short time period, could be conducted using localised data collected by fishing vessels, as outlined by WG-EMM and SG-ASAM. The impact of fishing at a regional scale and over a longer time period (e.g. annually) would be affected by emigration from, and immigration to, the area. The scale of the data collection and analysis would also affect the evaluation of the fishery impact on predators within FBM.

3.36 The Working Group noted that within the South African small pelagic fishery management system, a series of open and closed areas around islands on which predators are located are defined, and that these are rotated on a fixed time scale in a factorial design (Pichegru et al., 2010, 2012). Such experimental designs may be suited to the evaluation of the localised impact of the krill fishery on predators (paragraph 3.59). The CEMP data would form an important part of such a design process.

3.37 The Working Group noted that the risk assessment framework developed at WG-EMM and WG-FSA allows advice to be provided to the Scientific Committee on where interactions between the fishery and predators are increasing or decreasing and where there is a need for more information to be collected and analysed. The risk assessment framework allows spatial data or its absence to be integrated in a simple format that can be used to provide advice, and while the staged approach for the development of FBM is still being implemented, the Working Group agreed that the continued development of the risk assessment is important in order to progress the precautionary management of the krill fishery.

3.38 The Working Group discussed the availability of a range of data that is being analysed that could contribute to the risk analysis and FBM development and encouraged Members to make this data available in a readily accessible form (paragraph 3.10). The data descriptions, the methods used to collect the data and the quality/uncertainty in the data should form part of the analysis in order to allow the Working Group and the Scientific Committee to assess the utility of the results of analysis for the provision of management advice.

Ecological interactions: predators

Ross Sea

3.39 The Working Group considered WG-EMM-17/06 that reported recent monitoring of an Adélie penguin (*Pygoscelis adeliae*) colony at Cape Hallett in the northern Ross Sea. The colony is adjacent to the newly designated Ross Sea region MPA. The main results presented in the paper from initial field sampling suggest an increasing population over the last decade, up to 53 450 pairs from 47 169 (reported in 2013) and foraging ranges and durations consistent with short-range trips during the breeding season. Census methods using both ground and aerial images obtained from unmanned aerial vehicles (UAVs) suggest counting may benefit from UAV systems when colonies are so large.

3.40 The Working Group welcomed the paper, noting that the diet of Adélie penguins in the Ross Sea region may be quite different from those around the Antarctic Peninsula, and that the Republic of Korea has plans to undertake DNA analysis of penguin guano as part of its future studies in the Ross Sea region. The Working Group also welcomed the intent for monitoring of this penguin colony in the Ross Sea region to continue.

Diet and consumption estimates

3.41 The Working Group reviewed several papers on predator diet and methods to estimate total consumption. WG-EMM-17/P02 reported on diet content of gentoo penguins (*P. papua*) at Bird Island, South Georgia. The Working Group noted that gentoo penguin diets are characterised by fish and krill mixtures, with krill or fish assuming the dominant proportion in most years. Despite mixed diets, reproductive performance was best modelled based on the mass of krill in the diet. The Working Group noted that the sensitivity of breeding success to krill availability, even for species that consistently rely on multiple prey types, supports inference of the importance of krill for these predators.

3.42 The Working Group considered WG-EMM-17/13, which provided results from recent work using the extraction of prey DNA from penguin faecal samples as a non-invasive procedure to complement CEMP Standard Method A8. Primary results suggested that the method is able to identify interannual variability in diet and the identification of soft-bodied prey (e.g. Scyphozoa, Ctenophora and Siphonophora) that are not typically identified in standard stomach lavage studies. WG-EMM-17/13 outlined a pilot study to compare the prey DNA approach with stomach lavage from simultaneous samples collected from Adélie penguins.

3.43 The Working Group noted the potential importance of the method presented in WG-EMM-17/13 as an alternative to more invasive sampling methods, noting that in some cases non-destructive sampling methods can also be more cost effective. It was also noted that it was important to further validate the approach and consider the purpose of the data collection and requirements for particular sampling methods, and to also consider how changes in sampling methodology over time may affect data utility. The Working Group also noted that opportunistic data collection on diet could be a useful addition to ongoing diet studies. For example, the Working Group noted that the collection of stomach samples from flying seabirds incidentally killed by ship collision and during fishing operations may provide a potential source of data on krill consumption by these species.

3.44 The Working Group considered two papers based on the bioenergetics model of Southwell et al. (2015) to estimate consumption rates for Adélie penguins. WG-EMM-17/32 adapted the model to a Signy Island population and extrapolated results across breeding populations throughout Subareas 48.1 and 48.2 from abundance data collated by the mapping application for penguin populations and projected dynamics (MAPPPD) program. The Working Group noted that per capita consumption estimates ranged from 0.6 to 1.1 kg of krill and fish (approx. 96% of which is krill) and that translates to 293 815 tonnes of krill in Subarea 48.1 and 51 215 tonnes of krill in Subarea 48.2. The Working Group noted that these estimates are comparable, but more comprehensive, estimates of consumption reported by Lishman in 1983.

3.45 The Working Group noted that additional analysis on macaroni penguins (*Eudyptes chrysolophus*) was conducted last year and that analysis of chinstrap (*P. antarctica*), and potentially gentoo penguin, consumption was planned by the authors of WG-EMM-17/32 for the near future, highlighting the continued efforts to improve data on prey consumption by penguins.

3.46 WG-EMM-17/12 extended the bioenergetics analysis to examine consumption of the penguin population that includes breeders and non-breeders present in the colony and the component of the population that is not present at the breeding colony (including juveniles, pre-breeders and non-breeding individuals that remain at sea). The non-breeding component of the population can be large, and the authors reported that the size of the non-breeder population at Béchervaise Island may be approx. 76% of the entire breeding population. The Working Group welcomed this important analysis and agreed that estimating the consumption by the whole population must be considered to appropriately estimate predator demand for krill, taking into account the spatial foraging range of breeders and non-breeders (WG-EMM-17/07).

3.47 The Working Group noted that work to update estimates of krill consumption by flying seabirds is another priority of the Working Group and that estimating krill consumption of flying seabirds remains a data gap. Toward filling that gap, WG-EMM-17/11 provided an update on progress to estimate abundance for flying seabirds (including Antarctic petrels

(*Thalassoica antarctica*), Cape petrels (*Daption capense*), southern fulmars (*Fulmarus glacialoides*), snow petrels (*Pagodroma nivea*) and Wilson's storm petrels (*Oceanites oceanicus*)) from east Antarctic Divisions 58.4.1 and 58.4.2. The paper suggested that published counts of breeder abundance may be an order of magnitude lower than true population sizes, particularly given results that 2% of the potential flying seabird breeding habitat in Divisions 58.4.1 and 58.4.2 has been surveyed.

3.48 The Working Group welcomed these studies on updating consumption and abundance data for important krill predators and noted that the detailed description of ongoing search and census methods for snow petrels described in WG-EMM-17/11 may provide a model for improving abundance estimates of other flying seabird species. The Working Group further noted that complementary research in Subarea 48.1 to track understudied demographic groups, including male fur seals, juvenile and non-breeding penguins, will help to better understand the ecological role of krill predators in the Antarctic ecosystem.

3.49 Whales represent important krill predators in the Southern Ocean and WG-EMM-17/14 provided an analysis of minke whale (*Balaenoptera acutorostrata*) feeding habits and prey consumption. Data were collected from lethal sampling in International Whaling Commission (IWC) Antarctic management Areas III, IV, V and VI-West that occurred between 1989 and 2014 and was permitted by the Japanese whale research programs JARPA and JARPA II. The paper estimated daily prey consumption of 207 to 397 kg, depending on maturity stage and sex of the whale. The authors extrapolated krill consumption based on minke whale population estimates and suggested a total consumption of 6.1 million tonnes.

3.50 Regarding WG-EMM-17/14, some technical and analytical issues were raised with the paper. Thus, the Working Group was unable to comment further.

3.51 The Working Group noted that a general understanding of the ecological role of whales in the Antarctic ecosystem was important in an ecosystem-based approach to fishery management, and that the planned workshop between SC-CAMLR and the IWC SC would provide an opportunity to discuss this, including the technical issues raised at this meeting (paragraphs 5.20 to 5.23).

Habitat modelling

3.52 The Working Group considered a number of papers about penguin foraging behaviour and foraging habitats. WG-EMM-17/P01 reported on the foraging behaviours of chinstrap penguins at King George Island during the transition from incubation to chick-rearing period.

3.53 The Working Group welcomed this paper, noting that analyses of long-term monitoring of interannual variability in foraging behaviour in this colony will be presented at future WG-EMM meetings.

3.54 The Working Group considered WG-EMM-17/33 and17/34 that presented habitat models for chinstrap penguins. The models are based on at-sea tracking data. WG-EMM-17/33 developed the habitat model for chinstrap penguins breeding in the South Orkney Islands (Subarea 48.2) using global positioning system (GPS) and time depth recorder (TDR) telemetry data and WG-EMM-17/34 extended the models to Subarea 48.1 to predict suitable foraging habitat for penguins breeding in the South Shetland Islands using both GPS and Argos platform terminal transmitter (PTT) telemetry data. This modelling work was supported by the CEMP Fund.

3.55 Key results from WG-EMM-17/33 suggested that birds from all colonies tended to dive throughout the trip rather than commuting to specific foraging areas and that models built from location-only data performed as well as models that combined location and diving behaviour data. Selection of the model identified geometric covariates of distance from, and bearing to, the colony as the most informative habitat predictors. The models predicted a high probability of occurrence of chinstrap penguin habitats in shallow areas around the South Orkney Islands, including in areas that overlap with the main fishing grounds northwest of the South Orkney Islands.

3.56 WG-EMM-17/34 described the adaptation of the model described in WG-EMM-17/33 to the South Shetland Islands. This paper provided a validation for the use of raw tracking data derived from Argos location estimates as an input into habitat models, greatly expanding the utility of numerous tracking datasets. Models built with different underlying datasets showed comparable results highlighting chinstrap affinity for shallow coastal zones with slow-moving water, but with birds moving towards, and spending time in, the faster-flowing water beyond the shelf break. The analyses highlighted several hotspots of chinstrap penguin density in the western Bransfield Strait and north of King George Island. The results suggested that chinstrap penguins preferentially occupy habitats that are also important to the krill fishery, but for which we have little understanding of krill retention, depletion or replenishment rates, particularly on the spatial scales that are important to predators.

3.57 The Working Group welcomed these papers, noting that they address important gaps in understanding the distribution of predator demand in Subarea 48.1 and the foraging ecology of penguins in general.

3.58 The Working Group recalled previous work to explain the locations of large colonies of chinstrap penguins and the potential influence of sea-ice dissipation (Ichii et al., 1996). The Working Group noted that sea-ice variables and other environmental covariates were considered in the models, but that the coarse spatial resolution of available satellite data, relative to the fine-scale movements of predators from breeding colonies, limited their utility as covariates in this analysis.

3.59 The Working Group further discussed the general utility of the results from the habitat modelling with respect to the identification of wide-spread coastal areas as potential habitat for chinstrap penguins during the breeding season. In particular, the Working Group noted that the distribution of the chinstrap penguin population will affect predation pressure within the potential foraging habitat. The Working Group agreed that a better understanding of interactions between predators, prey and the fishery in these coastal areas is desirable. The Working Group further noted that an experimental framework could be developed within coastal zones to help study how krill movement and predation interact in the absence of fishing. Such experimental approaches could help to resolve the relative roles of predation and flux on krill distributions and improve the assessment of potential fisheries impacts on krill predators (paragraph 3.36).

3.60 The Working Group noted that results of the habitat models could help parameterise a risk assessment for the krill fishery and may help prioritise areas for such research. The Working Group recalled that a risk assessment required appropriate data from predators and the fishery, and that not all predator data relevant to the risk assessment process are CEMP data. The Working Group noted that several non-CEMP datasets are available (e.g. tracking data, at-sea observations) and that improving visibility of such data would be helpful. The Working

Group agreed that a metadata database to assimilate attributes of data that may be useful for a risk assessment would improve accessibility and transparency of the risk assessment process (paragraph 3.38).

3.61 The Working Group recalled a study (Warren and Demer, 2010) that reported that high and stable krill densities may be accrued in shallow nearshore waters up to 500 m in depth. This krill biomass may be more important ecologically for penguin colonies than krill found offshore. The Working Group noted that fishing vessels cannot operate in very shallow water, which can reduce some of the spatial interactions of fishery and penguins, but the Working Group recalled that there is evidence of overlap in predator foraging distributions and fishing activity. The Working Group also recalled previous studies that show that the krill fishery does operate close to shore at times (WG-EMM-16/17; SC-CAMLR-XXXV/BG/14), including within 5 km of the coast.

3.62 The Working Group noted that it is necessary to establish appropriate temporal scales for investigating interactions between predators, prey and the fishery. For example, criteria are needed for understanding observed krill biomass variability and for separating potential impacts of the fishery, predator consumption and environmental changes. It further noted that the predator feeding behaviour in relation to prey switching, prey distribution and prey density is another important issue to understand predator demand, and encouraged research in this field.

3.63 Dr S. Kasatkina (Russia) expressed concern that it would be difficult to adequately parameterise a risk assessment framework for the krill fishery at small spatial and temporal scales without the development of new field programs. Furthermore, she highlighted that a risk assessment for the krill fishery might require the development of target points for predator population states and that these target points should form part of krill fishery management. She noted that without reference points it would be difficult to clarify the extent to which the fishery is having an impact on the status of krill resources and krill-dependent predators.

3.64 The Working Group briefly discussed the appropriate scale for a risk assessment. It recalled that the risk assessment is intended to be an iterative process, and the scale of the risk assessment should be sensitive to the availability of data.

3.65 The Working Group considered an approach to identifying important bird areas (IBA) provided in WG-EMM-17/35. This paper updated prior analyses presented to WG-EMM (WG-EMM-15/32, WG-EMM-16/20) on methods to identify IBAs for penguin conservation.

3.66 The Working Group noted that the methods used in this analysis had identified five IBAs in Subareas 48.1 and 48.2 that cover the most important at-sea areas of ca. 100 000 pairs of chinstrap penguins, 200 000 pairs of Adélie penguins and 6 000 pairs of gentoo penguins. The IBA approach was compared to models described in WG-EMM-17/33 and, in general, the Working Group noted the general overlap of spatial results generated by the two approaches.

CEMP data

3.67 The Secretariat presented WG-EMM-17/17 that provided an update on the CEMP data submitted to the Secretariat and analysis of existing data from Subarea 48.1. The Working Group welcomed the submission of data from, and the establishment of, the new Narebski Point CEMP site in Subarea 48.1 by the Republic of Korea. The update on the spatial analysis of

CEMP data in Subarea 48.1 using combined standardised indices (CSIs) for breeding season parameters and population size data demonstrated a considerable degree of concordance between parameters for sites on either side of the Bransfield Strait. The long-term change in the standardised Adélie and chinstrap penguin breeding population size from 2000 to 2017 showed an early period characterised by a concordant decline, followed by a recent period with no trend, but with a lower level of concordance. The concordance in the combined indices using breeding season parameters indicated that predators show a similar response to conditions at the scale of the subarea, whereas the lower level of concordance in breeding population indices likely reflects the much larger spatial and temporal scales that influence these indices.

3.68 The Working Group thanked the Secretariat for this update and noted that the changing pattern observed in population size indices in recent years reflected changes in the index of population size at different sites and the method of standardisation rather than in an absolute measure of penguin abundance. The Working Group noted that further work on CEMP data analyses was planned (WG-EMM-17/02) as part of the proposed five-year work plan for the Scientific Committee. The Working Group recognised that evaluating different methods for the presentation of CEMP data would be valuable as part of this work. The Working Group thanked all Members that contributed data to CEMP and encouraged the consideration of the submission of additional data, consistent with the objectives of CEMP, including information from the use of new technologies for the collection of CEMP data.

3.69 WG-EMM-17/03 provided an assessment of the use of UAVs to assess the population size of Adélie, gentoo and chinstrap penguins at King George Island. Analysis of images from the UAVs provided an estimate of approximately 30 000 nests in 12 breeding sites during 2016. The study indicated that the main obstacles for the use of UAVs for population assessments were harsh weather conditions resulting in infrequent suitable conditions for UAV flights. There were also difficulties distinguishing between Adélie and chinstrap penguin nests at the same site because they have similar inter-nest spacing. Dr Korczak-Abshire highlighted the importance of starting the UAV a suitable distance from the colony to reduce the impact from noise on penguins during take-off. Despite some difficulties, the technology allowed access to areas for population counts which had not been previously accessible. The Working Group congratulated the authors and noted that the initiatives summarised in WG-EMM-17/03 were of considerable interest for CEMP and broader ecosystem monitoring.

3.70 Understanding where krill predators forage to provide overlap indices between tracking data and the spatial distribution of krill catches is a priority for the Working Group. WG-EMM-17/07 provided a brief update on progress towards this from a tracking study funded and supported by the Secretariat. Data from the deployment of 130 instruments during the 2016/17 breeding season at sites including King George Island, Livingston Island, Cierva Cove and Galindez Island, indicated a high level of utilisation of coastal zones by gentoo penguins, while Adélie and chinstrap penguins exhibited larger-scale movements into pelagic areas. The spatial use by penguins showed that some individuals stay within the small-scale management units (SSMUs) containing the deployment site, whereas others go beyond the SSMU. The Working Group noted that results emerging from this work were of interest. These results demonstrated both spatial and temporal overlap between the distribution of juvenile Adélie penguins tracked from Subarea 48.1 in this study and the location of post-breeding adult Adélie penguins tracked from Signy, Powell and Laurie Islands in Subarea 48.2 (in studies carried out by UK and Argentinean scientists in recent years). The areas used by all these penguins were to the south of the South Orkney Islands.

3.71 In recent years, the Working Group has acknowledged and welcomed the opportunity for expanding monitoring for CEMP by the use of remotely operated cameras. One recommendation associated with the use of cameras was the need to have a consistent approach to analysing images derived from these cameras. WG-EMM-17/10 described progress to develop a software tool for assessing nest camera images to achieve this objective. The Working Group was informed that work is currently underway through the Australian Antarctic Division to develop this software. Specifications for the software followed a consultation process with the CCAMLR camera users group. The Working Group noted the importance of this project to allow consistent data interpretation and analysis of images from the expanding camera network, and thanked the authors for their efforts to progress this work.

3.72 WG-EMM-17/16 Rev. 1 provided a brief update in the progress of the CEMP Special Fund project to establish a camera network in Subarea 48.1. The project was initiated in 2014/15 and is now fully operational. In 2016/17, data were recovered from 50 cameras across the range of the camera network which were monitoring Adélie, gentoo and chinstrap penguins at their breeding sites. Data summaries indicated variation in phenological timing within species across sites with relatively high reproductive success for all species across sites. The data indicated generally good breeding conditions across the camera sites, with breeding chronology varying primarily in relation to latitude. The paper also noted that Chile intends to extend the camera network with three new installations along the Peninsula. The Working Group noted that development of remotely operating cameras for collection of breeding success and phenology data is important for CEMP because it has allowed the expansion of monitoring to new sites, as well as the continuation of monitoring at sites where data collection would otherwise no longer be possible.

3.73 WG-EMM-17/21 described progress on the installation of cameras at Galindez, Petermann and Yalour Islands as the beginning of annual monitoring of chronology and breeding success of chinstrap and Adélie penguins in Subarea 48.1. The paper reported the successful operation of cameras and downloading of photos in the 2016/17 season and deployment of 15 satellite trackers on adult gentoo penguins. The Working Group thanked Ukraine for its contribution to the camera network project in Subarea 48.1, funded by the CEMP Special Fund. Dr L. Pshenichnov (Ukraine) highlighted that detailed and expanded information will be submitted to the meeting of the Scientific Committee in October 2017.

3.74 The Working Group recalled that additional cameras were being used for penguin monitoring in the Antarctic Peninsula through Penguin Lifelines (https://penguinlifelines.wordpress.com) and that data from these cameras could be useful for expanding CEMP camera monitoring. Dr P. Trathan (UK) agreed to approach the organisers of this initiative to explore whether the data could be made available.

3.75 Dr Kasatkina noted that it is important to clarify how the design of CEMP data sampling matches with predator distributions and population structure. Analysis of the structure and trends of CEMP indices should provide adequate information to reveal the response time between fishing activity and predator response and to delineate changes in CEMP indices caused by fishing activity and concurrent changes in the relationship between predator species.

Other monitoring data

3.76 WG-EMM-17/01 Rev. 1 presented Adélie penguin breeding success data from Adélie Land in East Antarctica, showing that in two out of the last three years there had been total reproductive failure across the colony. The paper described changes in the environment over the last six years in the vicinity of the colony, including extensive sea-ice preventing penguins from adequately provisioning their offspring coupled with poor weather conditions resulting in further chick mortality. The Working Group noted that there is information about pelagic prey in this sector from Japanese, Australian and French surveys conducted in the region. It further noted that the opening of a polynya immediately offshore of the colony allowed access to inshore depressions where penguins consumed Antarctic silverfish (*Pleuragramma antarctica*) and krill (*E. superba*), and that these conditions were associated with high breeding success. The Working Group requested further analysis of penguin data in relation to sea-ice and the pelagic prey field in the region.

3.77 The Working Group welcomed the submission of WG-EMM-17/01 Rev. 1. It noted that other penguin breeding sites had years with occasional reproductive failure (e.g. WG-EMM-17/P02). The Working Group considered that it was important to continue to monitor this site, particularly given the unusual environmental conditions in the area that have not been observed during the last six decades of monitoring. The Working Group encouraged submission of data from this site to CEMP and noted that data from this site is consistent with the objectives of CEMP and that the site could be used as a reference area to compare with other sites to distinguish changes due to fisheries compared with environmental change.

3.78 WG-EMM-17/49 outlined approaches for estimating abundance of Type A killer whales in the coastal waters around the Antarctic Peninsula. The study used satellite telemetry and photographic identification of individual whales over a decade to describe movement patterns of the whales and to estimate their abundance trends. Tracking data indicate wide-ranging movements, while the photographic record suggests an affinity of this population to the coastal areas along the Antarctic Peninsula and an increase in their annual abundance. The increase in abundance may be a result of changes in the sea-ice conditions and the positive influence that may have had on the whale's key prey species.

3.79 The Working Group welcomed such information regarding top predators and was interested in the increase in Type A killer whale abundance and recommended that this topic be included for consideration in preparation for the Joint SC-CAMLR–IWC Workshop (paragraphs 5.20 to 5.23).

Fishery dynamics

3.80 WG-EMM-17/27 described an analysis of metrics of interannual, monthly and inter-vessel variability from the krill fishery in Subarea 48.1 between 2010 and 2016. The analysis used standardised catch per unit effort (CPUE) as an index of krill biomass to propose that, as the krill biomass during the fishing season did not decrease, this provided evidence of krill biomass replacement due to flux and did not support the hypothesis of the fishery having an impact on krill-dependent predators.

3.81 The Working Group questioned the utility of using an overall CPUE from the krill fishery as an index of krill biomass as there was unlikely to be a consistent relationship between krill density and catch rates, as vessels target different quality of krill for particular products and were unlikely to simply optimise catch rates. There are probably also trends in the data due to development of technology and experience in the fleet.

3.82 Dr Kasatkina noted that CPUE values were standardised using GLM. She emphasised that the additional evidence on krill biomass replacement in the fishing grounds during the fishing season is that the dynamic change in the krill biomass was reflected by increasing CPUE of all vessels operating there. Moreover, observed changes in CPUE values correspond with acoustic observations on krill density provided on board Chinese commercial vessels operating in the fishing grounds (WG-EMM-17/40).

3.83 The Working Group noted the comments from WG-SAM on an analogous analysis (WG-SAM-17/23 and Annex 5, paragraphs 4.56 to 4.59), in particular the benefit of using GLM and/or GLMMs to use fishing method as an explanatory variable in the analysis, rather than to analyse fishing methods separately. Such an analysis should also include information of the product type being produced by a vessel as well as some index of technology development and experience of a vessel in the fishery.

3.84 The Working Group also noted that such an analysis would be required in order to substantiate the hypothesis presented in WG-EMM-17/27 on the role of krill flux and the absence of an effect of the fishery on krill-dependent predators.

3.85 Dr Kasatkina highlighted that investigation in WG-EMM-15/21, WG-EMM-16/40 and WG-EMM-17/27 had shown that the product type being produced, daily processing capacity and other indices of technology development can have a significant impact on the strategy of a fishing vessel that can influence the resulting CPUE values. She recalled that while information on vessel capacity and product type was included in the notifications it was not possible to use this information for daily or monthly analyses of CPUE.

3.86 The Working Group recalled the discussion on the issues with the reporting of krill catches in two-hour periods in the continuous fishing system (SC-CAMLR-XXXV, Annex 6, paragraphs 2.18 to 2.22) and that these discrepancies probably meant that an accurate estimation of CPUE from the continuous fishing system may not be possible with the data provided to CCAMLR at present.

3.87 WG-EMM-17/45 presented an examination of the fishing behaviour of the Chinese krill fishing fleet using the frequency distribution of distances between consecutive krill fishing locations and to investigate which random walk model best describes the pattern in the fishery. The results indicated that the behaviour of the Chinese fishery is consistent with a Levy walk model consistent with previous analyses of the Japanese krill fishery (WG-EMM-09/18).

3.88 The Working Group welcomed the analysis presented in WG-EMM-17/45 and noted that:

(i) it provides a baseline from the early years of the Chinese krill fishery against which to compare future changes in the behaviour of the fishery

(ii) changes in the slope parameter μ of the power function that might reflect spatial differences in the operation of the krill fishery, noting that both the analyses in WG-EMM-17/45 and WG-EMM-09/18 indicated differences between subareas in the form of the power law parameters

(iii) it suggested that the behaviour of the krill fishery was analogous to the foraging of natural predators and, hence, that the fishery was operating in the same way as other krill predators, which would also include analysis of the spatial concentration effects of the fleet, a factor that often is considered important for the spatial distribution of fishing effort.

3.89 The Working Group suggested that linking the analysis with acoustics data on the distribution of krill swarms collected from the krill fishing vessels would provide a means to expand the analyses to examine the relationship between fishery behaviour, krill abundance and catch rates.

3.90 Dr X. Zhao (China) introduced the elements of the report of SG-ASAM-17 (Annex 4) that were of particular relevance to WG-EMM. The major outcome of the SG-ASAM meeting had been the agreement on a swarm-based approach to acoustic data analysis, rather than the traditional along-transect echo-integration approach. SG-ASAM had also tested, and agreed to, the use of an EchoView template for automated data processing of acoustic data collected on fishing vessels to be used during the method development.

3.91 Dr Zhao also noted that SG-ASAM had reiterated that 70 kHz was likely to be the optimal frequency for krill, with an increasing number of krill fishing and research vessels being equipped with 70 kHz transducers, and encouraged further research on the properties of this frequency for krill biomass estimation.

3.92 The Working Group supported the agreement from SG-ASAM on the value of the collection of acoustic data by each vessel in the fishery from at least one nominated transect each month. In response to the suggestion from SG-ASAM on the need to examine incentives for vessels to undertake these transects, the Working Group encouraged all Members, particularly those engaged in the krill fishery, to propose implementable incentives and/or regulations to promote the undertaking of those krill acoustic transects (Annex 4, paragraphs 4.1 and 4.2).

3.93 The Working Group noted that in 2014 SG-ASAM had indicated that it planned to provide a method for processing krill acoustic data from krill fishing vessels by 2017 and congratulated all participants of the Subgroup for achieving this important objective.

3.94 Dr Godø thanked Dr Zhao and his colleagues for the very successful SG-ASAM meeting in Qingdao, China, that had made a major step forward in the ability of CCAMLR to use acoustic data from krill fishing vessels. Importantly, he noted that the agreement to use a swarm-based approach provided a method that was simple enough to allow an automated approach to data processing.

3.95 The Working Group noted that the use of the swarm-based approach provided a method to deliver very useful data on the distribution and abundance of krill at biologically meaningful scales that was not dependent on the use of calibrated two-frequency echosounders.

3.96 Dr Y.-P. Ying, the recipient of a CCAMLR scientific scholarship for 2017 and 2018, presented WG-EMM-17/41 on the standardisation of krill CPUE and comparison of krill CPUE and acoustic data collected from Chinese fishing vessels in Subarea 48.1. The analysis used general additive models to standardise CPUE data collected from Chinese fishing vessels from 2010 to 2014 and compared the CPUE data and acoustic data collected by the Chinese fishing vessel *Fu Rong Hai* from 2016. The result compared CPUE (catch per hour) and catch per vessel per day (CPVD) with the nautical area scattering coefficient (NASC) from concurrent acoustics over time and also investigated the potential effect of vertical distribution and movement of krill on the relationship between CPUE and acoustic data.

3.97 The Working Group congratulated Dr Ying on his analysis that provided a novel insight into the operation of the krill fishery and was another good example of the success of the CCAMLR scholarship scheme. The Working Group provided advice on the future development of the CPUE standardisation model, including the need to examine potential autocorrelation effects, examining the impact of daylight and diel changes in depth and the use of model selection approaches to determine the most suitable model configuration.

3.98 WG-EMM-17/41 included an analysis that showed the increase in the depth of the maximum values of NASC and the depth of fishing from March to May. However, the Working Group noted that although the fishing depths increased, the vessels appeared to be targeting shallower depths than the depth of the maximum NASC. This might indicate that as krill move deeper, the same amount of krill could be available in the water column but the portion of this krill that is in the upper 100 m, and most accessible to both the fishery and krill predators, might decrease and this could hence potentially increase the level of competition between fishery and predators.

3.99 The Working Group also suggested examining the potential to detect a threshold krill density for the operation of the Chinese krill fishery and comparison with historical analysis of Soviet fishing fleet dynamics.

3.100 In considering the analysis presented in WG-EMM-17/41, the Working Group noted that at a daily resolution CPVD appeared to show a closer relationship with the NASC values. The CPUE, the catch per hour when the vessel was actually fishing, could provide an index of krill density within individual swarms whereas the CPVD provided an index of the abundance of krill swarms as this index implicitly included searching time. The Working Group noted that the index of CPVD could be considered analogous to the foraging behaviour of a natural krill predator in which foraging success (krill consumption per day) would be expected to vary with the number and quality of krill swarms in an area.

3.101 WG-EMM-17/44 examined approaches to linking acoustics scattering to catch to study relationship between measures of CPUE and acoustics. The analysis of CPUE (catch per hour) and catch per unit area (CPUA) found that day time catches are higher than night-time catches. There was also a high correlation between catch/CPUA and NASC, but the authors underlined that more data is needed to properly study these relationships. They suggested that catch information might become an important source of informative on krill abundance and dynamics when used with caution.

3.102 The Working Group agreed that CPUE is a fundamental metric used in fisheries but its interpretation and use reflects specific attributes of different fisheries. Whereas, in some demersal finfish fisheries CPUE can provide a suitable index of biomass, this is not the case for small pelagic fisheries such as the krill fishery. Nevertheless, measures of catch and the effort/investment in obtaining those catches provides important information about the operation and performance of an individual vessel and/or an entire fishery. Therefore, when using CPUE data for preliminary (indicative) krill stock estimation, in case when no acoustic data are available, the methods should be specifically designed to ensure an adequacy of the used approach.

3.103 The Working Group agreed that the analyses presented in WG-EMM-17/40, 17/41 and 17/44 indicated that the combination of CPUE data and concurrent acoustic data provides a potentially powerful approach to the analysis of indices of CPUE.

3.104 The Working Group agreed that making progress on the use of indices of CPUE from the krill fishery would benefit from the extension of the analyses presented in WG-EMM-17/41 to different vessels fishing in different subareas and years. The Working Group encouraged the further analysis of CPUE and noted that such analyses should include a clearly articulated objective and use a measure of CPUE that was specifically designed to address this objective.

3.105 WG-EMM-17/08 described the surveys by the Republic of Korea carried out in Subarea 48.1 in the 2015/16 and 2016/17 fishing seasons, following the transects of the US AMLR Program to estimate the density and biomass of krill around the South Shetland Islands using the krill fishing vessels *Kwang Ja Ho* with 38 and 120 kHz echosounders in April 2016 and *Sejong Ho* with 38 and 200 kHz in March 2017. The paper included an update from the analysis presented in SG-ASAM-17/04 to include the use of the swarm-based approach to estimating krill abundance. The results from these surveys indicated that krill density and biomass were significantly higher in 2016 than in 2017.

3.106 It was noted that the 2017 survey used 200 kHz for biomass assessment and this may make results sensitive to krill behavioural impacts and reduces depth range available for assessment. The Working Group noted the discussion and recommendations at the SG-ASAM meeting (Annex 4) in relation to the use of this frequency. The Convener of SG-ASAM clarified that the use of the dB difference method is recommended as part of the CAMLR standard method for scientific acoustic surveys. However, an alternative more robust method (the swarm approach) is recommended to support collection of acoustic data, including automatic processing on board fishing vessels.

3.107 The Working Group welcomed the details of these two surveys conducted by acoustic scientists on board Korean fishing vessels and this was a very positive development for CAMLR.

3.108 The Working Group emphasised the progress made in collecting and using acoustic data from krill fishing vessels and thanked all those engaged in the planning, collection and analysis of this data.

Operational management regimes for FBM in the krill fishery

3.109 The Working Group noted WG-EMM-17/20, which described the first steps towards the development of a risk assessment of the krill fishery in Divisions 58.4.1 and 58.4.2, in response to the re-initiation of commercial krill fishing in this region. It noted that data layers on the historical distribution of krill catch, acoustic krill densities from the BROKE-West survey, and krill predators, including crabeater seals (*Lobodon carcinophagus*), penguins, flying seabirds and baleen whales, had been assembled for input into the risk assessment. It noted that the risk assessment was intended to evaluate whether the current conservation measures that apply in this region sufficiently mitigate the risk of the krill fishery disproportionately concentrating catches in areas that are also important to krill predators, using the same framework used for Area 48 (WG-EMM-16/69).

3.110 The Working Group welcomed the development of a risk assessment for the krill fishery in East Antarctica. It noted that the risk assessment method was becoming one of the approaches in the development of management procedures for the krill fishery. It encouraged the further development of the risk assessment for Areas 48 and 58, and recommended that the methodological components of the risk assessment and development of data layers be considered at WG-SAM-18. It further noted that as some datasets are relatively old or sparse, and, as the Southern Ocean is undergoing change, it recommended that explanatory habitat models be developed for incorporation into the risk assessment. It also recommended that data layers be developed that incorporate the changes in the historical krill fishery in relation to sea-ice retreat and position relative to the shelf break. It further recommended that scenarios be developed to evaluate the appropriate scale at which the krill catch might be distributed off East Antarctica.

Spatial management in Planning Domain 1

Data layers for Planning Domain 1

4.1 Dr Santos, Lic. A. Capurro and Dr Cárdenas presented WG-EMM-17/23, 17/24 and 17/25 Rev. 1, which were introduced in a single presentation which described the design process for an MPA in Domain 1 led by Argentina and Chile. The process has followed a multinational approach since its inception in 2012, and has resulted in the compilation and analysis of a large amount of information, including eight conservation objectives and 143 spatial data layers.

4.2 An MPA model was constructed using Marxan and took into account climate change and krill fishery management. Priority Areas for Conservation were identified among the three ecoregions – South Western Antarctic Peninsula (SWAP), North WAP (NWAP) and South Orkney Island (SOI) – which differ not only in their ecology, but also in their current management and resilience to climate change. The preliminary proposal incorporated fishing management strategies that included a combination of General Protection Zones and Special Fishery Management Zones (Figure 1), to take into account aspects such as spatial variability and the balance between fisheries and priority areas for conservation. Given the complexity of the area and the large number of human activities in the region, an Expert Group (referred to in the document as Steering Committee) was proposed. The Proponents expressed their gratitude towards all Members and Observers that were involved in the different stages of the planning process.

4.3 WG-EMM-17/22 described the work of Lic. Andrea Capurro, a CCAMLR scholarship recipient mentored by Dr Grant and co-mentored by Dr Santos. The work aims to improve the understanding of spatial and temporal variability in krill fishing activity in Domain 1, by providing further detail on the location of areas of high concentration of krill catches – or 'hotspots' – across an 11-year period from 2005/06 to 2015/16 aggregated by month and by year. The work investigated whether these hotspots could be incorporated into a single cost layer that adequately accounts for the variability in fishing dynamics, to assist in the MPA planning process. The authors concluded that the development of a single cost layer that adequately represents fishery patterns for Domain 1 is not feasible. However, krill fishing catch and effort information is an integral part of the Domain 1 MPA planning process and should be incorporated into the consideration of required management provisions, once priority areas for conservation have been identified.

4.4 The Working Group congratulated Lic. Capurro for the work done in the context of the scholarship and encouraged Members to continue to support this young scientist and her work associated with the Domain 1 initiative. The work provides a clear picture of the development of interannual and seasonal variation in fishing distributions. The Working Group noted that work on Domain 1 had progressed considerably since the workshop held in the margins of WG-EMM-16, and thanked colleagues from Argentina and Chile for this important step towards an MPA for a complex ecosystem in which climate change is a major threat. The Working Group appreciated:

(i) the submission of the three documents on 'Domain 1 Marine Protected Area Preliminary Proposal' (WG-EMM-17/23, 17/24 and 17/25 Rev. 1) which give comprehensive information about the scientific elements of the spatial planning process that was used

(ii) the impressive number of geographic layers used in this work (143 layers) which allowed identification of ecoregions from their abiotic and biotic characteristics.

4.5 Proponents of the Weddell Sea MPA (WSMPA) emphasised that both the Domain 1 and Domain 3 planning processes, that were undertaken separately, identified similar priority areas for protection in the overlap (approx. 4° latitude overlap) between the two domains.

4.6 Some participants suggested that additional data could be included in the analysis, such as further information on krill distribution and movement, and that krill distribution might be a useful proxy for the potential distribution of fishing. It was noted that the CCAMLR synoptic survey information on krill distribution is 17 years old and that a new survey might help with FBM and MPA planning. The proponents clarified that krill distribution data from KRILLBASE was included in their analysis. Complementary analyses that identify current and future favourable nursery areas for krill will be added and results will be presented during the meeting of the Scientific Committee in October 2017.

4.7 All data used in the proposal, including metadata, is available through the Domain 1 planning e-group. It was noted this data could be useful for other strategies such as spatial management of krill (paragraph 3.41).

4.8 Some Members expressed concern that krill fishing was not included as a cost layer in the analysis, and noted that other human activities also occur in Domain 1, including some research projects on toothfish species to the east of the South Orkney Islands. The proponents presented evidence and stressed that the main reason for not including information on the krill fishery as part of a single cost layer was the temporal variability in fishing patterns (as demonstrated in WG-EMM-17/22), with the effect that there is no distribution that adequately reflects fishery distribution for more than a few years. The proponents concluded that, since the variability of the fishery cannot be directly reflected in a cost layer, further research will be conducted into the potential displacement of fishing effort in order to evaluate management scenarios. The Working Group agreed that methods such as this could be an appropriate way to include information on fisheries in the MPA planning process, and looked forward to further results.

4.9 Dr Godø expressed concern that the Working Group was not provided with sufficient evidence that a cost layer based on krill fishing information could not be used, as concluded by the proponents. He asked the proponents to provide further information on the cost layers which had been considered, including associated Marxan results.

4.10 The Working Group discussed the proposed coastal buffers in NWAP-foraging grounds and SOI-benthic (Figure 1) and whether they should exist all year round or just during the predator breeding season. The proponents explained that these buffers should apply year-round in order to protect, inter alia:

(i) foraging areas of predators during summer

(ii) early stages of fish (larvae/young juveniles) that may be taken as by-catch by krill trawlers and

(iii) whale feeding grounds.

