SC-CAMLR-XXXI

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE THIRTY-FIRST MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
22–26 OCTOBER 2012

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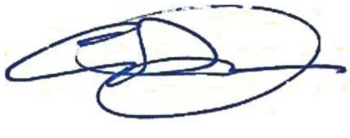

Chair of the Scientific Committee
November 2012

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Abstract

This document presents the adopted report of the Thirty-first Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 22 to 26 October 2012. 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

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REPORT OF THE THIRTY-FIRST MEETING OF THE SCIENTIFIC COMMITTEE
(Hobart, Australia, 22 to 26 October 2012)

OPENING OF MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met from 22 to 26 October 2012 at the CCAMLR Headquarters in Hobart, Tasmania, Australia. The meeting was chaired by Dr C. Jones (USA).

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

1.3 The Chair also welcomed to the meeting observers from the Netherlands (Acceding State), Singapore and Viet Nam, along with observers from ACAP, ARK, ASOC, CCSBT, CEP, COLTO, FAO, IUCN, IWC, SEAFO and SCAR (including SCOR) and encouraged them to participate in the meeting to the extent possible.

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

1.5 The report of the Scientific Committee was prepared by Drs J. Arata (Chile), M. Collins (UK), A. Constable (Australia), C. Darby (UK), Drs S. Hanchet (New Zealand), T. Ichii (Japan), K.-H. Kock (Germany), Prof. P. Koubbi (France), Prof. K. Kovacs (Norway), Dr R. Leslie (South Africa), Prof. O. Pin (Uruguay), Drs D. Ramm (Secretariat), K. Reid (Secretariat), C. Reiss (USA), R. Sarralde (Spain), R. Scott (UK), B. Sharp (New Zealand), S. Somhlaba (South Africa), V. Siegel (EU), S. Thanassekos (Secretariat), P. Trathan (UK), D. Welsford (Australia), X. Zhao (China) and P. Ziegler (Australia).

1.6 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.

Adoption of agenda

1.7 The Provisional Agenda had been circulated prior to the meeting (SC-CAMLR-XXXI/01). The Scientific Committee revised Item 5 (Spatial management of impacts on the Antarctic ecosystem) and consolidated consideration of the performance review, the CCAMLR scholarship and uses of the special funds under a new Item 11 (Future directions). The revised agenda was adopted without change (Annex 3).

Chair's report

1.8 The following meetings took place in 2012:

(i) SG-ASAM was held from 17 to 20 April 2012 in Bergen, Norway, and was co-convened by Drs R. Korneliussen (Norway) and J. Watkins (UK) (Annex 4)

(ii) WG-SAM was held from 25 to 29 June 2012 in Santa Cruz de Tenerife, Spain, and was convened by Dr Hanchet (Annex 5)

(iii) WG-EMM was held from 2 to 13 July 2012 also in Santa Cruz de Tenerife, Spain, and was convened by Drs S. Kawaguchi (Australia) and G. Watters (USA) (Annex 6)

(iv) WG-FSA was held from 8 to 19 October 2012 in Hobart and was convened by Dr M. Belchier (UK) (Annex 7).

1.9 In addition to these regular meetings there were three technical workshops to progress work on MPAs as agreed by the Scientific Committee last year:

(i) the Del Cano and Crozet (MPA Planning Domain 5) Workshop was held from 15 to 18 May 2012 in St Pierre, La Réunion, France, and was convened by Prof. Koubbi and Dr R. Crawford (South Africa)

(ii) the Western Antarctic Peninsula and South Scotia Arc (MPA Planning Domain 1) Workshop was held from 28 May to 1 June 2012 in Valparaíso, Chile, and was convened by Drs Arata and E. Marschoff (Argentina)

(iii) the Circumpolar Gap Analysis Workshop was held from 10 to 14 September 2012 in Brussels, Belgium, and was convened by Drs B. Danis and A. van de Putte (Belgium) (SC-CAMLR-XXXI/BG/16).

1.10 In all, this intersessional work represented approximately 1 600 person-days. Dr Jones, on behalf of the Scientific Committee, thanked all chairs, conveners and coordinators of intersessional meetings, and Belgium, Chile, France, Norway and Spain for hosting meetings of SG-ASAM, WG-SAM, WG-EMM and technical workshops in 2012.

1.11 The Scientific Committee agreed that:

(i) the technical workshops held in 2011/12 had facilitated broad contributions of knowledge from experts, including scientists and resource managers who may not usually participate in the work of working groups

(ii) the use of teleconferencing during the Circumpolar Gap Analysis Workshop had allowed remote contribution to that work, and had application to future meetings

(iii) further strategic planning was required in order to continue to make the best use of opportunities to share with, and benefit from, related experiences and expertise of other groups and organisations.

ADVANCES IN STATISTICS, ASSESSMENTS, MODELLING, ACOUSTICS AND SURVEY METHODS

Statistics, assessments and modelling

2.1 The Scientific Committee reviewed advice from WG-SAM. It recalled that this year's meeting of WG-SAM included a focus topic on the CCAMLR tagging program and also involved preliminary evaluation of research plans submitted under CM 21-02 in Subareas 48.6 and 58.4, and of other research proposals submitted under CM 24-01. The Working Group was convened by Dr Hanchet.

2.2 The Scientific Committee noted that most of the advice of WG-SAM (Annex 5) directly informed the work of WG-FSA and is considered under the relevant agenda items. The Scientific Committee noted, in particular, advice pertaining to the following items in Annex 5:

- data screening, sensitivity analyses and simulations (Annex 5, paragraphs 2.3 and 2.31)
- tag-based abundance estimates (Annex 5, paragraph 2.7)
- tagging information kit (Annex 5, paragraph 2.11)
- training package (Annex 5, paragraphs 2.13 to 2.15)
- experiments on the effect of handling and tagging on viability (Annex 5, paragraph 2.16)
- minimising exposure of fish to full sunlight during tagging (Annex 5, paragraph 2.18)
- removing the requirement to weigh fish during tagging (Annex 5, paragraph 2.26)
- tag-release programs in other regions (Annex 5, paragraphs 2.21 and 2.22).

2.3 The Scientific Committee recognised that CCAMLR's tagging program is unique in comparison to other programs in fisheries around the world and its importance in monitoring CCAMLR's toothfish fisheries, and endorsed recommendations to develop a training information kit and also a training package to improve the at-sea implementation of the tagging program. It encouraged further work to improve and evaluate tagging performance and methods to improve the utilisation of tagging data in assessments of CCAMLR fisheries.

2.4 The Scientific Committee also endorsed the establishment of an intersessional correspondence group to facilitate the coordination of research effort and plans between Members.

2.5 The Scientific Committee agreed that WG-SAM had provided an important function in reviewing and providing advice on research plans under CM 21-02 and research proposals under CM 24-01 and noted that this was likely to continue to be a standing topic for discussion.

2.6 The Scientific Committee noted that WG-SAM had identified the following items as possible future focus topics for the meeting of WG-SAM:

(i) Improvement of research proposals – to review progress in developing research plans in exploratory fisheries and evaluate the application of recommendations and advice provided by working groups and the Scientific Committee.

(ii) Multinational collaboration and research plans – to facilitate the development of collaborative research protocols in data-poor exploratory fisheries (paragraph 3.154).

(iii) Development of SPMs – to develop spatially explicit modelling approaches, including in exploratory fisheries and krill fisheries.

2.7 The Scientific Committee agreed that all three focus topics were important issues which needed to be addressed in the next one to two years.

Acoustic survey and analysis methods

2.8 The Scientific Committee thanked the Co-conveners and participants in SG-ASAM and endorsed their work related to developing the elements necessary to provide a proof of concept regarding the use of fishing vessels to collect acoustic data for use in estimating krill biomass and in understanding the distribution and patterns of occurrence of krill (Annex 4, paragraphs 2.37 and 2.38).

2.9 The Scientific Committee encouraged the development of the fishery-based acoustic surveys and considered that these surveys could produce reliable abundance estimates for krill when run with an appropriate CCAMLR design. The Scientific Committee also strongly cautioned that fishery-based surveys are not a replacement for scientific surveys for krill or other species.

2.10 The Scientific Committee noted that there is substantial interest in broadening the scope of fishery-based acoustic data for the determination of the distribution and abundance of finfish. The Scientific Committee encouraged Members to explore the utility of this.