4.11 Some participants suggested that the coastal buffers were important for minimising by-catch of larval fish by the krill fishery and were coherent with the ecological (important bird and mammal areas, fish essential habitats) and environmental values (large-scale pelagic system) of the area as described in WG-EMM-17/24. Other participants suggested that the fishery attempts to avoid by-catch to minimise catch contamination due to the nature of the products from this fishery.

4.12 The Working Group agreed that analysis of observer data on fish by-catch as well as updates on the status of stocks of adult demersal fish would be useful to establish the risks associated with fish by-catch. The research project described in WG-SAM-17/18, if conducted, should provide new information on the status of stocks. Reviewing previous advice from WG-FSA (SC-CAMLR-XXXI, Annex 7, Appendix E, paragraphs 26 and 27) on the status of depleted stocks and the impact of fish by-catch in the krill fishery, would also be worthwhile.

4.13 The Working Group noted that while the MPA design approach described in WG-EMM-17/23 may be adequate for the protection of benthic habitats, alternative approaches may be required to supplement the planning process for pelagic ecosystems.

4.14 Some participants noted that the MPA proposal over-represented some of the conservation objectives and under-represented others. The proponents stressed that some of the under-represented objectives are already protected by CM 24-04, or represented by other conservation objectives. It was also noted that Marxan analyses can lead to over-representation due to spatial complexity, including overlap between layers.

4.15 The Working Group agreed that there might be a need to evaluate how proposed MPAs could contribute to ecological resilience to climate change, particularly in Domain 1 and especially in pelagic parts of the ecosystem which are spatially dynamic relative to fixed MPA boundaries. MPAs which include ecological gradients might be useful in this regard. Also MPAs might be useful reference areas to assess the effects of climate change. The mechanism for responding to climate change might include rapid adjustment to MPA research and management plans.

4.16 The Working Group noted that the uses of MPAs include both fisheries management and ecosystem conservation. In this context, the Working Group noted a need for coordination between the various existing and proposed fishery management approaches in Domain 1. These include existing (CM 91-03) and potential MPAs, krill catch limits at the regional (Subareas 48.1 to 48.4) and subarea scale (CM 51-01 and CM 51-07), protection for areas exposed by ice-shelf retreat (CM 24-04), the prohibition of fishing for most finfish (CM 32-02), and the proposed FBM approach (CM 51-07). The Working Group requested that the Scientific Committee consider a strategy for integrating across the various existing and proposed management approaches for Domain 1.

4.17 The Working Group noted Members are investing substantial research effort to support the management approaches listed above, especially FBM. Where MPAs or other spatial measures displace fishing activity, it is important to evaluate the associated risks. The Working Group noted that ecosystem models can be used to help evaluate the effects of multiple conservation measures on the fishery and the ecosystem.

4.18 Dr Kasatkina noted that the MPA proposal did not provide any evidence of impact of the fishery or other human activities on the ecosystem and biodiversity. Moreover, potential threats from human activities regulated by effective conservation measures are very low, and protection against climate change cannot be achieved by MPAs. She recommended further clarification of the MPA objectives to protect ecosystems and conserve biodiversity, as well as criteria for assessing whether the MPA's specific objectives may be achieved. She emphasised concerns that MPA Planning Domain 1 includes the existing South Orkney Islands southern shelf MPA (SOISS MPA) and Special Areas for Scientific Study of ice-shelf retreat or collapse in Subarea 48.1.

4.19 The Working Group noted the importance of documenting the process by which decisions on proposed MPA boundaries and management regimes are made.

4.20 Some participants stressed that evidence of the need for an MPA in the proposed area should be an important element of the MPA proposal. Such evidence should identify endangered species that are protected by the proposed MPA, provide evidence of negative trends in these species and explain why existing conservation measures are inadequate to achieve this protection. It would be very useful to include in the proposal a forecast of the effects of the proposed MPA on the fishery in Subareas 48.1 and 48.2.

4.21 The proponents proposed that the creation of an Expert Group on Domain 1 MPA development would be an appropriate mechanism for addressing some of the issues that were raised. The proponents further suggested that the Expert Group should include two representatives from each interested Member, and observers from the fishing industry and non-governmental organisations (NGOs). The existing Domain 1 planning e-group should be used to draft the terms of reference for the Expert Group to be considered by the Scientific Committee meeting in October. The priority of the Expert Group would be to identify a work plan with clear goals and deadlines, for work to progress during the intersessional period. The Working Group agreed with this proposal and requested advice from the Scientific Committee on how to include observers from the fishing industry and NGOs in the Expert Group.

4.22 The Working Group noted the need to coordinate with the work plan of the Scientific Committee (paragraphs 6.24 to 6.29), and that some issues, such as how MPAs contribute to ecological resilience, are relevant to other planning domains. The Working Group also noted the opportunity for these issues to be discussed further during the proposed spatial planning workshop to be held during the 2018 intersessional meetings (WG-EMM-17/02).

4.23 WG-EMM-17/37 described analyses of biodiversity data from the 2016 benthic survey of the South Orkney Islands region (SO-AntEco), undertaken by the British Antarctic Survey in collaboration with an international team of scientists from the SCAR State of the Antarctic Ecosystem research program. The aim of the cruise was to investigate biodiversity within selected benthic habitats around the South Orkney Islands in relation to geomorphic zones both inside and outside the SOISS MPA, to detect differences in diversity between habitats, and to map species that are indicative of specific habitat types. This addresses one of the key objectives set out by the draft South Orkney Islands southern shelf MPA Research and Monitoring Plan. The results from this cruise will contribute towards the understanding of benthic habitats and vulnerable marine ecosystems (VMEs) in this region of Domain 1, and will be useful in the review and ongoing management of the South Orkney Islands southern shelf MPA, as well as in the wider context of marine spatial planning for Domain 1.

4.24 The Working Group thanked the authors and looked forward to further results from this survey. The paper provides a useful comparison between methods for assessing benthic assemblages. Previous work has shown identification of VMEs from camera images is as effective as identification by fishery observers (Welsford et al., 2014).

Other business

Weddell Sea MPA

5.1 WG-SAM-17/30 addressed questions raised by WG-EMM-16 (SC-CAMLR-XXXV, Annex 6, paragraphs 3.1 to 3.14) and SC-CAMLR-XXXV (SC-CAMLR-XXXV, paragraphs 5.14 to 5.28), including:

(i) development of additional data layers on flying seabirds and seals
(ii) Antarctic toothfish (*D. mawsoni*) habitat modelling
(iii) new Marxan analyses performed with revised data and cost layers
(iv) outline of how the results of the scientific analyses were translated into the draft WSMPA boundaries and management zones as set out in CCAMLR-XXXV/18.

5.2 The Working Group welcomed the significant work and new updates from the WSMPA project team, and congratulated them on their efforts to address these points.

5.3 The Working Group noted that penguin tracking data are now being collected by South Africa and can be made available for use in future analyses.

5.4 Dr Kasatkina asked for further information on how the MPA boundaries consider ice conditions for research fishing. She noted that the proposal for the establishment of an MPA in the Weddell Sea described the species composition of fish fauna and krill and Russia repeatedly indicated that information on commercial potential of dominant fish species and krill for future rational use should be included into the MPA proposal (SC-CAMLR-XXXIV, paragraphs 3.19 and 3.20). Dr Kasatkina asked what new information on commercial potential for dominant species in the MPA was obtained and what activities in relation to these issues are planned.

5.5 The Working Group noted that an ice analysis model is under development to identify potential ice-free areas suitable for research fishing, and to ensure that regular sampling in these areas is feasible.

5.6 The Working Group recalled the discussions by WG-SAM on this paper, which noted the following points (Annex 5, paragraph 6.8):

(i) the desire for increased clarity on the interaction between the CCAMLR decision rules and the 60% protection targets for toothfish in the Weddell Sea proposal

(ii) importance of determining toothfish life-history and stock dynamics of the region, including the offer from Germany to host a workshop in early 2018 to examine toothfish dynamics and movement in the region in order to inform a working stock structure hypothesis.

5.7 The Working Group supported the suggestion of holding a workshop to discuss the development of a toothfish population structure and movement hypothesis. It noted that WG-SAM had concluded that a stock hypothesis (as developed for the Ross Sea region) was needed to further develop its work in Subarea 48.6 and the wider region. Once a hypothesis has been developed, data can be collected to parameterise a model and used to inform stock assessment. This would be key to the work of WG-SAM as well as helping to inform spatial management in the region.

5.8 The Working Group welcomed Germany's offer to host the workshop, and recommended that representatives from the fishing industry could be invited to attend.

5.9 The Working Group considered WG-EMM-17/42 which outlined technical and procedural recommendations on the use of Marxan analyses to inform the delineation of MPA boundaries and fisheries considerations. Replication of the recursive Marxan approach developed by Germany produced very similar results. Additional comparisons were undertaken to investigate the suitability of data layers, and it was discussed how data layers using weighting schemes in particular might benefit from sensitivity analyses to ensure that appropriate weighting factors had been applied. The paper advised caution when using very sparse datasets, and particularly those where spatial sampling bias is evident. It also suggested that the complex recursive approach developed for the WSMPA planning process may not be necessary, as a simpler non-recursive approach produced very similar results. The use of a simpler approach may help to increase the understandability and clarity of the Marxan analysis, particularly for those Members who are less familiar with Marxan. The paper raised the question of the population structure of *D. mawsoni* in Domain 4, concluding that understanding the distribution of toothfish across the entire Domain 4 will be critical for designing an MPA in this region.

5.10 Prof. T. Brey (Germany) expressed his appreciation for this helpful analysis, which makes a valuable contribution to inform future work. He noted that the data used in the WSMPA analysis were available upon request to any Member who wished to undertake their own analyses. He highlighted that the core priority area for conservation identified by Marxan remained consistent within the range of conditions and settings of parameters explored by both approaches. However, he noted that WG-EMM-17/42 had identified a number of concerns and questions regarding data and analysis that required further consideration. Some of these have already been addressed in the analyses presented in WG-SAM-17/30, but further work will take into account issues including the spatial projection of data, the use of the recursive Marxan procedure, the reliability of the sparse datasets such as the larval krill layer, and the development of separate cost layers for krill and toothfish. He indicated that the WSMPA project team is ready to work with all Members to discuss these issues further, and that they welcome further inputs.

5.11 Dr Godø thanked the WSMPA project team for their cooperation, particularly for their patience in allowing time for Norway to provide this further input. He looked forward to further work to progress the development of this MPA.

5.12 The Working Group encouraged Members to continue working together to look at similarities and differences in their analyses, specifically:

(i) further use of sensitivity analyses to provide robust conclusions

(ii) further consideration and explanation of technical aspects of the use of Marxan, including the most effective use of cost layers, and the inclusion of high selection frequency areas to inform MPA proposals

(iii) consideration of how common ground from analyses presented in WG-SAM-17/30 and WG-EMM-17/42 might be taken forward

(iv) investigation of the ecological consequences of both approaches for the achievement of conservation objectives in the Weddell Sea region.

5.13 The Working Group noted the importance of consistent approaches, particularly when using the same software, for example the use of fishing data to develop a cost layer in Marxan. It noted that it is important to consider best-practice approaches and to find common solutions to technical analyses where possible. The proposed spatial management workshop in 2018 (WG-EMM-17/02) would be a valuable opportunity to consider such issues. However, it is also important to recognise that the unique characteristics, data availability and objectives of different regions should allow for the development of a range of different approaches and methodologies for MPA planning, that may be unique to each region.

5.14 The Working Group acknowledged that different analyses can be helpful in supporting and improving MPA planning processes, particularly where different groups undertake separate comparative investigations that can identify new issues and confirm consistent findings. It welcomed the positive progress on MPA planning for the Weddell Sea region, and encouraged Members to continue collaborating to further develop this work.

Vulnerable marine ecosystem (VME)

5.15 The Working Group considered WG-SAM-17/09 which introduced a new data acquisition protocol for by-catch of benthos in the French fisheries of the Southern Ocean, including Subarea 58.6 and Divisions 58.4.2, 58.4.3a, 58.4.4b and 58.5.1 for use in both longline fisheries and bottom trawl survey activities. Development of the protocol began in 2015 at the Muséum national d'histoire naturelle (MNHN) in Paris and aims to assist in producing presence and abundance data for benthic macro-invertebrates caught during fishing. This will provide additional information on the distribution of VMEs and assist in the development of MPAs by improving habitat mapping. The protocol is based on the collection, weighing and photographing of samples of benthic macroinvertebrates with subsequent identification by taxonomic experts.

5.16 The Working Group welcomed the development of the protocol undertaken by France and noted that it could save time for scientific observers and didn't require observers to possess specialist taxonomic skills as samples and images were sent to the MNHN for identification. The Working Group also noted that the protocol would be trialled alongside benthic camera deployments in the near future to help establish how representative invertebrates caught as by-catch are of the benthic communities from which they were sampled. The Working Group noted that a range of commercially available image analysis software and image database packages exist that may assist in VME studies.

Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP)

5.17 The Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP) was held at the Palazzo Farnesina (Ministry of Foreign Affairs and International Cooperation, MAECI) in Rome, Italy, from 26 to 28 April 2017 (WG-EMM-17/43). The draft research and monitoring plan (RMP) was considered by the Working Group. The RMP will be introduced to CCAMLR at the annual meetings of the Scientific Committee and Commission later this year, prior to the Ross Sea Region MPA's implementation in December 2017.

5.18 The Working Group noted that following the Workshop, the Co-conveners submitted the draft RMP to the Ross Sea MPA implementation e-group for further comment. The Working Group encouraged the submission of further comments on the RMP through the dedicated e-group and noted that it would be submitted to WG-FSA and the Scientific Committee for further consideration.

5.19 The Working Group recommended that time be made available during the proposed spatial management workshop (WG-EMM-17/02) to allow further consideration of the development, implementation and coordination of Members' research efforts supporting the objectives of the RMP. The Working Group noted that it was intended that the RMP would be a 'living document' that would require regular updating to reflect developments in regional research and monitoring activities.

International Whaling Commission (IWC)

5.20 WG-EMM-17/15 reported on progress towards a second Joint SC-CAMLR–IWC Workshop on the development of multi-species ecosystem models of interest to both organisations. The Working Group noted the revised terms of reference discussed at the IWC SC and the desire by the IWC workshop steering committee to hold two meetings, the first a two-day plenary meeting held in conjunction with the annual IWC SC meetings and the second a full workshop.

5.21 The Working Group agreed that whales were key krill predators in the Southern Ocean and would form a major component of regional ecosystem models. Whale distribution was also a key, but undeveloped, element of the risk assessment approach for Area 48.

5.22 The Working Group agreed that the terms of reference for the workshop were still relevant to the work of WG-EMM and the CCAMLR Scientific Committee but questioned the need to hold a plenary meeting in advance of the workshop rather than developing an agenda and identifying data requirements through an e-group. It was noted that some whale abundance and distribution data might already be available from the IWC.

5.23 The Working Group agreed that a single workshop would be desirable but, given its heavy work schedule, that it should be considered alongside the other priority issues and financial implications for WG-EMM and SC-CAMLR.

Southern Ocean Observing System (SOOS)

5.24 WG-EMM-17/38 Rev. 1 submitted to the Working Group on behalf of SOOS provided a general summary of the outcomes of the first meeting of the West Antarctic Peninsula (WAP) Working Group (WG) held at the British Antarctic Survey, Cambridge, UK, on 15 and 16 May 2017. At the well-attended and productive meeting, the structure of the WAP workplan was discussed. Participants also considered a range of issues relevant to the work of WG-EMM, including drivers of environmental change in the WAP and spatial heterogeneity in regional change. The Working Group noted that CCAMLR was likely to benefit from the work of SOOS, in particular in the development of data layers for the krill risk assessment. The Working Group noted the forthcoming Indian Ocean sector SOOS working group meeting in Japan scheduled for August 2017 and that this would be of interest to the work of CCAMLR.

5.25 The Working Group also noted that a scientist who is also engaged in the work of CCAMLR had attended the recent SCAR Assessment of Antarctic Biodiversity meeting held in Monaco in early July 2017. Engagement with a broad range of scientists from different programs and initiatives would help develop links between CCAMLR and the wider scientific community.

Sentiment analysis of online content

5.26 The results of a sentiment analysis of online content relating to Antarctic krill fishing and related search terms were reported in WG-EMM-17/18. Public perception of the fishery was analysed through sentiment and relevant keyword searches from three online platforms. The analysis revealed an overall neutral to positive sentiment of Antarctic krill fishing related content across all search platforms. This study formed a baseline result for future monitoring of sentiment regarding Antarctic krill fishing as it continues to operate in a changing environment as well as a providing a method for using online content sentiment analysis to gauge the public's perception of other fisheries.

5.27 The Working Group welcomed the study and agreed that undertaking similar work in the future would enable changes in public perception of Southern Ocean fisheries to be evaluated. The Working Group noted that while such a study may not truly reflect public perception, it highlighted which news items and online content were most accessed and most frequently read in relation to krill fisheries in the CCAMLR area. The Working Group suggested a similar exercise on other CCAMLR key issues, such as toothfish fishery, MPA development or ecosystem-based management.

5.28 The Working Group noted that analysis methods of scientific contents such as systematic reviews are available and these maybe of use to the work of the Scientific Committee. Prof. Koubbi proposed to table an overview of the use of these methods for consideration by the Scientific Committee.

5.29 The Working Group recommended that the Scientific Committee consider the development of a CCAMLR communications strategy, that integrates across different types of communications media and allows CCAMLR to promote its various activities, successes and actions over time.

Global Environment Facility proposal

5.30 WG-EMM-17/46 updated on the development by the Secretariat of a proposal for funding support from the Global Environment Facility (GEF) to build capacity among GEF-eligible CCAMLR Member countries to strengthen their participation in CCAMLR. The Working Group noted the approval of the project by the GEF Council at its meeting in May 2017 and the subsequent work that will be associated with developing the full Project Document over the next 12 months.

5.31 Representatives from GEF eligible CCAMLR Member countries Dr A. Makhado (South Africa), Dr H. Manjebrayakath (India), Dr Cárdenas and Dr K. Demianenko (Ukraine) welcomed the report by the Secretariat and thanked the Secretariat for the successful coordination. GEF-eligible CCAMLR Member countries all showed the commitment and recognise its importance in building capacity and progress the work of CCAMLR within their region.

5.32 The Working Group welcomed the report and agreed that, if successful, it would contribute significantly to building capacity within CCAMLR among GEF-eligible Members. The Working Group noted the outlined timetable for the process and looked forward to receiving updates on future progress.

5.33 The Working Group thanked the Secretariat for leading the development of the proposal with GEF-eligible CCAMLR Members and, in particular, noted the major contribution to the project made by Mr A. Wright, CCAMLR Executive Secretary.

Iceberg calving from Larsen C ice shelf

5.34 The Working Group noted that a large (5 800 km^2) iceberg calved from the Larsen C ice shelf in Subarea 48.5 on 12 July 2017. UK scientists, in accordance with CM 24-04, intend to examine the available data on the areal extent of this newly exposed area and, if appropriate, to submit information to the Secretariat on a proposed Stage 1 Special Area for Scientific Study.

CEMP Special Fund

5.35 The Working Group recalled SC CIRC 17/41 that described the change to the membership of the CEMP Special Fund management group and the revised timescale for the submission of proposals to 1 October 2017. The Working Group looked forward to the announcement of opportunity, including the priorities arising from WG-EMM, and encouraged Members to apply to the Fund to address priority areas of work to support CEMP monitoring.

Discards in CCAMLR fisheries

5.36 WS-SISO-17/02 highlighted how the lack of consistent terminology and definition of discards hampers the quantification of this globally important issue and the lack of consistent definition of ‘offal’, ‘discards’ and ‘by-catch’ in use in CCAMLR is an important precursor to the application of targets for non-target catch and discards in CCAMLR fisheries.

5.37 The Working Group agreed that a common set of definitions should be implemented in CCAMLR and noted that this issue had been discussed at WS-SISO and would be progressed in the Scheme of International Scientific Observation e-group. The Working Group noted that while internal consistency of terminology would be essential, it would also be beneficial to harmonise terminology used in other fisheries to help to achieve a broader understanding of the issue.

5.38 The Working Group discussed the potential difficulties in undertaking a full evaluation of total biomass removals in CCAMLR fisheries and requested that the Secretariat work with interested Members to provide a review of the fate of non-target catch in CCAMLR fisheries.

Future work

6.1 In this agenda item the Working Group considered a series of papers that described proposals for research projects and surveys that will contribute to the work of CCAMLR.

Norwegian SWARM project

6.2 WG-EMM-17/26 presented an update on plans from Norway to extend its monitoring efforts in the area around the South Orkney Islands by deploying acoustic moorings in an area of operation of the krill fishery. Data gathered from the moorings will be used to parametrise models, in order to gain better understanding of the interaction between ocean physics and behaviour in driving krill biomass variation in the area. The mooring will use a combination of acoustics and acoustic Doppler current profiler (ADCP) to monitor the movement of water and krill to examine real-time dynamics. The project will coordinate with multi-beam sonar data from commercial fishing vessels to collect 3-d data on krill swarms in the vicinity of the mooring.

6.3 The Working Group welcomed this research initiative and noted that the combination of upward looking moored acoustics and multi-beam sonar would allow a better description of the abundance of krill in the surface layer that is not sampled using conventional hull-mounted acoustics.

Modelling movement of Antarctic krill (MMAK)

6.4 WG-EMM-17/31 provided details of a project that will use numerical ocean sea-ice models at differing resolutions to improve current understanding of the regional and local/small-scale processes that influence the distribution of krill in Area 48. Modelling will focus on the South Orkney Islands region, and will help inform WG-EMM activities on the development of FBM procedures and provide the present-day context for considering the potential impacts of climate change on this region.

6.5 The Working Group noted that this modelling project will be closely linked to the SWARMS project (paragraphs 6.2 and 6.3) and will utilise high-resolution oceanographic models developed for Subareas 48.2 and 48.3 (WG-EMM-17/30).

6.6 In discussion of WG-EMM-17/26 and 17/31, the Working Group identified the need to determine the appropriate spatial and temporal scales to allow the integration of different processes as mismatches in the scales used may influence the interpretation of the results when used in management.

Plan for pelagic ecological research within the US AMLR Program

6.7 WG-EMM-17/04 presented an update on the proposal to revise at-sea research within the US AMLR Program to better address questions necessary for understanding the consequences of overlap among krill, predators and the krill fishery. This includes the movement away from ship-based research to an instrument-based (moorings and gliders) program of oceanographic and ecological observations and research to support the US commitment to CCAMLR and ecosystem science in the Southern Ocean.

6.8 The Working Group welcomed the decision of the US AMLR Program to implement a flexible program to collect data at finer time and space scales but that remain comparable to the historical data collected by the program. The Working Group acknowledged that the requirement for the presence of scientists to collect data was a challenge when working in the Antarctic and that, while there would be challenges in implementing this new program, it agreed that this presented an opportunity to demonstrate a new approach to collecting data that would be crucial to the effective management of the krill fishery.

6.9 The Working Group noted the desire for regular estimates of krill biomass from Subarea 48.1 in order to further understand the linkage with the reproductive performance of krill predators in the region.

German acoustic krill biomass survey in Subarea 48.1

6.10 WG-EMM-17/39 described a proposal from Germany for an acoustic krill biomass survey in Subarea 48.1 during April 2018 in relation to the hydrological environment and in conjunction with carbon cycling and temperature adaptation experiments of krill and salps. The survey will be part of a larger research program investigating the role of krill and salps in Southern Ocean carbon cycling and the temperature adaptation capacities of both species in the context of climate change.

6.11 An acoustic survey with associated physiological experiments will be conducted in conjunction with a detailed description of the biological and physical environment of the krill habitat. The overall objective of the research is to provide an assessment of the effect of climate change on krill and associated ecosystem processes.

6.12 The Working Group noted the importance of such surveys to its understanding of the processes affecting the dynamics of the pelagic ecosystem in Area 48, particularly in response to monitoring the effects of climate change. The Working Group emphasised the importance of using standardised survey procedures that are consistent with CCAMLR protocols such that the results can be used across a range of its research in the subareas to be surveyed.

Proposal for a dedicated krill survey for CCAMLR Division 58.4.1

6.13 WG-EMM-17/05 described a proposal for a dedicated krill survey to be conducted by the Japanese survey vessel *Kaiyo-maru* in Division 58.4.1 in 2018/19. The plan proposed to repeat the BROKE survey in order to provide an updated estimation of krill biomass and to collect oceanographic observations to evaluate long-term changes in this region. The survey will follow the same design as the BROKE survey conducted by Australia in this region in 1996.

6.14 Dr H. Murase (Japan) informed the Working Group that the final acoustics protocol for the survey would be submitted to SG-ASAM in 2018, including details of broadband data recoding methods, and the final plan for the entire survey would be submitted to WG-EMM in 2018.

6.15 The Working Group thanked Japan for this proposal and noted that WG-EMM-17/05 was based on a proposal for a dedicated krill survey that was originally presented in WG-EMM-15/43 and that had been considered by SG-ASAM (SG-ASAM-17/01; Annex 4, paragraphs 5.1 to 5.3). The Working Group welcomed the opportunities for collaboration with others who had more recent scientific surveys in the East Antarctic (Collaborative East Antarctic Marine Census, French National Programs, Kerguelen Axis program) to combine scientific efforts on the ecology of krill species and micronekton, including the use of stable isotopes for studying trophic webs. Dr Murase encouraged all scientists wishing to collaborate to contact him.

6.16 The Working Group noted the possibility of extending the range of the survey to include the Krill Research Zone and address priority research items identified in the Ross Sea region MPA RMP. However, such an expansion of the survey scope would be difficult to accommodate in the time available.

6.17 The Working Group noted that the spatial distribution of krill in the East Antarctic, where juvenile krill are typically found offshore, was distinctly different to the Atlantic sector, where juvenile krill are more typically found inshore and that this research survey would help to elucidate why these two regions were so different.

Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)

6.18 WG-EMM-17/36 provided an update from the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) program which is undertaking integrated circumpolar analyses with a major focus to more comprehensively assess (and where possible quantify) key impacts of change on Southern Ocean ecosystems. In response to the questions posed by WG-EMM in 2016 (SC-CAMLR-XXXV, Annex 6, paragraph 6.25), ICED will hold a

Projections Workshop in April 2018, in association with the Marine Ecosystem Assessment for the Southern Ocean (MEASO) conference, with the following objectives:

1. Assess the potential drivers of change (within three decades and over the 21st century) in the ecosystems in the Scotia Sea and Antarctic Peninsula region of the Southern Ocean (Area 48).

2. Assess potential future sea-ice change in Area 48 and the potential impacts on availability of krill to predators and the fishery.

3. Examine alternative approaches to modelling and projecting changes in distribution, abundance and biomass of Antarctic krill in Area 48.

6.19 The Working Group welcomed this proposal by ICED that directly addressed the questions and spatial focus presented by the Working Group in 2016. In response to the invitation from ICED for nominations for involvement in the workshop steering committee from WG-EMM, the Working Group agreed that having someone with a broad experience of CCAMLR would be an advantage in further developing the workshop objectives and preparatory activities, and ensuring the optimum outcomes for CCAMLR from the workshop.

6.20 The Working Group noted that future collaborations with ICED could have a focus on other regions by creating regional working groups as has been done by SOOS.

Climate change response work program

6.21 WG-EMM-17/19 presented a draft climate change response work program addressing the remaining terms of reference of the climate change intersessional correspondence group (ICG) to develop approaches for integrating considerations of the impacts of climate change into the work of CCAMLR. Acknowledging the important role of WG-EMM in CCAMLR, the climate change ICG sought feedback on the draft work program, specifically advice on issues, information gaps identified, proposed actions and relevant activities already underway, as well as advice on appropriate timeframes for responding to research activities.

6.22 The Working Group thanked Australia and Norway for preparing WG-EMM-17/19 and noted that the workplan set out in the paper would need to be considered in the context of the other priorities identified by the Scientific Committee. The Working Group recognised that there were important elements of climate change related work in almost all of its work and was, therefore, keen to support the climate change response work program and noted that there was a need to ensure that the program was kept up to date and relevant.

6.23 Dr Welsford drew the Working Group's attention to the MEASO conference to be held from 9 to 13 April 2018 in Hobart, Australia. He noted that the conference intended to progress many of the issues raised in the climate change response work program, including assessing and managing the impacts on climate change on Southern Ocean ecosystems and Antarctic marine living resources.

Development of a five-year work plan for the CCAMLR Scientific Committee

6.24 The Working Group considered the proposed five-year work plan for the Scientific Committee presented by the Chair of the Scientific Committee (WG-EMM-17/02). The paper provides an expansion of the recommendations of the Scientific Committee (SC-CAMLR-XXXV, Table 1) which were discussed and put forward by the Scientific Committee Symposium in October 2016. The paper outlined the work in themes and it also indicated a timeline by which each topic should be addressed.

6.25 The Working Group welcomed the plan outlined in WG-EMM-17/02 and thanked the Chair and also the conveners of the working groups for working with the Chair to advance this important topic for the Scientific Committee.

6.26 The Working Group noted that the timescales included in WG-EMM-17/02 should be consistent with the requirements to review particular conservation measures (e.g. CM 51-07).

6.27 The Working Group noted the proposal for a joint meeting of WG-EMM, WG-SAM and SG-ASAM in 2019 to consider acoustic survey methods and design to facilitate FBM and considered that it was helpful to focus on the theme of the meeting rather than emphasising that it was a joint meeting of existing working groups. In response to a question of how the planning for this meeting would be progressed, the Chair of the Scientific Committee clarified that, pending agreement of the Scientific Committee, a steering committee could be established to develop the terms of reference and agenda for the meeting, see also paragraph 3.14.

6.28 The Chair of the Scientific Committee also described how he had regular teleconferences with the Vice-chairs and the working group conveners to coordinate the work of the Scientific Committee and he hoped that this process would continue the enhance the delivery of the priorities of the Scientific Committee.

6.29 The Working Group encouraged the Scientific Committee Representatives to focus on priority topics when submitting their scientific work to be considered by WG-EMM meetings in order to assist the Working Group Convener to allocate meeting time to the discussions of priority topics.

Advice to the Scientific Committee

7.1 The Working Group's advice to the Scientific Committee is summarised below; the body of the report leading to these paragraphs should also be considered.

7.2 The Working Group advised, and sought advice from, the Scientific Committee on the following topics:

(i) review whether the catch and effort data submitted from the continuous fishing system is consistent with CMs 21-03 and 23-06 (paragraph 2.5)

(ii) changes to the instructions to observers for collecting data on by-catch in the krill fishery (paragraph 2.17)

(iii) collection of data on air-breathing predators as part of SISO (paragraph 2.26)

(iv) continuation of trials of a net monitoring cable in the krill fishery (paragraph 3.4)

(v) a strategy for integrating across the various existing and proposed management approaches for Domain 1 (paragraph 4.16)

(vi) the development of a CCAMLR communications strategy (paragraph 5.29).

Close of the meeting

8.1 In closing the meeting, Dr Korczak-Abshire thanked all participants for their enthusiasm and the rapporteurs for their hard work in preparing the report that she looked forward to presenting to the Scientific Committee.

8.2 Dr Korczak-Abshire thanked the hosts, in particular Ms Bárbara Casas, who had provided such a wonderful venue and provided the meeting participants with opportunities to experience a little of the history and culture of Buenos Aires. Dr Korczak-Abshire also thanked the Secretariat for their support and organisation.

8.3 Dr Korczak-Abshire highlighted the excellent contribution made to the meeting by the two scholarship recipients and encouraged all Members to find ways to engage early career scientists in the work of CCAMLR.

8.4 Dr Belchier, Chair of the Scientific Committee, congratulated Dr Korczak-Abshire for conducting her first meeting as Convener with humour and patience. He noted that she has confessed some nervousness prior to the meeting but appeared to have shown no sign at all of this in conducting the meeting.

8.5 Mr Gowland hoped that all participants had enjoyed their time in Buenos Aires and wished everyone a safe journey home.

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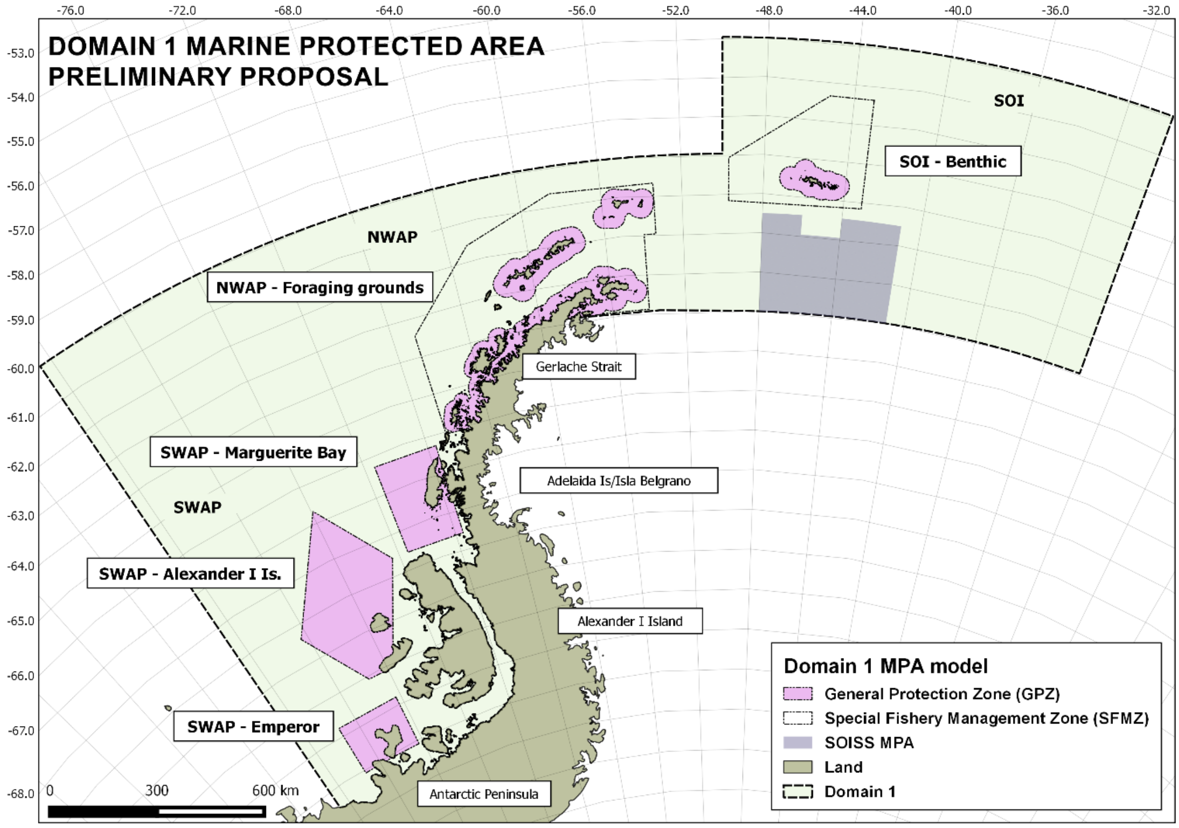

Figure 1: The Domain 1 MPA model presented in WG-EMM-17/23, including potential management components.

Appendix A

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(Buenos Aires, Argentina, 10 to 14 July 2017)

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Appendix B

Agenda

Working Group on Ecosystem Monitoring and Management
(Buenos Aires, Argentina, 10 to 14 July 2017)

1. Introduction

    1.1 Opening of the meeting
    1.2 Adoption of the agenda

2. The krill-centric ecosystem and issues related to management of the krill fishery

    2.1 Fishing activities (updates and data)
    2.2 Scientific observation

3. Operationalising feedback management in the krill fishery in Subarea 48.1

    3.1 Krill biology, ecology and population dynamics
        3.1.1 Krill life-history parameters
        3.1.2 Krill assessment models

    3.2 Ecological interactions: predators
        3.2.1 CEMP data
        3.2.2 Other monitoring data

    3.3 Fishery dynamics
        3.3.1 CPUE and spatial dynamics
        3.3.2 Fishing vessel surveys

    3.4 Operational management regimes for feedback management in the krill fishery

4. Spatial management in Planning Domain 1

    4.1 Data layers for Planning Domain 1
    4.2 CEMP and MPA research and monitoring data

5. Other business

6. Future work

7. Advice to the Scientific Committee and its working groups

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

Appendix C

List of Documents

Working Group on Ecosystem Monitoring and Management
(Buenos Aires, Argentina, 10 to 14 July 2017)

WG-EMM-17/01 Rev. 1	Adélie penguins as indicators of the state of the sea-ice in Adélie Land Y. Ropert-Coudert, A. Kato and C. Barbraud
WG-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)
WG-EMM-17/03	New possibilities of krill-dependent indicator species monitoring – UAV survey in Subarea 48.1 M. Korczak-Abshire, A. Zmarz, M. Rodzewicz, R. Storvold, M. Kycko, I. Karsznia, A. Kidawa and K.J. Chwedorzewska
WG-EMM-17/04	A new plan for pelagic ecological research within the US AMLR Program C. Reiss and G. Watters
WG-EMM-17/05	Proposal for a dedicated krill survey for CCAMLR Division 58.4.1 during 2018/19 season by the Japanese survey vessel, *Kaiyo-maru* H. Murase, K. Abe, T. Ichii and A. Kawabata
WG-EMM-17/06	A preliminary survey on breeding population of Adélie penguins at Cape Hallett in the Ross Sea region, Antarctica J.-H. Kim, H. Chung, W.Y. Lee, J.-W. Jung, M.C. Park, H.C. Shin and J.H. Kim
WG-EMM-17/07	Progress report of the CEMP Special Fund overwinter penguin tracking project J. Hinke, G. Watters, M. Santos, M. Korczak-Abshire, G. Milinevsky and V. Lytvynov
WG-EMM-17/08	Estimating density and biomass of Antarctic krill around South Sheltland Islands using the 2-dB difference method S.-G. Choi, K. Lee and D. An
WG-EMM-17/09	New data acquisition protocol for benthos by-catch in the French fisheries of the Southern Ocean, presentation of the protocol and first preliminary results A. Martin, M. Eléaume, N. Améziane, P. Pruvost and G. Duhamel

WG-EMM-17/10	Progress report of the CEMP Special Fund project to develop an image processing software tool for analysis of camera network monitoring data C. Southwell, L. Emmerson, K. Newbery, J. Hinke, G. Watters, M. Santos, G. Milinevsky, M. Korczak-Abshire, N. Ratcliffe and P. Trathan
WG-EMM-17/11	Update on work to estimate krill consumption by flying seabirds in CCAMLR Divisions 58.4.1 and 58.4.2 C. Southwell and L. Emmerson
WG-EMM-17/12	Estimating prey consumption of the non-breeder component of an Adélie penguin population L. Emmerson and C. Southwell
WG-EMM-17/13	Dietary studies of Adélie penguins through faecal DNA analysis L. Emmerson, B. Deagle, C. Waluda, M. Dunn, P. Trathan and C. Southwell
WG-EMM-17/14	Feeding habits and prey consumption of Antarctic minke whale *Balaenoptera bonaerensis* in the Indo–Pacific region of the Southern Ocean T. Tamura
WG-EMM-17/15	Outcomes from the IWC SC relating to progress towards SC-CAMLR–IWC workshops in 2018 and 2019 M. Belchier (Chair of SC-CAMLR)
WG-EMM-17/16 Rev. 1	Progress report of the CEMP Special Fund camera network in Subarea 48.1 J. Hinke, G. Watters, M. Santos, M. Korczak-Abshire, G. Milinevsky, V. Lytvynov, A. Barbosa, C. Southwell and L. Emmerson
WG-EMM-17/17	CEMP data summary and updated analysis of CEMP data from Subarea 48. Secretariat
WG-EMM-17/18	A sentiment analysis of online content containing Antarctic krill fishing search terms J. Barrett, K. Reid and J. Jabour
WG-EMM-17/19	Proposal for a Climate Change Response Work Program for CCAMLR Delegations of Australia and Norway on behalf of the Climate Change Intersessional Correspondence Group

WG-EMM-17/20	Towards an ecological risk assessment of krill fishing in East Antarctica (CCAMLR Divisions 58.4.1 and 58.4.2) N. Kelly, M. Cox, L. Emmerson, S. Kawaguchi, B. Raymond, C. Southwell and D. Welsford
WG-EMM-17/21	CEMP cameras and satellite transmitters installation by Ukraine at the Galindez, Petermann, and Yalour Islands penguin colonies as a part of CEMP Fund projects G. Milinevsky, I. Dykyy, D. Lutsenko, O. Savitsky, A. Simon, M. Telipska, V. Lytvynov and L. Pshenichnov
WG-EMM-17/22	Incorporating information on the distribution of the krill fishery into Domain 1 MPA planning – report of the CCAMLR scholarship recipient A. Capurro, M. Santos and S. Grant
WG-EMM-17/23	Domain 1 Marine Protected Area Preliminary Proposal – PART A: MPA Model Delegations of Argentina and Chile
WG-EMM-17/24	Domain 1 Marine Protected Area Preliminary Proposal – PART B: Conservation objectives Delegations of Argentina and Chile
WG-EMM-17/25 Rev. 1	Domain 1 Marine Protected Area Preliminary Proposal – PART C: Biodiversity Analysis by MPA zones Delegations of Argentina and Chile
WG-EMM-17/26	The Norwegian SWARM project: from swarming behaviour to trophic interactions: modelling dynamics of Antarctic krill in ecosystem hotspots using behaviour-based models T.A. Klevjer, G. Rieucau, A.H.H. Renner, G. Skaret and O.R. Godø
WG-EMM-17/27	Analysis of the krill fishery in Subarea 48.1 considering trawl fishing method used (2010–2016) S. Kasatkina S. and L. Boronina
WG-EMM-17/28	Analysis of inter-vessel variability of krill length distribution in the catches obtained in the fishery in the Bransfield Strait (Subarea 48.1) S. Kasatkina
WG-EMM-17/29	Density and geographical distribution of krill larvae in the Atlantic Sector of the Antarctic region during summer 2011, 2012 and 2014 E. Rombolá, C. Franzosi, G. Tossonotto, V. Alder and E. Marschoff

WG-EMM-17/30	Oceanography of the South Georgia and South Orkney Islands regions using high-resolution models E. Young, E. Murphy and P. Trathan
WG-EMM-17/31	Modelling Movement of Antarctic Krill (MMAK): the importance of retention, dispersal and behaviour for krill distribution S. Thorpe, E. Young and E. Murphy
WG-EMM-17/32	A bioenergetics model assessment of the prey consumption of Adélie penguins in Subarea 48.1 and 48.2 C. M. Waluda, L. Emmerson, C. Southwell and P.N. Trathan
WG-EMM-17/33	Using preferred habitat models for chinstrap penguins (*Pygoscelis antarctica*) to help improve krill fisheries management during the penguin breeding season V. Warwick-Evans, N. Ratcliffe, H.L. Clewlow, L. Ireland, A. Lowther, F. Manco and P.N. Trathan
WG-EMM-17/34	Characterising the preferred at-sea habitats used by chinstrap penguins and the fishery for Antarctic krill: slow-flowing, nearshore waters over shallow bathymetry P.N. Trathan, V. Warwick-Evans, J. Hinke, E.F. Young, A.P.B. Carneiro, M.P. Dias, K. Kovacs, O.R. Godø and M. Santos
WG-EMM-17/35	Identification of marine Important Bird and Biodiversity Areas for penguins in South Shetland and South Orkney Islands: a comparison of two different approaches M.P. Dias, A.P.B. Carneiro, V. Warwick-Evans, C. Harris, K. Lorenz, P. Trathan
WG-EMM-17/36	Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) program: developing ICED and CCAMLR joint activities E. Murphy on behalf of ICED SSC
WG-EMM-17/37	SO-AntEco: Contributing information and scientific advice on benthic biodiversity in the South Orkney Islands (Domain 1) region M.J. Brasier, S.M. Grant, P.N. Trathan, L. Allcock, O.S. Ashford, H. Blagbrough, A. Brandt, B. Danis, R. Downey, M. Eléaume, P. Enderlein, C. Ghiglione, O. Hogg, K. Linse, M. Mackenzie, C. Moreau, L. Robinson, E. Rodríguez, V. Spiridonov, A. Tate, M. Taylor, C. Waller, H. Wiklund and H.J. Griffiths
WG-EMM-17/38	Southern Ocean Observing System West Antarctic Peninsula (WAP) Working Group Meeting P. Trathan on behalf of the SOOS West Antarctic Peninsula (WAP) Working Group

WG-EMM-17/39	Proposal for an acoustic krill biomass survey in CCAMLR Subarea 48.1 in relation to the hydrological environment and in conjunction with carbon cycling and temperature adaptation experiments of krill and salps B. Meyer, L. Suberg, S. Fielding, O.R. Godø and C. Reiss
WG-EMM-17/40	Dynamics of Antarctic krill in the Bransfield Strait during austral summer and autumn investigated using acoustic data from a fishing vessel X. Wang, G. Skaret, O.R. Godø and X. Zhao
WG-EMM-17/41	Krill CPUE standardisation and comparison with acoustic data based on data collected from Chinese fishing vessels in Subarea 48.1 Y. Ying, X. Wang, J. Zhu and X. Zhao
WG-EMM-17/42	The Weddell Sea MPA revisited: questions, comments and suggestions M. Bristow and O.R. Godø
WG-EMM-17/43	The Ross Sea region Marine Protected Area Research and Monitoring Plan (WG-EMM 2017) A. Dunn, M. Vacchi and G. Watters
WG-EMM-17/44	Linking acoustic scattering coefficient to krill fishery data: feasibility of estimating krill abundance using fishing survey T. Wang, G.P. Zhu, J.F. Tong and L.X. Xu
WG-EMM-17/45	Fishing behaviour of Chinese krill fishing fleet R. Wang and G.P. Zhu
WG-EMM-17/46	Progress report 4: Proposal for GEF (Global Environment Facility) funding to support capacity building in the GEF-eligible CCAMLR Members CCAMLR Secretariat
WG-EMM-17/47	The use of net monitoring cable in trawl fishery for krill O.R. Godø
WG-EMM-17/48	Reporting procedures for the continuous fishing method O.R. Godø and T. Knutsen
WG-EMM-17/49	Increasing abundance of Type A killer whales (*Orcinus orca*) in the coastal waters around the Antarctic Peninsula H. Fearnbach, J.W. Durban, D.K. Ellifrit and R.L. Pitman

WG-EMM-17/50 Rev. 1	From CEMP to krill fishing: data collection, availability and spatial distribution in Subarea 48.1 M. Söffker

Other Documents

WG-EMM-17/P01	Diving location and depth of breeding chinstrap penguins during incubation and chick-rearing period in King George Island, Antarctica W.Y. Lee, S. Park, N. Choi, K.W. Kim, H. Chung and J.-H. Kim *Kor. J. Orni*., 23 (1) (2016): 41–48
WG-EMM-17/P02	Long term variability in the diet and reproductive performance of penguins at Bird Island, South Georgia C.M. Waluda, S.L. Hill, H.J. Peat and P.N. Trathan *Mar. Biol.* (accepted)
WG-EMM-17/P03	KRILLBASE: a circumpolar database of Antarctic krill and salp numerical densities, 1926–2016 A. Atkinson, S.L. Hill, E.A. Pakhomov, V. Siegel, R. Anadon, S. Chiba, K.L. Daly, R. Downie, S. Fielding, P. Fretwell, L. Gerrish, G.W. Hosie, M.J. Jessopp, S. Kawaguchi, B.A. Krafft, V. Loeb, J. Nishikawa, H.J. Peat, C.S. Reiss, R.M. Ross, L.B. Quetin, K. Schmidt, D.K. Steinberg, R.C. Subramaniam, G.A. Tarling and P. Ward *Earth Syst. Sci. Data*, 9 (2017): 193–210, doi:10.5194/essd-9-193-2017
SC-CAMLR-XXXVI/06	Report of the Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Qingdao, People's Republic of China, 15 to 19 May 2017)
WG-SAM-17/30	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2017 – Reflection of the recommendations by WG-EMM-16 and SC-CAMLR-XXXV K. Teschke, H. Pehlke and T. Brey on behalf of the German Weddell Sea MPA (WSMPA) project team
WS-SISO-17/02	Discards in Antarctic fisheries E. Marschoff and J.A. Serra
WS-SISO-17/05	Using fishing vessels as opportunistic seabird and marine mammal observation platforms M. Söffker, V. Laptikhovsky and J. Clark
WS-SISO-17/11	Observations on the continuous trawl fishing system for krill G. Robson, J. Clark and M. Söffker

Annex 7

Report of the Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

Contents

Report of the Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 2 to 13 October 2017. The Convener, Dr D. Welsford (Australia), opened the meeting and welcomed participants to Hobart (Appendix A). As in previous meetings, Dr Welsford encouraged all participants to engage in discussion and where differences of views existed that these be presented as different testable hypotheses rather than simply as statements of positions.

1.2 Mr A. Wright (Executive Secretary) extended the Secretariat's warm welcome to all participants and Mr T. Jones and Ms B. Blackburn (Secretariat) provided an overview of the meeting server and web-based support provided by the Secretariat.

Organisation of the meeting and adoption of the agenda

2.1 The work plan for WG-FSA at this meeting was focused on providing advice on:

(i) outcomes of assessments in CCAMLR fisheries
(ii) reviewing progress in research activities involving toothfish
(iii) review of outcomes of the Workshop on the Scheme of International Scientific Observation (WS-SISO) of relevance to WG-FSA.

2.2 The Working Group reviewed and adopted the agenda (Appendix B).

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

2.4 In this report, paragraphs dealing with advice to the Scientific Committee and other working groups have been highlighted. These paragraphs are listed under Item 9. In addition, the information used in developing assessments and other aspects of the Working Group's work is included in the Fishery Reports (www.ccamlr.org/node/75667).

2.5 The report was prepared by M. Belchier (UK), P. Burch (Australia), C. Darby and T. Earl (UK), J. Fenaughty (New Zealand), I. Forster and E. Grilly (Secretariat), C. Jones (USA), D. Maschette (Australia), S. Mormede and S. Parker (New Zealand), K. Reid (Secretariat), M. Söffker (UK), S. Somhlaba (South Africa), P. Yates and P. Ziegler (Australia).

Subgroup organisation and coordination

2.6 Dr Welsford reminded the Working Group that all substantive discussions, and particularly discussions leading to advice to the Scientific Committee, would be conducted in plenary. Where items require additional detailed discussion, some of the work of the meeting may be considered in subgroups and the outcomes of these subgroup discussions reported to the plenary.

Review of data available

Secretariat information and data systems

2.7 The Executive Secretary reported on a restructuring of Secretariat data services undertaken during 2017. He noted that the overarching goal was to strengthen the Secretariat's information and data services to Members. The restructure included the merging of the previous Data Services with Information and Communications Technology, the transfer of fishery monitoring responsibilities to Fishery Monitoring and Compliance, previously undertaken by Data Services, and securing appropriate information systems and data management expertise. He anticipated that the restructure would lead to improved efficiencies in relation to the use of available Secretariat resources, increased technical engagement with users, an unambiguous focus for information systems and data service responsibilities in the Secretariat and increased rigor around strategic planning to support information and data processes, including in relation to data quality, data products, web-based data services, data documentation and user requirements.

2.8 The Executive Secretary noted that the restructure had led to the departure of Dr David Ramm who had made a valuable contribution to CCAMLR over 21 years. This followed the departure of Lydia Millar in December 2016. Lydia had dedicated 19 years to CCAMLR. On behalf of all CCAMLR Members, the Executive Secretary expressed appreciation to Dr Ramm and Ms Millar for their respective contributions to the organisation.

2.9 The Working Group thanked the Secretariat for the very informative presentations and also thanked Dr Ramm and Ms Millar for their contributions to the Working Group over many years.

2.10 The Working Group noted the developments in Information Systems and Data Services during 2017, noting their relationship to the projects identified in SC-CAMLR-XXXV/BG/25. The Information Systems and Data Services Manager reported on the new automated data load and the resulting improvements in efficiencies and reliability of the data processing for catch and effort and observer data submissions and the proposed development for C1 and C2 data forms. It was also highlighted how the process of automating the data load also triggered developments in related projects, developing data rules and redeveloping a data registry. A new online GIS, currently in development by British Antarctic Survey (BAS), was presented to the Working Group, supported by a data portal that supports the provision of data and basic metadata.

2.11 The Working Group acknowledged the changes introduced by the Secretariat in the information and data systems management and recognised that this was a long-term project intended to yield efficiencies and improved data quality to the work of WG-FSA.

2.12 The Working Group noted that the e-group established to develop terms of reference for the data management group (DMG) had not been able to conclude its work intersessionally and provided feedback to the Secretariat in order to revise the terms of reference for presentation to the Scientific Committee. In particular, the Working Group noted the importance of providing an enhanced mechanism for communication between the Secretariat and data providers, as well as data users, in order to ensure that the workplan of the Secretariat and the expectations of Members with respect to information and data management services are met. The Working Group noted the terms of reference as documented in SC-CAMLR-XXXVI/BG/28 Rev. 1.

2.13 The Working Group agreed that through the period of change in the Secretariat's information and data management processes it was important to have documentation available in an accessible format in order to explain to data users what additional data quality measures are being implemented as part of the data loading process and the potential impacts of these as they are applied to historical data holdings.

Illegal, unreported and unregulated (IUU) fishing activities

2.14 The Secretariat presented CCAMLR-XXXVI/28 Rev. 2 that provided area-specific information on illegal, unreported and unregulated (IUU) fishing activity, including:

(i) in 2017, gillnets had been reported by Members during fishing operations in Subarea 48.6 and Divisions 58.4.1 and 58.5.2, but there were no reports of vessel sightings

(ii) various action taken by Contracting Parties, non-Contracting Parties and other organisations, including Interpol, in respect of CCAMLR IUU-listed vessels resulting in the investigation and prosecution of beneficial owners or the detainment or sinking of several IUU-listed vessels

(iii) catch data obtained by Spain from three IUU-listed vessels, the *Asian Warrior*, *Zemour 1* and *Zemour 2* operating in Division 58.4.1 in 2014. This data is likely to represent typical IUU fishing activity in Division 58.4.1 since 2004, when the vessels were first sighted, until 2015, when global action against these vessels was underway.

2.15 The Working Group welcomed the new information on IUU activity and, in particular, the catch data from the IUU-listed vessels using gillnets in areas in which research fishing is undertaken. The data emerging from ongoing investigations confirms that IUU fishing remains an important issue for CCAMLR and especially the potential impacts on research fishing in Division 58.4.1 (paragraph 4.136).

2.16 The Working Group noted the unprecedented availability of catch data from IUU vessels that included:

(i) reported removals
(ii) video footage
(iii) catch in gillnets recovered by an authorised vessel

and agreed that this data could allow a review of the relationship between reported IUU vessel sightings and levels of removals and requested further analysis of the data in order to evaluate:

(iv) any additional data that becomes available

(v) toothfish catch per unit effort (CPUE) (by weight and number) and spatial and temporal variations in catch rates

(vi) species and size compositions, including primary by-catch groups

(vii) size selectivity of gillnets

(viii) temporal variation in the spatial distribution of IUU activity (e.g. investigating the likelihood of a transition between exploratory and more targeted activity)

(ix) potential impacts of IUU removals on previous research conducted in the region (also with the aid of mapping the spatial and temporal overlap with CCAMLR research)

(x) the temporal and spatial distribution of authorised fishing vessels in relation to available IUU data.

2.17 The Working Group welcomed the offer from Dr Yates to work with the Secretariat to coordinate the analysis of IUU data from Division 58.4.1 and noted that if other data becomes available during the course of the intersessional period, then this should be included in the analysis.

2.18 The Working Group also noted that in 2014 the *Asian Warrior*, *Zemour 1* and *Zemour 2* appear to have concentrated fishing effort in areas coinciding with relatively high predicted mean weight and proportions of fish that were mature (WG-FSA-17/16). The Working Group noted that spatial predictions such as those in WG-FSA-17/16 may facilitate estimation of toothfish and by-catch catch compositions for these IUU vessels. Conversely, the data from IUU vessels may contribute to validating spatial predictions.

Long-distance movements of toothfish

2.19 The Secretariat presented WG-FSA-17/04 that provided an update of WG-FSA-16/04 on the long-distance movements of toothfish arising from the CCAMLR tagging program. The analysis indicated that while most toothfish are recaptured close to their tagging location, some fish undertake movements of thousands of kilometres between release and recapture. For both species, 80–90% of fish that undertook movements of >200 km (and moved between fisheries) moved in an anticlockwise direction, although the reason for this distinct pattern in directionality remains unclear.

2.20 The Working Group thanked the Secretariat for this useful paper and noted that while the pattern of movement is important in defining the biological population, this may have limited impacts on the definition of fishery stock units, but the potential for movements to introduce biases into assessments should be taken into consideration in stock assessments.

2.21 The Working Group also noted that investigating the length of fish that undertook long-distance movement, as well as potentially examining otolith microchemistry, could provide insights into the life-history characteristics of those fish that undertake long-distance movements (paragraphs 6.7 and 6.8).

Data from the current fishing season

2.22 The Working Group reviewed data submitted to the Secretariat from CCAMLR fisheries and fishery-based research in 2016/17 (SC-CAMLR-XXXVI/BG/01 Rev. 1) and noted the total catches in fisheries for Antarctic (*Dissostichus mawsoni)* and Patagonian (*D. eleginoides)* toothfish, mackerel icefish (*Champsocephalus gunnari*) and Antarctic krill (*Euphausia superba*) in the Convention Area.

2.23 The Working Group noted that some fisheries for *D. mawsoni* were closed by the Secretariat in 2016/17 (SC-CAMLR-XXXVI/BG/01 Rev. 1). All but one of these closures were triggered by catches of *D. mawsoni* approaching the relevant catch limits, while the closure of research block 5841_6 was triggered when the by-catch limit for Macrourids was reached (paragraph 6.7).

2.24 The Working Group noted that there was a 56% overrun of the catch limit in Subarea 88.1 SSRUs B, C, G with a catch of 596 tonnes compared to a catch limit of 378 tonnes with a closure date of 4 December 2016, four days after the opening of the fishery. The Working Group also noted that the overall catch in Subarea 88.1 was 98% of the catch limit for the whole fishery.

2.25 The Working Group noted that other options may be available to avoid catch overruns, such as effort limitation or increased frequency of catch and effort reporting to the Secretariat as well as the potential to increase the reporting to the fishery on the cumulative catch (paragraphs 3.88 to 3.100). The Working Group encouraged further consideration of such options.

CASAL verifications

2.26 The Secretariat performed verifications of CASAL-based assessments for *D. eleginoides* in Subareas 48.3, 48.4 and 58.6 and in Divisions 58.5.1 and 58.5.2 as well as for *D. mawsoni* in Subarea 88.1 using the input parameter files, output files and initial assessment results (maximum of the posterior density (MPD) estimates) from the CASAL assessments submitted to WG-FSA in 2017. CASAL version v. 2.30-2012-03-21 rev. 4648 was used for the verification runs. There was no difference in any of the *D. eleginoides* assessments and less than 2% difference in the MPD estimate of unfished spawning biomass (B_0) in the *D. mawsoni* assessment.

2.27 The Working Group recalled that in 2014 WG-SAM (SC-CAMLR-XXXIII, Annex 5, paragraph 2.29; SC-CAMLR-XXXIII, paragraph 2.7) recommended that CASAL version 2.30-2012-03-21 rev. 4648 be considered the current approved CCAMLR version until a process is agreed for validating and approving updated software and the use of newer versions of CASAL would need to be reviewed by WG-SAM and would require documentation and sufficient justification.

2.28 The Working Group agreed that if Members are aware of benefits of using newer versions of CASAL that these versions be brought to WG-SAM for review in order to allow all Members developing assessments to benefit from those newer versions.

Review of updated stock assessments and provision of management advice (all fisheries)

Champsocephalus gunnari

C. gunnari in Subarea 48.3

3.1 The fishery for *C. gunnari* in Subarea 48.3 operated in accordance with Conservation Measure (CM) 42-01 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 2 074 tonnes. Fishing early in the season was conducted by one vessel using midwater trawls and the total reported catch was 66 tonnes as of 28 September 2017. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.2 The Working Group noted that in recent years low amounts of fishing effort were being deployed in Subarea 48.3 and that this has resulted in a very low uptake of the catch limit by the fishery. Only one vessel had fished up to the time of the 2017 WG-FSA meeting, trawling for 89 hours, which compared to a total average vessel trawling time of 1 500 hours per season during the early 2000s when the uptake of the catch limits was higher.

3.3 In January 2017, as part of its regular monitoring program (WG-FSA-17/44), the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves. A total catch of 17.4 tonnes of *C. gunnari* was reported from the research survey. Stomach content analysis showed a higher than expected proportion of *Themisto* sp., rather than the krill seen in other years.

3.4 WG-FSA-17/51 compared methods of aggregating the length distributions from multiple hauls using a mean of positive values (as previous assessments in this subarea), or a sum (equivalent to a mean of all values). The Working Group agreed that the assessment should change to using the sum, which reduces the likelihood of over-representing young fish in the population length distribution when small fish are clustered in particular survey strata.

3.5 WG-FSA-17/47 presented a preliminary assessment of *C. gunnari* in Subarea 48.3 based on the random stratified bottom trawl survey. A bootstrap procedure was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this subarea. The bootstrap estimated the median demersal biomass at 91 531 tonnes, with a one-sided lower 95% confidence interval of 47 424 tonnes. A catch limit of 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19 would ensure at least 75% biomass escapement after a two-year projection period.

Management advice

3.6 The Working Group recommended that the catch limit for *C. gunnari* in Subarea 48.3 should be set at 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19.

C. gunnari at Kerguelen Islands (Division 58.5.1)

3.7 A short-term assessment of *C. gunnari* in Division 58.5.1 was conducted based on the northeast part of the 2017 POKER biomass survey (WG-FSA-17/63). A bootstrap procedure was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this stratum. The assessment was implemented using the generalised yield model (GYM). The bootstrap estimated the mean demersal biomass at 35 368 tonnes for the northeast shelf, with a one-sided lower 95% confidence interval of 19 399 tonnes. The catch was dominated by a single 2+ age class. The CCAMLR harvest control rule, which ensures 75% biomass escapement after a two-year projection period, yielded a catch limit of 3 081 tonnes for 2017/18 and 2 753 tonnes for 2018/19.

3.8 The Working Group recalled its advice regarding the design of strata used in the icefish assessment in Division 58.5.1 (SC-CAMLR-XXXV, Annex 7, paragraphs 3.9 to 3.13), and recommended that further stratification of the northeast region be considered in future surveys, taking account of factors such as depth and distribution observed in previous surveys. It also requested a report on the most recent POKER survey be tabled to WG-FSA.

C. gunnari at Heard Island (Division 58.5.2)

3.9 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 561 tonnes. Fishing was conducted by one vessel and the total reported catch up to 28 September 2017 was 523 tonnes. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.10 The results of a random stratified trawl survey in Division 58.5.2 undertaken in April 2017 were summarised in WG-FSA-17/14 Rev. 1. The Working Group noted that *C. gunnari* catch rates were substantially higher than the long-term average from 2006 to 2016. Based on data gathered during the survey, an assessment was presented in WG-FSA-17/22. The length–weight relationship and growth parameters were updated using the survey data. The best fit of CMIX to the survey length distribution was achieved when the population was estimated to consist of three year classes from 1+ to 3+, with the 3+ cohort containing the largest number of fish, and estimated to make up 97% of the biomass.

3.11 A short-term assessment was conducted in GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 901 tonnes of age 1+ to 3+ fish from the 2017 survey and fixed model parameters. Estimates of yield indicate that 526 tonnes of icefish could be taken in 2017/18 and 395 tonnes in 2018/19.

Management advice

3.12 The Working Group recommended that the catch limit for *C. gunnari* in Division 58.5.2 should be set in 2017/18 at 526 tonnes and at 395 tonnes in 2018/19.

Issues common to *C. gunnari* assessments

3.13 The Working Group recommended that a standard set of diagnostic plots and information are included in each of the assessments of *C. gunnari*, relating to the survey and assessment:

(i) Survey information –

(a) haul data – location (map including bubble plots) and catch and CPUE (table) including strata

(b) haul-by-haul CPUE (kg/km^2) column chart including strata

(c) number of fish measured and weighed from the survey used in the assessment

(d) time series of length-frequency distribution.

(ii) Assessment –

(a) distribution plot of the bootstrap runs of survey biomass

(b) survey biomass time series plot (estimates of biomass with confidence intervals including lower one-sided 95th percentile)

(c) CMIX plots where applicable

(d) code used for conducting calculations and assessment

(e) table of parameters used and their source

(f) previous lower 95th percentile stock assessment projection versus survey estimated time series.

3.14 Examples of these diagnostics will be developed intersessionally between interested Members and presented to WG-SAM-18.

3.15 The Working Group noted that in previous assessments, hauls with exceptionally high CPUE had been excluded from the analysis in an ad hoc fashion. The Working Group recommended that where outliers existed, a sensitivity analysis of their influence on the assessment should be performed, and further consideration given as to whether the stratification remains appropriate.

3.16 Dr S. Kasatkina (Russia) noted that *C. gunnari* is a species with semi-pelagic distribution. Investigations provided in previous years showed that bottom trawl surveys significantly underestimate *C. gunnari* biomass (SC-CAMLR-XXII, Annex 5, paragraphs 5.153 to 5.173). Length-age composition of catches taken by bottom trawls will not reflect the population structure in terms of young and immature fish to a considerable degree. Assessment for *C. gunnari* requires estimating demersal and pelagic components of ice-fish population in the water column above the layer sampled by bottom trawl.

3.17 Dr Kasatkina noted that icefish assessment should be prepared by combining data from bottom trawl survey and acoustic survey respectively. In this case a more representative estimate of the fish biomass and population structure might be available for the projection and management advice (SC-CAMLR-XXII, Annex 5, paragraph 5.166; SC-CAMLR-XXVIII, Annex 6, paragraphs 3.23 and 3.24). Moreover, the realistic data on *C. gunnari* stock state and distribution patterns is very important for understanding the trophic chain and competitive relations considering the consumption of considerable amounts of young icefish by penguins and mammals.

3.18 The Working Group noted that the method of biomass estimation of *C. gunnari* based on bottom trawl surveys excludes an unknown and variable pelagic component of the stock. The Working Group noted that the integration of acoustic data collection with trawl survey data could potentially allow total stock biomass to be estimated and should be explored as future work.

3.19 The Working Group also recalled previous advice (SC-CAMLR-XXXII, Annex 4, paragraphs 4.31 to 4.33) based on analysis in WG-SAM-13/31 Rev. 1, which described a retrospective analysis and sensitivity evaluation of the performance of the CCAMLR harvest control rule (HCR) for *C. gunnari* in Subarea 48.3. The Working Group noted that the retrospective analysis showed biomass projections using the CCAMLR HCR algorithm for icefish in Subarea 48.3 (which does not include recruitment or the pelagic biomass component) fall below the subsequent year's survey estimates with a high probability, indicating that the projections upon which the catch advice is based are consistent with CCAMLR objectives.

Dissostichus spp.

Generic advice on assessments

3.20 The Working Group recommended that where some data series are incomplete at the time of assessment, the assessment presented to the Working Group should be based on data that have been through data quality assurance processing rather than placing an emphasis on including the most recent data. It further recommended that toothfish stock assessments should be carried out up to, and including, the current season and include the reported catch data where fishing has been completed, or the anticipated catch for the current season.

3.21 The Working Group recommended that fitting survey data as two separate datasets, a biomass index and proportions-at-age, is preferred over the numbers of fish at age to be able to distinguish between signals in biomass and year-class strength (YCS) in the survey data.

3.22 The Working Group recommended that in addition to information available in the Fishery Reports, WG-SAM consider the further development of basic indicators of fishery performance and stock status (e.g. SC-CAMLR-XXXIII, Annex 7, paragraph 2.5) that could be reported in years between stock assessments to identify any trends that may indicate an unexpected change in status or fishery performance.

D. eleginoides in Subarea 48.3

3.23 The fishery for *D. eleginoides* in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2016/17, the catch limit for *D. eleginoides* was 2 750 tonnes and the total reported removal was 2 192 tonnes. Fishing in the current season finished on 14 September 2017 (www.ccamlr.org/node/75667).

3.24 WG-FSA-17/53 presented an updated integrated assessment for *D. eleginoides* in Subarea 48.3. Compared to the last assessment in 2015, the model was updated with available data from 2015/16 and 2016/17, revised tagging data extracted from the CCAMLR database, age–length keys (ALKs) were developed for the most recent two years, and depredation estimates were updated. Catch data for the 2016/17 season were complete and standardised CPUE was based on three of the six vessels (see paragraph 3.20). The CPUE and estimates of depredation were higher in 2017 than in previous assessments.

3.25 The assessment estimated B_0 at 83 200 tonnes (95% CIs: 79 000–88 100 tonnes), spawning stock biomass (SSB) of 42 200 tonnes (38 900–52 600 tonnes) and a stock status in 2017 of 0.51 (0.49–0.53). The long-term catch limit that satisfied the CCAMLR decision rules was 2 600 tonnes.

3.26 The Working Group noted that the likelihood profiles from the time series of cohorts of tagged fish showed a declining trend in the MPD values of SSB_0. The Working Group suggested that additional work to understand the pattern was a priority for future work on this assessment.

Management advice

3.27 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.3 be set at 2 600 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

Dissostichus spp. in Subarea 48.4

D. eleginoides in the South Sandwich Islands (Subarea 48.4)

3.28 The fishery for *D. eleginoides* in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. eleginoides* in Subarea 48.4 in 2016/17 was 47 tonnes and 28 tonnes were taken (www.ccamlr.org/node/75667).

3.29 WG-FSA-17/52 presented the stock assessment which was updated with data from the 2015/16 and 2016/17 seasons of catches, length distributions, tag release and recapture data, and age data.

3.30 The Working Group recommended that future work include investigations of a potential temporal pattern in the fits to the tag data, where expected values were higher than observed up to 2007/08, and then lower than observed after 2007/08.

3.31 The Working Group noted that there is migration of *D. eleginoides* between Subareas 48.3 and 48.4, and that fish tend not to reproductively mature in Subarea 48.4, rather they likely move to Subarea 48.3 to spawn. The Working Group recommended further review of the stock hypothesis and future work to reflect links between populations in the assessments of *D. eleginoides* in Subareas 48.3 and 48.4.

Management advice

3.32 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.4 should be set at 26 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

D. mawsoni in the South Sandwich Islands (Subarea 48.4)

3.33 The fishery for *D. mawsoni* in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. mawsoni* in Subarea 48.4 in 2016/17 was 38 tonnes plus 18 tonnes for the research survey outlined in WG-FSA-16/40 Rev. 1, of which 19 tonnes were taken in the fishery and 17 tonnes in the research plan (www.ccamlr.org/node/75667).

3.34 WG-FSA-17/49 presented an annual tag-recapture biomass estimate for the area that was conducted following the agreed procedure from SC-CAMLR-XXXV, Annex 7, paragraphs 3.29 to 3.31. The Chapman biomass estimate in 2017 was 970 tonnes (95% CI: 453–1 487 tonnes), just below the geometric mean of the series of Chapman estimates of 979 tonnes. A harvest rate of 0.038, applied to the geometric mean of the 2010–2017 series, resulted in a yield of 37 tonnes.

3.35 The Working Group noted that the confidence intervals were calculated analytically and that bootstrap or other methods to estimate uncertainty could be used to better describe the variability in the data, especially with low numbers of recaptures.

3.36 The Working Group noted that the decrease in tags recaptured from a tagged cohort with time was larger than expected and suggested further work to understand if the cause was emigration, the pattern in spatial overlap of fishing effort, and/or variability in recapture rate. This larger than expected decline in the number of tagged fish recaptured through time might impact on the estimate of local biomass, and sensitivities were suggested to understand the size of the effect. The Working Group further noted that the low numbers of tag recaptures, especially in the most recent years, can create variation in the estimation of biomass, especially when catch limits are low.

Management advice

3.37 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 be set at 37 tonnes for 2017/18 based on the results of the assessment.

D. eleginoides in Division 58.5.1

3.38 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French exclusive economic zone (EEZ). Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.39 WG-FSA-17/60 presented an updated stock assessment of *D. eleginoides* at Kerguelen Islands (Division 58.5.1 inside the French EEZ) which included a revised tag-shedding parameter and a compensation for fish migration between Division 58.5.1 and Division 58.5.2 at an annual migration rate of 0.004 as developed at WG-SAM-17 (WG-SAM-17/11).

3.40 The Working Group noted the continued progress with the development of the model and encouraged the continued expansion in the range of years with aged data in the model. The Working Group noted that as the amount of age data in the model increases, there would be an increase in the robustness of the model fit. The Working Group requested more details on the time series of catches used in the assessment (summarised in the Division 58.5.1 Fishery Report) and that for future assessments the full model diagnostic summary developed by WG-SAM is presented.

3.41 The updated assessment model estimated B_0 at 223 980 tonnes (95% CI: 205 030–245 900 tonnes), with the biomass in 2017 at 143 700 tonnes (123 060–167 030 tonnes). Estimated SSB status was 0.64 (0.60–0.68).

3.42 The Working Group agreed that the catch limit set by France of 5 050 tonnes in 2017/18, which allows for average depredation rates (313 tonnes, based on the average of the estimated depredation from the 2003/04 season to the 2015/16 season), is consistent with the CCAMLR decision rules for the model runs presented.

Management advice

3.43 No new information was available on the state of fish stocks in Division 58.5.1 outside areas of national jurisdiction. The Working Group, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

D. eleginoides in Division 58.5.2

3.44 The fishery for *D. eleginoides* in Division 58.5.2 operated in accordance with CM 41-08 and associated measures. Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.45 A series of research papers presented new information for consideration by the Working Group in the development of the Division 58.5.2 stock assessment, centred around previous recommendations on the development of the assessment from WG-FSA and WG-SAM. These included updated growth parameters, inclusion of a migration component from Division 58.5.2 to Division 58.5.1 of 1.0% per annum (WG-SAM-17/11), revised tag-loss estimates (WG-FSA-17/21) and a revised maturity-at-age relationship (WG-FSA-17/P04).

3.46 WG-FSA-17/P04 presented a revised maturity key for *D. eleginoides* in Division 58.5.2 based on histological analyses and calibration of macroscopic staging criteria from 2004 to 2015. Age-at-maturity estimates, obtained based on the assumption that fish of macroscopic stages ≥ 2 were mature, decreased between the 2004–2009 and 2010–2015 periods for both sexes. However, the magnitude of this temporal variation in age at maturity varied between gear types and fishing depths, and variable sampling regimes likely influenced these variations.

3.47 In the stock assessment model a new maturity ogive was used resulting in a 5% increase in the estimate of B_0 but at the same relative status of current biomass.

3.48 The Working Group noted that the revised maturity-at age-function predicted that some young fish in the age range of 1–7 are mature. This appears to be inconsistent with the expectation of the life-history characteristics of a long-lived deep-water species. The Working Group also noted that there seemed to be evidence of skip spawning. The Working Group encouraged further research and comparison with other stocks to determine whether the findings of the spawning characteristics of *D. eleginoides* in Division 58.5.2 were consistent with the information collected in other areas. The Working Group also noted that the revised maturity ogives in WG-FSA-17/P04 indicated differences in the age at maturity by sex, and that other evidence of different growth functions by sex suggest future work to consider the effect of developing a two-sex model.

3.49 WG-FSA-17/21 re-estimated tag-shedding rates in *D. eleginoides* fisheries in Division 58.5.2. Tag-loss rates were generally low, with longline-caught and recaptured fish losing their tags faster than trawl-caught and recaptured fish. Single tag-loss rates for longline varied strongly between time periods, with 0.7% for 2003–2006, 2.1% for 2007–2011 and 0.6% for 2012–2015. The longline parameter estimates for these time periods were used in the revised stock assessment for *D. eleginoides* in Division 58.5.2, resulting in a negligible change in the B_0 and stock status estimates.

3.50 Two additional changes to the assessment model structure and fit were also made in 2017, converting the survey data from numbers at age and length into a biomass index and proportions at age, and using the Francis method of data weighting similarly to the approach in other toothfish stock assessments. These changes resulted in increased estimates of B_0 and relative status of the current biomass and revised the time series of recruitment estimates.

3.51 The Working Group noted that the assessment model estimated selectivities in the fishery, which has low selection at the youngest ages and a dome-shaped selection at the oldest ages, indicating that that there was the potential for cryptic spawning biomass.

3.52 The Working Group requested that WG-SAM review the impact of the selectivity assumptions used in CASAL models on the proportion of cryptic biomass, including in relation to maturity proportions at age. The review should consider standardised approaches to estimation, diagnostics, their usage and interpretation, and the implications for management advice (SC-CAMLR-XXXII, Annex 6, paragraphs 4.104 and 4.105).

3.53 The updated assessment model leads to a smaller estimate of B_0 than that obtained in 2015, with a Markov Chain Monte Carlo (MCMC) estimate of 77 286 tonnes (95% CI: 71 492–84 210 tonnes). Estimated SSB status was 0.61 (0.58–0.64). Despite the smaller biomass, changes to the model compared to 2015, in particular its higher productivity, with the updated maturity parameters, meant that the catch limit that satisfies the CCAMLR decision rules has increased from 3 405 tonnes to 3 525 tonnes.

Management advice

3.54 The Working Group recommended that the catch limit for *D. eleginoides* in Division 58.5.2 be set at 3 525 tonnes for 2017/18 and 2018/19 based on the outcome of this assessment.

D. eleginoides in Subarea 58.6

3.55 The fishery for *D. eleginoides* at Crozet Islands is conducted within the French EEZ and includes parts of Subarea 58.6 and Area 51 outside the Convention Area. Details of this fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.56 WG-FSA-17/59 presented an updated stock assessment of *D. eleginoides* at Crozet Islands (Subarea 58.6 inside the French EEZ). Outputs from a series of model runs were considered which included updated depredation rates and tag-shedding estimates.

3.57 The Working Group requested more details on the time series of catches (summarised in the Subarea 58.6 Fishery Report) used in the assessment and that for future assessments the full model diagnostic summaries developed by WG-SAM-15 should be presented with an assessment.

3.58 The updated assessment model estimated B_0 at 56 810 tonnes (95% CI: 50 750–63 060 tonnes), with the biomass in 2017 at 37 900 tonnes (32 030–44 400 tonnes). Estimated SSB status was 0.67 (0.63–0.70).

3.59 The Working Group agreed that the catch limit set by France of 1 100 tonnes in 2017/18, which allows for average depredation rates (527 tonnes, based on the average of the last three years), is consistent with the CCAMLR decision rules for the model runs presented.

Management advice

3.60 No new information was available on the state of fish stocks in Subarea 58.6 outside areas of national jurisdiction. The Working Group, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

D. mawsoni in Subarea 88.1

3.61 The exploratory fishery for *Dissostichus* spp. in Subarea 88.1 operated in accordance with CM 41-09 and associated measures. In 2016/17, the catch limit for *Dissostichus* spp. was 2 870 tonnes, including 40 tonnes set aside for the Ross Sea shelf survey. Fishing was conducted by 16 longline vessels and the total reported catch was 2 821 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.62 WG-FSA-17/56 reported on an analysis of variability in catch rates of target and by-catch species of different longline gear types within selected small-scale research units (SSRUs) of Subareas 88.1 and 88.2. Catch rates (kg/1 000 hooks) were used to compare spatial and temporal variability in catch and by-catch rates by evaluating residual deviations from the long-term average and cluster analysis on spatial heterogeneity with the Coniss method. The analysis indicated spatio–temporal variability in catch rates by SSRU and season, as well as differences in toothfish length distributions. It also indicated the influence of gear type on by-catch rate data and length-species compositions of non-target fish species in the catches. The paper recommended that the gear type should be considered when planning research programs and analysing the fishery performance.