2.11 The Scientific Committee also encouraged Members to consider links to the broader scientific community in respect to other parallel programs like SOOS and IMOS.

2.12 The Scientific Committee agreed that SG-ASAM should not meet until 2014 to allow Members to collect data, as described in the proof of concept, over the 2012/13 fishing season, and have adequate time to analyse data before reporting to SG-ASAM and WG-EMM.

2.13 The Scientific Committee further agreed that a correspondence group of Members and interested parties be established to facilitate communication about implementing the proof of concept chaired by the 2012 Co-conveners of SG-ASAM.

HARVESTED SPECIES

Krill resources

Status and trends

3.1 The Scientific Committee considered a number of issues related to krill resources, following advice from WG-EMM (Annex 6).

Catch in the current fishing season, 2011/12

3.2 The Scientific Committee noted that the 2011/12 fishing season for krill is still under way and that the final figures for the season are not yet available; however, five Members have fished for krill and up to 24 September 2012 approximately 75 000 tonnes have been taken from Subarea 48.1, 30 000 tonnes from Subarea 48.2 and 53 000 tonnes from Subarea 48.3 (Tables 1 and 2).

Notifications for the next fishing season, 2012/13

3.3 The Scientific Committee considered notifications for krill fishing in 2012/13 (Annex 6, paragraphs 2.7 to 2.11). It noted that the notified catch for Area 48 in 2012/13 is the highest on record and in excess of the trigger level of 620 000 tonnes (Annex 6, paragraph 2.10). The Scientific Committee noted the discrepancy between notified and actual catches in the past, and recognised that the notifications are likely to be more indicative of the total capacity of the vessels rather than their actual expectations of achieving those catches (Annex 6, paragraph 2.10).

3.4 The Scientific Committee also noted that environmental conditions in a given year, such as sea-ice extent and duration, may also impact on how much catch is actually taken and how it may compare with notified catch. For example, it noted that sea-ice extent in the winter of 2011/12 was unusually low (Annex 6, paragraph 2.6), a phenomenon that has occurred previously. In 2010 during such conditions, krill vessels operated in Subarea 48.1 to the extent that the catch reached the subarea trigger; ice conditions were such that catch was even taken in Admiralty Bay close to populations of seabirds and seals.

3.5 The Scientific Committee noted that all notifications provided the basic information needed, but that there were some inconsistencies between notifications (Annex 6, paragraph 2.11):

(i) in many cases, the indications of proposed catches, fishing areas and dates do not necessarily provide the information on their exact plans regarding spatial and temporal fishing patterns

(ii) notifications from four Members used an old version of the notification form in CM 21-03, Annex 21-03/A, which was revised by the Commission in 2010.

3.6 The Scientific Committee noted that four of the notifications considered by WG-EMM had subsequently been modified (Table 3):

(i) the Chilean notification did not specify the name of the vessel, but this has now been confirmed to be the *Ila*

(ii) the Chinese notification specified the name for one of their vessels as the *An Xing Hai*, but this vessel has now been replaced by the *Long Teng*

(iii) the Japanese notification was for the vessel *Fukuei Maru*; however, this vessel has now been sold and Japan has no intention of replacing the vessel. The new owners are a Chinese company and they have renamed the vessel as *Fu Rong Hai*. China has submitted a notification for the vessel which was circulated as a Commission Circular (COMM CIRC 12/135)

(iv) the Polish notification for the *Alina* has been withdrawn.

3.7 The Scientific Committee noted that the predicted catch of krill given in the Chinese notification for the *Fu Rong Hai* is exactly the same as that in the Japanese notification for the same vessel, and that the notified fishing areas/seasons differ slightly owing to the difference in fishing practices of the two operators.

3.8 Dr Zhao indicated that, if these differences in fishing practices were a cause of concern, the fishing vessel can be required to operate within the areas/seasons specified in the original Japanese notification.

Green weight

3.9 The Scientific Committee noted the discussions at WG-EMM about the uncertainty in green weight estimation for krill catches and its impact on krill management advice (Annex 6, paragraphs 2.12 to 2.23).

3.10 The Scientific Committee endorsed the recommendations from WG-EMM (Annex 6, paragraphs 2.13 and 2.14), that the total removals of krill should not exceed the catch limit.

3.11 It also recognised that reported catches have errors in their estimation, and the level of error is dependent on the process by which the reported catch is estimated, which may vary between product types, vessels and inherent attributes of krill at a given time of year. The Scientific Committee noted that a fishery may need to be closed when the reported catch is less than the catch limit so that the total removals have no more than an agreed probability of exceeding the catch limit, and an acceptable level of risk needs to be determined by the Commission.

3.12 Dr Zhao questioned the use of the term ‘error’ in Annex 6, paragraphs 2.13 and 2.14, as the word error can either mean ‘systematic error’ or ‘random error’ in the context of statistics. Systematic error is related to accuracy; it is a one-sided bias in relation to the mean, when present, and needs to be corrected. Random error is related to precision; it is associated with almost every measurement/estimate, but it is a two-sided deviation; therefore, when random error is of concern, both overestimate and underestimate need to be considered.

3.13 The Scientific Committee confirmed that the use of the term 'error' includes both types of errors and that future research should endeavour to disentangle the two types of errors. It indicated that the consideration of green weight estimation requires further development.

3.14 The Scientific Committee noted that although the notifications to fish for krill in 2012/13 contained descriptions of a range of different methods for estimating green weight, these descriptions did not generally include sufficient details to progress work on quantifying uncertainty in green weight (Annex 6, paragraph 2.15). It also noted that WG-EMM recommended (Annex 6, paragraphs 2.16 and 2.17) that information presented in Annex 6, Appendix D, Table 2, provided a clear indication of what should be included in the 'description of the exact detailed method of estimation of the green weight of krill caught' for notifications for the krill fishery (Annex 21-03/A).

3.15 The Scientific Committee welcomed papers submitted by the EU on the issue of green weight estimation (CCAMLR-XXXI/33 and XXXI/34).

3.16 The Scientific Committee reviewed the information in the proposed table contained in Annex 6, Appendix D, Table 2, and noted that this was a work in progress. However, the Scientific Committee agreed on the importance of including this information in the notifications for krill fishing as well as in the reporting of krill catches. Consequently, the Scientific Committee recommended changes to the following conservation measures:

(i) CM 23-03 should include an Annex A containing Table 2 of Annex 6, Appendix D, as a guideline for all vessels fishing for krill, with the understanding that this table is not a mandatory requirement

(ii) modifications to the form C1 for trawl fisheries in order to accommodate the recording of the necessary data described in the proposed new Annex A of CM 23-03

(iii) CM 21-03 should be updated in order to include in footnote 1 of Annex 21-03/A a request to provide the necessary information for estimating the error and uncertainty associated to the method used by the vessel for estimating the green weight of the catch, as outlined in the proposed new Annex A of CM 23-03.

3.17 The Scientific Committee agreed that the practical and pragmatic way to provide recommendations about green weight determination, including information on accuracy and uncertainty, was to collect relevant data from a range of vessels that could then be considered by a group of experts that included scientists, scientific observers and fishers at a specially convened meeting of ad hoc TASO. Without adequate data, the Scientific Committee recognised that little progress would be made in determining green weight estimation.

Digitisation of historical data from the Soviet krill fishery

3.18 The Scientific Committee considered the possibility of digitising historical biological data from the Soviet krill fishery expeditions (Annex 6, paragraphs 2.24 and 2.25; see also SC-CAMLR-XXVIII, paragraphs 13.8 to 13.10). It agreed that a specifically costed proposal would be necessary before it was possible to adequately assess the benefits of such a program of work. Further, that such a proposal would best be considered alongside other proposals for any research funds that might be available to the Scientific Committee.

Krill ecology and management

3.19 The Scientific Committee considered how environmental variability and climate change impact the production of krill (Annex 6, paragraphs 2.50 to 2.57) and endorsed advice from WG-EMM that a proposed new growth model for Antarctic krill, which may be useful for quantifying how the environment impacts krill production, should be submitted to WG-SAM for review to be incorporated into future assessments of yield and in developing feedback management procedures for krill (Annex 6, paragraph 2.57).