3.63 The Working Group recalled that this analysis had been presented to WG-SAM-17 (Annex 5, paragraphs 4.56 to 4.60) and noted the necessity to provide additional analyses on differences between catch rates and length- or species compositions of catch obtained from different gear types.

3.64 WG-SAM-17 had noted that there was a range of additional variables that were likely to influence catch rates of target and non-target species, such as depth and bait type. The Working Group noted that WG-SAM-16 and WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraph 3.57) and WG-SAM-17 had recommended the use of multivariate methods such as generalised linear mixed models (GLMMs) and generalised additive models (GAMs) for the analysis of catch data in order to address this issue and recommended exploration using these statistical methods. These methods have indicated that factors other than gear type were important in describing catch rates of *D. mawsoni* in Divisions 58.4.1 and 58.4.2 in WG-FSA-17/16.

3.65 The Working Group discussed difficulties in standardising CPUE on trotlines by using the number of hooks, making comparison with Spanish longline and autoline problematic. The Working Group also noted that considerable differences in the reporting rate of by-catch between vessels had been highlighted during the 2016 meeting of the Scientific Committee (WG-FSA-15/04 Rev. 1) and these reporting differences should be considered in future generalised linear model (GLM) and GLMM analyses.

3.66 The Working Group noted that spatial and temporal analyses and gear-specific differences in catch rates should be considered when calculating toothfish density used in the first stages of the development of research plans. However, it was also noted that differences in the gear type of vessels operating within fisheries as in Subarea 88.1 and Division 58.5.2 have not been a barrier to the development of integrated stock assessments for toothfish.

3.67 WG-FSA-17/07 provided an updated characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B), including recommendations for new catch limits for by-catch species in the areas open to fishing (paragraphs 6.21 to 6.23).

3.68 WG-FSA-17/36 described the tag-recapture data inputs to the 2017 Ross Sea region stock assessment, including estimates of effective tag detection and tagging survival rates. Vessel-specific effective tag survival and detection rates describe the relative likelihood of the survival of fish tagged by a vessel and the detection of tagged fish by a vessel.

3.69 The Working Group recalled that the method directly estimates vessel-specific tag detection and tagging survival rates by pairing each individual tag release or recapture event with all other fishing events that occurred within a specified distance and in the same fishing season and had shown that there were significant differences between vessels in the Ross Sea region (Mormede and Dunn, 2013). For the stock assessment, effective tag survival and detection rates for a vessel are calculated from a combination of the individual vessel tag survival and detection rates and the catch proportion of the vessel in the fishery.

3.70 The Working Group noted that although individual vessel effective tag survival and detection rates did not change in a consistent way towards better or worse performance over time (as indicated by analyses carried out during the meeting), the decreases in the overall effective tag survival and detection rates were caused by vessels with poor performance taking a higher percentage of the total catch in more recent years. The catch-weighted effective survival rates of tagged fish for the fishery have generally decreased since 2001 from 80% to about 65% and the effective tag detection rates from 100% to about 85% in the most recent years (WG-FSA-17/36, Table 7).

3.71 The Working Group noted that the effective tag detection rates were relatively similar across gear type and Member during the period from 2014 to 2017, whereas the effective tag survival rate varied strongly by gear type and Member (Figures 1 and 2). The effective tag survival rate for trotline was nearly half that for autoline and Spanish longline, and substantially lower for Korean, Russian and Ukrainian vessels compared to other Members fishing in the Ross Sea region.

3.72 The Working Group noted that differences in training programs and tagging practices implemented by each Member may contribute to variation in effective tagging rates. The Working Group recalled a similar discussion on reported by-catch in the Ross Sea toothfish fishery in 2015 (SC-CAMLR-XXXIV, Annex 7, paragraphs 8.1 to 8.9) with similar groupings of Members. The by-catch differences had also been linked to operational practices.

3.73 The Working Group requested that all Members fishing in the Ross Sea region provide information about their tagging training processes and provide video footage of the tagging process on board each fishing vessel to WG-FSA-18 to enable an evaluation of tagging practices. The Working Group also noted that photos of large numbers of tagged fish would help with an evaluation of the variability in tagging practices on a vessel.

3.74 The Working Group requested that the Secretariat update the meta-analysis on by-catch in the Ross Sea toothfish fishery for WG-FSA-18 (WG-FSA-15/04 Rev. 1).

3.75 WG-FSA-17/37 Rev. 1 and 17/38 presented an updated assessment model for *D. mawsoni* in the Ross Sea region that used catch, catch-at-age and tag-recapture data from 1998 to 2017 and included the results from the Ross Sea shelf survey from 2012 to 2017. The MPD estimate of B_0 using CASAL rev. 4648 were within 2% of that from rev. 5470 used in WG-FSA-17/37 (see paragraph 2.26). The model estimates of unfished biomass of 72 620 tonnes (95% CI: 65 040−81 050 tonnes) and current status of 0.72 (0.69–0.75) were higher than those from the 2015 assessment. This difference was likely driven by the revised estimates of the effective tag survival and detection rates.

3.76 Model sensitivity runs indicated that the data from the Ross Sea shelf survey were required to reliably estimate relative YCS from 2003 to 2011. The Working Group noted that the information from the survey data on YCS contrasted strongly with that from the commercial catch-at-age data.

3.77 The Working Group noted a consistent bias in estimated versus observed median length of tag recaptures in the diagnostic plot and recommended future work to investigate this issue.

3.78 The yield that satisfied the CCAMLR decision rules was estimated using different scenarios for a catch split between the shelf, slope and north areas of the Ross Sea region consistent with previous fishing activities, or between the areas north and south of 70°S and the special research zone (SRZ) of Ross Sea region marine protected area (MPA) consistent with CM 91-05. The estimated yields ranged from 3 213 to 3 378 tonnes.

3.79 All yield estimates were higher than that pre-specified catch limit for 2018 in CM 91-05 which states that 'the total catch limit shall be fixed at a level within the range of 2 583 to 3 157 tonnes per fishing season, based on advice from the Scientific Committee in 2017, 2018 and 2019 (CM 91-05, paragraph 28i)'. The Working Group therefore agreed that the catch limit be set at 3 157 tonnes for the 2017/18 and 2018/19 fishing seasons as per CM 91-05.

Shelf survey

3.80 WG-FSA-17/57 presented a summary of longline surveys that have been conducted to monitor recruitment of *D. mawsoni* in the southern Ross Sea since 2012. Six annual surveys have been conducted at a similar time of the year using standardised gear.

3.81 The Working Group noted that the survey time series has successfully tracked strong year classes through time, providing the first estimates of YCS, recruitment variability and recruitment autocorrelation for the *D. mawsoni* stock in the Ross Sea.

3.82 The Working Group noted that it was important to identify the relationship between sub-adult *D. mawsoni* and fish length-frequency data collected subsequently from commercial catch. Such an analysis could also provide information on fish movement.

3.83 The Working Group considered the proposal by New Zealand in WG-SAM-17/39 to continue the Ross Sea shelf survey for a further five years from 2018 and recalled the advice from WG-SAM-17 (Annex 5, paragraphs 4.69 to 4.72). The Working Group noted that the core strata would be sampled every year with the McMurdo and Terra Nova strata sampled in alternate years. Although an effort-limited survey, the different maximum catch rates observed in these strata would give rise to a total catch limit of 45 tonnes in 2018, 2020, 2022 and 65 tonnes in 2019 and 2021.

3.84 The Working Group noted that, to date, the survey has taken place following the commercial fishing season in areas where commercial fishing occurs. Following the adoption of CM 91-05, from 2017/18 the surveys will take place within a region of the MPA where fishing activities will be otherwise prohibited. Changes to fish density in the region resulting from a reduction in fishing effort may result in higher survey catch rates in the future and the survey catch limit may need to be reviewed.

3.85 The Working Group noted that in 2017, operational and sea-ice constraints meant the survey commenced from Terra Nova Bay in the northwestern stratum of the survey area. High catch rates encountered in this region at the start of the survey in 2017 required a reduction in station numbers in the southern strata to avoid exceeding the catch limit. Sampling fewer stations in the core strata resulted in a higher variance of survey estimates.

Management advice

3.86 The Working Group recommended that the catch limit be set at 45 tonnes for the 2017/18 survey and 65 tonnes for the 2018/19 survey and that the catch limits are deducted from, and not additional to, the Ross Sea region catch limit.

3.87 The Working Group recommended that following the procedure outlined in CM 91-05, the catch limit for the Ross Sea region (Subarea 88.1 and SSRUs 882A–B) in the 2017/18 season be 3 157 tonnes, with 467 tonnes allocated to the SRZ, 591 tonnes north of 70°S, 2 054 tonnes south of 70°S, and 45 tonnes for the Ross Sea shelf survey.

Capacity

3.88 WG-FSA-17/05 updated the metrics of capacity and capacity utilisation presented in WG-SAM-14/19 and WG-FSA-15/09 to monitor trends in capacity in exploratory toothfish fisheries in Subareas 88.1 and 88.2. The updated metrics showed a similar pattern to previous updates and did not indicate an over-capacity in the fishery. In the 2016/17 season, catch rates in Subarea 88.1 were the highest on record and the fishery was closed on 31 December 2016.

3.89 Based on a measure of potential daily fishing capacity and the catch limit for an area, the Working Group noted that the notified fishing capacity in some management areas compromises the ability of the Secretariat to forecast and issue a timely closure notice using the current fishery forecasting procedure. Catch overruns are likely to occur in areas with small catch limits, high catch variability and where substantial numbers of vessels enter simultaneously.

3.90 In the 2016/17 season, the fishery in SSRUs 881B, C and G was closed on 4 December 2016 with an overrun of 58% (218 tonnes). The Working Group noted that this overrun was the result of the combination of a relatively small catch limit and high catch rates (up to 50 tonnes per line) of vessels on a fishing ground that had been inaccessible for many years due to sea-ice.

3.91 At the request of the Working Group, the Secretariat reviewed the data from the fishery in SSRUs 881B, C and G in December 2016 and provided an illustration of the predicted cumulative catch based on the sum of the previous individual daily catch rates of the vessels in the fishery (Figure 3), which showed that the predicted and actual catches were very similar as the catch limit was approached.

3.92 The Working Group agreed that, had a pre-emptive closure been issued such that vessels were required to set and haul all gear by 00:00h on 2 December 2016, then it is likely that the level of overrun would have been reduced.

3.93 The Working Group also noted that the number of hooks deployed is reported in the daily catch and effort reports, but is not currently used in the catch forecasting. The Working Group agreed that CPUE (catch per hook) and the hook count could be used to improve the forecasting process by including catch that might be taken after the closure date from gear set prior to the closure into the predicted closure date forecast.

3.94 The Working Group noted that other options may also be available to avoid catch overruns, for example effort limitation, increased frequency of catch and effort reporting, or increased reporting to the fishery by the Secretariat on the current cumulative catch. The Working Group requested the Scientific Committee to further consider such options.

3.95 Within the current closure forecasting approach, where the catch limit may be reached within seven days of the start of the fishery, it may not be possible to collect sufficient catch data to issue a closure notice in time to prevent an overrun. The Working Group asked the Scientific Committee to consider whether in these instances a pre-emptive closure notice should be issued using predicted catch rates from previous years, and that incremental extensions to the closure date could then be issued accordingly.

3.96 Where the catch limit may be reached within seven days it may not be possible to collect sufficient catch data and issue a closure notice to prevent an overrun utilising the existing closure forecasting approach.

3.97 The Working Group agreed that in situations where catch limits may be reached before the Secretariat is able to predict a closure time, a pre-emptive closure notice should be issued based on the predicted catch rates and that extensions for the closure could be issued should the rate of increase in the cumulative catch be less than predicted.

3.98 The Working Group noted that catch allocations to individual Members or vessels in a fishery, or an area with a small catch limit, could help to avoid catch overruns. In addition, any substantial catch overrun in an area in a fishing season could be compensated by the catch limit in the subsequent fishing season.

3.99 The Working Group noted that with the introduction of the Ross Sea region MPA in 2017/18, mechanisms to avoid catch overruns may need to be considered for the management of the Olympic fishery in the SRZ due to its relatively low catch limit.

3.100 Dr Kasatkina noted that WG-FSA-17/05 linked capacity in the fishery with the ability of the Secretariat to forecast and issue a timely closure notice. She was concerned that the current fishery forecasting system could lead to restrictions for notified vessels to enter simultaneously in some management areas. Dr Kasatkina noted that the Secretariat should be able to develop systems to forecast timely closure notices that would support all notified vessels that operate in accordance with CM 41-09 in the Ross Sea fishery.

Research proposals in the special research zone of the Ross Sea region marine protected area (MPA)

3.101 The Working Group considered two proposals by Members to conduct toothfish research in the newly created SRZ of the Ross Sea region MPA submitted by Russia (WG-FSA-17/26) and Ukraine (WG-FSA-17/35).

3.102 WG-FSA-17/26 presented a proposal for a 10-year research program under CM 24-01 in the SRZ with a focus on providing data on toothfish biomass, stock structure, movement and life history. The proposed research fishing follows a grid in a main research area as recommended by the Scientific Committee in 2013 (SC-CAMLR-XXXII, paragraphs 3.155 to 3.160) and an additional area following one of three options, with a tagging rate of 5 fish per tonne and a catch limit of 100 tonnes (60 tonnes in the main research area and 40 tonnes in the additional area). The proposal indicated that the research program provides opportunities for collaborative investigations in the SRZ by the Russian vessel in the main area and vessels from other CCAMLR Members in the additional area.

3.103 WG-FSA-17/35 presented a proposal by Ukraine for scientific research in the SRZ under CM 24-01. The proposed research includes tag deployments to examine the toothfish life cycle, abundance and movement, stratified surveys of slope habitats with contrasting local exploitation rates to monitor effects of fishing on toothfish and other demersal fishes, and biological sampling to investigate life-history hypotheses and biological parameters, including the stock structure, of toothfish. The proposal suggested a tagging rate of 3 fish per tonne for the first 30 tonnes of catch and 1 fish per tonne thereafter and included a program of plankton sampling and the collection of acoustic and temperature data.

3.104 Dr K. Demianenko (Ukraine) informed the Working Group that, if the proposal was approved, the Ukrainian vessel would concentrate its fishing activity on the proposed research, but if the proposal was not approved, it would still be able to conduct some of the proposed research as part of the Olympic fishery in the SRZ.

3.105 The Working Group recalled its advice from WG-SAM-17 (Annex 5, paragraphs 4.73 to 4.81) that the SRZ will be open to exploratory fishing from 2017/18 onwards with a catch limit of 15% of the overall catch limit for the Ross Sea region. It further noted that there is no requirement in CM 91-05 for Members to submit proposals for conducting research in the SRZ, and that under CM 91-05 a requirement to tag toothfish at a rate of 3 fish per tonne would not be introduced until the start of the 2020/21 season.

3.106 The Working Group noted that careful consideration should be given to the potential impact of research conducted within the SRZ upon the Ross Sea region stock assessment. As the SRZ is open to all vessels notified to fish in the Ross Sea region fishery, concern was raised that prior to the introduction of a 3 fish per tonne requirement in 2020/21, different tagging rates as indicated in the research proposals could introduce bias into the stock assessment.

3.107 The Working Group requested that the Scientific Committee consider how research proposals conducted in the SRZ link to the Ross Sea region MPA research and monitoring plan (RMP) and/or contribute to the management of *D. mawsoni* in the Ross Sea region.

3.108 The Working Group evaluated the two research plans against the priority elements for scientific research in support of the Ross Sea region MPA in the SRZ in CM 91-05, Annex 91-05/C, Table 2.

3.109 With respect to the Ukrainian proposal, the Working Group noted that, despite the recommendation from WG-SAM-17, the proposal still lacks specific objectives and details about the data collection program, data analyses and how these analyses contribute to the research objectives and priority elements. The Working Group also noted that standard protocols are yet to be developed for the collection and analysis of acoustic data from longline vessels before acoustic data can be used.

3.110 With respect to the Russian proposal, the Working Group noted that the systematic survey design was a suitable approach to develop time series of a range of data such as abundance indices and catch composition and biological characteristics in the SRZ. The Working Group also welcomed the links between outcomes of this research with the topics from the RMP (SC-CAMLR-XXXVI/20) presented during the meeting.

3.111 The Working Group noted that 60 hauls were proposed for the main area by the Russian autoline vessel *Palmer* and 40 hauls in an additional area by a vessel from another Member. The location of the additional area was dependent on sea-ice conditions, but the Working Group noted that the strategy where fishing would take place with variable sea-ice conditions was unclear (SC-CAMLR-XXXIV/BG/31).

3.112 The Working Group noted that catch rates from previous research in the same area (autoline from 2002 to 2006 and trotline from 2010 to 2012) should be used to estimate a catch limit for this effort-limited survey.

3.113 The Working Group recommended that proponents of research within the SRZ should consider the impact of exploratory fishing in the SRZ on their ability to conduct specific research plans. Coordination of research activities with other Members may reduce these impacts.

3.114 The Working Group noted that CM 91-05 does not prescribe how catch limits for research within the SRZ are to be allocated. The Working Group recommended that this issue should be considered by the Scientific Committee. It recommended that research catches in the SRZ should be allocated from the SRZ catch limit to ensure that the objective of limiting the exploitation rate in the SRZ is preserved.

D. mawsoni in Subarea 88.2

3.115 WG-FSA-17/39 presented a summary of the toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) and assessed whether the current research plan in this area is thus far achieving its goals and if the current fishing levels are precautionary.

3.116 The Working Group noted that catch rates, length-frequency data, access to research blocks and Chapman biomass estimates for the north and south areas all indicate that the current catch limits in the Amundsen Sea region are precautionary.

3.117 The Working Group recommended that the research plan should continue as recommended by the Scientific Committee in 2016 (SC-CAMLR-XXXV, paragraph 3.215).

3.118 The Working Group noted that the rate of development of scientific information needed for the development of an assessment may be improved by a coordinated approach to the collection and analyses of data from SSRUs 882C–H. In particular, while the research blocks developed by the Scientific Committee in 2014 (SC-CAMLR-XXXIII, paragraphs 3.173 and 3.174) had successfully focused effort into areas of tag release, there was still a lack of spatial overlap of effort between years. In addition, in recent years, a number of new vessels had entered the fishery that had unknown metrics of tagged fish survivability or rates of detection of tagged fish and inter-vessel calibration of these had not been undertaken.

3.119 The Working Group recommended that vessels intending to participate in research fishing in SSRUs 882C–H in 2017/18 coordinate their research fishing for the coming seasons by targeting those seamounts in SSRU 882H and in the research blocks in SSRUs 882C–G that had been fished in recent years to maximise the likelihood of recapturing tagged fish.

3.120 Further, the Working Group encouraged Members to coordinate their research fishing to allow for vessel calibration analyses to be undertaken (i.e. fishing within 20 km of locations fished by other vessels in the same season).

3.121 The Working Group requested that the Scientific Committee consider approaches by which research by Members who intend to carry out research in SSRUs 882C–H can be coordinated to develop the progress towards achieving a robust assessment for the region.

3.122 The Working Group also noted that there were a number of years and research blocks in SSRUs 882C–H for which no ageing data was available. The Working Group recalled previous advice (SC-CAMLR-XXXV, paragraph 3.213) requesting that Members provide validated age data for the area.

3.123 The Working Group requested that Members age otoliths as per the priorities given in Table 1 to develop annual ALKs.

3.124 The Working Group recommended that each Member when ageing otoliths should:

(i) use a standard reading protocol for *D. mawsoni* as documented in SC-CAMLR-XXXI, Annex 7, paragraphs 10.1 to 10.19, WG-FSA-12/43 and Australian (WG-FSA-14/45) or Russian (WG-FSA-12/18) manuals

(ii) cross-validate their readings both using multiple readings of the same otolith by the same laboratory and between different Member laboratories, and by readings of standard reference otolith sets, and report these to WG-SAM. This can be done with both physical otolith preparations and high-resolution photographs of prepared otoliths (SC-CAMLR-XXXI, Annex 7, paragraphs 10.9 to 10.17)

(iii) seek coordination among Members to conduct cross-validation tests that could be organised and conducted through the use of an e-group, and a repository of photographic reference sets that could be made available on the CCAMLR website. Discussions within the e-group could include developing a standardised format for photographic reference sets.

3.125 In selecting otoliths for ageing from the otolith collection, the Working Group recommended that otoliths selected for ageing should be taken as a random sample from the available otoliths, with a minimum of five otoliths from fish in each 10 cm length bin for each sex (or if five are not available, then the maximum number available) for each Member in each year.

3.126 The Working Group noted that these age data, including readings of the reference set, should be provided to the Secretariat, and reported, along with sampling methods, ageing methodology and progress on cross-validation, to WG-SAM-18 for evaluation and hence potential inclusion in analyses for WG-FSA-18 for SSRUs 882C–H.

Research to inform current or future assessments in 'data-poor' fisheries (e.g. closed areas, areas with zero catch limits and Subareas 48.6 and 58.4) notified under Conservation Measures 21-02 and 24-01

Generic issues and advice from WG-SAM-17

4.1 The WG-SAM Convener summarised advice from the 2017 meeting of the Working Group, including recommendations related to procedures for proposals and reporting on research plans in data-poor fisheries. The Working Group recalled that the primary goal of research plans conducted in data-poor fisheries should be to develop a robust estimate of stock status and enable the estimation of precautionary catch limits consistent with CCAMLR decision rules (SC-CAMLR-XXX, Annex 5, paragraph 2.25), and that research objectives should be to develop: (i) an index of stock abundance, (ii) a hypothesis of relationship of fish in the research area to the overall stock, and (iii) estimates of biological parameters relating to productivity (i.e. maturity, growth and recruitment) (SC-CAMLR-XXX, Annex 5, paragraph 2.27).

4.2 The Working Group recognised that not all research programs proposed in accordance with CM 24-01 are aimed at developing a stock assessment, and that specific objectives for these research proposals must be clearly described, as they may be exempt from a number of conservation measures.

4.3 WG-FSA-17/13 proposed procedures for proposals and reporting on research plans in data-poor fisheries. The Working Group reviewed these criteria and their potential application to proposals for research in data-poor fisheries. The Working Group agreed that it is important to have clearly identified standardised requirements for proposal reviews, and that these requirements provide structure and clarity for those Members developing research proposals. It will also provide clarity for the Working Groups when evaluating these proposals.

4.4 The Working Group noted that specific milestones, as demonstrated in several proposals, should be developed in all research plans for data-poor fisheries. This can include information from previous papers, etc. to demonstrate that this work has been done successfully. The Working Group developed a number of specific milestones that may be applicable to research plans in data-poor areas as suggestions for milestones to be incorporated into proposals submitted next year as appropriate (Table 2).

4.5 The Working Group drew on elements of WG-FSA-17/13, along with discussions during the course of the meeting to develop research criteria for evaluating research proposals submitted for data-poor fisheries.

4.6 The Working Group recalled that CM 24-01, Annex 24-01/A, format 2 provides the template for research proponents to provide information on planned research and research capability. The Working Group used the categories in CM 24-01/A, format 2 and advice from the Scientific Committee to evaluate research proposals and progress reports in data-poor fisheries (i.e. research plans submitted under CMs 21-02 and 24-01 in areas where no stock assessment is in place) (SC-CAMLR-XXIX, paragraph 3.126; SC-CAMLR-XXIX, Annex 6, paragraph 5.1) to evaluate if research plans would be likely to meet their objectives.

4.7 The Working Group therefore recommended evaluating research proposals against the following criteria:

(i) Is the proposed research likely to:

   (a) generate an index of localised stock abundance
   (b) estimate biological parameters relating to productivity
   (c) test a hypothesis of relationship of fish in the research area to the overall stock (SC-CAMLR-XXX, paragraph 2.4; SC-CAMLR-XXX, Annex 5, paragraph 2.27)?

(ii) Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention (CM 24-01, Annex 24-01/A, format 2, category 4b)?

(iii) Are the likely impacts from the proposed research on dependent and related species consistent with Article II (CM 24-01/A, format 2, category 4c)?

(iv) Does the proposed research contain the details needed for WG-SAM, WG-FSA, and the Scientific Committee to evaluate the likelihood of success and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal (CM 24-01/A, format 2, category 3)? Appropriate milestones are set out in Table 2.

(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs (CM 24-01/A, format 2, category 5)?

For example:

(a) vessels with no or little experience in toothfish tagging programs may organise extra training, crew exchange, or scientific collaboration to demonstrate capability

(b) new vessels could gain experience outside data-poor fisheries, using experienced vessels for participation in research plans.

(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carrying out the proposed research plan on the water (CM 24-01/A, format 2, category 5)?

(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research data and sample analysis (CM 24-01/A, format 2, category 5)?

For example:

(a) the research team may bring in experience from other CCAMLR Members with the needed experience, including non-fishing Members

(b) the research team may identify specific tasks to be completed by contractors by identifying the contractors and detailing the arrangement.

4.8 The Working Group recommended that other considerations beyond target catch and finfish by-catch should be included in research proposals in data-poor areas and reported to the Working Groups. This should include data collection protocols and characterisation of vulnerable marine ecosystem (VME) taxa, seabirds and marine mammals (such as described in WG-FSA-17/45 and 17/46). Further consideration could include information on other components of the ecosystem within the proposed research area, such as physical oceanographic properties or habitat characteristics, which could be collected by the vessel or characterised though other research initiatives. The latter could elucidate other potential ecosystem interactions with the proposed research, or allow for more robust evaluation and optimisation of methodologies and/or sampling designs to address stated objectives and hypotheses.

4.9 The Working Group recommended to the Scientific Committee that a new or modified proposal tabled in future years should directly address the evaluation criteria by cross-referencing paragraphs in the proposal to these criteria, or cross-referencing to previous report text.

4.10 The Working Group considered the issue of proposals that had been revised during the meeting and new elements, ad hoc modifications, or revisions in sampling designs of research proposals that were beyond that originally tabled and formally discussed at WG-FSA. It agreed that the role of WG-FSA was to evaluate and provide comment on proposals submitted by the deadline to WG-FSA. Additional comments from WG-FSA on the proposals, as well as potential revisions to proposals by the proponents should be forwarded to the Scientific Committee for consideration.

4.11 The Working Group noted the difficulty of evaluating the capability of proponents to implement: (i) at-sea activities if a new research platform is proposed, and given there is currently no mechanism to evaluate the importance of different kinds of at-sea experience (e.g. experience of scientific observers, crew, and officers), (ii) proposed data and sample analyses where no such analyses have been presented to working groups in the past.

4.12 The Working Group reviewed an updated map of regions contained in all proposals (Figure 4) and requested that all proponents provide the geographic data required (Annex 5, paragraph 4.16) in order that the Secretariat can provide this to working groups routinely in the future.

4.13 The Working Group noted that the different geographic projections used in the display of maps in the different proposals made the review of those proposals very difficult. It recommended that all plots use the projection provided by CCAMLR in its GIS and R packages (Thanassekos and Robinson, 2017) or state the projection used on the map.

4.14 The Working Group noted that the large and scattered number of research blocks for these proposals would benefit from a more integrated, holistic strategy, which was also a recommendation set out in the Second CCAMLR Performance Review (CCAMLR-XXXVI/01) and requested guidance from the Scientific Committee on how to develop such a strategy.

4.15 The Working Group noted that Ukraine has proposed to conduct research in Subareas 48.1 (WG-FSA-17/32), 48.2 (17/27), 88.1 (17/35), 88.3 (17/34) and Division 58.4.2 (17/33). The Working Group noted the large amount of data and sample analysis activity that would be required to achieve the research objectives, including ageing the required number of otoliths across multiple subareas/divisions. It was noted that an overarching strategy or scheme of prioritisation for research undertaken by Ukraine would assist the Working Group to provide advice on whether the respective research plans are likely to achieve the objectives.

4.16 The Working Group requested that the Scientific Committee give consideration to the feasibility of proposals where individual Members have notified to undertake research in multiple division/subareas, since they may not have the capacity to complete milestones of the research when commitments are spread across multiple research programs.

4.17 The Working Group discussed the issue that in several of the data-poor research plans, research that was agreed was not completed due to a variety of reasons. In particular, the Working Group noted that considerable time was dedicated to discussing and improving research proposals both at WG-SAM and WG-FSA, but noted research is often not completed as priority is given to other fisheries (e.g. Olympic fisheries, or other research proposals) rather than the completion of the research plan. The Working Group noted that the data collection phase can cease while the data analysis phase continues and is not considered as failing to meet all the objectives.

4.18 The Working Group requested the Scientific Committee to develop mechanisms to ensure that completion of existing research is given priority.

Gear selectivity and standardisation of effort

4.19 The Working Group noted the ongoing discussions about gear selectivity and standardisation of effort between trotlines and Spanish/autolines (Annex 5, paragraphs 4.22, 4.39 and 4.41). The Working Group recalled that the effect of gear type will depend on the research question asked (SC-CAMLR-XXXV, Annex 7, paragraphs 4.55 to 4.61), for example questions regarding stock hypotheses such as life stages in areas, biological parameters or spatial distributions may not be affected, whereas catch rate analyses or tag release performance may be (paragraph 3.71 and Figure 1). However, at present gear type and Member State are often still conflated variables that would need to be disentangled (WG-FSA-15/04 Rev. 1 and 17/16).

4.20 The difference between model-based and design-based effects on analysis is an area of active discussion in statistics, and the Working Group noted that particularly regarding the characteristics of different gears, a focus topic at WG-SAM would be useful to address the following issues:

(i) design-based versus model-based approaches to gear standardisation

(ii) performance of tag releases and recaptures associated with gear type

(iii) approaches to consolidate effort between different gear types for CPUE evaluations

(iv) characterisations of gear types, such as bait types or hook types and line length and number of hooks.

Estimates of local biomass and catch limit for data-poor fisheries

4.21 WG-FSA-17/42 provided estimates of local biomass of toothfish with bootstrapped confidence intervals, for *D. mawsoni* and *D. eleginoides* in research blocks in Subareas 48.2, 48.6, 58.4 and 88.3. The default CPUE by seabed area and Chapman mark-recapture methods agreed at WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 2.28) were applied with revised parameter values agreed at WG-SAM-17 (Annex 5, paragraph 3.10).

4.22 Estimates of local biomass presented in WG-FSA-17/42 were updated over the course of the meeting to include:

(i) vulnerable biomass estimates from the 2017 assessments in the Subarea 88.1 and Division 58.5.2 reference areas

(ii) a median CPUE in the last three complete seasons in which fishing occurred, applied to calculate the reference areas' CPUE

(iii) the agreed natural mortality value of 0.13, applied in the calculation of the number of tagged *D. mawsoni* available for recapture

(iv) fixing of some small data-processing issues to ensure all catch and tagged fish recaptures were being included in estimates

(v) one year of tags at liberty, used in Chapman estimates in research blocks 486_2 and 486_3 (paragraph 4.80).

4.23 Changes made throughout the course of the meeting to the R Markdown used to generate the local biomass were documented in a GitHub repository that was shared with Working Group members for review and comment.

4.24 The Working Group noted that the Ross Sea region vulnerable biomass estimated in the 2017 assessment increased by about 10% relative to the 2015 assessment whilst the Heard Island and McDonald Islands (HIMI) vulnerable biomass decreased by about 25%. These changes were reflected in changes in the CPUE by seabed area estimates of biomass for the research blocks.

4.25 The Working Group noted that *D. mawsoni* biomass estimates from the CPUE by seabed area method in WG-FSA-17/42 have increased relative to the estimates that were presented at WG-FSA-16, and that these changes were due to reference area biomass and the reference seabed area in the Ross Sea region. These estimates also demonstrated greater overlap in confidence intervals with the Chapman estimates in some *D. mawsoni* research blocks. It was further noted that there was less change in biomass estimates for *D. eleginoides* compared to WG-FSA-16 estimates relative to *D. mawsoni*, as there was only a change in the reference area biomass parameter value and no change to the seabed area parameter value for the HIMI reference area.

4.26 The Working Group recalled past advice to use the lowest of the two values, as well as the desire to move to tag-based estimates where suitable. It further recalled that the CPUE by seabed area method is only intended as a first indication where no other information is available. Development of an integrated method using both values and their uncertainty was presented at WG-SAM-17 (WG-SAM-17/37) and further development was encouraged. The Working Group noted that the trends in the tag-based estimates of biomass could provide further information on the suitability of such estimates to provide advice.

4.27 The Working Group noted that in some cases there were still differences in estimates between methods, and that these may be due to a systematic bias in both methods, which could be related to tag survival, migrations and other factors. Specific reasons for these differences require further exploration in the future.

Development of trend analysis rules for methodology and calculation of catch limits in data-poor toothfish fisheries

4.28 The Working Group considered whether there was the potential to use the available time series of biomass estimates in existing research blocks to indicate how the local stock might be responding to the catches within the research blocks. It considered methods for determining catch limits for research blocks to interpret this information, including using a rule based on a qualitative interpretation of trend to recommend catch limits.

4.29 The time series of biomass indices for each research block (Figure 5 for *D. mawsoni* and Figure 6 for *D. eleginoides*) were qualitatively evaluated by the Working Group to determine if the trend in the indices was increasing, stable, decreasing, or was not able to be determined.

4.30 Where the trend was stable or increasing, the Working Group considered rules that would allow the catch limit to increase, but not be subject to high levels of interannual variability. Similarly, where the trend showed a decrease, the Working Group considered that reductions in catch limits would be appropriate, and these should be robust to high interannual fluctuations as well.

4.31 The Working Group noted that the International Council for the Exploration of the Sea (ICES) had adopted a procedure that used recent trends in abundance indices to update the catch limit, while restricting interannual fluctuations to a maximum of 20% per year (ICES, 2012).

4.32 The Working Group then developed a set of trend analysis rules based on the qualitative evaluation of trend, and used the biomass estimates from the Chapman method if reliable, and the CPUE method otherwise, to determine a proposed catch limit for each of the research blocks. These estimates were then constrained so that they did not change by more than 20% per annum.

4.33 The trend analysis rules developed by the Working Group for choosing a methodology for estimation and calculation of catch were:

> Apply a 4% exploitation rate to the Chapman and/or CPUE by seabed area biomass estimates, including up to the most recent season in which sampling has been completed for each research block (B4%):

- IF the trend was stable –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate.
- IF the trend was declining –
  - use the current catch limit × 0.8 (regardless of adequate recaptures or not).
- IF the trend was increasing –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate.
- IF the trend was too short, too variable, or trends between abundance indices are in conflict –
  - if adequate recaptures, use the B4% from the most recent Chapman estimate
  - otherwise use the B4% from the most recent CPUE by seabed area estimate.
- AND constraining any changes in the proposed catch limit to be not more than a 20% increase or decrease from the current catch limit.

4.34 Trends were qualitatively evaluated over recent years, and adequate recaptures are defined as at least three recaptures per year in at least two of the last three years.

4.35 The results of the applied trend analysis rules to estimate catches for data-poor fisheries in 2017/18 are set out in Table 3. The Working Group recommended that these catches be used for management advice of these fisheries in the 2017/18 season.

4.36 The Working Group noted that similar rules applied by ICES for low-information stocks had been evaluated using management strategy evaluation (MSE) (ICES, 2012). Whilst the Working Group agreed that the trend analysis rules developed here to calculate catches could be used for management advice for the 2017/18 season, it acknowledged that it lacked a formal evaluation of how the different methods may perform for the management of data-poor stocks in CCAMLR.

4.37 The Working Group recommended the Scientific Committee consider the following as priority work for WG-SAM and WG-FSA:

(i) MSEs underlying the establishment of these trend analysis rules for providing advice on catch limits be a priority topic for WG-SAM-18, particularly if they are to be applied in future years

(ii) the method for qualitative evaluation of trends be better formalised

(iii) how Members who fish in research blocks develop methods to understand the relationship of local biomass estimates to the rest of the stock, and describe these methods to WG-SAM-18

(iv) how Members who fish in research blocks investigate the patterns in Chapman biomass estimation using both one and three years of tagged fish at liberty, and recommend only tagged fish recaptured after one year at liberty be used if evidence of immigration was found

(v) that additional work should be conducted to examine the applicability of these trend analysis rules when survey designs change (e.g. changes in fixed effort surveys, or changes in participating vessels).

4.38 It was recognised that fishing within research blocks as a strategy for obtaining information necessary to provide management advice is an interim step in the much broader goal of understanding the dynamics and productivity of overall toothfish stocks in the CAMLR Convention Area. As such, the Working Group acknowledged that new methods and strategies will be required to incorporate consideration of future proposals that endeavour to undertake research fishing outside of existing research blocks.

Management area research reviews

Dissostichus spp. in Area 48

4.39 WG-FSA-17/54 noted that although there are many research proposals tabled for Area 48, there is currently no coordinated research strategy for the area. It recommended the development of regional stock hypotheses which would allow Members to focus on specific aspects of required research, the results of which would in turn assist in developing additional testable hypotheses.

4.40 The Working Group considered that the requirement of the development of stock hypotheses is a priority for data-poor fisheries research, including the identification of critical areas to test hypotheses for all regions beyond local area research proposals that sample only a limited portion of the stock (paragraphs 4.131 to 4.133). It noted that such effort was already underway in Area 58 and followed the research plan established in the Ross Sea region. Potential processes to develop such overarching structures were discussed, including setting up multi-Member workshops such as that proposed by Germany in February 2018 (paragraph 8.22), or bringing stock hypothesis papers to the CCAMLR working groups. The Working Group noted that in areas where information was missing to develop stock hypotheses, such as hydrological models, then collating that information and developing hypotheses should be a first priority and the resulting stock hypotheses should be used to direct research activity.

Review of available information and data quality

Subarea 48.2

4.41 WG-FSA-17/30 presented the results from an elemental microchemistry study of *Dissostichus* spp. in Subarea 48.2 by Chile. Results indicated differences in nursery areas and adults between *D. mawsoni* and *D. eleginoides*, consistent with *D. mawsoni* inhabiting colder areas, which might be latitude and/or depth related. Results also showed significant differences within species consistent with an ontogenetic habitat shift in both species. Future work will include further otolith sampling and ageing of the fish analysed, as well as an increase in water chemistry sampling to help elucidate the patterns seen.

4.42 The Working Group thanked Chile for bringing such an advanced analysis so soon after the survey was completed. It noted that the expected distributions and movement of toothfish based on otolith microchemistry were consistent with that based on other information such as length frequencies in different areas. It further noted that previous work (e.g. Darnaude et al., 2014; Sturrock et al., 2015) showed the influence of physiological processes on the deposition of metals in otoliths and that the environmental signal could be confounded with the physiological signal. The Working Group suggested that using such a method on recaptured tagged fish after a long-distance migration might help to identify signals in microchemistry data. The Working Group agreed that incorporating the age of the fish into the analysis would be useful and suggested that a workshop on otolith ageing and otolith microchemistry might be helpful to foster collaborations and progress in this field.

4.43 WG-FSA-17/43 reported the results of the survey by Ukraine in Subarea 48.2. The results included catch, length–weight and age data for both species of toothfish.

4.44 The Working Group thanked Ukraine for ageing toothfish in this area. It recommended that the ages be validated using a CCAMLR otolith reference set, that between-reader calibrations be conducted and results of those be presented as a separate paper to WG-SAM along with a description of the method used.

4.45 The Secretariat encouraged Members who have collected otoliths and aged them to contribute to the Secretariat reference set, as only one is available at the moment, although a digital reference set is also available. Australia noted that it is currently in the process of developing another otolith reference set based on a different preparation methodology as detailed in WG-FSA-17/15. Further diagnostic plots such as age frequency were also requested.

4.46 The Working Group further recommended that detailed mark-recapture data be presented by year of release and of recapture by species, and that a description of the gear be provided to the Secretariat for addition to the gear library.

4.47 The Working Group noted that the sample size for biological analyses seemed very low based on the number of fish caught. It requested that a protocol specifying the sampling targets for biological data be provided. It also noted that these data should be statistically analysed, and that equations and fits should be provided for the biological relationships such as the growth curve.

4.48 The Working Group recalled that the local area sampled in a research plan does not comprise a stock, and that local area Chapman biomass estimates do not constitute a stock assessment and, therefore, the abundance estimation, while essential for the determination of precautionary catch limits for the survey, was only representative of local abundance. Furthermore, some Members recalled that the *Simeiz* presented a low effective tagging survival rate and tag-detection rate in the Ross Sea region (WG-FSA-17/36, Table 6), and that this should be taken into consideration when calculating local biomass based on mark-recapture data from this vessel. The Working Group suggested that biomass estimates from the Secretariat could be used to set catch limits.

4.49 The Working Group noted a five-fold increase in Macrourid by-catch in the 2016/17 season and recalled the advice from WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 4.114) to provide spatial and depth plots of these catches as well as corresponding numbers of toothfish caught. The Working Group suggested that a separate paper on by-catch in the area should be presented to WG-FSA. It further noted there might be a need to implement move-on rules within this research proposal.

Subareas 48.2 and 48.4

4.50 WG-FSA-17/46 reported an update on the results of the first year of a survey by the UK to investigate the connectivity between Subareas 48.2 and 48.4. The survey is located in an area where both species are expected to be found.

4.51 WG-FSA-17/48 presented the proposed location of research stations for all the Subarea 48.2 proposals in the 2018 fishery. The Working Group thanked the authors for collating all the information in one document (paragraph 4.73).

Review of progress towards a stock assessment and research proposals

4.52 The research proposals in the format submitted to WG-FSA were assessed following the criteria set out in paragraph 4.7 and summarised in Table 5. The Working Group agreed that the review criteria were aimed at evaluating new proposals and not progress made on existing proposals. The Working Group noted that it provided advice generic to all proposals and the discussion below is specific to where the proposal did not clearly meet a criterion.

Subarea 48.1

4.53 WG-FSA-17/32 presented the proposal by Ukraine to conduct research in Subarea 48.1. This proposal assumes that Subarea 48.1 comprises an entire stock unit delimited by contours and currents.

4.54 The Working Group noted that the research proposal is likely to generate a local abundance index but is geographically constrained with no plan to widen the research into a broader stock hypothesis. It reiterated the need to develop stock hypotheses in this area. The Working Group recalled that a number of demersal fish surveys have been carried out over the years, mostly in the shelf zone in the Subarea 48.1, notably by the USA and Germany. These surveys had caught small toothfish, and incorporating that information would help inform the development of a stock hypothesis.

4.55 The Working Group recalled the advice by WG-SAM-17 (Annex 5, paragraph 4.103) to present to WG-FSA information that was missing in the proposal submitted to WG-SAM. It noted that although some recommendations were implemented, biological sampling and statistical analyses proposed were still missing. The Working Group recalled that there are many proposals by Ukraine to carry out research and that the capacity of this Member to carry out all the proposed data and sample analysis is uncertain.

4.56 The Working Group noted that a new vessel is proposed for the work in Subarea 48.1 which has no demonstrated experience and performance in toothfish tagging programs. The Working Group welcomed the information offered by Dr Demianenko that the research proposed will include a video program documenting every tagging event, which will help document the suitability of fish that were tagged.

4.57 The Working Group noted that the sea-ice analyses were inconsistent with the experience of scientists in the same area at the time sea-ice conditions were summarised, and that the extent of sea-ice might be underestimated in the proposal, with many areas potentially inaccessible at the time of the survey.

4.58 The Working Group noted that not enough information was available to assess if the proposed catch limit of 40 tonnes was consistent with Article II, or if the survey was to be catch or effort limited. It noted that a local biomass estimate based on 2011 data suggested 68 tonnes, and that previous effort in the region could have been used to estimate local area biomass based on CPUE by seabed area (Arana and Vega, 1999).

4.59 Dr Demianenko stressed that research on toothfish in Subarea 48.1 will take into account the data-poor status of this marine area, in particular concerning toothfish. He also mentioned that Ukraine is ready to involve other vessels in this research program, including those with multiannual experience in the Antarctic fishery, including research activities.

Subarea 48.2

4.60 WG-FSA-17/27 presented the proposal by Chile to continue research in Subarea 48.2, including a change of vessel to the FV *Puerto Toro*, which uses trotlines. The design was the same as that presented at WG-SAM-17, with additional oceanographic transects to help inform biogeographic models where both species of toothfish occur. As tagging is very important, the proponents noted their intention to use baskets to haul fish and thoroughly assess the suitability of fish for tagging. This proposal was coordinated with Ukraine, and operational agreements were reached for this season. Chile noted that it is willing to continue collaboration with other countries in the future.

4.61 The Working Group noted that the research proposal from Chile is likely to generate local abundance indices but is geographically constrained with no plan to widen the research into a broader stock hypothesis. It further noted that although the proposal has a data collection plan for by-catch, it is not currently looking at the impacts of the research on by-catch species.

4.62 The Working Group noted that a new vessel is proposed by Chile which has no demonstrated experience and performance in toothfish tagging programs. It acknowledged that the observer has extensive experience in the Chilean national tagging program.

4.63 The Working Group noted that, consistent with the principles for research plans described in WG-FSA-17/13, the prospecting phase in any one area should be limited to one year, and that estimations of local biomass using CPUE by seabed area or Chapman estimates should be developed thereafter.

4.64 WG-FSA-17/31 presented the proposal by Ukraine to continue research in Subarea 48.2. This revised proposal included the recommendations from WG-SAM-17 and the intent to conduct plankton, acoustics and conductivity temperature depth probe (CTD) sampling.

4.65 The Working Group noted that the research proposal is likely to generate local abundance indices but is geographically constrained with no plan to widen the research into a broader stock hypothesis. Recalling previous discussions, the Working Group noted the need for a stock structure hypothesis in this area.

4.66 The Working Group welcomed the collection of information on the wider ecosystem and was interested in how the information collected using the plankton net would be used. It noted that although the proposal has a data collection plan for by-catch, it is not currently looking at the impacts of the research on by-catch species. The Working Group further recalled that there are many proposals by Ukraine to carry out research and that the capacity of this Member to carry out all the proposed data and sample analysis is uncertain.

4.67 The Working Group noted that the proposed vessel has multiple years of experience in the fishery but that its effective tagging performance is quite low (WG-FSA-17/36, Table 6). The Working Group noted that this information is not currently included in the assessments of proposals and requested advice from the Scientific Committee on ways to include this information more formally.

Management advice

4.68 The Working Group recommended that the existing 75 tonne catch limit be applied as the precautionary catch limit for the research proposed by Chile and Ukraine.

4.69 The Working Group noted the proposal that half the catch limit be allocated to each of the two vessels, and that the catch of the Chilean vessel be reallocated to the Ukrainian vessel fishing in March should the Chilean vessel not be able to fish in February due to, for example, unfavourable sea-ice conditions, as it was reflected in SC-CAMLR-XXXIV, paragraph 3.262.

Subareas 48.2 and 48.4

4.70 WG-FSA-17/45 presented the proposal by the UK to continue research investigating the connectivity between Subareas 48.2 and 48.4. The proposal includes a further two years of on-board activity and a subsequent two years of desk-based analyses of the data. The Working Group thanked the UK for including all the recommendations made at WG-SAM-17 and noted that the sampling regime in the updated proposal was in addition to the routine sampling proposed in the initial proposal. The Working Group noted that this proposal satisfied all the criteria set out in paragraph 4.7.

4.71 The Working Group noted that the proposal is effort-limited with 20 stations planned in the coming year and a precautionary catch limit for toothfish was proposed at 18 tonnes in Subarea 48.4 and 23 tonnes in 48.2 based on average catch rates for *D. mawsoni* in Subarea 48.4 under CM 41-03. The Working Group noted that in the previously agreed UK effort-limited proposal, the addition of an extra two stations, from 18 to 20 stations, had been planned and therefore there was a consequent need to increase the catch limit accordingly, particularly as the 2016/17 catches in Subarea 48.4 had nearly reached the catch limit. Calculation of the required increase in the catch limit was not discussed during the meeting of the Working Group.

Management advice

4.72 The Working Group requested that the Scientific Committee consider a catch limit taking into account its previous advice as well as the proposed modifications to this survey.

4.73 The Working Group noted that all of the proponents of research in Subarea 48.2 were present at the WG-FSA meeting, allowing collaboration to be developed further. The proponents submitted WG-FSA-17/48 Rev. 1, further clarifying the coordination of the research and analysis within each proposal as already previously outlined in WG-FSA-17/48.

Subarea 48.5

4.74 WG-FSA-17/25 presented an updated proposal for the third stage of the Russian research program in the Weddell Sea. A five-year longline survey program was proposed in the eastern region of the Weddell Sea, with the objectives to estimate fish distribution and abundance and assess biological parameters related to productivity of toothfish and by-catch species in Subarea 48.5, and to collect data for biological analysis of toothfish, including gonad histology, genetic analysis and parasitological analysis.

4.75 The Working Group recalled that the history of the reviews of this proposal was described in Annex 5, paragraphs 4.90 to 4.94. It noted that the Scientific Committee had requested an update on the analyses of catch rates in Subarea 48.5 (SC-CAMLR-XXXIII, paragraph 3.230; SC-CAMLR-XXXIV, paragraphs 3.271 to 3.275 and Annex 5, paragraph 4.94), and that such an update had not been provided to WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 4.71). It noted that WG-SAM-17 was not able to evaluate the proposal and that WG-FSA could not review the proposal either.

4.76 Dr Kasatkina noted that the background paper on previous Russian survey activities undertaken in Subarea 48.5 was submitted to the Commission in 2016 (CCAMLR-XXXV/BG/29 Rev. 1). She also noted that one or two vessels of the CCAMLR Member countries operating an autoline system are invited to take part in the Russian research program in the Weddell Sea. International scientific observation is invited on board the Russian vessel. She also noted that implementation of the research program will provide data on toothfish resource potential that is needed for planning the MPA in the Weddell Sea.

Subarea 48.6

4.77 WG-FSA-17/10 presented an update on the proposal by Japan and South Africa to continue their research plan in Subarea 48.6. Although the proposal was similar to that presented at WG-SAM-17, the proposal to extend research block 486_2 was withdrawn.

4.78 Analysis of mark-recapture data showed that including more than one year at liberty for tags increased the biomass estimate in research blocks 486_2 and 486_3, and that larger fish were present in those areas, consistent with a migration hypothesis, as seen in SSRU 882H. The proponents further proposed that research block 486_2 not be split into two blocks for the coming season due to a lack of clear scientific evidence at this stage.

4.79 The Working Group thanked the proponents for presenting their stock hypothesis for this region, and suggested it be brought to the workshop next year (paragraph 8.22). It also noted that the biomass estimates based on mark-recapture data were consistent over time, which provided additional confidence in these results.

4.80 The Working Group agreed that tags recaptured after one year at liberty only (rather than up to three) be used for research block 486_2 and 486_3 and that all research proposals investigate the effects of this option in the future. It further agreed that research block 486_2 not be split in the forthcoming year, but that data analyses consider the difference between the two parts of the research block.

4.81 The Working Group noted that the proposed vessels have multiple years of experience in the fishery but that their effective tagging performance metrics are currently unknown.

4.82 The Working Group noted that there have been ongoing issues implementing the research plan due to either accessibility of the fishing grounds or fishing capacity, including vessel commitments or preferences to fish elsewhere. It further noted that the aim of the research in the different research blocks varies and that annual access to all the grounds was not necessary for the success of some objectives of the research. Fishing capacity was still highlighted as a potential issue which might be mitigated by the inclusion of the Norwegian proposal in a single plan in the future.

4.83 WG-FSA-17/61 presented the proposal by Norway to start a survey in Subarea 48.6. The proposed research aims to investigate the east–west stock connectivity in the region, noting that the proposal in WG-FSA-17/10 investigates the north–south connectivity in the region, including the use of acoustics, of pop-up satellite archival tags (PSATs), and of environmental data collection. The authors noted that based on PSAT results from the Ross Sea, the detailed behaviour of toothfish is similar to that of cod, and using acoustic data might help describe vertical movement patterns of toothfish, as well as movements to areas not fished (such as deeper waters). They also noted that the gear type is different from other surveys and will allow comparison with other vessels.

4.84 The Working Group sought clarification of the areas Norway proposed to fish, and noted that the Norwegian proposal was in a prospecting phase whilst the joint Japanese/South African proposal (WG-FSA-17/10) was already in a catch-limited phase. The proponents confirmed that in the first year the research would be carried out in the research blocks and would develop the stock hypothesis to direct the location of research in the following years.

4.85 The Working Group noted that the proposal did not provide sufficient details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal. The Working Group further discussed the plans to estimate toothfish density using acoustics, and how to compare it with other methods. It welcomed the proposed research and noted previous efforts to separate toothfish from macrourid acoustics signatures which might be of help.

4.86 The proponents began collaboration with Japan and South Africa (WG-FSA-17/10) and submitted a revision of WG-FSA-17/61 highlighting this collaboration and the revision from a prospecting phase design to a catch-limited survey design to match the existing research plan. The Working Group acknowledged the collaboration achieved during the meeting, however, it could not comment on the revised proposal and assessed the original proposal as submitted.

Management advice

4.87 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

Dissostichus spp. in Subarea 58.4

4.88 WG-FSA-17/09 presented results on sex ratios, gonadal development and validation of macro- versus micro-staging of maturity in *D. mawsoni* from Subarea 88.2 and Division 58.4.1 from samples collected in February and March 2013. Sex ratios were, on average, 0.5 and skewing towards females with larger sizes. The paper stated that the ovarian development was consistent with group-synchronous spawning, and that at the time of data collection, 45% of females were at a mature stage. At a total length of 100 cm, 80% of females were mature, while 100% of males larger than 150 cm total length were mature.

4.89 The Working Group noted these results in relation to discussions around WG-FSA-17/16. The Working Group suggested further work to progress towards maturity ogives on age and length at smaller spatial scales, evaluate spatial patterns in gonadosomatic indices and sex ratios, and explore gonadosomatic indices for a selected size mode throughout the regions.

4.90 The Working Group considered WG-FSA-17/12, presenting results of fatty acid and stable isotope signature analyses to examine the feeding ecology of *D. mawsoni*. The paper found spatial variation in resource utilisation between the Ross Sea shelf and western Indian Ocean sector of the Southern Ocean and the slope towards the Pacific Ocean sector, indicating a depth-dependent dietary difference between these regions, apparently closely related to an ontogenetic shift during migration. Bayesian models highlighted the nutritional importance of Notothenid fish to the diet of *D. mawsoni* and estimated a dietary shift during ontogeny and associated migration to deeper water.

4.91 The Working Group noted the distinct distribution of the posteriors showing that the Ross Sea ecosystem diet composition stood out as different from the Indian and Pacific Ocean sectors, indicating that the foodweb may have a different structure between areas. However, the Working Group also recalled that the Ross Sea samples came primarily from the Ross Sea shelf survey, sampling typically fish of <100 cm. The observed difference could, therefore, be a sign of an ontogenetic shift where size drives some of the prey choice, and the posterior distribution of the results on diet composition mirrored the size distribution obtained during the Ross Sea shelf survey.

4.92 The Working Group suggested as future work to link the dietary work presented in this paper to the wider stock hypotheses for the studied regions, and to test whether the observed differences in the diet composition of smaller fish was indeed evidence of an ontogenetic shift.

4.93 WG-FSA-17/P03 presented results of next-generation sequencing of stomach contents collected from *D. mawsoni* in Subareas 58.4 and 88.3. A total of 19 species were identified from the stomach of *D. mawsoni* in this study, which included 14 fish species and five molluscs. Two fish species, Whitson's grenadier (*Macrourus whitsoni*) and *Chionobathyscus dewitti*, were the most important prey items. These results suggested that using next-generation sequencing for diet studies is, within limitations, possible.

4.94 The Working Group noted that genetic sequences of Antarctic metazoans were not always readily available on GenBank. The Working Group noted that a list of species or species groups that are encountered during research fishing in the CCAMLR area could specifically contribute to addressing these gaps. Prof H. Kim (Republic of Korea) noted that his research group had no such list but would generally welcome Members providing more samples of metazoans from the Convention Area which they offered to sequence and upload to GenBank.

4.95 The Working Group considered WG-FSA-17/P02, which described levels of mercury concentration in different organs of *D. mawsoni* collected in Subarea 88.3 and Division 58.4.1. While 40% of the total mercury concentration was found in the muscle, both muscle and liver showed signs of bioaccumulation. Mercury concentrations were correlated with fish weight and length. The levels found in *D. mawsoni* were below the tolerable weekly intake for total mercury recommended by the Joint FAO/WHO Expert Committee on Food Additives and the tolerable weekly intake for methylmercury proposed by the European Food Safety Authority, suggesting that consumption of *D. mawsoni* presents no health risk to humans. The Working Group noted that the normal pattern of biomagnification in the Antarctic food chain as proposed by Gionfriddo et al., 2016 was not observed for *D. mawsoni* as top predator, and speculated whether the longevity or other physiological attributes of *D. mawsoni* may play a role in this. The Working Group suggested to look at methylmercury concentrations in different age groups of toothfish to see whether there was evidence of age-related susceptibility to methylmercury accumulation.

4.96 WG-FSA-17/15 presented an update on the ageing of *D. mawsoni* from Subarea 88.2 and Division 58.4.1 undertaken by Australia. Using a subset of otoliths from the New Zealand reference collection, all pairwise comparisons between Australian readers and against the reference ages showed a high level of precision. The level of age-estimation overlap between the 'bake and embed' and 'thin section' methods for each reader was high, indicating that either method can be used to provide reliable age estimates for *D. mawsoni*.

4.97 The Working Group noted that Australia and New Zealand are developing digital collections of aged *D. mawsoni* otolith images prepared from thin sections. Acknowledging the potential for digital reference collections to support inter-laboratory calibration in multi-Member ageing programs, the Working Group encouraged the development of digital reference sets by all Members undertaking *D. mawsoni* ageing.

4.98 The Working Group recommended that Members provide the appropriate material in order that the Secretariat can create a digital repository on the CCAMLR website containing otolith ageing and calibration instruction manuals (including WG-FSA-17/15), digital reference collections and a record of the locations of physical reference material. Growth bands in some digital images could also be annotated for training purposes. The Working Group further noted that a centralised database of ages would facilitate the increasing number or multi-Member ageing programs, and recalled that this was discussed at SC-CAMLR-XXXI, Annex 7, paragraphs 10.18 and 10.19.

4.99 WG-FSA-17/66 presented preliminary results for age and growth of *D. mawsoni* in Division 58.4.1. Estimated growth curves differed from estimates in previous years and comparisons were made between growth curves from all seasons in this division and those used in the Ross Sea integrated assessment.

4.100 The Working Group welcomed the progress made and presented in this paper. The Working Group noted the low variance of readings at older ages, suggesting cross-validation between readers to minimise reading errors at the more difficult reading ages, and to explore whether regional differences could contribute to the observed difference in growth curves.

4.101 The Working Group noted the shift of the growth curve over time, suggesting that *D. mawsoni* in this region are growing larger at older ages than in previous years, suggesting a change over time which could be indicative of changes in the environment, such as climate change (paragraphs 8.6 to 8.10), or result from interannual differences in sampling rates of older fish. The Working Group recommended that plots of age–length curves should be routinely provided for assessments, and for datasets of more than one year of readings should contain:

(i) panels with and without the estimated growth curves
(ii) data points distinguished by sex and/or year

to facilitate the observation and understanding of temporal or biological trends in ageing data.

4.102 The Working Group also encouraged the exploration of alternative growth models and parameterisation, which could also help understand and detect changes and patterns such as associated with environmental change and/or regional differences in growth.

4.103 The Working Group considered WG-FSA-17/16 which reported on the development of generalised additive mixed models (GAMMs) to characterise relationships between the relative density, weight, maturity and sex ratio of *D. mawsoni* with environmental variables, to progress the development of a stock hypothesis for Subarea 58.4. Spatial heterogeneity in catch composition indicated that *D. mawsoni* were not randomly distributed across the area. Models were used to generate predictions of *D. mawsoni* density and composition across a broad spatial scale and revise hypotheses relating to the structure and functioning of the stock.

4.104 The Working Group noted that fishing depths reported by vessels were used for the estimation, and GEBCO depths for the predictions, and recommended to use the same depth dataset for the estimation and prediction. The Working Group recommended to cross-validate the model estimation by leaving out components of latitude and longitude data and then back-estimating into that space, to check the performance of the model. The Working Group also noted that some thought would need to be given on how environmental data, collected at fine-scale level, would be used to generate predictions across the scale of divisions.

4.105 The Working Group noted that the model had standardised catch data to number of hooks, and included gear as a fixed effect in the initial model, as well as including vessel as a random effect. The Working Group noted that the presented paper provided both the initial model and the final model, and recommended that all papers including statistical modelling processes should: (i) include the initial as well as the final model (i.e. the preferred model based on model selection), and (ii) describe the model optimisation and selection process from the initial to the final model.

4.106 The paper identified BANZARE Bank as a region of spawning activity for toothfish, and the Working Group discussed the role of BANZARE Bank as a source of toothfish larvae in this region. Following the work of Hanchet et al., 2008 and WG-FSA-12/48 on passive circumpolar dispersion of *D. mawsoni* larvae, the current hypothesis is that potential spawning around BANZARE may be retained along the continent and provide juveniles for the entire region. Spawning activity has been observed on BANZARE during a survey in 2008 (WG-FSA-08/57), an area where only large fish without any recruits or juveniles were observed. The Working Group noted that BANZARE Bank could be a region where large *D. mawsoni* migrate to spawn, in line with the predictions generated in the paper.

4.107 The Working Group discussed the potential of the work presented in this paper to inform the research design and questions in this region, noting that the results provide sufficient information to refine existing stock hypotheses, which could be further evaluated by appropriate research questions and use of research blocks or modifications to research locations. The Working Group noted the analogous situation to the development of the fishery in the Ross Sea, where the stock hypothesis informed the research designed in the area, and recommended the development of specific research questions around the stock hypothesis that could be addressed in research proposals in the future.

4.108 Mr Maschette informed the Working Group that in addition to progressing the stock hypothesis through modelling, genetic investigations are planned to inform delineation of *D. mawsoni* stocks in the subarea as well as throughout the CCAMLR region and adjacent management regions. Mr Maschette thanked scientists from New Zealand, South Africa and the UK for providing samples to progress this work and invited all Members fishing to collaborate through tissue sample contributions.

D. mawsoni in Divisions 58.4.1 and 58.4.2

4.109 A report of progress on exploratory fishing activity undertaken by Australia, France, Japan, Republic of Korea and Spain between the 2011/12 and 2016/17 fishing seasons in Divisions 58.4.1 and 58.4.2 was presented in WG-FSA-17/17 Rev. 1. The report included the quantity of data and samples collected and an overview of progress toward research milestones. The associated research plan and reports relating to specific research milestones were submitted as companion papers.

4.110 The Working Group discussed the different reasons as to why research could not be completed in the research blocks. The research proponents noted that this was due to mechanical problems (Australia), macrourid by-catch limits (Australia), sea-ice limiting access (Korea), and insufficient fuel on board to complete research in Division 58.4.1 after the fishing season in Area 88 (Spain). The Working Group noted that there is an allocation system in place to distribute initial catch shares between the research proponents in this area. This system guarantees an agreed catch proportion in a research block, but can lead to the catch limit not being taken in a research block. The Working Group noted that the date for redistribution of catch allocations was brought forward to 1 February for the next season in order to provide a longer time window for the vessels to carry out research.

4.111 The research proposals in the format submitted to WG-FSA were assessed following the criteria set out in paragraph 4.7, summarised in Table 5. The Working Group acknowledged that this process is aimed at new proposals and not existing proposals, and the intent of the criteria was assessed. The Working Group noted that it provided advice generic to all proposals (paragraphs 4.52 to 4.87). Advice provided below is by exception, whereby only questions for further clarification, or criteria not fully satisfied, are discussed in this section. All research proposals under this agenda item were proposed under CM 21-02.

4.112 The Working Group considered WG-FSA-17/18 Rev. 1, a proposal for the continuation of the research plan on *D. mawsoni* by Australia, France, Japan, Republic of Korea and Spain as set out in WG-FSA-16/29. The proposal contained changes relating to the agreement among proponents relating to the deadline for redistribution of initial catch allocations between proponents, and to by-catch sampling.

4.113 The Working Group noted that 2018 will be the final year of the research plan, with a comprehensive re-evaluation scheduled in 2018, which will include questions such as catch limits not being reached.

4.114 Dr Kasatkina noted that implementation of the research programs in Subarea 58.4 is based on data collection by several vessels in each research block. These vessels operate using different gear types, which also have significant differences in line length and number of hooks and this may influence data used in estimates of biomass, stock structure and productivity parameters. Gear effect might be a critical factor for efficiency and reliability of multiple years' programs in Subarea 58.4. She recommended providing inter-calibration between fishing systems in frame of each research block and including this activity into research programs.

4.115 The Working Group noted that this research proposal satisfied all criteria set out in paragraph 4.7 (Table 5).

Management advice

4.116 The Working Group noted that the catch limits were calculated using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

D. mawsoni in Division 58.4.2

4.117 The Working Group considered WG-FSA-17/33, a proposal for research fishing by Ukraine on *D. mawsoni* in three research blocks in SSRUs A and B of Division 58.4.2 during the 2017/18 season, and recalled the recommendations made by WG-SAM-17 on this proposal (Annex 5, paragraphs 4.34 to 4.37).

4.118 The Working Group was not able to evaluate this proposal in regard to the likelihood of generating a local biomass index and whether the proposed research was likely to test a hypothesis of relationship of fish in the research area to the overall stock. The Working Group considered that the proposal did not contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success.

4.119 The Working Group noted that the research plan proposed a catch limit as well as an effort limit, but the impact on the dependent and related species and the target species stock was not clear from the information presented in the proposal.

4.120 While the proposed research platforms have demonstrated experience in toothfish tagging programs, the Working Group noted that the notified vessel had low calculated effective survival rates (WG-FSA-17/36, Table 6).

4.121 The Working Group noted concerns about the accessibility of the proposed research region during the proposed survey times due to sea-ice, and further noted that the same vessel was notified as research platform in Subareas 88.1 and 88.2, raising concerns as to whether the vessel would be able to commit to all proposed research.

4.122 The Working Group noted that the historical research already conducted in this region was not taken into account in the proposed research in WG-FSA-17/33, with questions also raised as to how the resulting data would be incorporated into the existing results. The Working Group recalled discussions on this subject elsewhere (paragraphs 4.16, 4.17 and 4.20).

D. eleginoides in Division 58.4.3a

4.123 WG-FSA-17/55 outlined the research plan in Division 58.4.3a by France and Japan as a continuation of the plan set out in WG-FSA-16/55, including recommendations made by the Scientific Committee in 2016 (SC-CAMLR-XXXV, paragraph 3.250).

4.124 The Working Group noted that the proposal is likely to generate local abundance indices, but is geographically constrained, and that there is no description of a plan to widen the research into a broader stock hypothesis.

4.125 The Working Group noted that the proposed vessels have multiple years of experience but have unknown calculated effective survival rates. The *Mascareignes III* has participated in the *D. eleginoides* fishery in Subarea 58.6 and Division 58.5.1 for 16 years and been a participant in tagging operations that have released 59 038 tagged *D. eleginoides* between 2006 and 2017 of which 6 386 have subsequently been recaptured (WG-FSA-17/59, 17/60). The *Mascareignes III* has tagged 8 140 and recaptured 895 *D. eleginoides*. Thus, more than 800 tagged *D. eleginoides* by the *Mascareignes III* were recaptured by the vessels operating in Subarea 58.6 and Division 58.5.1. Therefore, sufficient tagging data exists for the proponents to evaluate effective tagging survival and tag detection rates for the *Mascareignes III* in the intersessional period using the methods developed by Mormede and Dunn (2013). No comparative information was available for the *Shinsei Maru No. 3*.

4.126 The Working Group recalled discussions at WG-SAM-17 regarding why the catch limit has not been taken since 2013/14 and further recommendations made by WG-SAM-17 (Annex 5, paragraphs 4.43 and 4.44), and noted that these recommendations have been addressed in WG-FSA-17/55. The Working Group noted that research was still being conducted at the time of the WG-FSA meeting.

Management advice

4.127 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

D. eleginoides in Division 58.4.4

4.128 WG-FSA-17/11 outlined the revised research plan by France and Japan for research blocks 5844b_1 and 5844b_2 in the 2017/18 season and included advice from WG-SAM-17. The research plan proposed to continue the current research operation for the next fishing season with the same survey design as before.

4.129 The Working Group noted that the proposed vessels have multiple years of experience but have unknown effective tagging survival rates. For both French vessels that proposed to carry out the research, the *Saint-André* and *Ile Bourbon*, sufficient tagging data exists from activity in other CCAMLR subareas for the proponents to evaluate effective tagging survival and tag detection rates for these vessels in the intersessional period using the methods developed by Mormede and Dunn (2013).

Management advice

4.130 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

General discussion on Subarea 58

4.131 The Working Group noted that an important purpose of the designation of research blocks is to concentrate research effort to maximise the likelihood of recaptures in areas where tagged fish had been released.

4.132 The Working Group noted that research on the density and length distribution of fish, spatial patterns in their biology, movement of fish and linkages to areas outside of research blocks, such as provided in WG-FSA-17/16, would be helpful to design such research.

4.133 The Working Group considered that, based on the available information for Subarea 58.4 presented in WG-FSA-17/16, the population hypothesis could now be reviewed for the region. This would allow future research with the objective of developing a spatial management advice and to guide future research efforts, for example, to gain a better understanding of the location of areas critical to the life history of toothfish, such as spawning regions, juvenile areas or feeding grounds. Oceanographical research and activities conducted on non-fishing vessels could also contribute to the further development of the stock hypotheses.

4.134 The Working Group also recalled Figure 1 in WG-FSA-17/13, noting that the central part of the diagram outlined the process for progressing from a research-block focus to developing a regional stock assessment. It was considered that the research in this region was now close to this stage. Consequently, the review of the research, scheduled by the proponents for 2018, should consider moving to the next stage in the process.

4.135 The Working Group recalled that a focus topic on the stock hypothesis of *D. mawsoni* in Divisions 58.4.1 and 58.4.2 was planned for WG-SAM-18 as part of the strategic work plan of the Scientific Committee. The Working Group encouraged close intersessional collaboration of research proponents in Divisions 58.4.1 and 58.4.2 in preparation for this focus topic.

4.136 The Working Group recalled that the data emerging from ongoing investigations confirms that IUU fishing remains an important issue for CCAMLR and especially in the potential impacts on research fishing in Division 58.4.1 (paragraphs 2.14 to 2.18) and that impacts of IUU fishing could be a significant impact on research conducted in the region.

4.137 The Chair of the Scientific Committee recalled that within the strategic planning for the Scientific Committee, a focus topic on Area 58 was planned for WG-SAM-18.

D. mawsoni in Subarea 88.3

Review of available information and data quality

Review of progress towards a stock assessment and research proposals

4.138 The Working Group considered a revised proposal from Ukraine (WG-FSA-17/34) and a new joint proposal from the Republic of Korea and New Zealand (WG-FSA-17/40) to conduct research in Subarea 88.3. The Working Group recalled that WG-SAM-17 recommended that the proponents collaborate to produce a single multi-Member coordinated research proposal for presentation at WG-FSA-17 (Annex 5, paragraph 4.89). The Working Group further noted that such a collaboration would require development of a detailed plan:

(i) to coordinate the spatial distribution of effort among proponents and between seasons

(ii) for the allocation of total catch and distribution of responsibility for milestone achievements among proponents.

4.139 WG-FSA-17/34 and 17/40 were assessed following the criteria summarised in Table 6.

4.140 The Working Group noted that the Ukrainian proposal in WG-FSA-17/34 had not fully addressed feedback from WG-SAM-17. In particular, the proposal stated the intention to acquire toothfish age data and develop an assessment model, however, there remained insufficient specification of how and when this would be achieved (e.g. a research timeline and detailed milestones that could be used to evaluate research progress).

4.141 The Working Group noted a lack of detail in WG-FSA-17/34 on a stock hypothesis, including ambiguity about which of the *Dissostichus* species were being investigated (Table 6(i)c).

4.142 The Working Group noted that the joint proposal from the Republic of Korea and New Zealand was designed to build on previous research by continuing to focus on those research blocks where tagged fish have previously been released on the slope, whilst also prospecting two of the northern seamount complexes and two areas on the southern shelf where no fishing has occurred. The main objective of the proposal is to determine the abundance of *D. mawsoni* in Subarea 88.3. Secondary objectives are to improve understanding of stock structure of toothfish in this area, to carry out calibration trials between the two vessels, investigate the spatial and depth distributions of by-catch species and to trial electronic monitoring systems. The Working Group noted that surveys will be effort limited in the 2017/18 season and catch limited in the 2018/19 and 2019/20 seasons.

4.143 The Working Group agreed that, rather than standardising fishing operations between the *Greenstar* and *Janas* during vessel calibration trials (including soak time and length of line), the *Greenstar* should retain its normal gear configurations to facilitate comparison of data collected by the Republic of Korea among areas.

4.144 The Working Group noted interannual variation in toothfish length compositions in some locations within Subarea 88.3, including research blocks 883_3 and 883_4 and on the seamounts, and that these variations complicate the development of a stock hypothesis. It was further noted that the plan for more controlled depth stratification, as outlined in WG-FSA-17/40, can be used to investigate whether these variations are likely to be influenced by fishing depth.

4.145 The Working Group recalled previous recommendations for the prioritisation of research blocks in Subarea 88.3 which were based on increasing the likelihood of recapturing tagged fish (SC-CAMLR-XXXIV, paragraph 3.290; SC-CAMLR-XXXV, paragraph 3.257). However, given recent releases of tagged fish across all research blocks (WG-FSA-17/40, Table 2), the Working Group agreed that research block prioritisation could be based on sea-ice conditions and vessel safety, with the exception of research block 883_3, which should be a high priority for completion of the calibration trial and recapturing of tagged fish.

4.146 The Working Group noted the proposed number of sets and anticipated catch by research block or prospecting area for the *Greenstar* and *Janas* (WG-FSA-17/40, Table 7) and agreed that these are appropriate for achieving the research objectives.

Management advice

4.147 The Working Group recommended that the catch limits be applied as shown in Table 7.

Other fisheries research

4.148 The Working Group reviewed WG-FSA-17/28, which presented a revised research plan from Chile proposing a bottom trawl research survey of the distribution, abundance and biological characteristics of Antarctic demersal fish communities in the 2017/18 season on the shelf areas of Subarea 48.1 (Elephant Island) and Subarea 48.2 (South Orkney Islands).

4.149 The proposed survey will be conducted in four depth strata between 100 and 500 m using two bottom trawl nets, with stations in the same approximate geographic coordinates as those used by RV *Polarstern* (led by Germany) around Elephant Island in 2012, and by the RV *Yuzhmorgeologiya* (led by the USA) around the South Orkney Islands in 2009. The proposed catch limits for this research are 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2. The survey will be using two nets: the 'Hardbottom Snapper Trawl' and the 'Casanova 55.80-71.00' bottom trawl nets.

4.150 The Working Group recommended that the Hardbottom Snapper Trawl, which is the bottom trawl that was used by the USA in the previous survey in 2009, be prioritised during the survey and Casanova 55.80-71.00 be used in the inter-calibration between the two nets to allow the standardisation and ultimately the comparability between catches made using the two nets. The Working Group agreed that the proposed catch limits of 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2 were appropriate for the survey. Station location and trawl duration should replicate previous trawl survey research undertaken by the USA and Germany in the region.

4.151 Prof. P. Arana (Chile) confirmed that, as chief scientist of the research proposal, he will be on board the fishing vessel to ensure that the survey will be conducted as planned. He noted that the US trawl would be used for the survey as a priority and further noted that, in the face of potential operational difficulties during fishing sampling hauls, the US sampling gear will be replaced by the Casanova gear.

4.152 The Working Group was informed of additional research initiatives beyond the primary demersal biomass survey objectives set out in WG-FSA-17/28. These include collecting finfish specimens to investigate the origin and maintenance of Antarctic fish biodiversity, as well as specimen, genetic, haematological and life-history data to investigate the subtle changes in diversity patterns across the spatial distribution of notothenioid fish species.

4.153 WG-FSA-17/P01 provided results of a time series of trammel net catches in Potter Cove (King George Islands). The Working Group welcomed the results in the paper and it noted that the discussions of these analyses were sufficiently dealt with in WG-FSA-16 and the conclusion of the Working Group is essentially similar to those given in SC-CAMLR-XXXV, Annex 7, paragraph 6.6. The Working Group further noted that the trends of these results, which are consistent with sporadic surveys that have been conducted in the offshore areas of this region and offshore survey by Chile, using the same gear type as previous surveys in the region, will provide further information on the status of these resources.

Scheme of International Scientific Observation (SISO)

5.1 Data collected by observers on all fishing vessels operating in the Convention Area during 2016/17, based on data received by the Secretariat up until 15 September 2017, were presented by the Secretariat (WG-FSA-17/58 Rev. 2).

5.2 The Working Group noted that in previous years this paper only contained data from longline and finfish trawl vessels, however, this year the Secretariat has included incidental mortality associated with fishing (IMAF) and sampling information from krill trawl vessels to provide a more complete summary of SISO information for the season. Extrapolated seabird mortalities in the longline fishery were the second lowest on record, although the Secretariat noted that there were still observer datasets outstanding which were likely to contain mortalities that had been reported in vessel catch and effort data. The Working Group supported the updated content and design of the paper and agreed that the summary table of mortalities from all CCAMLR fisheries presented be included in the WG-FSA report for consideration.

5.3 The Working Group thanked all SISO observers for their contribution to scientific data collection this season. Collectively, the observers in the Convention Area have collected over 500 000 biometric measurements in 2016/17.

5.4 WG-FSA-17/41 presented New Zealand's submission to the CCAMLR Observer Training Program Accreditation Scheme (COTPAS). An initial review of the submission had been completed by the Secretariat and Members were invited to participate in a peer review of the submission through a closed e-group, as per the process outlined in SC-CAMLR-XXXIII/10.

5.5 The Working Group welcomed New Zealand's submission, noting the value of understanding individual Members' observer training standards. The Working Group noted that Australia undertook the peer review process in 2014 and reiterated the opportunity it provides for Members to review and improve their national observer program. Invitations for Members to participate in the peer review of the New Zealand submission will be provided in an SC circular.

5.6 WG-FSA-17/03 presented the redesigned observer logbooks for longline and trawl finfish fisheries. The Working Group endorsed the design and content of the new logbooks, noting the recommendations developed from the WG-FSA considerations outlined in the WS-SISO Convener's report (SC-CAMLR-XXXVI/08). The Working Group recommended that the Scientific Committee endorse the new logbooks, noting that they will be applied for the 2018/19 season, although they are available for Members to use voluntarily for the 2017/18 season as detailed in SC-CAMLR-XXXVI/BG/38.