Recalculation of biomass estimates from Division 58.4.2

3.20 The Scientific Committee congratulated Australia for updating estimates of krill biomass for Division 58.4.2. It noted that the report of WG-EMM (Annex 6, paragraphs 2.61 to 2.64) summarised work to recalculate an estimate of krill biomass for the 2006 BROKE-West survey in Division 58.4.2, applying the most recent advice from SG-ASAM. Further, the Scientific Committee noted that in Division 58.4.2 the estimated krill biomass was 24.48 million tonnes (CV 0.20) in 2006, with 14.87 million tonnes (CV 0.22) in the western area, and 8.05 million tonnes (CV 0.33) in the eastern area.

3.21 The Scientific Committee recognised that the revised biomass estimates were lower than those used to determine yield estimates in 2010, but did not recommend a recalculation of the potential yield and a revision to CM 51-03 as further work is needed to improve parameterisation of recruitment variation in the GYM.

Revision of the GYM

3.22 The Scientific Committee noted the WG-EMM discussions (Annex 6, paragraphs 2.65 to 2.72) on issues relating to recruitment variability and mortality of krill on application of the GYM and decision rules. It endorsed advice from WG-EMM that its future work plan shall focus on:

(i) better accommodating krill recruitment in current assessments
(ii) reviewing the decision rules for the krill fishery in light of climate change.

3.23 The Scientific Committee recalled the krill catch limits contained in the current conservation measures (CM 51-01, 51-02 and 51-03), and reiterated that for Area 48 (CM 51-07) and Divisions 58.4.2 (CM 51-03) and 58.4.1 (CM 51-02) the existing subdivisions of catch limits and trigger levels should remain in force.

Ecosystem effects of krill fishing

3.24 CCAMLR-XXXI/BG/17 considered penguins and krill in a changing ocean. The paper considered a number of issues related to the management of krill and the monitoring of krill predators. Many of the issues highlighted in the paper are pertinent to the work of the Scientific Committee and its working groups, therefore the Chair of the Scientific Committee thanked the authors, indicating that the paper would help inform different aspects of ongoing work.

Feedback management

3.25 The Scientific Committee considered the WG-EMM discussion on issues related to the development of a feedback management strategy for krill in Area 48 (Annex 6, paragraphs 2.74 to 2.116). It recalled that the work plan included six elements, and discussion this year focused on the first two elements:

- (i) developing a list of candidate feedback management approaches
- (ii) identifying indicators for each candidate.

3.26 The Scientific Committee noted the WG-EMM discussion on general monitoring issues (Annex 6, paragraphs 2.77 to 2.85). It also noted that the current management approach for the krill fishery could be extended by utilising more frequent assessments of krill biomass, and that this would thus become a feedback management approach, but various other indicators could also be used in feedback management, including indicators of predator status and trends and indicators from the krill fishery.

3.27 The Scientific Committee noted the WG-EMM discussions on the monitoring of land-based predators, including new or expanded monitoring programs, and potential indicators arising from such activities that could be used to inform a feedback management approach (Annex 6, paragraphs 2.86 to 2.99). The Scientific Committee agreed that maintaining existing CEMP monitoring is critically important, but the current CEMP may not allow detection of fishery-induced change until harvesting levels increase (Annex 6, paragraph 2.97).

3.28 The Scientific Committee also noted the WG-EMM discussions on krill-related monitoring issues (Annex 6, paragraphs 2.100 to 2.107). The Scientific Committee recalled that the last synoptic survey of krill biomass in Area 48 was conducted in 2000 and that a feedback management approach would require assessments of krill biomass, and that an updated assessment of krill biomass in Area 48 was a priority.

3.29 The Scientific Committee noted the WG-EMM discussions on candidate feedback management approaches. It welcomed the eight candidate approaches that were identified and which are compared in Annex 6, paragraphs 2.108 to 2.116 and Tables 1 and 2. It further noted that near-term implementation of these approaches may require precautionary controls on catch limits to account for uncertainties, but higher catch limits could be allowed in the longer term if these uncertainties are reduced.

3.30 The Scientific Committee noted that it may be feasible to implement one or other of the more simple candidate approaches, and move towards one or other of the more complex candidate approaches in a phased manner.

3.31 The Scientific Committee encouraged scientists developing candidate approaches to continue their work and to prioritise questions of spatial scale, and the relationship between indicators and objectives. It also recommended that scientists developing candidate approaches engage with WG-SAM so that technical and modelling aspects of each approach might be considered (Annex 6, paragraph 2.115).

3.32 The Scientific Committee noted that the current work program on feedback management does not include specific reference to the SSMUs or to the spatial allocation of krill catch to these SSMUs, although it may do so in the future. It therefore noted that further development of the feedback management approach was necessary in order to provide new advice on this issue.

3.33 In discussing the feedback management approach, the Scientific Committee noted that a number of causal mechanisms may alter the state of the ecosystem and that there is the potential to confound these different causes when attempting to understand certain ecosystem responses (Annex 6, paragraph 2.80). The Scientific Committee agreed that, where there is the potential to confound different drivers, further work will be necessary in order to better understand the relationships.

3.34 The Scientific Committee agreed that the precautionary principle may mean that CCAMLR may wish to take action in managing the krill fishery if it believes the fishery is implicated in change and until it better understands the causal mechanisms involved. Where multiple causal mechanisms drive the ecosystem in a particular direction, or where they are additive, or multiplicative, CCAMLR may place a high level of emphasis on the precautionary principle.

3.35 The Scientific Committee noted that Members contributing time series of monitoring data for management purposes continually face challenges in securing the resources needed for maintaining their programs (Annex 6, paragraph 2.84). The Scientific Committee therefore wished to bring to the attention of the Commission the value of these programs, and their potential utility in feedback management.

3.36 The Scientific Committee noted that the US AMLR program would no longer be undertaking an acoustic survey in the summer months in the northern Antarctic Peninsula region. It therefore highlighted to the Commission this important reduction in monitoring effort.

3.37 The Scientific Committee welcomed news that Norway plans to increase research effort in the Southern Ocean and that this will include links between the Institute of Marine Research, the Norwegian Polar Research Institute and the krill fishing industry. Furthermore, in collaboration with the fishing industry, Norway intends to undertake acoustic surveys around the South Orkney Islands every year for as long as Norwegian fishing vessels continue to target krill. The Scientific Committee noted that Norway plans to build a new research vessel with ice breaker capability; also, that in 2014/15 Norway plans to undertake a research cruise in the South Orkney Islands and Bouvet Island regions, funds permitting.

3.38 The Scientific Committee noted that Norway's research effort was collaborative and included links with both the UK and China. It also noted that UK scientists were actively pursuing process studies at the South Orkney Islands and they plan to continue these studies in the coming years. Such process studies will be important, for example, for understanding how krill predators forage for krill, or how krill predators may be impacted by changes in the ecosystem. The Scientific Committee noted that Chinese scientists are participating in the Norwegian acoustic surveys, and young scientists are gaining practical experience of acoustic survey methods. It also noted that one of the Chinese fishing companies is fitting one of its newly acquired vessels with a three-frequency scientific echo sounder, and is hoping to contribute to the CCAMLR integrated assessment of krill in the near future.

CEMP and WG-EMM-STAPP

3.39 The Scientific Committee noted the WG-EMM discussions on CEMP and WG-EMM-STAPP (Annex 6, paragraphs 2.117 to 2.157), and in particular the advice that CCAMLR's requirement for ecosystem monitoring is likely to increase in support of feedback management of the krill fishery and MPAs (Annex 6, paragraph 2.135), and noted that this could be achieved by:

(i) considering additional monitoring data that is currently being collected but is not submitted to CCAMLR as part of CEMP

(ii) starting CEMP monitoring programs at important locations where no such monitoring is under way

(iii) developing and applying methods, other than current CEMP methods, that allow appropriate monitoring at more sites in a cost-effective way.

3.40 The Scientific Committee endorsed advice from WG-EMM that, while new data and methods offer the potential to expand CEMP, additional data would need to be collected using methods that had been endorsed by WG-EMM to ensure that data quality and comparability of CEMP data are maintained (Annex 6, paragraph 2.139).

3.41 The Scientific Committee noted the need for WG-EMM-STAPP to maintain its focus on work to estimate overall predator abundance and krill consumption, and that the work on modelling foraging data should not detract from this task. It noted that work to estimate the abundance of fur seals and penguins and their consumption of krill is expected to be complete by 2014. The Scientific Committee noted that work to develop estimates of abundance and krill consumption by flying seabirds required additional effort (Annex 6, paragraph 2.152).