Workshop on SISO report and recommendations

5.7 The WS-SISO Convener's report (SC-CAMLR-XXXVI/08) presented the results from the Workshop held in Buenos Aires, Argentina, from 3 to 7 July 2017. The Working Group noted the importance of the first dedicated SISO Workshop and its success in the development of new observer data collection protocols and forms.

5.8 The Working Group welcomed and endorsed the Convener's report and provided recommendations on the following issues that were addressed to WG-FSA:

(i) Observers should continue with the current practice of using basket, trot or magazine numbers as an indicator of the section of line and observer samples for by-catch, rather than using the VME line segment number, as in many cases they are analogous, and not all fisheries are required to collect VME data. The Working Group also recommended that observers should be able to use a range for these numbers as it is often difficult to tell exactly in which basket, trot or magazine the by-catch was sampled. The Working Group encouraged Members to ensure that the crew on vessels work closely with observers to assist the observer in identifying the correct section of the line.

(ii) Fields in the observer logbooks that were introduced to collect data for the Year-of-the-Skate should be removed, as the relevant information is captured in the remaining forms.

(iii) The requirement for skates to be hauled to the roller, rather than cut off at the surface, should be retained, as this approach allows for accurate assessment of skate condition as skates in poor health are required to be landed under CM 33-03. Additionally, the Working Group recalled WG-FSA-08/30 which detailed the physical difficulty of releasing skates at the surface, the potential for injury to the animal during the procedure and significant safety risks for the crew undertaking the procedure. The Working Group further noted that while WG-FSA-08/30 detailed skate handling procedures for autoline vessels, a similar understanding of procedures on Spanish and trotline gear types was desirable, and encouraged Members to submit materials describing skate handing methodology, including, if possible, videos of skates being hauled from the water to the roller and released.

(iv) Due to the difficulty in quantifying and determining the number and cause of mortalities, collection of data on seabird collisions with fishing vessels was not considered to be a priority for SISO. Further discussion on this matter is found in paragraphs 6.26 to 6.28.

Non-target catch and interactions in CCAMLR fisheries

Fish and invertebrate by-catch

6.1 The Secretariat presented WG-FSA-17/04 providing an update on fish by-catch in the krill fishery. Commercial catch data and CCAMLR SISO data up to 1 September 2017 were used to examine the frequency of occurrence, length-frequency distribution and geographic provenance of the key fish taxa reported. There is continued evidence of an increase in the data quality from the observer scheme, as well as an increase in the reporting of fish by-catch in the commercial krill fishery catch data. The paper noted a high degree of overlap in the most frequently reported taxa between the C1 data and SISO data. Species distributions for main species were plotted, with painted rockcod (*Lepidonotothen larseni*) the most frequently reported species in both datasets. The characteristics (species and size frequency) of fish taken as by-catch in the krill fishery are consistent with those reported in the diet of krill-dependent predators from the region in which the krill fishery operates.

6.2 The Working Group noted that there may be sufficient data on fish by-catch in the krill fishery to examine the factors influencing vessel-specific differences in the frequency of fish by-catch and encouraged such analyses to be conducted. The Working Group recalled the work carried out in the Ross Sea using a pairwise comparison to assess the fish tagging performance of vessels and suggested that a comparative method (e.g. Mormede and Dunn, 2013) be investigated to evaluate by-catch data from krill fisheries. The Working Group also noted that issues remain with the ability to scale estimates of fish by-catch to total catch with the data reported from vessels using a continuous fishing system.

6.3 The Working Group recalled the advice from WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraphs 5.11 to 5.13) encouraging national coordinators to task SISO observers to collect quality close-up photographs of each species identified in a trip and subsequently submitting verified photos to the CCAMLR Secretariat in order that these can be made available in by-catch guides for observers. The Working Group reiterated the need for correct species identifications and noted the importance of expert comparison and confirmation of observer identifications to maintain and improve data quality.

6.4 The Working Group noted that although by-catch data is presented in individual fishery reports, currently there are no similar summaries of by-catch from the toothfish or icefish fisheries and requested the Secretariat to present this information at future meetings.

6.5 WG-FSA-17/64 presented length–weight relationships for six fish species commonly associated with the *E. superba* fishery. The samples were collected during krill fishing operations in the Atlantic sector of the Southern Ocean from January to August 2016. Additional information detailing the relationships between standard length and total length of the species studied was also presented.

6.6 The Working Group noted that information on fish species derived from the *E. superba* fishery will be very helpful in understanding the interaction between the krill fishery and fish communities associated with krill swarms and acknowledged that krill fishing vessels can provide a useful scientific platform to produce relevant biological information for fish species associated with krill populations.

6.7 WG-FSA-17/65 described the use of otolith elemental signatures to understand the habitat shifts of *Electrona carlsbergi*. This is one of the most important pelagic myctophids in the Convention Area, having a circumpolar distribution between the subtropical confluence zone and the Southern Ocean. This study provides a stock structure hypothesis building on biological studies carried out during the 1990s and providing useful information to study the habitat shift of this species using otolith elemental signature analysis.

6.8 The Working Group noted that this form of analysis could be used to test habitat shift and life-history processes of fish species in the Southern Ocean and to couple elemental signature analysis with water chemistry providing a good pathway for understanding energy transfer in Southern Ocean ecosystems. The Working Group welcomed a plan for future work which may incorporate other trace elements, linking with published biological data to look at migration routes and other fish species. The Working Group suggested that additional studies might consider incorporating ageing information and differentiation by sex. The Working Group suggested that this technique might be evaluated for testing hypotheses of toothfish movement in data-poor areas, as has been done for Subareas 88.1 and 88.2 (WG-SAM-14/33).

6.9 In 2016/17, research undertaken by Australia and Spain in research block 5841_6 was not completed due to exceeding the 16% by-catch limit for *Macrourus* spp. WG-FSA-17/23 presented an analysis which concluded that concentrating fishing for *D. mawsoni* in the depth range of 1 100–1 600 m would reduce by-catch of *Macrourus* spp. The authors highlighted that the current research grid in research block 5841_6 inhibits the ability of vessels to avoid *Macrourus* spp. by-catch. They proposed to either modify the research grid to avoid the depth range of high by-catch, or remove it completely, consistent with research in the majority of research blocks in Divisions 58.4.1 and 58.4.2.

6.10 The Working Group recalled the three principles of CCAMLR's strategy for managing by-catch in the Convention Area (SC-CAMLR-XXII, Annex 5, paragraph 5.230), which are:

(i) avoidance
(ii) mitigation, and lastly
(iii) the assessment of yield for finfish if mortality is not preventable.

6.11 These are applied in order to ensure that research and fisheries are consistent with CCAMLR's objectives to limit the catch of non-target species. The Working Group further agreed that by-catch limits should consider impacts on by-catch species and the ecosystem, as well as avoiding excessive removals of biomass that are not utilised.

6.12 The Working Group noted that while undertaking research in research block 5841_6 in 2016/17, the *Antarctic Discovery* triggered two move-on rules. The *Antarctic Discovery* caught ≥ 1 tonne of *Macrourus* spp. in one haul triggering CM 33-03, paragraph 5, and also exceeded 16% of the vessel catch of *Dissostichus* spp. in a 10-day period in research block 5841_6, triggering CM 33-03, paragraph 6.

6.13 The Working Group requested that the Scientific Committee consider whether the existing move-on rule should be reviewed to potentially explore whether modifications in the move-on rule may help avoiding or mitigating *Macrourus* by-catch whilst still allowing vessels to continue undertaking research in this research block in the future. The Working Group noted that consideration should be extended to other areas where a similar issue might occur.

6.14 The Working Group recalled that the original purpose of the research grid in research block 5841_6 was to maximise the likelihood of tag recaptures from the Spanish depletion experiment (SC-CAMLR-XXXI, paragraphs 3.141 to 3.143).

6.15 To allow the avoidance and mitigation of *Macrourus* by-catch, the Working Group recommended to remove the research grid in research block 5841_6 and to structure research fishing similarly as in other research blocks within Division 58.4.1 that do not have research grids, i.e. distribute fishing effort across a range of depth strata (<1 000, 1 001–1 500, 1 501−2 000 m) with at least five longlines in each depth strata per fishing Member deployed in accordance with the minimum separation distances in CM 41-01, Annex 41-01/B.

6.16 WG-FSA-17/23 also provided estimates of biomass and sustainable catch limits for the *M. whitsoni*/*caml* species morph in all research blocks of Divisions 58.4.1 and 58.4.2 by applying the CPUE by seabed area method following the recommendation from WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraph 6.17). The analysis used biomass estimates of *M. whitsoni* from the 2008 Ross Sea assessment as the reference biomass (SC-CAMLR-XXVII, Annex 5, paragraphs 6.18 and 6.19). *Macrourus* spp. biomass was estimated separately by longline gear type in each research block due to differences in reported catch rates. The authors considered that the biomass and sustainable catch estimates from this study be considered as the basis for management advice in setting sustainable catch limits for *Macrourus* spp. within these divisions.

6.17 The Working Group noted the differences in *Macrourus* catch rates for the three longline gear types that were presented for the Ross Sea and how the catch rates had changed over time. These differences included the decline in the catch rates of autoline and the concurrent increase in Spanish longline and trotline catch rates in 2016 and 2017.

6.18 The Working Group recalled the analysis of by-catch in the Ross Sea undertaken by the Secretariat in 2015 (WG-FSA-15/04 Rev. 1) and that the apparent by-catch rates may also be associated with whether it is the crew or the observer that is tasked with collection of the data used for by-catch reporting by the vessel. The Working Group requested the Secretariat to reissue the survey reported in WG-FSA-15/04 Rev. 1 in order to evaluate whether recent changes in by-catch reporting rates were as a result of changes in how by-catch reporting is implemented on vessels. In addition, the Working Group requested the Secretariat to evaluate possible correlations with tag survivability and detection as discussed in paragraphs 3.71, 3.72 and 3.74.

6.19 The Working Group noted that the catches of *Macrourus* spp. in research block 5841_6 in 2016/17 were well below the removals that would be considered sustainable if part of a targeted fishery based on the estimates provided by WG-FSA-17/23.

6.20 The Working Group recommended that the by-catch limits for *Macrourus* spp. in Divisions 58.4.1 and 58.4.2 be retained at 16% of the *D. mawsoni* catch limit for 2017/18 and that multi-Member research proposals should be reviewed in 2018 to account for areas of high by-catch and incorporate the habitat model and stock hypothesis developed by WG-FSA-17/16.

6.21 WG-FSA-17/07 provided an updated characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B), including recommendations for new catch limits among areas for by-catch species to accompany the introduction of the Ross Sea region MPA. By-catch limits in the open areas south of 70°S, north of 70°S and in the SRZ were either fixed based on a local area biomass estimate if available or otherwise set as a percentage of the toothfish catch limit for the area.

6.22 The Working Group recommended updated catch limits by area for Macrourids, skates and other species in the Ross Sea region, consistent with the implementation of the Ross Sea region MPA (CM 91-05). The by-catch limits using the recommended toothfish catch limit for the Ross Sea region of 3 157 tonnes are shown in Table 8.

6.23 The Working Group requested that the Scientific Committee note CM 91-05 (2016), and review related conservation measures, including CM 33-03 governing the limitation of by-catch in new and exploratory fisheries and CM 41-09 setting limits on the exploratory fishery for *D. mawsoni* in Subarea 88.1 prior to the season start on 1 December 2017.

Marine mammal and seabird by-catch

6.24 The Secretariat presented WG-FSA-17/58 Rev. 2 providing a summary of the scientific observer data collected in CCAMLR fisheries in the Convention Area during 2016/17. This paper summarised the data collected by scientific observers operating in the Convention Area on board fishing vessels during the 2016/17 season from data received by the Secretariat up to 15 September 2017. Information on observer deployments, incidental mortality and fish sampling was presented.

6.25 The Working Group thanked the Secretariat for presenting this information and noted that the extrapolated incidental mortality of 116 seabirds in all CCAMLR longline fisheries in 2017 (Table 9) was the second-lowest on record.

6.26 The Working Group also noted that the number of seabird interactions in longline fishing activities in the CAMLR Convention Area was very low compared to other longline fisheries globally. There has been a steady and significant decrease of seabird mortalities due to fishing gear interactions in the CCAMLR area following the development of mitigation measures by the Working Group on Incidental Mortality Associated with Fishing (WG-IMAF) and the Agreement on the Conservation of Albatrosses and Petrels (ACAP), which are now providing a template for other regional management organisations.

6.27 The Working Group noted that there are likely to be a number of other seabird mortalities within the Convention Area that are not directly reported by the observer as captured on the fishing gear during their tally period. These additional mortalities can arise when seabirds hit the superstructure of vessels, including fishing vessels, tourist vessels and other vessels operating in the Convention Area.

6.28 The Working Group recommended that the Scientific Committee consider whether the matter of seabird mortalities not associated with fishing gear be included as a potential topic of mutual interest with the Committee for Environmental Protection (CEP). This would allow a broader range of information from other sources of mortality to be available for monitoring status and trends of seabird mortality in the Convention Area, as well as potential options for mitigation.

6.29 WG-FSA-17/20 presented an update on the fishing effort and seabird interactions in the longline fishery in Division 58.5.2 for the season extension trials in the periods 1–14 November 2016, 15–30 November 2016, 1–14 April 2017 and 15–30 April 2017. During the two November 2016 extension trials, four white chinned petrels (*Procellaria aequinoctialis*) and a macaroni penguin (*Eudyptes chrysolophus*) were caught. In the April 2017 season extension trials, one grey petrel (*P. cinerea*) and one *P. aequinoctialis* were caught.

6.30 The Working Group noted that it was important to analyse seabird interactions with respect to the level of fishing effort deployed during the season, considering the increase in effort in the latter part of the season in recent years in Division 58.5.2.

6.31 WG-FSA-17/24 proposed to amend CM 25-02 such that the instruction to longline fishing vessels to deploy streamer lines while setting is removed for vessels that use longline weighting according to CM 24-02. The proponents highlighted the effectiveness of longline weighting (CM 24-02) in reducing seabird mortalities and suggested that this instruction in CM 25-02 was obsolete and the conservation measure should be updated.

6.32 The Working Group recalled that in the past when proposals for modification of conservation measures were presented, they were accompanied by an analysis of a scientific trial of the effects of the proposed change. The Working Group recalled WG-FSA-16/38, a proposal by Norway to trial the use of a third wire on krill trawl vessels that was approved by the Scientific Committee (SC-CAMLR-XXXV, paragraphs 4.10 and 4.11). It also recommended that such a scientific trial of the need for streamer lines should be presented to ACAP.

6.33 The Working Group noted that current best practice for the mitigation of seabird interactions during setting of longline fishing gear from ACAP was to use both streamer lines and longline weighting and recommended that CM 25-02 should remain in place.

6.34 WG-FSA-17/50 highlighted problems in the sampling and extrapolation of seabird mortalities using observer-reported seabird interactions outside the standard observation period. The authors noted that the inclusion of non-random observations such as interactions provided to the observer by the crew and interaction observations recorded from video footage taken outside the standard observation period, if not reported correctly, may result in bias in the raised seabird mortality estimates.

6.35 The Working Group discussed whether the method used to extrapolate seabird mortalities was appropriate when observations were non-random or in areas with seasonal variability in seabird mortality. The Working Group noted that observation periods may not be random when observers are notified by crew of a mortality event occurring outside the observation period, and the observer consequently starting their observation period to coincide with the mortality event to accurately record seabird mortalities.

6.36 The Working Group recalled the work of WG-IMAF on developing the extrapolation method and suggested that alternative methods for extrapolating seabird mortalities, such as raising numbers per haul per vessel rather than per season per area, could be considered by WG-SAM.

6.37 The Working Group noted that it was essential for observers to be issued with clear instructions how to report seabird mortalities both during and outside the observation period, and recommended Members work with their scientific observer coordinators to ensure appropriate guidance was provided on this issue. The Working Group also recommended that such instructions be included in the forthcoming CCAMLR SISO manual.

Future work

Five-year strategic plan for the CCAMLR Scientific Committee

7.1 The Working Group considered the proposed five-year work plan for the Scientific Committee presented by the Chair of the Scientific Committee (WG-EMM-17/02). The paper provides an expansion of the recommendations of the Scientific Committee (SC-CAMLR-XXXV, Table 1) which were discussed and put forward by the Scientific Committee Symposium in October 2016. The paper outlined the work plan across themes and indicated a timeline by which each topic should be addressed. The Working Group noted that WG-SAM and WG-EMM had provided feedback and suggestions relating to the document.

7.2 The Chair of Scientific Committee noted that the document will be updated to include the recommendations for future work arising from the WG-FSA meeting and submitted as a revision to the Scientific Committee for further consideration. This would include reference to the proposed workshop on the development of a stock hypothesis for toothfish in the Weddell Sea region (paragraph 8.22) proposed by Germany for February 2018 and the proposed independent review of CCAMLR's CASAL integrated toothfish stock assessments, proposed for Norwich, UK, in the week prior to the 2018 WG-SAM meeting (paragraphs 7.11 to 7.14).

Pop-up satellite archival tags (PSATs) workshop

7.3 The Working Group recalled discussion at WG-SAM-17 (Annex 5, paragraph 4.65) relating to a proposal for a two-day workshop to consider the use of PSATs in CCAMLR toothfish research (WG-SAM-17/33). The Working Group discussed the paper's recommendation that a two-day workshop involving scientists with an interest in archival tagging and PSAT manufacturers would be a useful way of advancing the use of PSATs for toothfish studies.

7.4 The Working Group noted that the arrangements suggested by Germany for a CCAMLR technical expert workshop to develop an interim toothfish population hypothesis for Area 48 and a regional toothfish research strategy for Subarea 48.6 to be convened in February 2018 in Berlin (Germany) would allow for a separate two-day PSAT workshop to be convened back-to-back. It also noted that there may be interest from the Coalition of Legal Toothfish Operators (COLTO) in attending and contributing to this workshop.

7.5 The Working Group agreed that, given the increasing use of PSATs in CCAMLR fisheries research, developing a mechanism for scientists to engage in detailed discussion on their use would be beneficial. Issues such as tag design and data storage and management, battery life, geolocation capability, deployment, attachment and data analysis methods were topics of interest to the Working Group. The Working Group also noted that trials on the suitability of different tags for use in Southern Ocean deployments, as presented in WG-SAM-17/33, were a useful method for assessing tag performance.

7.6 The Working Group noted that it could be beneficial for WG-FSA to develop a strategy for the use of PSATs in CCAMLR fisheries research in advance of a workshop involving manufacturers and fishing industry. This would enable consideration of the specific requirements and specifications for PSATs used in toothfish research in the Southern Ocean that could then be communicated to tag manufacturers. As tags with different sensors and capabilities will require new designs, these tags would need to be tested in Antarctic environments. The work program associated with the development and implementation of PSAT tagging programs for CCAMLR could be considered during WG-FSA-18. The Working Group encouraged the submission of information to the Working Group on other fisheries research programs in which PSATs are deployed and noted that PSAT deployment could provide information on long-term survivorship of rajids returned to the sea following capture in toothfish fisheries.

7.7 The Working Group noted that Korean scientists will be carrying out a program of research using PSATs in the southwest Atlantic Ocean sector (FAO Area 41) with the results expected in 2019 and Japan and Norway planned to deploy PSATs in Subarea 48.6 in 2018.

Fish in the Antarctic ecosystem

7.8 The Working Group noted that fisheries research programs carried out by CCAMLR Members provided extensive information on the ecology and biology of non-target fish species within CCAMLR. However, it was unclear whether such information was more appropriately considered by WG-FSA or WG-EMM and often ended up not being considered in detail by either working group.

7.9 The Working Group noted that there were opportunities to work with external bodies such as the Scientific Committee on Antarctic Research (SCAR) to bring greater visibility to such research. It was noted that a joint CCAMLR/SCAR themed symposium on 'the role of fish in Antarctic ecosystems', run in conjunction with a future SCAR biology meeting, could provide a mechanism to showcase research on non-target fish species. The Chair of the Scientific Committee undertook to develop this further during the intersessional period and noted that the next SCAR biology symposium would be in 2020.

Environmental data

7.10 The Working Group considered the collection of environmental data from fishing vessels operating within CCAMLR and how these data may be brought into the working groups. The Working Group noted that there are a number of initiatives currently underway by CCAMLR Members, both within and outside the CCAMLR region, where fishing vessels are used to collect environmental data. Such programs using fishing vessels as 'vessels of opportunity' could provide information to other Members on how the collection of such data can be coordinated. However, it was noted that these data are often of variable quality and issues of instrument calibration and data resolution could prevent their use. The Working Group also noted that, where possible, environmental data streams should be integrated with existing initiatives such as the Southern Ocean Observing System (SOOS) to avoid the possible duplication of data standards and management.

Independent review of integrated stock assessment methods

7.11 The Working Group considered a proposal to establish an independent review process of CCAMLR's integrated stock assessments (WG-FSA-17/62). The Working Group recalled that in 2013, the Commission endorsed the Scientific Committee's recommendation to develop a process to facilitate independent reviews of CCAMLR stock assessments (CCAMLR-XXXII, paragraph 5.14) and noted a request from the Scientific Committee that the group comprising the Scientific Committee Chair and Vice-Chairs and the working group conveners provide further advice on the process in 2017 (SC-CAMLR-XXXV, paragraph 13.24).

7.12 The terms of reference for the review process (Appendix D) were considered by the Working Group, noting that the primary objective for the expert panel is to provide advice to the Scientific Committee and its working groups on the adequacy of the modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments. CCAMLR's assessments would be compared relative to international best practices, and improvements to the assessment methods suggested where appropriate. The current toothfish stock assessments to be reviewed at a single meeting are the Ross Sea region (Subarea 88.1), HIMI (Division 58.5.2) and South Georgia (Subarea 48.3).

7.13 The Working Group considered the selection of external reviewers and recommended that they should be as independent from the CCAMLR stock assessment process as practicably possible. It was agreed that three reviewers were likely to be the optimum number and that they should have extensive fish stock assessment experience with extensive experience of Bayesian methods. Suggestions for reviewers would be sought from Members and agreed by the Chair of the Scientific Committee and the conveners of WG-SAM and WG-FSA and this process could be facilitated by the Secretariat.

7.14 The Working Group recommended that the Scientific Committee consider the choice of convener for the meeting and also clarify the process for report development and submission. It was noted that the report could be provided to WG-SAM immediately after the independent review panel meeting and its findings be considered by the Working Group.

7.15 The Working Group noted that the request for funds for the reviewers, estimated to be approximately US$53 400 (Appendix D), would need to be further considered by the Standing Committee on Administration and Finance (SCAF). The Working Group noted that the meeting would be open to all Members but that those attending should be experienced in the use of Bayesian integrated stock assessment methods.

Other business

Sea-ice analysis

8.1 The Working Group noted that the sea-ice analysis presented in WG-FSA-17/08 linked sea-surface temperature in the Pacific Ocean associated with El Niño/La Nina conditions, the extent of sea-ice in the Weddell Sea and the Ross Sea and the potential that such large-scale teleconnections can be used to predict future access to research blocks.

8.2 The Working Group noted that sea-ice distribution in the Southern Ocean reflected a complex interaction of physical processes, including the Southern Annular Mode, the Amundsen Sea Low and the ozone hole, and that existing global climate models were unable to resolve spatial differences in sea-ice around the Antarctic and have limited potential use in operational decisions. The Working Group suggested that the time series presented in WG-FSA-17/08 could be compared with when fishing activity took place in research blocks to better evaluate the potential predictive capacity of such approaches for research fishing.

Marine debris

8.3 The Secretariat presented an update on the CCAMLR marine debris monitoring program (WG-FSA-17/02) and included a review of the occurrence of plastic debris on beaches and in seabird colonies in the entanglement of marine mammals. Overall, the frequency of occurrence of man-made debris on beach surveys and in seabird colonies is lower than historical levels but remains an issue in the CAMLR Convention Area. The Secretariat thanked those Members that had submitted data to the marine debris program and encouraged all Members that conduct fieldwork in the CCAMLR region to submit similar data.

8.4 The Working Group thanked the Secretariat for the update and noted that this CCAMLR program was established to monitor the potential impacts of fishing on the marine environment and requested that lost gear reported from vessels, from both observer and commercial data, be included in future annual updates on marine debris from the Secretariat.

8.5 The Working Group noted that marine debris data was submitted by three Members and encouraged the Scientific Committee to consider ways to encourage more Members to participate in marine debris monitoring, including potential links with the CEP and Council of Managers of National Antarctic Programs (COMNAP) in expanding engagement across more sites and national programs (see SC-CAMLR-XXXV, Annex 7, paragraph 8.38).

Climate change response work program

8.6 WG-FSA-17/01 presented a draft climate change response work program addressing the remaining terms of reference of the climate change intersessional correspondence group (ICG) to develop approaches for integrating considerations of the impacts of climate change into the work of CCAMLR. The ICG sought feedback from WG-FSA on the draft work program, specifically advice on issues, information gaps identified, proposed actions and relevant activities already underway, as well as advice on appropriate timeframes for responding to research activities.

8.7 The Working Group thanked Australia and Norway for preparing WG-FSA-17/01 and noted that it is important for WG-FSA to consider issues related to climate change. It also noted that the workplan set out in the paper would need to be considered in the context of the other priorities identified by the Scientific Committee. The Working Group recognised that a number of the activities identified in the plan were already part of the five-year plan for the Scientific Committee and that it would be important for WG-FSA and the Scientific Committee to have a strategy to ensure that it was able to deliver advice that was robust to the potential effects of climate change.

8.8 The Working Group noted that despite being the focus of a great deal of work in WG-FSA, there was no specific mention of toothfish in the work program despite there being climate change impacts on the benthic habitats in the Antarctic (Griffith et al., 2017). The Working Group recommended that an appropriate mechanism be developed to bring climate change science and the potential impacts on finfish in the Southern Ocean into the work of WG-FSA and noted that this could include the routine analyses of time series of data from fisheries and associated research data to detect potential climate-related changes.

8.9 The Working Group noted that the proposed Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) workshop to be held in Hobart in April 2018 directly addressed questions provided by WG-EMM and had a spatial focus on Area 48 and encouraged Members to engage with this work (SC-CAMLR-XXXV, Annex 6, paragraphs 6.18 and 6.19).

8.10 The Working Group also noted that there were considerable opportunities for fishing vessels to participate in the collection of oceanographic data, including through CTDs attached to gear, that could be coordinated in a way that enhanced their contribution to climate-related science.

Global Environment Facility proposal

8.11 CCAMLR-XXXVI/02 provided an update on the development of the proposal for funding support from the Global Environment Facility (GEF) to build capacity among GEF-eligible CCAMLR Member countries to strengthen their participation in CCAMLR. The project was approved by the GEF Council at its meeting in May 2017 and work is currently underway to develop the full project document.

8.12 The Working Group welcomed the report and agreed that, if successful, it would contribute significantly to building capacity within CCAMLR among GEF-eligible Members. It encouraged all Members to consider whether opportunities existed within their research programs to create opportunities to raise capacity in CCAMLR that could contribute to the success of the project.

8.13 The Working Group noted that the operational details and mechanisms for supporting the proposal, including implications for Secretariat support, were a matter for the Commission.

Ross Sea region MPA Research and Monitoring Plan

8.14 SC-CAMLR-XXXVI/20 presented a proposed RMP for the Ross Sea region MPA and the Working Group noted that the Co-conveners of the Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP-17) had undertaken to seek recommendations from all of the working groups in order to provide a revised RMP to the Scientific Committee for consideration.

8.15 The Working Group noted that the draft RMP contained a description of the research requirements associated with the SRZ, but that some clarity of the requirements in the short and long term would be desirable.

8.16 The Working Group noted that the RMP did not seek to prioritise the areas of research that had been identified but that it is advantageous to allow national Antarctic programs to select the work that they would undertake rather than for CCAMLR to seek to agree on a priority for the list of important research areas.

8.17 The Working Group noted that the first five-year review would reveal gaps in the delivery of the RMP and that this would likely require an update of the RMP and a prioritisation to address identified gaps.

8.18 The Working Group noted that coordination of research between different Members is important and that there was a need for a mechanism to achieve coordination. To help with the evaluation of a research plan, the Working Group requested the Scientific Committee develop a research plan pro forma, similar to the one for data-poor fisheries. Information from the RMP should also be used, including the list of topics (SC-CAMLR-XXXVI/20, Table 1), how the list related to geographic locations (SC-CAMLR-XXXVI/20, Table 2) and project details as listed in SC-CAMLR-XXXVI/20, paragraph 10.

Weddell Sea MPA

8.19 The Working Group considered the scientific background document in support of the Weddell Sea MPA proposal (WG-FSA-17/29). The document informed on the work carried out intersessionally to develop analyses of relevant data layers, including an updated *D. mawsoni* habitat model and associated cost layers.

8.20 The Working Group recalled the discussion from WG-SAM-17 (Annex 5, paragraph 6.8) and clarified that the 60% protection targets for adult *D. mawsoni* reflected the spatial distribution of protection, including areas under ice, and was not analogous to a target level of a spawning stock biomass in the CCAMLR decision rules. The Working Group also noted that, where protection was provided as a result of areas currently being inaccessible due to ice cover, the MPA review process would provide a mechanism to ensure that the protection targets are maintained in the event of large-scale environmental change.

8.21 The Working Group noted that the current Marxan analysis was restricted to adult toothfish and that data on other life-history stages of toothfish, such as the distribution of juveniles for surveys in Subarea 48.1 (see Kock et al., 2000), including from adjacent regions, could be used to better reflect the distribution of *D. mawsoni* in the Weddell Sea.

8.22 The Working Group welcomed the proposal from Germany to host a workshop in 2018 to further examine toothfish dynamics and movement in the region to inform a working stock structure hypothesis (SC CIRC 17/58) and noted that the development of this hypothesis would contribute to the management of *D. mawsoni* in Area 48 and to the definition of the fishery research zones in the Weddell Sea MPA proposal.

8.23 Dr Kasatkina noted that there are populations of dominant fish species in the Weddell Sea that are of commercial importance, or potential commercial importance, including *D. mawsoni*; spiny icefish (*Chaenodraco wilsoni*); *P. antarctica* and Antarctic rockcod (*Trematomus eulepidotus*). She noted that Russia had repeatedly indicated that information on the commercial potential of these fish species and krill for future rational use should be included in the MPA proposal (SC-CAMLR-XXXIV, paragraphs 3.19 and 3.20; SC-CAMLR-XXXVI, Annex 3, paragraph 5.4) and requested clarification on planned activities in relation to these issues.

Collaboration on code used for analysis

8.24 The Working Group noted the increasing use of GitHub by Members as the preferred environment for collaborating code development during this Working Group. It was agreed that there were many benefits arising from sharing code in a version-controlled transparent environment such as GitHub.

8.25 The Working Group was informed by the Secretariat that a GitHub organisation and corporate account had been created by the Secretariat (www.github.com/ccamlr) to allow centralised administration of code.

8.26 It was noted that participation in code repositories that are private can be facilitated by the Secretariat using the CCAMLR corporate account, but this would require an annual fee (currently A$21 per person, per month) and would have to be considered by SCAF.

Advice to the Scientific Committee

9.1 The Working Group's advice to the Scientific Committee and its working groups is summarised below, and the body of the report leading to these paragraphs should also be considered.

(i) IUU fishing activity –

(a) the unprecedented availability of catch data from IUU vessels (paragraph 2.16).

(ii) Assessments –

(a) catch limit for *C. gunnari* in Subarea 48.3 (paragraph 3.6)

(b) catch limit for *C. gunnari* in Division 58.5.2 (paragraph 3.12)

(c) catch limit for *D. eleginoides* in Subarea 48.3 (paragraph 3.27)

(d) catch limits for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 (paragraphs 3.32 and 3.37 respectively)

(e) prohibition of directed fishing for *D. eleginoides* in Division 58.5.1 outside areas of national jurisdiction (paragraph 3.43)

(f) catch limit for *D. eleginoides* in Division 58.5.2 (paragraph 3.54)

(g) prohibition of directed fishing for *D. eleginoides* in Subarea 58.6 outside areas of national jurisdiction (paragraph 3.60)

(h) catch limits for *D. mawsoni* in Subarea 88.1 including shelf survey (paragraphs 3.86 and 3.87).

(iii) Ross Sea region –

(a) monitoring fishing capacity and potential improvements to fishery closure forecasting (paragraphs 3.94 to 3.97)

(b) tagging details using video (paragraph 3.73)

(c) research in SRZ of the Ross Sea region MPA (paragraphs 3.107 and 3.114).

(iv) Subarea 88.2 –

(a) continuation of research plan with coordination between Members intending to carry out research (paragraphs 3.117, 3.119 and 3.121).

(v) Research fishing in data-poor fisheries for *Dissostichus* spp. –

(a) cross-referencing evaluation criteria in new or modified proposals (paragraph 4.9)

(b) revision process and review of research proposals (paragraph 4.10)

(c) integrated strategy for research proposal (paragraph 4.14)

(d) capacity to complete planned research and evaluation of vessel performance in research (paragraphs 4.16, 4.18 and 4.67)

(e) priority work for WG-SAM and WG-FSA (paragraph 4.37)

(f) research fishing in Subareas 48.2 and 48.4 (paragraphs 4.68 and 4.72)

(g) research fishing in Subarea 48.6 (paragraph 4.87)

(h) research fishing in Divisions 58.4.1 and 58.4.2 (paragraph 4.116)

(i) research fishing in Division 58.4.3a (paragraph 4.127)

(j) research fishing in Division 58.4.4b (paragraph 4.130)

(k) research fishing in Subarea 88.3 (paragraph 4.147).

(vi) Scheme of International Scientific Observation (SISO) –

(a) redesigned observer logbooks (paragraph 5.6).

(vii) Non-target catch and interactions in CCAMLR fisheries –

(a) mechanisms to avoid *Macrourus* by-catch in Division 58.4.1, including move-on rules and catch limits (paragraphs 6.13, 6.15 and 6.20)

(b) mechanisms to avoid *Macrourus* by-catch in Subarea 88.1 associated with the Ross Sea region MPA (paragraphs 6.22 and 6.23)

(c) incidental mortality of seabirds in CCAMLR fisheries (paragraphs 6.25 and 6.28).

(viii) Future work –

(a) independent review process of CCAMLR's integrated stock assessments (paragraphs 7.14 and 7.15).

(ix) Other business –

(a) Marine debris monitoring (paragraph 8.5)

(b) Ross Sea region MPA RMP (paragraph 8.18).

Close of meeting

10.1 In closing the meeting, Dr Welsford thanked all participants for their patience and hard work in accomplishing the long list of tasks presented to the Working Group, including the provision of advice on catch limits in assessed fisheries and the development of review criteria and advice on research proposals for research on toothfish. He also thanked the rapporteurs and the Secretariat for their support to the work of WG-FSA-17.

10.2 On behalf of the Working Group, Dr Belchier thanked Dr Welsford for his strong leadership combined with a good sense of humour that had enabled the Working Group to deliver such a large amount of clear advice to the Scientific Committee.

10.3 The Working Group noted that the former Convener, Dr Stuart Hanchet, would be retiring next year and therefore would not be returning the Working Group. Mr Dunn was asked to convey the Working Group's thanks and best wishes to Dr Hanchet for his sustained positive contribution to the work of WG-FSA and CCAMLR.

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Table 1: Number of *D. mawsoni* otoliths collected on Member vessels and ages available by year for small-scale research units (SSRUs) 882H and 882C–G. The priorities for the ageing of otoliths are indicated as high, medium or lower priority collections for ageing by green, orange and blue respectively. Existing collections from which some otoliths have been aged are shown in yellow. ARG – Argentina; AUS – Australia; ESP – Spain; GBR – United Kingdom; KOR – Republic of Korea; NOR – Norway; NZL – New Zealand; RUS – Russian Federation; UKR – Ukraine; URY – Uruguay; ZAF – South Africa.

Year	Number aged	Member										
		Number of otoliths collected										
		ARG	AUS	ESP	GBR	KOR	NOR	NZL	RUS	UKR	URY	ZAF
882North (882H)												
2003	184	0	0	0	0	0	0	563	0	0	0	0
2004	235	0	0	0	0	0	0	596	0	0	0	0
2005	234	0	0	0	0	0	55	332	0	0	0	0
2006	173	0	0	0	170	0	750	245	0	0	0	0
2007	0	136	0	0	67	0	475	0	117	0	0	0
2008	289	0	0	0	46	0	0	862	113	0	3	0
2009	13	0	0	16	715	47	0	22	0	0	0	701
2010	0	48	0	9	386	9	0	0	0	0	0	0
2011	251	0	0	0	233	36	0	817	553	0	0	0
2012	244	0	0	0	264	49	0	907	140	0	0	0
2013	388	0	0	0	22	24	40	775	235	32	0	0
2014	169	0	0	0	68	111	0	249	26	48	0	0
2015	335	0	339	0	0	0	76	0	0	32	0	0
2016	0	0	0	0	395	0	0	0	122	0	0	0
2017	0	0	342	0	0	0	0	0	0	0	107	0
882South (882C–G)												
2006	23	0	0	0	71	0	0	131	6	0	0	0
2007	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2009	341	0	0	0	120	0	0	405	0	0	0	0
2010	0	0	0	30	0	0	0	0	0	0	0	0
2011	121	0	0	0	45	10	0	286	511	0	0	0
2012	0	0	0	0	0	0	0	0	70	0	0	0
2013	383	0	0	0	0	0	0	505	0	0	0	0
2014	29	0	0	0	186	42	220	33	301	40	0	0
2015	166	0	307	0	0	308	610	0	50	96	0	0
2016	180	0	0	492	661	138	0	275	799	192	0	0
2017	0	0	177	0	0	345	0	1	490	943	123	0

Table 2: Prospective milestones for reporting information to WG-SAM and WG-FSA from research plans in data-poor fisheries as defined in SC-CAMLR-XXIX, Annex 6, paragraph 5.1. The items listed below are a guide for creating a tailored set of milestones according to the individual objectives of each research plan in data-poor fisheries against which WG-FSA can assess progress of each research plan, as appropriate. Due dates for milestones should be specified in each individual research plan. Actual milestones to be agreed by the Scientific Committee for each research plan.

	Milestones
Fishing operations	1. Fishing operational data specified in the research plan (e.g. standardisation of gear or procedures or data to be collected)
	2. Sampling requirements as specified in the research plan (e.g. fish length, weight, otoliths, by-catch species composition, tags deployed, vulnerable marine ecosystem sampling)
Biological sampling and analysis	3. Tissue samples collected as specified: otolith sampling, gonad sampling, other
Sample processing as agreed	4. Otoliths to be aged, validation procedures completed and adequate for use
	5. Maturity analysis as specified (methods, sample sizes, by sex)
Biological parameter estimation	6. Length–weight relationships
	7. Maturity ogive parameter values
	8. Age–length keys, growth model parameters
Tagging data	9. Tagging rate achieved, tag releases by season in each research block, overlap statistic achieved
	10. Vessel calibration studies conducted
By-catch data	11. Data and samples collected as specified in the research plan
	12. Analyses conducted as specified in the research plan (e.g. satellite tagging, oceanography, diet)
Data analysis, as specified in the research plan	13. Hypothesis testing of stock structure
	14. Vessel calibration studies as specified: catch rate and size selectivity, tagged fish survival and tag detection analysis
	15. Illegal, unreported and unregulated fishing estimation (current and historical)
	16. Expected tagging program performance
	17. Preliminary stock status, and biomass estimates, and harvest rate incorporating data collected to date (e.g. selectivity, size, biological parameters)
	18. Analysis of biological data for target and non-target species
	19. Analysis of potential effects of fishing on the ecosystem

Table 3: Toothfish catch limits for the 2016/17 season, decision rules used for choice of methodology and calculation of catch, and proposed catch limits for the 2017/18 fishing season for data-poor fisheries, by research block for data-poor toothfish fisheries.