3.42 The Scientific Committee welcomed news that Ukraine is planning to undertake CEMP work in the Argentine Islands. Ukraine indicated that a research plan explaining the type and scale of the work would be presented to WG-EMM in 2013.

Fish resources

Fisheries information

Catch, effort, length and age data reported to CCAMLR

3.43 Members' fishing vessels operated in the fisheries targeting icefish (*Champsocephalus gunnari*) and toothfish (*Dissostichus eleginoides* and/or *D. mawsoni*), and catches reported to 24 September 2012 are summarised in Table 1; no directed fishing occurred on crabs (*Paralomis* spp.) during the season (see also SC-CAMLR-XXXI/BG/01). Activities in exploratory fisheries for *Dissostichus* spp. are summarised in more detail in paragraphs 3.117 to 3.176.

3.44 Three other fisheries were conducted in the Convention Area in 2011/12:

- fishery for *D. eleginoides* in the French EEZ in Division 58.5.1
- fishery for *D. eleginoides* in the French EEZ in Subarea 58.6
- fishery for *D. eleginoides* in the South African EEZ in Subareas 58.6 and 58.7, which also includes associated fishing in Area 51 outside the Convention Area.

3.45 The Scientific Committee noted the development of procedures, databases and data forms developed by the Secretariat during the intersessional period (Annex 7, paragraph 3.2). This included updating the fishery and scientific observer data forms, processing data, facilitating the deployment of research hauls in the exploratory fisheries in Subareas 48.6 and 58.4, and updating the Fishery Reports and the Report on Bottom Fisheries and VMEs.

3.46 The Scientific Committee recalled that daily catch and effort reporting in exploratory finfish fisheries was introduced to assist the Secretariat in monitoring fisheries during the seasons (CM 23-07). This reporting system has been operating alongside the five-day catch and effort system (CM 23-01) and there is considerable duplication in the reporting and processing of data (CCAMLR-XXXI/BG/06, Figure 1).

3.47 The Scientific Committee agreed that five-day catch and effort reporting in exploratory finfish fisheries was no longer necessary, and it recommended that the requirement for five-day reporting (CM 23-01) be removed from these fisheries. The Scientific Committee agreed that all data required in the existing five-day, 10-day and monthly catch and effort reporting forms can be incorporated into a single data reporting form (see CCAMLR-XXXI/BG/06).

3.48 The Scientific Committee endorsed the recommendation of WG-SAM that fishing vessels undertaking research fishing under CMs 21-02 or 24-01 and carrying observers would use form C1 (trawl) or C2 (longline) throughout these activities to record catch and effort, and the scientific observers on board would use cruise reports and logbooks to record biological and tagging data (Annex 5, paragraph 3.6). Vessels undertaking trawl surveys under CM 24-01 would continue to use form C4 to record catch, effort and biological data and would not be required to complete C1 data.

3.49 The 2011/12 fishing season started on 1 December 2011 and will end on 30 November 2012, and fishing was still in progress in some areas at the time of the meeting. Members' fishing vessels operated in the fisheries targeting icefish (*C. gunnari*) and toothfish

(*D. eleginoides* and/or *D. mawsoni*), and catches reported to September 2012 are summarised in Table 1. Detailed information is provided in the Fishery Reports (Annex 7, Appendices G to U).

Assessments and management advice

3.50 The Scientific Committee endorsed the general recommendations made by WG-FSA that should apply to all stock assessments. These include:

(i) for assessment methods that incorporate a composite likelihood (e.g. CASAL), a plot or table showing the contribution to the total likelihood of each likelihood component, as well as a plot of the likelihood profile for SSB_0, should be displayed

(ii) an evaluation of the spawning biomass estimated by the assessment model to be in a population but not vulnerable to the fisheries should be reported and its influence on management advice considered (e.g. through a sensitivity analysis using alternative selectivity)

(iii) work plans be developed to allow species-specific analyses and management advice for toothfish assessments and catch limits where both species co-occur, such as in Subareas 48.6 and 88.1, as opposed to combined species (*Dissostichus* spp.) catch limits

(iv) development of methods to incorporate the effect of depredation on stock assessments, including the impact on catch rates, and the quantity and size distribution of fish taken by depredation.

Champsocephalus gunnari South Georgia (Subarea 48.3)

3.51 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Annex 7, Appendix G, and discussion by WG-FSA is in Annex 7, paragraphs 4.3 to 4.5.

3.52 In 2011/12, the catch limit for *C. gunnari* was 3 072 tonnes. Commercial fishing was conducted by two vessels and the total reported catch up to 24 September 2012 was 546 tonnes, although the fishery is still open and a third vessel entered the fishery in September 2012.

3.53 The Scientific Committee noted that as a result of vessel time constraints a restricted groundfish survey was conducted in January 2012 in Subarea 48.3. Twenty hauls were conducted around Shag Rocks covering the toothfish recruitment area, and three hauls northwest of South Georgia. The survey indicated mainly age 2+ and 3+ icefish around Shag Rocks. Mainly 2+ icefish were found in the northwest of South Georgia compared to 1+ and 2+ fish last year. This survey did not provide adequate spatial coverage to provide an updated assessment.

3.54 Dr E. Barrera-Oro (Argentina) noted that there had been negligible catches of icefish in the last two seasons (2009/10 and 2010/11) and that the continued low catches made by the fishery thus far in 2011/12 were cause for concern. He emphasised the discrepancy observed between the reported catch and the size of the catch limit established in the past two and the present seasons. As a precautionary approach for this fishery he suggested that the level of capture taken by the commercial fishery in a given season should be an element to consider in the assessment of the catch limit for the following season. Hence, the catch limit for 2012/13 should be lower than the 3 000 tonnes calculated by WG-FSA.

3.55 Drs Darby and Collins noted that the fishery is still in progress and so the final catch is not yet known. They also clarified that the catch limit is an upper catch limit restricting the maximum yield available to the fishery, is highly precautionary and is determined using a procedure agreed by CCAMLR. The upper limit to a catch will not always be achieved in every fishery. In the case of mackerel icefish in Subarea 48.3 the ability of pelagic trawls to catch icefish is related to the vertical distribution of icefish, which in turn is related to the availability of krill. In years of poor krill abundance, icefish catches are low as occurred in 2009/10 and 2010/11; in good krill years the aggregations of icefish are more available to the fishing vessels, as has been recorded this year.

Management advice

3.56 The Scientific Committee noted that the assessment of *C. gunnari* for Subarea 48.3 had not been updated in 2012, and recalled its advice from 2011 that the catch limit for *C. gunnari* should be set at 2 933 tonnes in 2012/13 based on the outcome of the short-term projection undertaken in 2011.

Champsocephalus gunnari Heard Island (Division 58.5.2)

3.57 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Annex 7, Appendix H, and discussion by WG-FSA is in Annex 7, paragraphs 4.7 to 4.13.

3.58 In 2011/12, the fishery was closed to commercial fishing operations and a catch limit of 30 tonnes of *C. gunnari* was set aside for research and by-catch (4.4 tonnes were taken in the survey).

3.59 The Scientific Committee evaluated the preliminary assessment of *C. gunnari* in Division 58.5.2, based on survey results set out in WG-FSA-12/26. The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 987 tonnes from the 2012 survey and using the revised growth parameters described in WG-FSA-10/12.

3.60 The population projection of fish of the 1+ to 3+ age classes from 2011/12 gave an estimated yield of 679 tonnes in 2012/13 and 573 tonnes in 2013/14.

Management advice

3.61 The Scientific Committee recommended that the catch limit for *C. gunnari* in Division 58.5.2 should be 679 tonnes for 2012/13 and 573 tonnes for 2013/14 based on the outcome of the short-term projection.

Dissostichus eleginoides South Georgia (Subarea 48.3)

3.62 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Annex 7, Appendix I. The catch limit for *D. eleginoides* in 2011/12 was 2 600 tonnes. The total reported catch to September 2012 was 1 844 tonnes.

Management advice

3.63 The Scientific Committee noted that an assessment of this stock had not been undertaken in 2012, and had no additional management advice. The Scientific Committee therefore recommended that CM 41-02 be carried forward in its entirety for the 2012/13 fishing season.

Dissostichus spp. South Sandwich Islands (Subarea 48.4)

3.64 The Fishery Report for *Dissostichus* spp.in Subarea 48.4 is contained in Annex 7, Appendix O, and the discussion by WG-FSA is in Annex 7, paragraphs 5.25 to 5.32.

3.65 In 2011/12, the catch limits of the fishery for *Dissostichus* spp. in Subarea 48.4 were 48 tonnes for *D. eleginoides* in the north and 33 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined) in the south. The reported catch of *Dissostichus* spp. in Subareas 48.4 North and 48.4 South was 44 tonnes and 33 tonnes respectively.

3.66 The Scientific Committee noted that preliminary assessments of *Dissostichus* spp. in Subarea 48.4 had been completed. An age-based assessment using CASAL was used for *D. eleginoides* in the northern area of Subarea 48.4, and Petersen biomass estimates were conducted separately for *D. eleginoides* and *D. mawsoni* in the southern area.

3.67 The Scientific Committee endorsed the recommendations for further work identified by WG-FSA, including the development of species-specific assessments to be conducted for the entire management area (Annex 7, paragraphs 5.25 to 5.32).

Management advice

3.68 The Scientific Committee recommended the following limits for toothfish and by-catch in Subarea 48.4:

(i) Subarea 48.4 North –

(a) a catch limit of 63 tonnes for *D. eleginoides*

(b) the continued prohibition of the targeting of *D. mawsoni*. Any *D. mawsoni* that are retained must be counted against the catch limit of *Dissostichus* spp. in the southern area

(c) maintenance of catch limits for by-catch species, with a limit for macrourids of 10 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 3 tonnes (5% of the catch limit for *D. eleginoides*).

(ii) Subarea 48.4 South –

(a) a catch limit of 52 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined)

(b) maintenance of a move-on rule for by-catch species, with a minimum macrourid trigger of 150 kg and 16% of the catch of *Dissostichus* spp. per line, and a trigger for rajids set at 5% of the catch of *Dissostichus* spp. per line.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

3.69 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Annex 7, Appendix K, and the discussion by WG-FSA is in Annex 7, paragraphs 4.20 to 4.24.

3.70 In 2011/12, the catch limit of *D. eleginoides* set by France in its EEZ in Division 58.5.1 was 5 100 tonnes (season 1 September to 31 August), allocated to seven longliners. The catch for the current CCAMLR season reported to October 2012 was 2 957 tonnes.

3.71 The Scientific Committee noted that WG-FSA had reviewed an assessment of *D. eleginoides* in Division 58.5.1. The integrated assessment model, fitted using CASAL, included catch, CPUE and length-frequency data from the commercial fishery (1979–2012), IUU estimates, abundance estimates from scientific surveys and tagging data to derive estimates of yield. Several issues had been identified regarding model fits to catch rate, tagging and length-frequency data in the model.

3.72 A series of sensitivity runs were conducted during the WG-FSA meeting to explore the effects of different data sources and assumptions on model outputs. Three scenarios were run with the year-class strength fixed to 1, excluding CPUE data for the model fit, and assuming twice the observed levels of IUU catches in each year. This resulted in estimates of B_0 ranging from 215 835 to 244 460 tonnes compared to 218 078 tonnes in the base case; *SSB* status ranged from 0.62 to 0.67 compared to 0.72 in the base case.

3.73 The Scientific Committee welcomed the revised assessment and noted the progress made during the intersessional period in the development of the model for this important exploited stock. It endorsed the work plan for an improved stock assessment recommended by WG-FSA as outlined in Annex 7, paragraphs 4.24(i) to (v).

Management advice

3.74 The Scientific Committee agreed that the current catch limit of 5 100 tonnes for *D. eleginoides* in the French EEZ in Division 58.5.1 could be used as management advice for 2012/13. It also agreed that a more robust stock assessment was required to provide advice on catch limits beyond 2012/13.

3.75 Prof. G. Duhamel (France) noted that France intends to progress the work plan outlined by WG-FSA during the intersessional period and to present a more robust stock assessment model to the 2013 meeting of WG-FSA.

3.76 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 32-13, remain in force.

Dissostichus eleginoides Heard Island (Division 58.5.2)

3.77 The fishery report for *D. eleginoides* at Heard Island (Division 58.5.2) is contained in Annex 7, Appendix J.

3.78 In 2011/12, the catch limit of *D. eleginoides* was 2 730 tonnes. The catch of *D. eleginoides* reported for this division by the end of September 2012 was 1 935 tonnes.

Management advice

3.79 The Scientific Committee did not undertake an assessment of this stock in 2012, and had no additional management advice. The Scientific Committee therefore recommended that CM 41-08 be carried forward in its entirety for the 2012/13 fishing season.

Dissostichus eleginoides Crozet Islands (Subarea 58.6)

3.80 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Annex 7, Appendix L.

3.81 In 2011/12, the catch of *D. eleginoides* reported in Subarea 58.6 to October 2012 was 480 tonnes.

Management advice

3.82 The Scientific Committee encouraged France to continue its tagging program in Subarea 58.6 (French EEZ), to estimate biological parameters for *D. eleginoides*, and to start the development of a stock assessment for this area.

3.83 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 32-11, remain in force.

Dissostichus eleginoides Prince Edward and Marion Islands (Subareas 58.6 and 58.7) and Area 51 inside the South African EEZ

3.84 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 and Area 51 inside the South African EEZ is contained in Annex 7, Appendix M.

3.85 Dr Leslie informed the Scientific Committee that a revised operational management procedure to form the basis for management advice is under development by South African scientists and will be brought to WG-SAM when available. An interim catch limit of 320 tonnes of *D. eleginoides* was applied for the South African EEZ for 2011/12, and it is likely that this limit will be retained for 2012/13.

3.86 The total reported catch of *D. eleginoides* was 60 tonnes up to 24 September 2012, but two vessels are currently still active in this fishery.

Management advice for *D. eleginoides* at Prince Edward and Marion Islands (Subareas 58.6 and 58.7) inside the EEZ

3.87 The Scientific Committee was unable to provide management advice for the fishery in the South African EEZ at the Prince Edward Islands.

Management advice for *D. eleginoides* at Prince Edward Islands (Subareas 58.6 and 58.7 and Division 58.4.4) outside the EEZ

3.88 No new information was available on the state of fish stocks in Subareas 58.6 and 58.7 and Division 58.4.4 outside areas of national jurisdiction. The Scientific Committee therefore advised that the prohibition of directed fishing for *D. eleginoides*, described in CMs 32-10, 32-11 and 32-12, remain in force.

Assessment and management advice for depleted and recovering stocks

Antarctic Peninsula and South Shetland Islands (Subarea 48.1) and South Orkney Islands (Subarea 48.2)

3.89 The Scientific Committee recalled that populations of *C. gunnari* and *Notothenia rossii* were heavily exploited in this subarea in the late 1970s and 1980s, and the fishery was closed after 1989/90 due to a considerable decline in these populations. Thus, any potential recovery of these populations from depletion is of considerable interest to CCAMLR. The Scientific Committee considered the discussion by WG-FSA on this issue in Annex 7, paragraphs 5.185 to 5.187 and 9.26 to 9.31.

3.90 The Scientific Committee noted that during the 2012 random stratified trawl survey of the South Shetland Islands by Germany and the USA with the RV *Polarstern*, *C. gunnari* were regularly encountered across the northwestern and northern shelves of Elephant Island. The estimate of total standing stock biomass for *C. gunnari* for the total surveyed area was 25 038 tonnes, primarily composed of age 3+ fish. The survey indicated the first substantial signal of recovery for this population, and recorded the highest level of biomass observed since the fishery was closed and the population monitored on a semi-annual basis by the USA and Germany (1996 to 2012).

3.91 The Scientific Committee noted that there had also been an increase in catches of *N. rossii* around Elephant Island during this survey, although the aggregating nature of this species means that trawl surveys have a high number of hauls with zero/low catches, and a few sites with high catch rates (>5 tonnes per 30 mins), resulting in uncertain biomass estimates. Further analyses could be undertaken on catch rates, and modification to existing survey design would compromise the time series, and a species-specific survey may be required. The Scientific Committee recommended a further survey be undertaken using an improved survey design.