Research block	2016/17 catch limit	Qualitative rule	Adequate tag recaptures	Agreed method	Chapman method estimate	CPUE method estimate	Catch limit without 20% max. change	Catch limit proposed for 2017/18 with 20% max. change
486_2	170	Stable	Y	Chapman	169	121	169	169
486_3	50	Declining	Y	Catch limit × 0.8	82	18	40	40
486_4	100	Stable	Y	Chapman	230	142	230	120
486_5	190	n/a	-	CPUE	-	334	334	228
5841_1	80	n/a	-	CPUE	480	142	142	96
5841_2	81	Stable	N	CPUE	-	170	170	97
5841_3	233	Stable	N	CPUE	532	145	145	186
5841_4	13	n/a	-	CPUE	-	24	24	16
5841_5	35	Not certain	N	CPUE	172	213	213	42
5841_6	90	Increasing	N	CPUE	243	165	165	108
5842_1	35	n/a	-	CPUE	-	129	129	42
5843a_1*	32	Not certain	N	CPUE	73	64	64	38
5844b_1*	25	Stable	N	CPUE	104	18	18	20
5844b_2*	35	Declining	N	Catch limit × 0.8	45	18	28	28

* Catch for the current season is incomplete.

Table 4: Summary of the assessment of the Area 48 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the scores are in the notes below, and details in paragraphs 4.52 to 4.87. n/e indicates not evaluated.

Subarea:	48.1	48.2		48.2 and 48.4	48.5	48.6	
Proposal and country/criteria:	WG-FSA-17/32 Ukraine	WG-FSA-17/27 Chile	WG-FSA-17/31 Ukraine	WG-FSA-17/45 UK	WG-FSA-17/25 Russia	WG-FSA-17/10 Japan and South Africa	WG-FSA-17/61 Rev. 1 Norway
Conservation measure under which proposal submitted	24-01	24-01	24-01	24-01	n/e	21-02	21-02
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	Y	Y	n/e	Y	Y
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y	Y	Y	n/e	Y	Y
(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	1	1	1	Y	n/e	Y	Y
(ii) Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?	5	Y	Y	Y	n/e	Y	Y
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	2	2	Y	n/e	Y	Y
(iv) Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?	4	Y	Y	Y	n/e	Y	5
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	6	7	8	Y	n/e	9	Y
(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?[10]	Y[11]	Y	Y	Y	n/e	12	Y

(continued)

Table 4 (continued)

Subarea:	48.1	48.2		48.2 and 48.4	48.5	48.6	
Proposal and country/criteria:	WG-FSA-17/32 Ukraine	WG-FSA-17/27 Chile	WG-FSA-17/31 Ukraine	WG-FSA-17/45 UK	WG-FSA-17/25 Russia	WG-FSA-17/10 Japan and South Africa	WG-FSA-17/61 Rev. 1 Norway
(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[10]	Y[10]	Y	Y[10]	Y	n/e	Y	Y

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):
1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 5: Summary of the assessment of the Area 58 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the scores are in the notes below, and details in paragraphs 4.88 to 4.129.

Subarea:	58.4.3a	58.4.4b	58.4.1 and 58.4.2	58.4.2
Proposal and country/criteria:	WG-FSA-17/55 Japan and France	WG-FSA-17/11 Japan and France	WG-FSA-17/18 Rev. 1 Australia, France, Japan, Republic of Korea and Spain	WG-FSA-17/33 Ukraine
Conservation measure under which proposal submitted	CM 21-02	CM 24-01	CM 21-02	CM 21-02
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	Y	5
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y	Y	Y
(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	1	Y	Y	5
(ii) Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?	Y	Y	Y	13
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	Y	Y	Y
(iv) Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?	Y	Y	Y	5
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	Y[9]	Y[9]	**Y**	Y[8]
(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?[10]	Y[10]	Y[10]	Y	Y[11]
(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[10]	Y	Y	Y	Y[10]

(continued)

Table 5 (continued)

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):

1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 6: Summary of the assessment of the Subarea 88.3 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the numbers are in the notes below, and additional details in paragraphs 4.138 to 4.146.

Subarea:			88.3	
Proposal and country/criteria:			WG-FSA-17/34 Ukraine	WG-FSA-17/40 Republic of Korea and New Zealand
Conservation measure under which proposal submitted			24-01	24-01
(i)	(a)	Is the proposed research likely to generate an index of local stock abundance?	Y	Y
	(b)	Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y
	(c)	Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	5	Y
(ii)	Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?		5	Y
(iii)	Are the likely impacts from the proposed research to dependent and related species consistent with Article II?		2	Y
(iv)	Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?		5	Y
(v)	Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?		6	Y
(vi)	Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?[10]		14	Y

(continued)

Table 6 (continued)

Subarea:	88.3	
Proposal and country/criteria:	WG-FSA-17/34 Ukraine	WG-FSA-17/40 Republic of Korea and New Zealand
(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[10]	10	Y

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):

1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 7: Number of sets and catch limits by small-scale research units (SSRU) and research block or prospecting area for New Zealand and the Republic of Korea research in Subarea 88.3 as described in WG-FSA-17/40, Table 3.

SSRU	Research block/ prospecting area	Region	*Greenstar*		*Janas*		Total	
			Sets	Catch	Sets	Catch	Sets	Catch
883A	883_1	slope	18	20	-	-	18	20
	883_2	shelf	14	25	-	-	14	25
883B	883_3	slope	15	25	15	25	30	50
	P_6	shelf	-	-	15	30	15	30
	P_8	north	-	-	10	10	10	10
883C	883_4	slope	50	50	-	-	50	50
	P_7	shelf	-	-	15	30	15	30
	P_9	north	-	-	10	10	10	10
883D	883_5	slope	18	10	-	-	18	10
	P_10	north	-	-	10	10	10	10
Totals			115	130	75	115	190	245

Table 8: Proposed catch limits for by-catch species in the Ross Sea region following the implementation of the Ross Sea region marine protected area (MPA). Each value is either fixed based on a local area biomass estimate or set as a percentage of the toothfish catch limit. The catch limits in brackets are based on the toothfish catch limit recommended of 3 157 tonnes.

	Macrourid		Skates		Other	
Special research zone	Fixed	(72 tonnes)	5%	(23 tonnes)	5%	(23 tonnes)
All areas outside the MPA and south of 70°S	Fixed	(317 tonnes)	5%	(104 tonnes)	5%	(104 tonnes)
All areas outside the MPA and north of 70°S	16%	(96 tonnes)	5%	(30 tonnes)	5%	(30 tonnes)

Table 9: Numbers of incidental mortalities of seabirds and marine mammals (IMAF) in 2016/17 received through vessel and observer data. Data source 'Obs. tally period' is the haul observation period conducted by observers, and the mortalities recorded during this period are used to calculate the extrapolated total (scaled by the percentage of hooks observed) for seabird mortalities. 'Obs. total' is the total number of mortalities reported by observers (includes incidental mortalities reported from outside the haul observation/tally period). Catch and effort are summary catch and effort data reported at 1-, 5- or 10-day intervals depending on the fishery. C1 and C2 data are haul-by-haul vessel data reported to the Secretariat at monthly intervals. Subareas and divisions[1] that are marked with an asterisk have incomplete datasets and fields marked with a dash have no fishing activity present, or data is not submitted to the Secretariat.

	Data source	Subarea					Division		Total
		48.1*	48.2*	48.3*	48.4	58.6 (French EEZ)	58.5.1 (French EEZ)	58.5.2*	
Longline									
Seabirds	Obs. tally period	-	0	12	1	4	14	2	33
	Obs. total	-	0	21	1	-	-	2	24
	Extrapolated total	-	0	37	3	16	56	4	116
	Catch and effort	-	0	24	1	-	-	2	27
	C2	-	0	20	1	-	-	2	23
Marine mammals	Vessel	-	0	0	0	-	-	6	6
	Observer	-	0	0	0	0	0	3	3
Finfish trawl									
Seabirds	Observer	-	-	3	-	-	-	0	3
	Catch and effort	-	-	3	-	-	-	0	3
	C1	-	-	3	-	-	-	0	3
Marine mammals	Vessel	-	-	0	-	-	-	0	0
	Observer	-	-	1	-	-	-	0	1
Krill trawl									
Seabirds	Observer	0	0	0	-	-	-	-	0
	Catch and effort	1	1	0	-	-	-	-	2
	C1	1	1	0	-	-	-	-	2
Marine mammals	Vessel	0	0	0	-	-	-	-	0
	Observer	0	0	0	-	-	-	-	0

1 Subareas and divisions not listed in this table had no reported mortalities during 2016/17 or no fishing activities were undertaken.

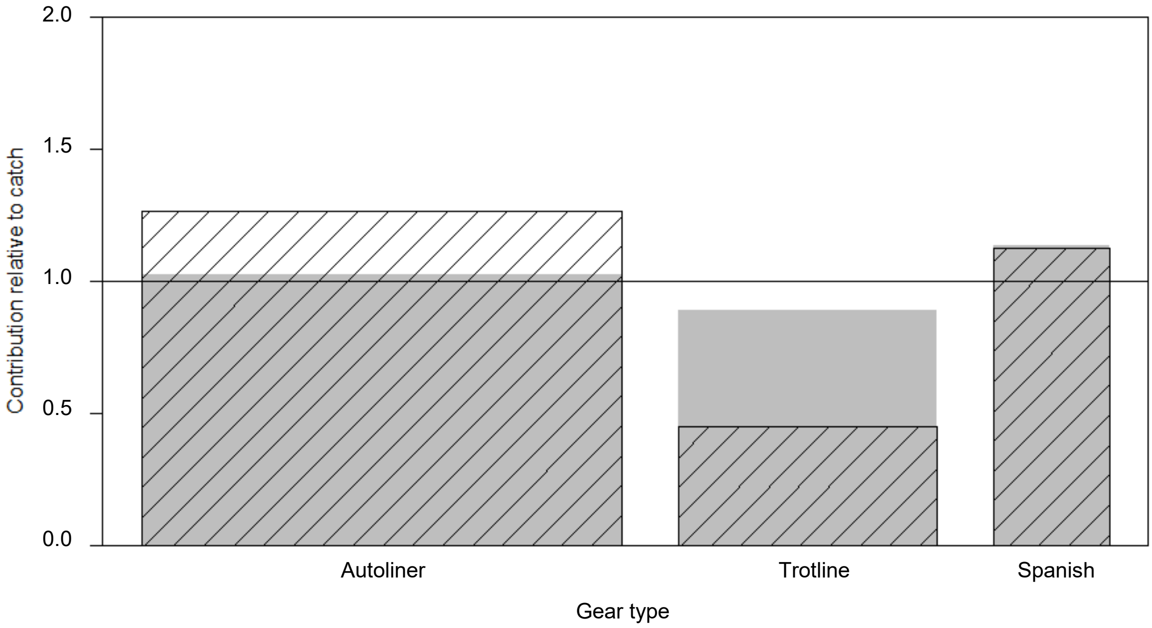

Figure 1: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by gear type, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each gear type and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each gear type and used within the Ross Sea region assessment model. Gear types are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36.

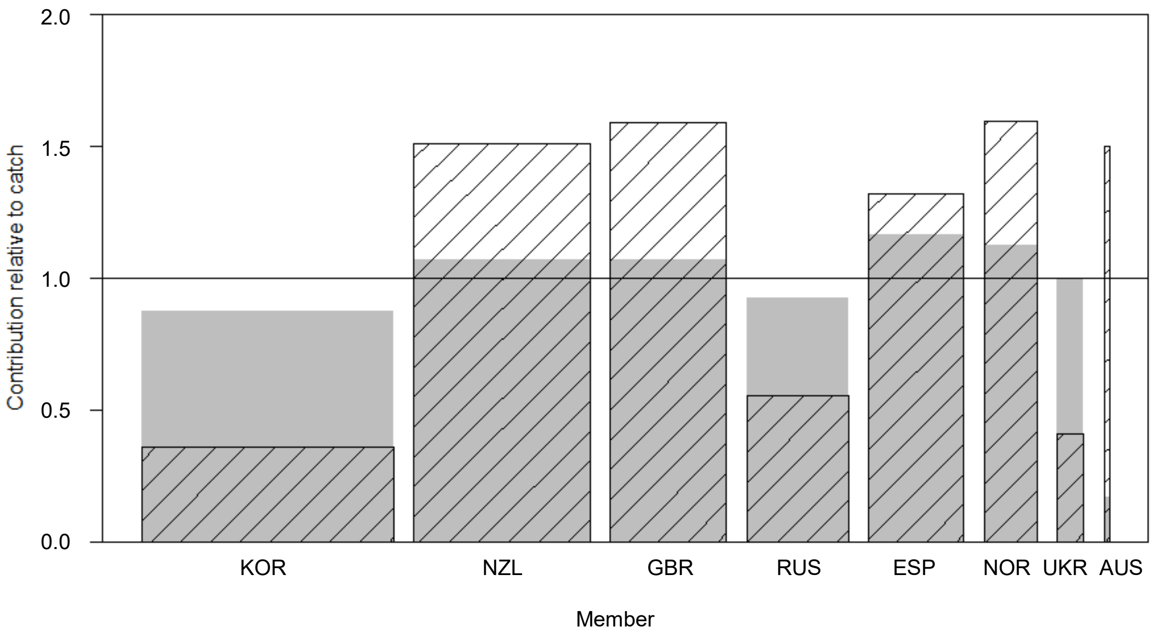

Figure 2: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by Member, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each Member and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each Member and used within the Ross Sea region assessment model. Members are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36. KOR – Republic of Korea; NZL – New Zealand; GBR – United Kingdom; RUS – Russia; ESP – Spain; NOR – Norway; UKR – Ukraine; AUS – Australia.

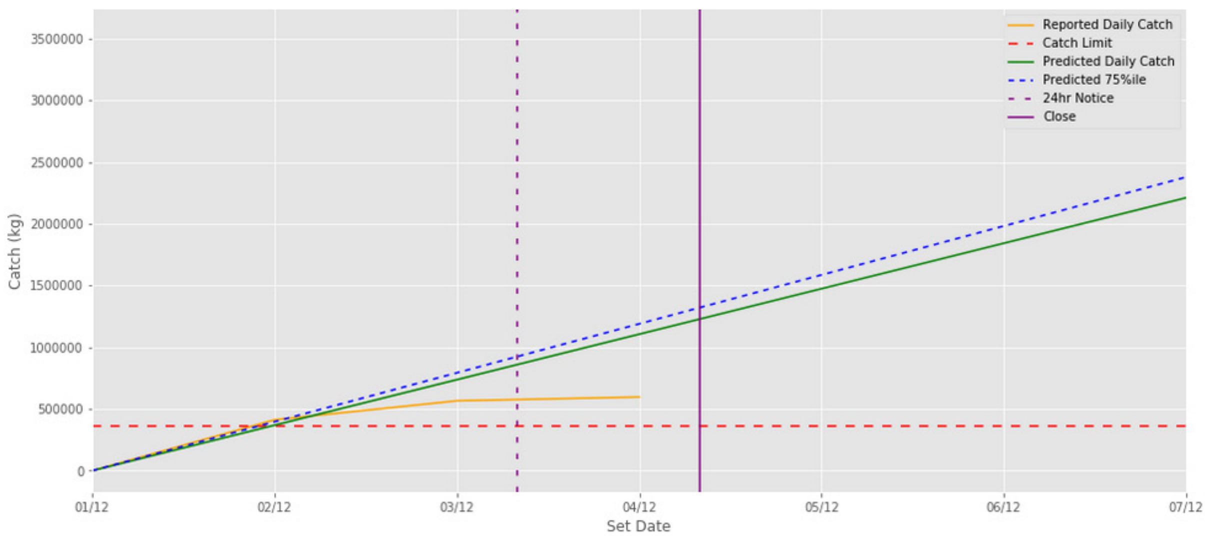

Figure 3: Predicted and reported cumulative daily catch, catch limit, closure notice and fishery closure for December 2016 in Subarea 88.1 SSRUs B, C and G. The daily cumulative catches are shown for the date on which gear was set rather than the date on which the catch was landed to simulate the use of potential catch (based on the number of hooks deployed).

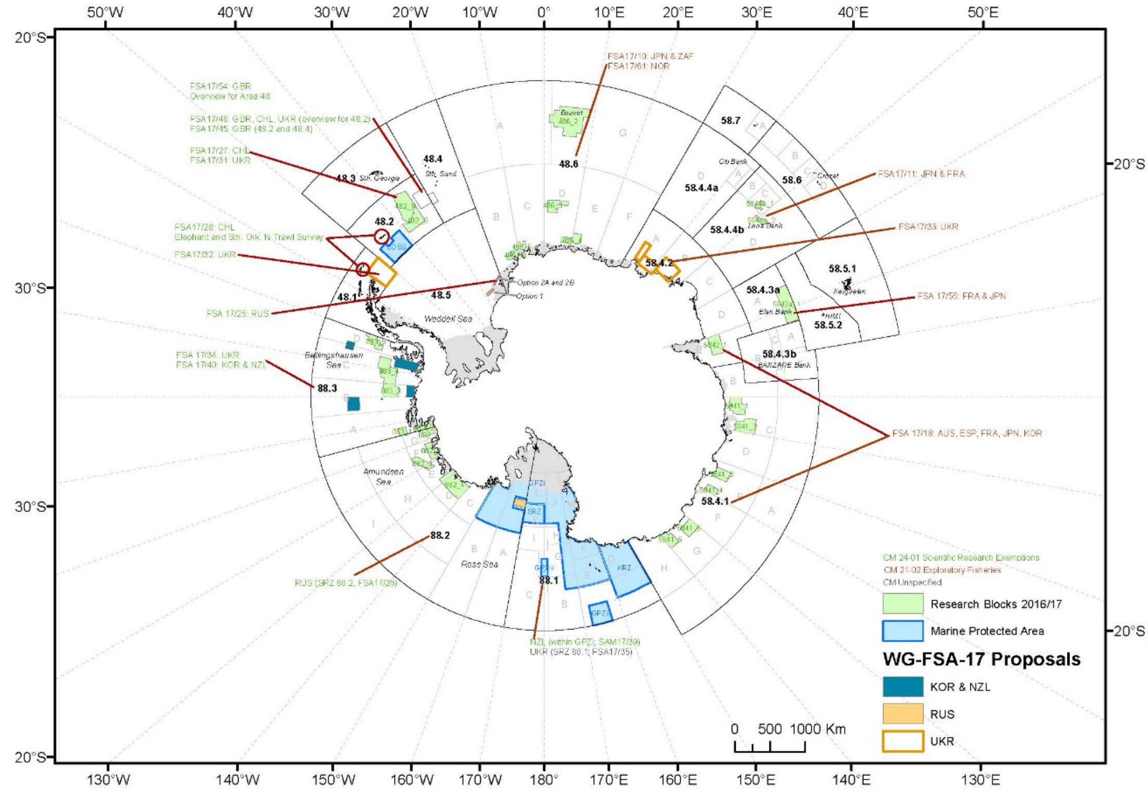

Figure 4: Map of existing and proposed research activities involving toothfish considered at WG-FSA-17. AUS – Australia; CHL – Chile; ESP – Spain; FRA – France; GBR – United Kingdom; JPN – Japan; KOR – Republic of Korea; NZL – New Zealand; NOR – Norway; RUS – Russia; UKR – Ukraine; ZAF – South Africa. RB – research block; GPZ – general protection zone; SRZ – special research zone.

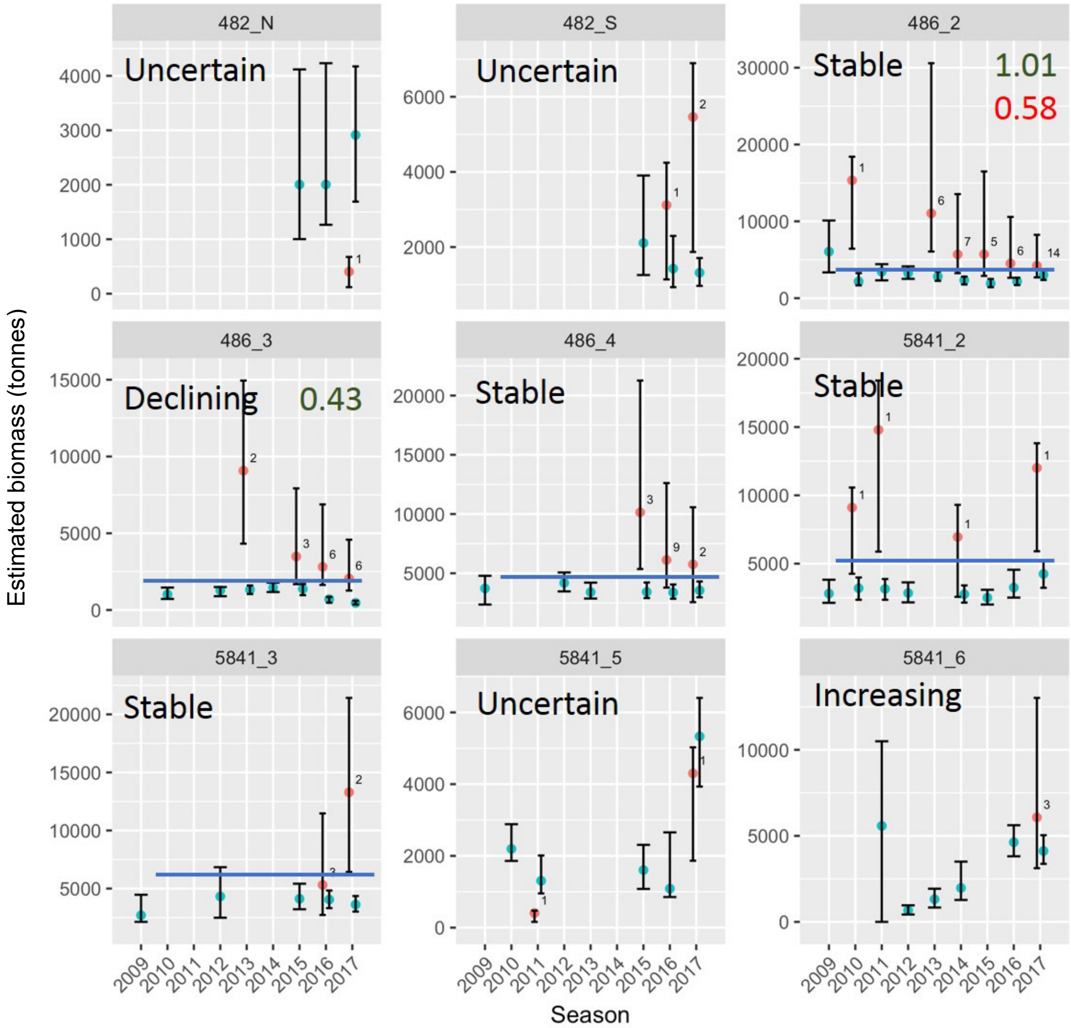

Figure 5: Estimated biomass of Antarctic toothfish (*Dissostichus mawsoni*) from 2009 to 2017 from nine research blocks within Subareas 48.2 and 48.6 and Division 58.4.1. Blue points represent CPUE estimates, and red points represent Chapman estimates. Numbers adjacent to symbols show the number of tags used in Chapman estimates.

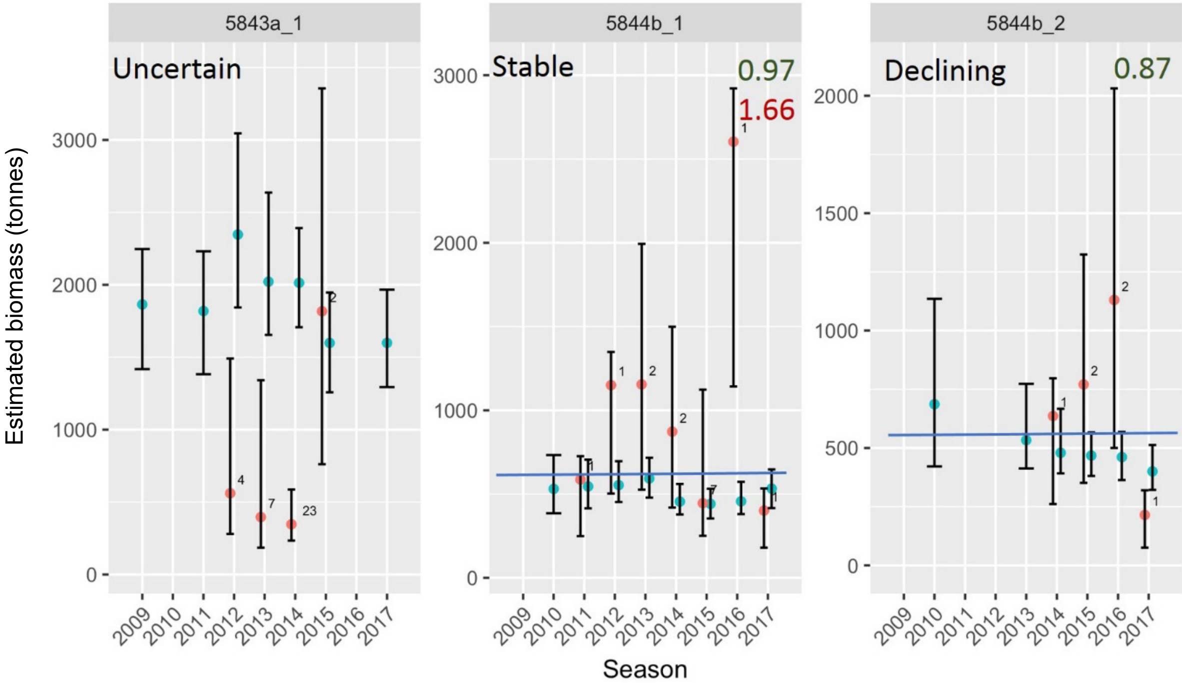

Figure 6: Estimated biomass of Patagonian toothfish (*Dissostichus eleginoides*) from 2009 to 2017 from three research blocks within Divisions 58.4.3a and 58.4.4b. Blue points represent CPUE estimates, and red points represent Chapman estimates. Numbers adjacent to symbols show the number of tags used in Chapman estimates.

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(Hobart, Australia, 2 to 13 October 2017)

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French Translator	Bénédicte Graham
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Spanish Translator	Margarita Fernández
Spanish Translator	Marcia Fernández
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Information Systems and Data Services Manager	Tim Jones
Systems Analyst	Ian Meredith
Business Systems and Data Analyst	Dr Sascha Frydman

Appendix B

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

1. Opening of the meeting

2. Organisation of the meeting and adoption of the agenda

   2.1 Organisation of the meeting
   2.2 Subgroup organisation and coordination
   2.3 Review of data available

3. Review of updated stock assessments and provision of management advice (all fisheries)

   3.1 *Champsocephalus gunnari*
      3.1.1 *Champsocephalus gunnari* in Subarea 48.3
      3.1.2 *Champsocephalus gunnari* in Division 58.5.1
      3.1.3 *Champsocephalus gunnari* in Division 58.5.2

   3.2 *Dissostichus* spp.
      3.2.1 *D. eleginoides* in Subarea 48.3
      3.2.2 *Dissostichus* spp. in Subarea 48.4
      3.2.3 *D. eleginoides* in Division 58.5.1
      3.2.4 *D. eleginoides* in Division 58.5.2
      3.2.5 *D. eleginoides* in Subarea 58.6
      3.2.6 *D. mawsoni* in Subarea 88.1
      3.2.7 *D. mawsoni* in Subarea 88.2

   3.3 Fishery Report updates

4. Research to inform current or future assessments in ‘data-poor’ fisheries (e.g. closed areas, areas with zero catch limits and Subareas 48.6 and 58.4) notified under Conservation Measures 21-02 and 24-01

   4.1 Generic issues and advice from WG-SAM-17

   4.2 Management area research reviews

      4.2.1 *Dissostichus* spp. in Area 48
         4.2.1.1 Review of available information and data quality
         4.2.1.2 Review of progress towards a stock assessment and research proposals
         4.2.1.3 Management advice and revision of Fishery Reports

4.2.2 *Dissostichus* spp. in Area 58
- 4.2.2.1 Review of available information and data quality
- 4.2.2.2 Review of progress towards a stock assessment and research proposals
- 4.2.2.3 Management advice and revisions to Fishery Reports

4.2.3 *Dissostichus mawsoni* in Area 88
- 4.2.3.1 Review of available information and data quality
- 4.2.3.2 Review of progress towards a stock assessment and research proposals
- 4.2.3.3 Management advice and revisions to Fishery Reports

4.2.4 Other fisheries research

5. Scheme of International Scientific Observation

   5.1 Recommendations from WS-SISO-17

6. Non-target catch and interactions in CCAMLR fisheries

   6.1 Fish and invertebrate by-catch
   6.2 Marine mammal and seabird by-catch
   6.3 Bottom fishing activities and vulnerable marine ecosystems (VMEs)

7. Future work

   7.1 SC-CAMLR five-year strategic plan
   7.2 Organisation of intersessional activities
   7.3 Notifications of other scientific research

8. Other business

   8.1 Reconciling krill catch and effort on continuous fishing system vessels
   8.2 Other priority business not addressed elsewhere

9. Advice to the Scientific Committee

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

Appendix C

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

WG-FSA-17/01	Proposal for a Climate Change Response Work Program for CCAMLR Delegations of Australia and Norway on behalf the Climate Change Intersessional Correspondence Group
WG-FSA-17/02	Report on the CCAMLR marine debris monitoring program Secretariat
WG-FSA-17/03	Proposed observer logbooks for the 2019 longline and finfish trawl fisheries Secretariat
WG-FSA-17/04	Fish by-catch in the krill fishery: 2017 update Secretariat
WG-FSA-17/05	Measurement of capacity in CCAMLR exploratory fisheries in Subareas 88.1 and 88.2: Secretariat update 2017 Secretariat
WG-FSA-17/06	Long-distance movements of Patagonian (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*) from fishery-based mark-recapture data Secretariat
WG-FSA-17/07	A characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 88.2A–B) to 2016–17 S. Parker and S. Mormede
WG-FSA-17/08	Correlation of sea-surface temperature in Ross Sea, Weddell Sea and the sea off Peru for the ice analysis T. Namba, T. Ichii and T. Okuda
WG-FSA-17/09	Gonad analysis of Antarctic toothfish in Subareas 58.4 and 88.3 J. Kim, S.-G. Choi, J. Lee, J. Lee and D. An
WG-FSA-17/10	Revised research plan for the 2017/18 exploratory longline fishery of *D. mawsoni* in Subarea 48.6 by South Africa and Japan Delegations of Japan and South Africa

WG-FSA-17/11	Revised research plan for the 2017/18 toothfish fishery in Division 58.4.4b by Japan and France Delegations of Japan and France
WG-FSA-17/12	Diets of Antarctic toothfish estimated from fatty acids and stable isotopes C.-K. Kang, S.-G. Choi, J. Lee, J. Lee and D. An
WG-FSA-17/13	Procedures for proposals and reporting on research plans in data-poor fisheries S.J. Parker and D.C. Welsford
WG-FSA-17/14 Rev. 1	The random stratified trawl survey to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* in the waters surrounding Heard Island (Division 58.5.2) for 2017 G.B. Nowara, T. D. Lamb and P. Ziegler
WG-FSA-17/15	An update on the ageing of Antarctic toothfish, *Dissostichus mawsoni*, from East Antarctica and the Amundsen Sea G. Nowara, B. Farmer, T. Barnes, P. Ziegler and D. Welsford
WG-FSA-17/16	Spatial variation in Antarctic toothfish (*Dissostichus mawsoni*) catch rate, mean weight, maturity stage and sex ratio across Divisions 58.4.1, 58.4.2 and 58.4.3b P. Yates, P. Ziegler, P. Burch, D. Maschette, D. Welsford and S. Wotherspoon
WG-FSA-17/17 Rev. 1	Joint report on exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2016/17 fishing seasons Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-17/18 Rev. 1	Continuation of multi-Member research on the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) by Australia, France, Japan, Republic of Korea and Spain Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-17/19	An integrated stock assessment for the Heard Island and McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery in Division 58.5.2 P. Ziegler
WG-FSA-17/20	Report on fishing effort and seabird interactions during the season extension trials in the longline fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2 T. Lamb

WG-FSA-17/21	Estimation of tag-loss rates for tagged fish in the Patagonian toothfish (*Dissostichus eleginoides*) fisheries at Heard Island and McDonald Islands in Division 58.5.2 P. Ziegler
WG-FSA-17/22	A preliminary assessment and revised growth model of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2017 random stratified trawl survey D. Maschette, P. Burch, P. Yates and D. Welsford
WG-FSA-17/23	Mitigation of *Macrourus* by-catch in research block 58.4.1_6 and estimation of *Macrourus* biomass and sustainable catch in Divisions 58.4.1 and 58.4.2 D. Maschette, P. Burch, P. Yates and P. Ziegler
WG-FSA-17/24	Proposal to modify Conservation Measure 24-02 regarding the use of a streamer line Y. Korzun and S. Kasatkina
WG-FSA-17/25	Plan of the research program of Russian Federation in Subarea 48.5 (Weddell Sea) in season 2017/18 Delegation of the Russian Federation
WG-FSA-17/26	Research program to examine the life-cycle and resource potential of *Dissostichus* species in the Special Research Zone within the Ross Sea region Marine Protected Area (RSRMPA) in 2017–2027 Delegation of the Russian Federation
WG-FSA-17/27	Revised research longline fishing proposal for *Dissostichus* spp. in Subarea 48.2, second season Delegation of Chile
WG-FSA-17/28	Demersal finfish distribution, abundance and their biological characteristics in Statistical Subareas 48.1 (northern part) and 48.2 (2018–2020) Delegation of Chile
WG-FSA-17/29	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2017 – Reflection of the recommendations by WG-EMM-16 and SC-CAMLR-XXXV K. Teschke, H. Pehlke and T. Brey
WG-FSA-17/30	Preliminary results of otolith elemental composition analysis of *Dissostichus* spp. in Subarea 48.2 Delegation of Chile

WG-FSA-17/31	Proposal for continuation of the Ukrainian research survey in Subarea 48.2 in 2017/18 and 2018/19 seasons Delegation of Ukraine
WG-FSA-17/32	Revised research program of Ukraine in Subarea 48.1 in 2018 Delegation of Ukraine
WG-FSA-17/33	Revised research plan for the 2017/18 exploratory longline fishery of *Dissostichus* spp. in Division 58.4.2 Delegation of Ukraine
WG-FSA-17/34	Revised research program of Ukraine in Subarea 88.3 Delegation of Ukraine
WG-FSA-17/35	Ukrainian research proposal for the 2017/18 season in Subarea 88.1 Delegation of Ukraine
WG-FSA-17/36	Mark-recapture inputs to the 2017 Ross Sea region stock assessment (Subarea 88.1 and SSRUs 88.2A–B) S. Parker and S. Mormede
WG-FSA-17/37 Rev. 1	Assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region to 2016/17 S. Mormede
WG-FSA-17/38	Diagnostic plots of stock assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region to 2016/17 S. Mormede
WG-FSA-17/39	The toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) to 2016/17 S. Parker and S. Mormede
WG-FSA-17/40	Joint research proposal for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea and New Zealand Delegations of the Republic of Korea and New Zealand
WG-FSA-17/41	New Zealand submission for the trial of the CCAMLR observer training program accreditation scheme A. Dunn, D. Kerrigan and A. McNabb
WG-FSA-17/42	Estimates of local biomass, including estimates of uncertainty, for Antarctic (*Dissostichus mawsoni*) and Patagonian (*Dissostichus eleginoides*) toothfish in research blocks in Subareas 48.2, 48.6, 58.4 and 88.3 CCAMLR Secretariat

WG-FSA-17/43	Report on the survey in Subarea 48.2 in 2015–2017 Delegation of Ukraine
WG-FSA-17/44	Report of the UK groundfish survey at South Georgia (CCAMLR Subarea 48.3) in January 2017 M. Belchier, V. Foster, S. Gregory, S. Hill, V. Laptikhovsky, P. Lafite and L. Featherstone
WG-FSA-17/45	Outline for year 2 of the 3-year longline survey to determine toothfish population connectivity between Subareas 48.2 and 48.4 M. Söffker and M. Belchier
WG-FSA-17/46	Preliminary results from the first year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4 K. Olsson, M. Belchier and M. Söffker
WG-FSA-17/47	Preliminary assessment of mackerel icefish *Champsocephalus gunnari* in Subarea 48.3 based on the 2017 groundfish survey T. Earl
WG-FSA-17/48 Rev. 1	Subarea 48.2 research and research proposals for 2018 – overview M. Söffker, M. Belchier, A. Zuleta, S. Hopf, P. Ruiz, J.C. Quiroz, L. Pshenichnov, D. Marichev and C. Darby
WG-FSA-17/49	Preliminary tag-recapture based population assessment of Antarctic toothfish in Subarea 48.4 N.D. Walker and T. Earl
WG-FSA-17/50	Estimating seabird by-catch in CCAMLR longline fisheries C. Darby and K. Olsson
WG-FSA-17/51	Estimates of length-frequency in the assessment of mackerel icefish *Champsocephalus gunnari* in Subarea 48.3 T. Earl
WG-FSA-17/52	Assessment of Patagonian toothfish (*D. eleginoides*) in Subarea 48.4 T. Earl
WG-FSA-17/53	Assessment of Patagonian toothfish (*D. eleginoides*) in Subarea 48.3 T. Earl and S. Fischer

WG-FSA-17/54	Developing a strategy for coordinated research leading to achievement of the CCAMLR objectives for Antarctic toothfish (*D. mawsoni*) in Area 48 C. Darby and M. Söffker
WG-FSA-17/55	Continuation of multi-Member research on the *Dissostichus eleginoides* exploratory fishery in 2017/18 in Division 58.4.3a by France and Japan Delegations of France and Japan
WG-FSA-17/56	Analysis of the toothfish fishery indices in Subareas 88.1 and 88.2 when using different types of longline gears S. Kasatkina
WG-FSA-17/57	Monitoring Antarctic toothfish (*D. mawsoni*) recruitment in the southern Ross Sea S.M. Hanchet, S. Mormede, S. Parker, K. Large, A. Dunn and B. Sharp
WG-FSA-17/58 Rev. 2	Summary of scientific observer data collected in CCAMLR fisheries in the Convention Area during 2017 CCAMLR Secretariat
WG-FSA-17/59	Updated assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Crozet Islands (Subarea 58.6) R. Sinegre, G. Duhamel and J.B. Lecomte
WG-FSA-17/60	Updated stock assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Kerguelen Islands (Division 58.5.1) R. Sinegre, G. Duhamel and J.B. Lecomte
WG-FSA-17/61 Rev. 1	Proposal for a longline survey on toothfish in Statistical Subarea 48.6 in 2017/18 Delegation of Norway
WG-FSA-17/62	Proposed process for independent review of CCAMLR toothfish stock assessments Scientific Committee Chair and Vice-Chairs and the working group conveners
WG-FSA-17/63	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2017 Poker Biomass survey R. Sinegre and G. Duhamel

WG-FSA-17/64	Length-weight relationships of six fish species associated with krill fishery in the Atlantic sector of the Southern Ocean L. Wei, G.P. Zhu and Q.Y. Yang
WG-FSA-17/65	Otolith elemental signatures reveal habitat shift of *Electrona carlsbergi* L. Wei and G.P. Zhu
WG-FSA-17/66	Update of ongoing work on age and growth of Antarctic toothfish (*Dissostichus mawsoni*) from Division 58.4.1 by Spain L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde and S. Barreiro

Other documents

WG-FSA-17/P01	Changing status of three notothenioid fish at the South Shetland Islands (1983–2016) after impacts of the 1970–80s commercial fishery E. Barrera-Oro, E. Marschoff and D. Ainley *Polar Biol.*, 201 (2017): 1–8 http://dx.doi.org/10.1007/s00300-017-2125-0
WG-FSA-17/P02	Total mercury and methylmercury concentrations in Antarctic toothfish (*Dissostichus mawsoni*): Health risk assessment M. Yoon, M.-R. Jo, K.-T. Son, W.-S. Choi, S.I. Kang, S.-G. Choi, J.H. Lee and T.S. Lee *Arch. Environ. Con. Tox.* (in press)
WG-FSA-17/P03	Metabarcoding analysis of the stomach contents of the Antarctic toothfish (*Dissostichus mawsoni*) collected in the Antarctic Ocean T.-H. Yoon, H.-E. Kang, S.R. Lee, J.-B. Lee, G.W. Baeck, H. Park and H.-W. Kim *PeerJ* 5:e3977 https://doi.org/10.7717/peerj.3977
WG-FSA-17/P04	Spatio–temporal dynamics in maturation and spawning of Patagonian toothfish *Dissostichus eleginoides* on the subantarctic Kerguelen Plateau P. Yates, P. Ziegler, D. Welsford, J. McIvor, B. Farmer and E. Woodcock *J. Fish Biol.* (accepted), doi: 10.1111/jfb.13479
WG-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)

WG-SAM-17/39	Proposal to continue the time series of research surveys to monitor abundance of Antarctic toothfish in the southern Ross Sea, 2018–2022 S.M. Hanchet, K. Large, S.J. Parker, S. Mormede and A. Dunn
WG-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)
CCAMLR-XXXVI/02	Proposal for GEF (Global Environment Facility) funding to support capacity building in the GEF-eligible CCAMLR Members Delegations of Chile, India, Namibia, South Africa, Ukraine and the CCAMLR Secretariat
CCAMLR-XXXVI/28 Rev. 2	IUU fishing activity and trends in 2016/17 and IUU Vessel Lists Secretariat
SC-CAMLR-XXXVI/08	Convener's Report of the Workshop on the CCAMLR Scheme of International Scientific Observation (WS-SISO) (Buenos Aires, Argentina, 3 to 7 July 2017) WS-SISO Convener (J. Moir Clark (EU))
SC-CAMLR-XXXVI/20	The Ross Sea region Marine Protected Area Research and Monitoring Plan A. Dunn, M. Vacchi and G. Watters (Co-conveners)
SC-CAMLR-XXXVI/BG/01 Rev. 1	Catches of target species in the Convention Area Secretariat
SC-CAMLR-XXXVI/BG/38 Rev. 1	CCAMLR information and data systems update Secretariat

Appendix D

Terms of reference, outline funding requirements and timeline for the proposed independent CCAMLR stock assessment review

Terms of reference

1. The primary objective for the expert panel is to provide advice to the Scientific Committee and its working groups on the adequacy of the modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments relative to international best practices, and to suggest improvements to the assessment methods where appropriate. Specifically:

(i) Inputs: Review the extent to which the data, modelling assumptions, model structure, priors and penalties are appropriate (including assessment of both biological and fishery components). This includes the choice of observations (survey, catch per unit effort (CPUE), tag, age, length), treatment and processing of observations, and biological parameters (values and derivation).