3.92 The Scientific Committee also noted that catch rates for *Gobionotothen gibberifrons* had declined across the time series of trawl surveys. There were also additional data on declining trends in the inshore abundance of several species from trammel nets (WG-FSA-12/P01). It encouraged scientists working on fish resources in Subarea 48.1 to review the trends in abundance of various species in the context of the profound changes in the ocean environment that are currently happening in this region.

3.93 The Scientific Committee also noted that Article II.3(c) of the Convention aims to prevent changes that are not potentially reversible over two or three decades. Given that targeted fisheries for *N. rossii* and *C. gunnari* were prohibited over two decades ago, studies on these populations may now inform on the appropriateness of this time frame for their recoveries. The Scientific Committee agreed that improved studies on the age composition of these populations would be valuable in assessing population age structure as an indicator of stock recovery.

3.94 The Scientific Committee recommended that this fishery remains closed until such time that another survey(s) be undertaken to confirm the recovery of these populations and an assessment be undertaken. It therefore recommended that the existing CMs 32-02 and 32-04 on the prohibition of fishing in Subareas 48.1 and 48.2 respectively remain in force.

3.95 The Scientific Committee noted discussion of WG-FSA and recognised that the data collected in CCAMLR fisheries had provided a unique dataset with which to study the biology and ecology of Southern Ocean systems. In this regard, the Scientific Committee recognised that understanding the relationships of local-scale monitoring data to regional-scale changes was a key area of research of relevance to CCAMLR in much of its work. An example of this would be linking the effects of changes in the diet and the decline in population size of Antarctic shags at monitoring sites in the South Shetland Islands with changes in previously exploited fish populations in Subarea 48.1 as presented in WG-FSA-12/05.

Champsocephalus gunnari Kerguelen Islands (Division 58.5.1)

3.96 There is currently no Fishery Report for this species in Division 58.5.1, and discussion by WG-FSA is in Annex 7, paragraphs 5.188 to 5.191. Prof. Duhamel indicated that he intended to provide information necessary to compile a Fishery Report for this species in this division.

3.97 The Scientific Committee noted that a preliminary stock assessment of *C. gunnari* in the vicinity of the Kerguelen Islands (Division 58.5.1) based on the 2010 POKER biomass survey had been reviewed by WG-FSA. The assessment used the same procedure to that used for this species in Division 58.5.2.

3.98 The Scientific Committee thanked France for the preliminary assessment, agreed that the approach was a valid methodology to use for assessing icefish in this division, and encouraged progress toward a new assessment based on the 2013 POKER survey.

Management advice

3.99 The Scientific Committee did not provide management advice for the *C. gunnari* fishery in the French EEZ.

Toothfish catches from outside the Convention Area

3.100 Prof. Pin informed the Scientific Committee that the total catch of *D. eleginoides* by Uruguayan longline fishing vessels within the Uruguayan EEZ during the 2011/12 fishing season was approximately 198 tonnes. The fishery used Spanish-system and trotlines, including the use of cachaloteras with the latter. Given the relatively small total catch, no tagged fish were recaptured

3.101 Dr Barrera-Oro provided information on the catch of *D. eleginoides* in the Patagonian sector of the Argentine EEZ (Area 41). The catch limit established for 2012 was 3 500 tonnes. All longlines were set at depths greater than 800 m to protect the juvenile stock. Tagging of two fish per tonne of catch has been mandatory since 2007.

Fish and invertebrate by-catch

3.102 The Scientific Committee noted WG-FSA's discussions concerning the finfish by-catch within the fisheries for krill and the analysis of impact by a single vessel operating in the krill fishery in Subarea 48.1 (Annex 7, paragraphs 8.2 to 8.4). The Scientific Committee noted the requirement to extend this type of study across the krill fishing fleet for vessels using other trawl gears in order to determine the impact of krill fishing on finfish populations.

3.103 In order to facilitate data collection on fish by-catch by CCAMLR observers, the Scientific Committee requested that the Secretariat develop an identification guide, with the help of scientists from Members, that can be added to the CCAMLR website and that would allow identification of the finfish by-catch species at least to family level (Annex 7, paragraph 8.4).

3.104 The Scientific Committee noted WG-FSA's preliminary review of the data arising from the increased skate tagging effort undertaken during CCAMLRs 'Year-of-the-Skate'. The Scientific Committee agreed that the impact of the initiative had been limited in that the Year-of-the-Skate had increased the number of tag releases but the overall numbers released in the data-poor exploratory fishery areas remained low.

3.105 In order to provide a background to further analysis of the skate tagging data collected by CCAMLR observers, the Scientific Committee requested that the Secretariat prepare a review of the skate and ray by-catch and tagging program for WG-SAM-13 as specified in Annex 7, paragraph 8.18.

3.106 Dr Welsford welcomed the review and offered help by contributing information and expertise from the Australian skate tagging program in Division 58.5.2. Dr Hanchet offered help by contributing information and expertise from the New Zealand skate tagging program in the Ross Sea.

3.107 The Scientific Committee noted that tagged skate may have a higher susceptibility to hook injury induced mortality than previously considered and that this may be a reason for the lack of increase in tag returns. It agreed that experimental comparisons of the survival of skates captured across a variety of methods such as pots, longlines and trawls would be useful in determining the extent and variation in mortality of skate following capture. Dr Welsford indicated that Australia had tagged trawl- and longline-caught skate and that this could be used to determine relative survival rates between different gear types.

3.108 The Scientific Committee discussed the potential for a future term of reference to be added to the work of WG-SAM and WG-FSA to develop a risk-based sustainable management approach for the impact of toothfish fisheries on Rajidae spp. in the CCAMLR management units.

Skate by-catch in Division 58.4.3a

3.109 The Scientific Committee raised concerns about high skate catch and mortality rates observed by the vessel fishing in Division 58.4.3a in 2011/12 where the weight of skate by-catch almost equalled the weight of the target catch of *Dissostichus* spp.

3.110 Such a high skate by-catch mortality rate introduces a complication in determining the vessel's suitability to conduct research fishing without consideration of further substantial by-catch of skate and subsequent potential impact on the skate stock in the division.

3.111 Prof. Duhamel noted that the high by-catch rate of skate recorded by the vessel fishing in Division 58.4.3a in 2011/12 resulted from the use of integrated weight longline gear in order to mitigate against seabird mortality. Prof. Duhamel considered that the skate catch rate is not unusual when analysing CCAMLR catches using this technique in this division.

3.112 Other Members considered that the high skate mortality rate was unusual in comparison with other areas in which tagging of skate was occurring using the same gear type and in which live fish were returned to the water as described in the review of the Year-of-the-Skate.

3.113 Prof. Duhamel noted that the master of the vessel had consulted with the CCAMLR and French observers on board to confirm that the skate were dead or unviable and in consultation agreed that the skate were to be retained on board.

3.114 The Scientific Committee recommended the following conditions should be applied to the vessel during the exploratory fishing within Division 58.4.3a:

(i) a move-on rule set at 0.5 tonnes per set would ensure that the vessel is likely to be moved on from any high skate density locations within the survey area

(ii) soak times restricted to a maximum of 30 hours with a target range of 12–24 hours

(iii) restricting fishing to the shelf area between 66.5°E and 68.5°E.

3.115 The Scientific Committee noted that toothfish catches were lower in areas of the highest skate density so that applying the restrictions to the fishery would improve catch and tagging rates in the experiment. In addition, the spatial restrictions applied in paragraph 3.114(iii) would require a reallocation of the distribution of fishing locations presented within the research proposal (WG-FSA-12/29).

3.116 The Scientific Committee recommended that France provide information on the species composition of skate by-catch, areal distribution and condition of those brought on board for future evaluation of the potential impact of longline fishing in this area.

Exploratory fisheries

3.117 Seven exploratory longline fisheries were agreed for 2011/12 (CMs 41-04 to 41-07 and 41-09 to 41-11) (Annex 7, Table 8).

3.118 Ten Members notified 26 vessels for exploratory longline fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b for 2011/12 (Annex 7, Table 8). No new fisheries were notified for 2012/13.

Catch limit overruns

3.119 The Scientific Committee noted that the number of notified vessels had increased since 2011/12. It also noted that larger numbers of vessels may increase the risk of overruns in areas with unpredictably high catch rates or low catch limits relative to the number of vessels. The Scientific Committee noted that there had been an overrun of 123 tonnes of the catch limit in SSRUs 881B, C and G. It was further noted that the overall catch limit in Subarea 88.1 had not been overrun.

3.120 The Scientific Committee noted that overruns in data-poor exploratory fisheries posed a high risk that an unsustainable impact may occur, and that catch limits could be discounted in seasons following catch overruns. However, it noted that overruns in fisheries that had catch limits determined using the CCAMLR decision rules would be incorporated in the updated assessments and subsequent management advice. It also noted that the SPM being developed by New Zealand provided a mechanism for evaluating the impact of catches being taken in different locations in the Ross Sea.

3.121 The Scientific Committee noted that if sea-ice prevents retrieval of gear set prior to the catch limit being reached, vessels could tag and release the fish on those lines to reduce the magnitude of an overrun.

3.122 The Scientific Committee requested the Commission consider mechanisms to manage capacity in exploratory fisheries and prevent overruns of catch limits.

Vessel performance and crew experience

3.123 The Scientific Committee noted that three Members had changed the vessels they had notified for participation in exploratory fisheries in 2012/13. It noted the advice of WG-FSA that factors such as the experience of the crew with tagging may contribute to variability observed in relative tag mortality and recapture rates observed in the Ross Sea (WG-FSA-12/47 Rev. 1). It further noted that it was the notifying Members' responsibility to ensure that vessels were able to achieve the tagging requirements in CM 41-04.

3.124 The Scientific Committee also noted the recommendation that a framework for the analysis of research implementation and vessel performance and associated quantitative metrics be developed (Annex 7, paragraph 5.143). The Scientific Committee requested that the Commission consider how information on factors that may influence vessel performance, such as crew experience with implementing CCAMLR conservation measures, could be obtained for analysis by the Scientific Committee.

Hook loss

3.125 The Scientific Committee noted that 313 000 to 318 000 hooks attached to sections of longline were lost in each of the last two seasons in exploratory fisheries (Annex 7, paragraph 5.5). It agreed that minimising hook loss was a high priority. However, it noted that not all vessels engaged in exploratory fisheries reported numbers of hooks lost, and therefore a comprehensive assessment of hook loss was not possible.

3.126 The Scientific Committee requested the Commission consider an appropriate mechanism to ensure that all vessels provide the required information on loss of hooks attached to sections of longline in the C2 form.

Anomalous CPUE

3.127 The Scientific Committee noted that WG-FSA had been unable to provide a scientific explanation for the anomalously high CPUE data reported by three Korean vessels from exploratory fishing: the *Insung No. 22* in 2009, the *Insung No. 2* in 2010 and the *Insung No. 7* in 2011. The Scientific Committee noted that all data, including tagging data, collected from these vessels should be reviewed. The Scientific Committee noted that the issue of the anomalously high CPUE data had first arisen when a CPUE standardisation had been conducted using data from Divisions 58.4.1 and 58.4.2 (SC-CAMLR-XXX, Annex 7, paragraph 4.39). The Scientific Committee welcomed the undertaking by the Republic of Korea and other interested Members to work with the Secretariat to provide an analysis of all data collected from these vessels for presentation at WG-SAM in 2013 (Annex 7, paragraph 5.12).

Advice on catch limits – Subareas 88.1 and 88.2

3.128 The Scientific Committee noted that the assessment for the exploratory *Dissostichus* spp. fisheries in Subareas 88.1 and 88.2 had not been updated, and therefore endorsed the recommendation of WG-FSA that the advice from 2011 be carried forward in its entirety for 2012/13.

Pre-recruit survey

3.129 The Scientific Committee noted the discussion by WG-FSA on the results of the first year of the pre-recruit survey conducted in the southern part of the Ross Sea. It noted the value of continuing the pre-recruit survey and agreed that the second pre-recruit survey comprising 65 sets be carried out in the southern Ross Sea in 2012/13. It further noted that 31 tonnes had been caught during the first survey and that the remainder of the 80 tonne catch limit allocated for the first two years of the survey, 49 tonnes, would be an appropriate catch limit for the 2012/13 survey (SC-CAMLR-XXX, paragraph 3.174).

Progress in developing assessments in data-poor exploratory fisheries

3.130 The Scientific Committee noted that research proposals for data-poor fisheries had been provided by Japan, the Republic of Korea, South Africa, Spain and France under CM 21-02 for the data-poor fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b. The Scientific Committee noted the advice of WG-FSA and WG-SAM on these research proposals (Annex 7, paragraphs 5.37 to 5.94). The Scientific Committee thanked

WG-SAM and WG-FSA for the considerable progress that had been made in developing research plans to provide assessments in data-poor fisheries in accordance with CM 21-02.

3.131 The Scientific Committee noted the process used by WG-FSA in evaluating the research proposal requirements as described in CM 21-02, and the specific advice provided by WG-SAM. It agreed that the process described in Annex 7, paragraphs 5.35 and 5.36, provides a useful process for reviewing the merit of the research designs.

3.132 The Scientific Committee agreed that under CM 21-02 it had the responsibility to develop a Data Collection Plan for exploratory fisheries. It also agreed that it had the responsibility to provide advice to the Commission on when advice on the fishery potential for data-poor areas will be available. It further agreed that it was required to provide advice on the catch required to collect the data for an assessment, as well as the risk that this catch may pose to stocks, including in areas which may no longer be pristine due to IUU fishing.

3.133 The Scientific Committee noted that by definition data-poor fisheries have no robust estimates of stock abundance or status, and that the research framework for data-poor fisheries described in SC-CAMLR-XXIX, Annex 8, paragraphs 5.1 to 5.12, is intended to deliver the information necessary to develop such estimates.

3.134 The Scientific Committee agreed that it would initially consider the proposals by area and make recommendations regarding appropriate research designs in each area, and then provide general advice on how to progress towards assessments for data-poor exploratory fisheries.

Subarea 48.6

3.135 The Scientific Committee noted that South Africa and Japan had provided research proposals for Subarea 48.6 under CM 21-02.

3.136 The Scientific Committee noted the development by South Africa of an assessment framework for Subarea 48.6 based on the age-structured production model (ASPM) (Annex 7, paragraphs 5.38 and 5.39), and that Japan intend to develop a preliminary assessment using CASAL. It welcomed the development of assessments using a variety of modelling frameworks and endorsed the recommendation of WG-FSA that the ASPM be submitted to WG-SAM for evaluation (Annex 7, paragraph 5.40).

3.137 The Scientific Committee noted that the Japanese proposal identified several research blocks, centred on the fine-scale rectangles where high numbers of tagged fish had been released in 2011/12, and that WG-FSA had recommended that research focus in the two northern and two southern research blocks indicated in the Japanese proposal. It endorsed the advice that all sets conducted in Subarea 48.6 should be research sets until such time as a robust stock assessment has been undertaken (Annex 7, paragraph 5.48).

Divisions 58.4.1 and 58.4.2

3.138 The Scientific Committee noted that Spain, Japan and the Republic of Korea had proposed research in Divisions 58.4.1 and 58.4.2 under CM 21-02. The Scientific Committee also noted that South Africa had submitted a research proposal for fishing in Division 58.4.2 to WG-SAM, but had not resubmitted the proposal.

3.139 The Scientific Committee noted the advice from WG-FSA that the research blocks proposed by Japan were appropriate (Annex 7, paragraph 5.72; WG-FSA-12/60 Rev. 1). It noted WG-FSA had agreed that the estimated catch limits provided by Japan were appropriate to achieve the objectives of the proposal (Annex 7, paragraphs 5.58 to 5.66).

3.140 The Scientific Committee noted the advice from WG-FSA regarding the research proposal provided by the Republic of Korea (Annex 7, paragraphs 5.67 to 5.70). It agreed that, of the methods noted in this proposal, tag-based integrated assessment had the highest likelihood of estimating yields consistent with the objectives of Article II of the Convention.

3.141 The Scientific Committee noted that Spain proposed a combination tagging and depletion experiment in the closed SSRUs 5841G and H, and noted the advice from WG-FSA on this research proposal that there was great potential value in conducting a simultaneous depletion and tagging experiment, and that even in the absence of a statistically significant depletion the tag-based component of the research would still be valuable (Annex 7, paragraphs 5.73 to 5.82). The Scientific Committee recalled that depletion experiments and analyses had been attempted before in CCAMLR fisheries (e.g. Parkes et al., 1996), with varying results.