(ii) Implementation: Review whether the statistical modelling and the resulting inferences on stock status and dynamics have been implemented using best-practice methods, including how these are implemented using CASAL. This includes modelling methods (i.e. best practices), estimation and data weighting, Markov Chain Monte Carlo (MCMCs) and diagnostics used.

(iii) Improvements to modelling: Comment on any improvements that could or should be made to the methods to increase the reliability of the results for future management decision-making – including the potential use of alternative models or model structures.

(iv) Improvements to data and research: Comment on other key areas of research or data collection that could decrease uncertainty or increase the utility of the modelling for future management decision-making.

2. Evaluate the utility of alternative models and structures that could be explored for the assessment of CCAMLR stocks and provide input to the evaluation process.

Funding required

- Hosting Member: meeting venue and meeting operations
- Assessing Members: develop presentations, documents, review time and travel to participate
- CCAMLR: expert reviewers' time and travel expenses to prepare, review and report outcomes.

Time:	Five days for preparation (background reading and assessment papers), five days for the review of the three assessments, five days for travel to and from the meeting, and report preparation for three reviewers at US$ 1 000/day =	US$45 000
Expenses:	Hotel and meals for six days × three reviewers × US$300/day =	US$5 400
Airfare:	US$1 000 (on average) × three reviewers =	US$3 000
Total estimated cost:		US$53 400

Timeline

Task	Timing
Scientific Committee endorses review, terms of reference and budget	October 2017
Reviewers identified and coordinated by the Chair of the Scientific Committee and the conveners of WG-SAM and WG-FSA and communicated via SC circular for comment	January 2018
Documents distributed	April 2018
Review occurs, including external experts	1 week prior to WG-SAM (2018)
CCAMLR report and external expert report presented to WG-SAM	June 2018
CCAMLR report and external expert report presented to WG-FSA	October 2018
Scientific Committee recommends actions based on review report and working group comments	October 2018
Update assessments and analyses as required for WG-SAM and WG-FSA	June to September 2019
Stock assessments and analyses presented based on the review recommendations	June to September 2019

Annex 8

Vessel Tagging Notification Pro Forma

Vessel Tagging Notification Pro Forma

All vessels should follow the CCAMLR tagging protocol for tagging toothfish (www.ccamlr.org/node/85702).

Please select the most appropriate fields for your vessel's tagging procedures or provide details where appropriate. In addition to this notification, please attach a document describing the methods of training crew on each vessel used for developing skills to evaluate suitability, tag and release toothfish (e.g. pre-departure briefing, at-sea training from experienced crew members, observer assistance).

Equipment and set up	
Tagging station location	On deck – Open air
	On deck – Under cover
	In factory
	Other – Please describe
	Distance from tagging station location to roller/release position (m)
Holding tank	Y/N
Holding tank information (if used)	Volume (l)
	Shape (square, rectangle, circle etc.)
	Does the tank have flowing water (Y/N)
Landing and handling fish	
Large fish recovery and lifting equipment	Net
	Sling
	Stretcher
	Other – Please describe
	Approximate minimum length of fish when lifting gear is used (cm)
Fish recovery and release positions	Vertical distance from water surface to fish handling position (m)
	Vertical distance from fish release position to water surface (m)
	Do you use a sling to release tagged fish (Y/N)
Personnel and training	
Tagging and tag recovery responsibilities	Crew
	Observer(s)
	Combination
	Number of crew trained for tagging procedures
	Main spoken languages by crew
	Title of person responsible for overall tagging training (e.g. fishing master, bosun, factory manager, observer, company representative)
Assessment of fish suitability for tagging	CCAMLR tagging protocol used: (Y/N)
	CCAMLR tagging protocol available for viewing near tagging station: (Y/N)
	Handlers of tagged fish trained in assessment of fish condition: (Y/N)

Terms of Reference: Outline Funding Requirements and Timeline for the Proposed Independent CCAMLR Stock Assessment Review

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Terms of reference

1. The primary objective for the expert panel is to provide advice to the Scientific Committee and its working groups on the adequacy of the modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments relative to international best practices, and to suggest improvements to the assessment methods where appropriate. Specifically:

(i) Inputs: Review the extent to which the data, modelling assumptions, model structure, priors and penalties are appropriate (including assessment of both biological and fishery components). This includes the choice of observations (survey, catch per unit effort (CPUE), tag, age, length), treatment and processing of observations, and biological parameters (values and derivation).

(ii) Implementation: Review whether the statistical modelling and the resulting inferences on stock status and dynamics have been implemented using best-practice methods, including how these are implemented using CASAL. This includes modelling methods (i.e. best practices), estimation and data weighting, Markov Chain Monte Carlo (MCMCs) and diagnostics used.

(iii) Improvements to modelling: Comment on any improvements that could or should be made to the methods to increase the reliability of the results for future management decision-making – including the potential use of alternative models or model structures.

(iv) Improvements to data and research: Comment on other key areas of research or data collection that could decrease uncertainty or increase the utility of the modelling for future management decision-making.

2. Evaluate the utility of alternative models and structures that could be explored for the assessment of CCAMLR stocks and provide input to the evaluation process.

Funding required

- Hosting Member: meeting venue and meeting operations
- Assessing Members: develop presentations, documents, review time and travel to participate
- CCAMLR: expert reviewers' time and travel expenses to prepare, review and report outcomes.

Time:	Five days for preparation (background reading and assessment papers), five days for the review of the three assessments, five days for travel to and from the meeting, and report preparation for three reviewers at US$ 1 000/day =	US$45 000
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CCAMLR report and external expert report presented to WG-FSA	October 2018
Scientific Committee recommends actions based on review report and working group comments	October 2018
Update assessments and analyses as required for WG-SAM and WG-FSA	June to September 2019
Stock assessments and analyses presented based on the review recommendations	June to September 2019

Terms of Reference for the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48

(19 to 21 February 2018, Berlin, Germany)

Terms of Reference for the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48
(19 to 21 February 2018, Berlin, Germany)

Rationale

1. The rationale for Germany to offer hosting a CCAMLR workshop was set out in COMM CIRC 17/77–SC CIRC 17/58.

2. Submissions for new research and data collection programs on Antarctic toothfish (*Dissostichus mawsoni*) in Area 48 have recently become widely dispersed with little coordination or strategic integration. At the same time, Germany has carried out a lot of work on a proposal for establishing a marine protected area (MPA) in the wider Weddell Sea region. Without regional coordination, research in this area is unlikely to deliver, within a realistic timeframe, the objectives of the Commission.

3. Coordinated by the Scientific Committee, the development of an Area 48 regional stock hypothesis with an associated strategic approach to the sampling and collation of data to test and further refine this hypothesis, will enable the Scientific Committee to provide improved and integrated advice to the Commission on the spatial management of the *D. mawsoni* stock(s) in Area 48.

4. Consequently, the Scientific Committee welcomed the offer of Germany and proposed a CCAMLR workshop that will bring together experts on the life history and dynamics of *D. mawsoni* and experts on the regional biological, hydrographic and bathymetric conditions in Area 48.

Objectives

5. The main objectives of the workshop are:

(i) to develop a hypothesis of the spatial distribution of key life-history stages of *D. mawsoni* in Area 48 and how these are linked –

this toothfish population hypothesis should be suitable for coordinating and structuring the research in Area 48

(ii) to develop a sampling design to collate data and information for testing and reviewing the hypothesis formulated under (i) –

this will also guide and improve the design and structure of future research on toothfish to be carried out in Area 48 and should facilitate the review of this research by the relevant CCAMLR working groups

(iii) to identify preliminary options for the further development of spatial management of the wider Weddell Sea, especially regarding the management and conservation approaches, including the relevant *D. mawsoni* research and monitoring requirements foreseen, for example, under the proposed Weddell Sea MPA (in accordance with SC-CAMLR-XXXV, Annexes 5 and 6).

6. In order to achieve these objectives, the workshop will, inter alia, review and evaluate the relevant documentation submitted by CCAMLR Members to previous meetings of WG-SAM, WG-EMM, WG-FSA and the Scientific Committee. Experts attending the workshop are specifically invited to submit additional information prior to the workshop that addresses the terms of reference.

Organisational arrangements

7. A meeting webpage and an e-group will be created on the CCAMLR website to facilitate registration, submission and access to papers, and provide logistic details for the workshop. The e-group will also provide a means for discussion and information exchange prior to, and after, the workshop. Germany has limited funds available to support participation of invited experts (if required).

8. The results of the workshop will be summarised in a convener's report after the meeting and the e-group members will be asked to comment on this report. The report will subsequently be submitted to the 2018 meetings of WG-SAM, WG-EMM, WG-FSA and the Scientific Committee. The results of the workshop are also intended to be taken into account by the EU and Germany in the revision of the Weddell Sea MPA proposal, including the location and management of the fisheries research zone and the associated research and monitoring requirements.

Draft Terms of Reference for the CCAMLR Data Management Group (DMG)

Draft Terms of Reference for the CCAMLR Data Management Group (DMG)

1. The Data Management Group (DMG) will be a conduit between CCAMLR data users and the Secretariat, and will provide feedback and advice on:

(i) communication of information on data and metadata management and development

(ii) development of data quality standards and rules

(iii) development of data infrastructure, including data submission processes

(iv) provision of data extracts to Members

(v) development of data analysis tools.

2. The DMG will review the Secretariat Information System and Data Services workplan annually and provide feedback on the prioritisation and scope of data projects planned for the following year.

3. The Convener of the DMG will be selected by the Scientific Committee and be responsible for the coordination of the work of the group. The DMG will conduct its work using the most effective means, which can include the CCAMLR e-group facility, teleconferences, or online meetings. It may also meet periodically in association with a Scientific Committee and/or relevant working group meetings. Summaries of DMG discussions will be communicated via an e-group as well as reported to relevant working groups and annually to the Scientific Committee.

4. Participation in the DMG is open to all Members with participants nominated by their respective Scientific Committee Representative. The DMG may call on invited experts to develop specific aspects of its work following the procedures for inviting experts to meetings of the Scientific Committee and its working groups.

Appendix A

Project Updates as Provided by SC-CAMLR-XXXVI/BG/38 Rev. 1
Illustrating the Scope of Data-related Activities Expected to be Considered by the Data Management Group (DMG)

Automated data loading

1. Introducing automation into the process of receiving and loading of data into the CCAMLR database provides the fundamental cornerstone of data processing that will allow the Secretariat to be responsive to changing requirements and provide increased transparency in how data is processed.

2. The process of loading data consists of registering the data submission in a data registry, loading the data into a staging database where a series of data quality (DQ) checks occur in accordance with a defined set of DQ rules, followed by the transfer of data into the CCAMLR database once the data has passed the DQ checks. DQ issues detected are referred back to data owners to resolve and resubmit corrected data.

3. Automated data loading has been completed for:

(i) catch and effort data – used for in-season monitoring
(ii) observer logbook – longline
(iii) observer logbook – krill trawl.

4. Longline observer logbook processing has been completed for both MS Excel and MS Access data submission formats (see WS-SISO-17/04 for more detail), and provides a more efficient process, with enhanced DQ feedback reports provided to technical coordinators. The automated loading system will also allow the Secretariat to accept proposed new versions of observer logbooks in a more timely fashion (WG-FSA-17/03). The fine-scale catch and effort data continues to be manually processed. It is the next dataset scheduled for automated processing.

Rules repository

5. The rules repository has been implemented as a set of database tables that allow for the systematic recording of all rules that are applied during data loading. These range from checking data types (number, date, string), ensuring mandatory items exist (not null), verifying related data exists (haul must have corresponding set, etc.) and checking value ranges (measurement between high and low values). The rules repository will continue to evolve as the systems development continues and new rules are defined.

6. Detailing the rules for the automated observer longline processing, and mapping of these rules to the source logbook fields has been completed, and made available to Members through the Scheme of International Scientific Observation e-group (https://groups.ccamlr.org/siso/node/812). Mapping and detailing of the krill autoload rules is currently under development, and will be

available on the Scheme of International Scientific Observation e-group by the end of November 2017. Catch and effort data processing rules are available from the Secretariat on request.

Data collection forms

7. A number of data collection forms have been revised to improve the useability of the form, reduce the likelihood of errors and to facilitate the autoload process. The catch and effort forms were released immediately prior to the 2017 fishing season. Feedback on the use of these new forms has been positive and resulted in a reduced burden of data reporting on vessels and Flag States.

8. The new observer logbook forms have been refined throughout the year with good engagement by various stakeholders at the Workshop on the Scheme of International Scientific Observation (WS-SISO) and via the e-group (WG-FSA-17/03). The proposed new logbooks use the same Excel-based format of a workbook with separate worksheets for each aspect of data collection, but removing many of the data fields that were duplicated between the observer and commercial data forms. The logbooks also have considerable built-in data validations to assist observers in entering data correctly.

9. The development of the new forms in 2017 would mean that (pending their agreement by the Scientific Committee) they would be introduced for use in the 2019 season. However, through broad engagement in the revision process, including at WS-SISO, some Members have expressed an interest to start using the forms in the 2018 season. With the new autoload system in operation, the Secretariat is now able to accept data from either the new or old form, and apply the same DQ rules.

Electronic reporting

10. A trial with New Zealand on the collection of toothfish tagging data has been described in WS-SISO-17/01. The initial results from the trial were positive and the Secretariat would welcome the opportunity to work with Members to continue to pursue opportunities to improve the usability, timeliness and quality of data collection systems.

Enhancing reference data

11. Spatial data that uniquely defines the spatial extent of an area, can be used to georeference data by, for example, allocating activities recorded in latitude/longitude to a statistical area, research block or small-scale research unit (SSRU), etc. This can be used to visualise data by providing the files needed to display data in a mapping application, or assist vessels in their compliance by providing accurate spatially referenced files that can be incorporated into a global positioning system (GPS).

12. The Secretariat has completed extensive work to validate the reference data polygons, that is spatial data originating from CCAMLR, to ensure contiguous boundaries are consistent

in both polar and non-polar projections and that there are no overlapping boundaries, etc. The new polygons have been published on the CCAMLR GIS and are available to download, or use directly, in any GIS application that supports web services.

13. The new polygon data are being used directly in analyses and for cartographic purposes in the CCAMLRGIS R package. Additionally, data extracts can now take advantage of 'spatial queries' to extract data using any of the geographical areas such as research blocks, marine protected areas (MPAs) or SSRUs as filter criteria.

14. With ongoing support from the British Antarctic Survey (BAS), the online GIS has also been undergoing extensive improvements, updating the software to later versions, providing improved reliability, functionality, speed and support for modern browsers.

Data portal

15. The Secretariat has created a data portal (https://data.ccamlr.org/) based on the CKAN (https://ckan.org/) framework with extensions that will allow us to publish secure data based on the CCAMLR user directory and associated security groups. The data portal is a convenient mechanism to publish the spatial data visible on the GIS in a variety of formats available to download such as SHP, KML and GPX. It also provides an opportunity for the Secretariat, and others, to evaluate the viability of this platform for other purposes such as publishing metadata for externally hosted datasets such as acoustic data.

VMS

16. The CCAMLR vessel monitoring system (VMS) continues to underpin the positional accuracy of both location and temporal data supplied from other sources. Furthermore, to support active monitoring, control and surveillance (MCS) activities, the VMS is now able to provide scheduled, near real-time reports of vessel positions within a specified statistical area to authorised recipients automatically. In the past, these reports were manually prepared and transmitted.

e-CDS

17. The redevelopment of the electronic web-based Catch Documentation Scheme for *Dissostichus* spp. (e-CDS) was the culmination of work that commenced in 2014 with the independent review of CCAMLR's CDS. The review recommended that the e-CDS be updated. Work was undertaken from 2014 to 2016 to develop, implement and test a new e-CDS with support from Members through CCAMLR e-groups and at an e-CDS workshop held in 2016.

18. Apart from being much more intuitive and simple to use, the benefits for e-CDS users include an ability to manage access permissions, browse recent documents, correct/edit data while maintaining a complete audit trail and report on imports and exports within each user's jurisdiction.

19. The e-CDS was rewritten to support the full list of enhancements requested by the CDS Review Panel (CCAMLR-XXXIV/09) and taking advantage of the reference data developments in respect to vessels and geographical areas. This integration allows the Secretariat to perform routine data quality assurance processes using data from all available sources.

Annex 12

Terms of Reference for the Scientific Committee Bureau

Terms of Reference for the Scientific Committee Bureau

Composition

1. The Scientific Committee Bureau will comprise the Scientific Committee Chair, Vice-Chairs, working group and subgroup conveners and the Convener of the Data Management Group (DMG).

Role

2. Scientific Committee Bureau will act to facilitate and coordinate the work of the Scientific Committee and its working groups. It will not be a decision-making body. It will:

(i) coordinate actions to address priorities identified for the Scientific Committee and its working groups in the five-year workplan

(ii) provide a forum to identify emerging issues to enable more flexible agendas of the Scientific Committee and its working groups to facilitate better coordination of intersessional activities

(iii) organise and coordinate the various scientific activities during the annual Scientific Committee meeting

(iv) facilitate the transfer of corporate knowledge among the Scientific Committee and its working groups, including providing for effective handover of ongoing issues to incoming Chairs

(v) coordinate responses to intersessional invitations for the representation of the Scientific Committee at external meetings where the scheduling does not allow consideration at the next Scientific Committee meeting.

Glossary of acronyms and abbreviations used in SC-CAMLR reports

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AAD	Australian Government Antarctic Division
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ACAP BSWG	ACAP Breeding Sites Working Group (BSWG)
ACC	Antarctic Circumpolar Current
ACW	Antarctic Circumpolar Wave
ADCP	Acoustic Doppler Current Profiler (mounted on the hull)
ADL	Aerobic Dive Limit
AEM	Ageing Error Matrix
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIS	Automatic Identification System
AKES	Antarctic Krill and Ecosystem Studies
ALK	Age–length Key
AMD	Antarctic Master Directory
AMES	Antarctic Marine Ecosystem Studies
AMLR	Antarctic Marine Living Resources
AMSR-E	Advanced Microwave Scanning Radiometer – Earth Observing System
ANDEEP	Antarctic Benthic Deep-sea Biodiversity
APBSW	Bransfield Strait West (SSMU)
APDPE	Drake Passage East (SSMU)
APDPW	Drake Passage West (SSMU)
APE	Antarctic Peninsula East (SSMU)
APEC	Asia-Pacific Economic Cooperation
APECS	Association of Polar Early Career Scientists

APEI	Elephant Island (SSMU)
APEME Steering Committee	Steering Committee on Antarctic Plausible Ecosystem Modelling Efforts
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
APW	Antarctic Peninsula West (SSMU)
ARK	Association of Responsible Krill harvesting companies
ASE	Assessment Strategy Evaluation
ASI	Antarctic Site Inventory
ASIP	Antarctic Site Inventory Project
ASMA	Antarctic Specially Managed Area
ASOC	Antarctic and Southern Ocean Coalition
ASPA	Antarctic Specially Protected Area
ASPM	Age-Structured Production Model
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATME	Antarctic Treaty Meeting of Experts on the Impacts of Climate Change for Management and Governance of the Antarctic region
ATS	Antarctic Treaty System
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced Very High Resolution Radiometry
BAS	British Antarctic Survey
BED	Bird Excluder Device
BICS	Benthic Impact Camera System
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks (SCAR/SCOR)
BROKE	Baseline Research on Oceanography, Krill and the Environment
BRT	Boosted Regression Trees

CAC	Comprehensive Assessment of Compliance
cADL	calculated Aerobic Dive Limit
CAF	Central Ageing Facility
CAML	Census of Antarctic Marine Life
CAMLR Convention	Convention on the Conservation of Antarctic Marine Living Resources
CAML SSC	CAML Scientific Steering Committee
CAR	Comprehensiveness, Adequacy, Representativeness
CASAL	C++ Algorithmic Stock Assessment Laboratory
CBD	Convention on Biodiversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-2000 Survey	CCAMLR 2000 Krill Synoptic Survey of Area 48
CCAMLR-IPY-2008 Survey	CCAMLR-IPY 2008 Krill Synoptic Survey in the South Atlantic Region
CCAS	Convention on the Conservation of Antarctic Seals
CCEP	CCAMLR Compliance Evaluation Procedure
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CCSBT-ERS WG	CCSBT Ecologically Related Species Working Group
CDS	Catch Documentation Scheme for *Dissostichus* spp.
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CF	Conversion Factor
CircAntCML	Circum-Antarctic Census of Antarctic Marine Life
CITES	Convention on International Trade in Endangered Species
CM	Conservation Measure

CMIX	CCAMLR's Mixture Analysis Program
CMP	Conservation Management Plan
CMS	Convention on the Conservation of Migratory Species of Wild Animals
COFI	Committee on Fisheries (FAO)
COLTO	Coalition of Legal Toothfish Operators
CoML	Census of Marine Life
COMM CIRC	Commission Circular (CCAMLR)
COMNAP	Council of Managers of National Antarctic Programs (SCAR)
CON	CCAMLR Otolith Network
COTPAS	CCAMLR Observer Training Program Accreditation Scheme
CPD	Critical Period–Distance
CPPS	Permanent Commission on the South Pacific
CPR	Continuous Plankton Recorder
CPUE	Catch-per-unit-effort
CQFE	Center for Quantitative Fisheries Ecology (USA)
CS-EASIZ	Coastal Shelf Sector of the Ecology of the Antarctic Sea-Ice Zone (SCAR)
CSI	Combined Standardised Index
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CT	Computed Tomography
CTD	Conductivity Temperature Depth Probe
CV	Coefficient of Variation
C-VMS	Centralised Vessel Monitoring System
CVS	Concurrent Version System
CWP	Coordinating Working Party on Fishery Statistics (FAO)
DCD	*Dissostichus* Catch Document

DMSP	Defense Meteorological Satellite Program
DPM	Dynamic Production Model
DPOI	Drake Passage Oscillation Index
DQA	Data quality assurance
DVM	Diel vertical migration
DWBA	Distorted wave Born approximation model
EAF	Ecosystem Approaches to Fishing
EASIZ	Ecology of the Antarctic Sea-Ice Zone
E-CDS	Electronic Web-based Catch Documentation Scheme for *Dissostichus* spp.
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
ECOSIM	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
EEZ	Exclusive Economic Zone
EG-BAMM	Expert Group on Birds and Marine Mammals (SCAR)
EIV	Ecologically Important Value
ENFA	Environmental Niche Factor Analysis
ENSO	El Niño Southern Oscillation
EOF/PC	Empirical Orthogonal Function/Principal Component
EoI	Expression of Intent (for activities in the IPY)
EPOC	Ecosystem, productivity, ocean, climate modelling framework
EPOS	European *Polarstern* Study
EPROM	Erasable Programmable Read-Only Memory
eSB	Electronic version of CCAMLR's *Statistical Bulletin*
ESS	Effective Sample Size(s)

FAO	Food and Agriculture Organization of the United Nations
FBM	Feedback Management
FEMA	Workshop on Fisheries and Ecosystem Models in the Antarctic
FEMA2	Second Workshop on Fisheries and Ecosystem Models in the Antarctic
FFA	Forum Fisheries Agency
FFO	Foraging–Fishery Overlap
FIBEX	First International BIOMASS Experiment
FIGIS	Fisheries Global Information System (FAO)
FIRMS	Fishery Resources Monitoring System (FAO)
FMP	Fishery Management Plan
FOOSA	Krill–Predator–Fishery Model (previously KPFM2)
FPI	Fishing-to-Predation Index
FRAM	Fine Resolution Antarctic Model
FV	Fishing Vessel
GAM	Generalised Additive Model
GATT	General Agreement on Tariffs and Trade
GBIF	Global Biodiversity Information Facility
GBM	Generalised Boosted Model
GCMD	Global Change Master Directory
GDM	Generalised Dissimilarity Modelling
GEBCO	General Bathymetric Chart of the Oceans
GEOSS	Global Earth Observing System of Systems
GIS	Geographic Information System
GIWA	Global International Waters Assessment (SCAR)
GLM	Generalised Linear Model
GLMM	Generalised Linear Mixed Model

GLOBEC	Global Ocean Ecosystems Dynamics Research
GLOCHANT	Global Change in the Antarctic (SCAR)
GMT	Greenwich Mean Time
GOOS	Global Ocean Observing System (SCOR)
GOSEAC	Group of Specialists on Environmental Affairs and Conservation (SCAR)
GOSSOE	Group of Specialists on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
GUI	Graphical User Interface
GRT	Gross Registered Tonnage
GTS	Greene et al., (1990) linear TS versus length relationship
GYM	Generalised Yield Model
HAC	A global standard being developed for the storage of hydroacoustic data
HCR	Harvest Control Rule
HIMI	Heard Island and McDonald Islands
IA	Impact Assessment
IAATO	International Association of Antarctica Tour Operators
IASOS	Institute for Antarctic and Southern Ocean Studies (Australia)
IASOS/CRC	IASOS Cooperative Research Centre for the Antarctic and Southern Ocean Environment
IATTC	Inter-American Tropical Tuna Commission
ICAIR	International Centre for Antarctic Information and Research
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICED	Integrating Climate and Ecosystem Dynamics in the Southern Ocean
ICES	International Council for the Exploration of the Sea
ICESCAPE	Integrating Count Effort by Seasonally Correcting Animal Population Estimates

ICES WGFAST	ICES Working Group on Fisheries Acoustics Science and Technology
ICFA	International Coalition of Fisheries Associations
ICG-SF	Intersessional Correspondence Group on Sustainable Financing
ICSEAF	International Commission for the Southeast Atlantic Fisheries
ICSU	International Council for Science
IDCR	International Decade of Cetacean Research
IFF	International Fishers' Forum
IGBP	International Geosphere-Biosphere Programme
IGR	Instantaneous Growth Rate
IHO	International Hydrographic Organisation
IKMT	Isaacs-Kidd Midwater Trawl
IMAF	Incidental Mortality Associated with Fishing
IMALF	Incidental Mortality Arising from Longline Fishing
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research (IGBP)
IMO	International Maritime Organization
IMP	Inter-moult Period
IOC	Intergovernmental Oceanographic Commission
IOCSOC	IOC Regional Committee for the Southern Ocean
IOFC	Indian Ocean Fisheries Commission
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
IPOA	International Plan of Action
IPOA-Seabirds	FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries
IPY	International Polar Year
IRCS	International Radio Call Sign
ISO	International Organization for Standardization

ISR	Integrated Study Region
ITLOS	International Tribunal for the Law of the Sea
IUCN	International Union for the Conservation of Nature and Natural Resources – the World Conservation Union
IUU	Illegal, Unreported and Unregulated
IW	Integrated Weight
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
IWC SC	Scientific Committee of the IWC
IWL	Integrated Weighted Line
IYGPT	International Young Gadoids Pelagic Trawl
JAG	Joint Assessment Group
JARPA	Japanese Whale Research Program under special permit in the Antarctic
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
KPFM	Krill–Predatory–Fishery Model (used in 2005)
KPFM2	Krill–Predatory–Fishery Model (used in 2006) – renamed FOOSA
KYM	Krill Yield Model
LADCP	Lowered Acoustic Doppler Current Profiler (lowered through the water column)
LAKRIS	Lazarev Sea Krill Study
LBRS	Length-bin Random Sampling
LMM	Linear Mixed Model
LMR	Living Marine Resources Module (GOOS)
LSSS	Large-Scale Server System
LTER	Long-term Ecological Research (USA)
M	Natural Mortality

MARPOL Convention	International Convention for the Prevention of Pollution from Ships
MARS	Multivariate Adaptive Regression Splines
MAXENT	Maximum Entropy modelling
MBAL	Minimum Biologically Acceptable Limits
MCMC	Markov Chain Monte Carlo
MCS	Monitoring Control and Surveillance
MDS	Mitigation Development Strategy
MEA	Multilateral Environmental Agreement
MEOW	Marine Ecoregions of the World
MFTS	Multiple-Frequency Method for in situ TS Measurements
MIA	Marginal Increment Analysis
MIZ	Marginal Ice Zone
MLD	Mixed-layer Depth
MODIS	Moderate Resolution Imaging Spectroradiometer
MoU	Memorandum of Understanding
MP	Management Procedure
MPA	Marine Protected Area
MPD	Maximum of the Posterior Density
MRAG	Marine Resources Assessment Group (UK)
MRM	Minimum Realistic Model
MSE	Management Strategy Evaluation
MSY	Maximum Sustainable Yield
MV	Merchant Vessel
MVBS	Mean Volume Backscattering Strength
MVP	Minimum Viable Populations
MVUE	Minimum Variance Unbiased Estimate

NAFO	Northwest Atlantic Fisheries Organization
NASA	National Aeronautical and Space Administration (USA)
NASC	Nautical Area Scattering Coefficient
NCAR	National Center for Atmospheric Research (USA)
NEAFC	North East Atlantic Fisheries Commission
NCP	Non-Contracting Party
NGO	Non-Governmental Organisation
NI	Nearest Integer
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
nMDS	non-Metric Multidimensional Scaling
NMFS	National Marine Fisheries Service (USA)
NMML	National Marine Mammal Laboratory (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPOA	National Plan of Action
NPOA-Seabirds	FAO National Plans of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries
NRT	Net Registered Tonnage
NSF	National Science Foundation (USA)
NSIDC	National Snow and Ice Data Center (USA)
OBIS	Ocean Biogeographic Information System
OCCAM Project	Ocean Circulation Climate Advanced Modelling Project
OCTS	Ocean Colour and Temperature Scanner
OECD	Organisation for Economic Cooperation and Development
OM	Operating Model
PaCSWG	Population and Conservation Status Working Group (ACAP)
PAR	Photosynthetically Active Radiation
PBR	Permitted Biological Removal

PCA	Principal Component Analysis
PCR	Per Capita Recruitment
pdf	Portable Document Format
PF	Polar Front
PFZ	Polar Frontal Zone
PIT	Passive Integrated Transponder
PRP	CCAMLR Performance Review Panel
PS	Paired Streamer Line
PSAT	Pop-up satellite archival tag
PTT	Platform Terminal Transmitter
RES	Relative Environmental Suitability
RFB	Regional Fishery Body
RFMO	Regional Fishery Management Organisation
RMT	Research Midwater Trawl
ROV	Remotely-Operated Vehicle
RPO	Realised Potential Overlap
RTMP	Real-Time Monitoring Program
RV	Research Vessel
RVA	Register of Vulnerable Areas
SACCB	Southern Antarctic Circumpolar Current Boundary
SACCF	Southern Antarctic Circumpolar Current Front
SAER	State of the Antarctic Environment Report
SAF	Sub-Antarctic Front
SBDY	Southern Boundary of the ACC
SBWG	Seabird Bycatch Working Group (ACAP)
SCAF	Standing Committee on Administration and Finance (CCAMLR)

SCAR	Scientific Committee on Antarctic Research
SCAR-ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (SCAR Program)
SCAR-BBS	SCAR Bird Biology Subcommittee
SCAR-CPRAG	Action Group on Continuous Plankton Recorder Research
SCAR-EASIZ	Ecology of the Antarctic Sea-Ice Zone (SCAR Program)
SCAR-EBA	Evolution and Biodiversity in Antarctica (SCAR Program)
SCAR-EGBAMM	Expert Group on Birds And Marine Mammals
SCAR-GEB	SCAR Group of Experts on Birds
SCAR-GOSEAC	SCAR Group of Specialists on Environmental Affairs and Conservation
SCAR-GSS	SCAR Group of Specialists on Seals
SCAR-MarBIN	SCAR Marine Biodiversity Information Network
SCAR/SCOR-GOSSOE	SCAR/SCOR Group of Specialists on Southern Ocean Ecology
SCAR WG-Biology	SCAR Working Group on Biology
SC-CAMLR	Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC CIRC	Scientific Committee Circular (CCAMLR)
SC-CMS	Scientific Committee for CMS
SCIC	Standing Committee on Implementation and Compliance (CCAMLR)
SCOI	Standing Committee on Observation and Inspection (CCAMLR)
SCOR	Scientific Committee on Oceanic Research
SCP	Systematic Conservation planning
SD	Standard Deviation
SDWBA	Stochastic Distorted-wave Born Approximation
SEAFO	South East Atlantic Fisheries Organisation
SeaWiFS	Sea-viewing Wide Field-of-view Sensor

SG-ASAM	Subgroup on Acoustic Survey and Analysis Methods
SGE	South Georgia East
SGSR	South Georgia–Shag Rocks
SGW	South Georgia West (SSMU)
SIBEX	Second International BIOMASS Experiment
SIC	Scientist-in-Charge
SIOFA	Southern Indian Ocean Fisheries Agreement
SIR Algorithm	Sampling/Importance Resampling Algorithm
SISO	Scheme of International Scientific Observation (CCAMLR)
SMOM	Spatial Multispecies Operating Model
SNP	Single Nucleotide Polymorphism
SO-CPR	Southern Ocean CPR
SO GLOBEC	Southern Ocean GLOBEC
SOI	Southern Oscillation Index
SO JGOFS	Southern Ocean JGOFS
SOMBASE	Southern Ocean Molluscan Database
SONE	South Orkney North East (SSMU)
SOOS	Southern Ocean Observing System
SOPA	South Orkney Pelagic Area (SSMU)
SOS Workshop	Southern Ocean Sentinel Workshop
SOW	South Orkney West (SSMU)
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Specially Protected Area
SPC	Secretariat of the Pacific Community
SPGANT	Ocean Colour Chlorophyll-*a* algorithm for the Southern Ocean
SPM	Spatial Population Model

SPRFMO	South Pacific Regional Fisheries Management Organisation
SSB	Spawning Stock Biomass
SSG-LS	The Standing Scientific Group on Life Sciences (SCAR)
SSM/I	Special Sensor Microwave Imager
SSMU	Small-scale Management Unit
SSMU Workshop	Workshop on Small-scale Management Units, such as Predator Units
SSRU	Small-scale Research Unit
SSSI	Site of Special Scientific Interest
SST	Sea-Surface Temperature
STC	Subtropical Convergence
SWIOFC	Southwest Indian Ocean Fisheries Commission
TASO	ad hoc Technical Group for At-Sea Operations (CCAMLR)
TDR	Time Depth Recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TISVPA	Triple Instantaneous Separable VPA (previously TSVPA)
ToR	Term of Reference
TrawlCI	Estimation of Abundance from Trawl Surveys
TS	Target Strength
TVG	Time Varied Gain
UBC	University of British Columbia (Canada)
UCDW	Upper Circumpolar Deep Water
UN	United Nations
UNCED	UN Conference on Environment and Development
UNCLOS	UN Convention on the Law of the Sea
UNEP	UN Environment Programme

UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNFSA	the United Nations Fish Stock Agreement is the 1995 United Nations Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
UNGA	United Nations General Assembly
UPGMA	Unweighted Pair Group Method with Arithmetic Mean
US AMLR	United States Antarctic Marine Living Resources Program
US LTER	United States Long-term Ecological Research
UV	Ultra-Violet
UW	Unweighted
UWL	Unweighted Longline
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
VOGON	Value Outside the Generally Observed Norm
VPA	Virtual Population Analysis
WAMI	Workshop on Assessment Methods for Icefish (CCAMLR)
WC	Weddell Circulation
WCO	World Customs Organization
WFC	World Fisheries Congress
WCPFC	Western and Central Pacific Fisheries Convention
WG-CEMP	Working Group for the CCAMLR Ecosystem Monitoring Program (CCAMLR)
WG-EMM	Working Group on Ecosystem Monitoring and Management (CCAMLR)
WG-EMM-STAPP	Subgroup on Status and Trend Assessment of Predator Populations
WG-FSA	Working Group on Fish Stock Assessment (CCAMLR)

WG-FSA-SAM	Subgroup on Assessment Methods
WG-FSA-SFA	Subgroup on Fisheries Acoustics
WG-IMAF	Working Group on Incidental Mortality Associated with Fishing (CCAMLR)
WG-IMALF	ad hoc Working Group on Incidental Mortality Arising from Longline Fishing (CCAMLR)
WG-Krill	Working Group on Krill (CCAMLR)
WG-SAM	Working Group on Statistics, Assessments and Modelling
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WSC	Weddell–Scotia Confluence
WS-Flux	Workshop on Evaluating Krill Flux Factors (CCAMLR)
WS-MAD	Workshop on Methods for the Assessment of *D. eleginoides* (CCAMLR)
WSSD	World Summit on Sustainable Development
WS-VME	Workshop on Vulnerable Marine Ecosystems
WTO	World Trade Organization
WWD	West Wind Drift
WWF	World Wide Fund for Nature
WWW	World Wide Web
XBT	Expendable Bathythermograph
XML	Extensible Mark-up Language
Y2K	Year 2000
YCS	Year-class Strength(s)