3.142 Some Members agreed with the advice of WG-FSA that controlled depletion experiments are expected to be of higher value than the opportunistic use of commercial data to look for evidence of local depletion. Other Members noted that depletion experiments conducted on stocks that are already depleted may not show a strong signal that can be used to estimate biomass.

3.143 The Scientific Committee noted the advice of WG-FSA that a catch of 50 tonnes in each of SSRUs 5841B, C, D, G and H and 5842E would be likely to be sufficient to enable the research to be conducted. It further noted that this research was more likely to achieve the objective of developing a stock assessment if there was a commitment to return to the areas where tags were released in 2012/13 in subsequent years.

3.144 The Scientific Committee agreed that it would be useful to develop a summary of research and analysis methods, such as depletion experiments, and where they have been successful and/or unsuccessful, and how these may lead to assessments. It requested that successful applicants for the CCAMLR scholarship could consider working with the Secretariat to develop such a summary.

3.145 The Scientific Committee noted that WG-FSA had requested clarification as to the application of conservation measures during the depletion experiment proposed by Spain (Annex 7, paragraph 6.5). It agreed that, as the research was notified under CM 21-02, then CMs 22-06 and 22-07 would apply. It also agreed that no part of research hauls during the searching phase of the depletion experiment should occur closer than 10 n miles from the centre point of the two VMEs currently registered in Division 58.4.1. It noted the advice of

WG-FSA that lines set during the searching phase should be set in clusters of 3–5 short lines with a constrained soak time, set 10 n miles apart. It also noted that the depletion phase should commence once the vessel locates an area of >0.3 kg/hook, and end once it declines to <0.2 kg/hook, and that a program be provided for use on board the vessel to ensure a declining CPUE and evidence of depletion can be detected in a statistically robust way (Annex 7, paragraphs 5.77, 5.79 and 5.80).

Division 58.4.3a Elan Bank

3.146 The Scientific Committee noted that France and Japan had proposed research in Division 58.4.3a under CM 21-02. The Scientific Committee also noted that South Africa had submitted a research proposal for fishing in this division to WG-SAM, but had not resubmitted the proposal.

3.147 The Scientific Committee noted the advice regarding the research proposals in Division 58.4.3a (Annex 7, paragraphs 5.84 to 5.93). It welcomed the development of an assessment framework using CASAL during the meeting of WG-FSA and agreed that this work should be progressed to develop an assessment that is suitable to provide management advice. It also agreed that ageing the otoliths collected in this area by France in 2011/12 would be a priority to enable the input of catch-at-age data into the assessment. It further noted that WG-FSA had agreed that a catch limit of 32 tonnes was appropriate for the research proposed in 2011/12.

Division 58.4.3b BANZARE Bank

3.148 The Scientific Committee noted that Japan had proposed continuing research in Division 58.4.3b under CM 21-02.

3.149 The Scientific Committee recalled its advice regarding research at BANZARE Bank (SC-CAMLR-XXX, paragraphs 9.34 and 9.36). It noted that the analyses requested in these paragraphs had not been provided to WG-FSA.

3.150 The Scientific Committee agreed that it would not be able to provide any advice on further research plans or revised management advice until the analyses noted in SC-CAMLR-XXX, paragraphs 9.34 and 9.36, had been provided.

3.151 Japan noted that in its view it was important that the research on BANZARE Bank is continued. Japan had submitted all the results of the analysis on catch and effort and biological data provided from research conducted by the Japanese fishing vessel in six consecutive seasons from 2006/07 to 2011/12, according to the advice in Annex 5, paragraph 4.7. However, as WG-FSA had noted, the design and implementation of the research from 2006/07 to 2010/11 had not provided the basis for a robust assessment (Annex 7, paragraph 5.26).

3.152 The research design agreed by WG-FSA-11 had modified the spatial designs in order to increase the probability of tag recapture given the expected levels of toothfish movement in two to three years (SC-CAMLR-XXX, Annex 7, paragraph 5.26). However, unfortunately the

2011/12 research plan could not be undertaken for operational and safety reasons and therefore, in the view of Japan, it is extremely important to conduct research for at least the next two years to accomplish the stock assessment of toothfish on BANZARE Bank. Japan also emphasised that, in order to resolve the difficulty pointed out in Annex 7, paragraph 9.34, and to establish a plan of research in accordance with Annex 7, paragraph 9.36, it is essential to continue the research.

3.153 Japan committed to submit the result of the analysis by 2017 as indicated in WG-FSA-12/56 and further committed to deliver this analysis as quickly as possible, in response to Annex 7, paragraph 5.98.

Member-independent, multi-vessel, multi-Member research plans

3.154 The Scientific Committee recalled its discussions and advice in developing research plans for CCAMLR-sponsored research and exploratory fisheries. It endorsed the advice from WG-SAM that there were significant scientific benefits in collaboration, for example, between Members proposing research in data-poor fisheries (Annex 5, paragraph 3.23). It further agreed that Member-independent, multi-vessel, multi-national research plans are likely to provide a more efficient and robust method of developing advice for the Commission (Annex 7, paragraphs 5.137 and 11.3). It noted that:

(i) this type of research could substantially decrease the time necessary to collect information that would lead to a robust stock assessment

(ii) it could avoid a race to fish which has the potential to compromise effective research implementation

(iii) the scientific merit of research will be substantially improved if there is a balance of catch and effort between vessels and they fish in the same spatially constrained area.

3.155 The Scientific Committee noted that the CCAMLR-2000 Survey was a useful example of how such research could be designed, conducted and analysed. However, it also noted that important differences existed for research where fishing vessels are currently the primary platform used to conduct research into *Dissostichus* stocks.

3.156 The Scientific Committee further noted that it had several single-vessel research proposals in 2012 that had the potential to be pursued as multi-vessel multi-national surveys. It therefore requested that work be conducted intersessionally to develop a framework that would facilitate multi-vessel multi-national research plans for consideration at the next meeting of WG-SAM, taking into account:

(i) the identification of priority areas to conduct research, and the priority datasets and analyses necessary to be collected

(ii) the information and format required for the development of research plans, noting the advice of SC-CAMLR-XXX, Annex 5, paragraphs 2.21 to 2.49 and Format 2 in CM 24-01, Annex A

(iii) the necessary timelines for generating such plans, and where they will be reviewed, noting that a two-year lead time for research proposals may be more feasible than the current method identified in CM 21-02

(iv) a process to enable Members to express interest in pursuing an approved research plan

(v) a process to standardise data across vessels participating in research

(vi) the need for contingency plans where a Member or vessel may not be able to complete a research commitment, to ensure that research still achieves its objectives.

3.157 The Scientific Committee recalled that, prior to the adoption of the work plan for implementing research in data-poor exploratory fisheries (SC-CAMLR-XXIX, paragraphs 3.132 and 3.133) and subsequent focus topic discussion on methods to advance the development of assessments in data-poor fisheries at WG-SAM in 2011, there had been little progress toward assessments in these areas despite many years of data collection and tags released. Recommendations arising from that focus topic have guided the design of research plans in data-poor areas (SC-CAMLR-XXX, Annex 5, paragraph 2.40), and led to new requirements, first to constrain fishing within fine-scale rectangles where tags have been previously released (CM 41-01, Annex B), and subsequently to require that notifications to participate in data-poor fisheries under CM 21-02 be accompanied by research plans. The Scientific Committee noted this approach has yielded progress and that tag returns have increased in some areas, and there has been progress toward the development of preliminary stock assessments in Subarea 48.6 and Divisions 58.4.3a and 58.4.4b. The Scientific Committee welcomed these preliminary successes and encouraged multi-Member and multi-vessel coordination to build on, but not impede, further progress to deliver individual research plans using the approaches endorsed in 2011 (Annex 7, paragraphs 5.137 and 5.138).

3.158 The Scientific Committee agreed that the development of Member-independent, multi-vessel, multi-Member research plans would not prevent Members proposing research using single vessels. It also agreed that consultations with representatives of the fishing industry may assist with the implementation of the plans as they are developed.

General advice on research in data-poor exploratory fisheries

3.159 The Scientific Committee noted that WG-FSA had requested advice on appropriate exploitation rates to consider when developing research proposals (Annex 7, paragraph 5.133), however, it considered that it was not yet in a position to provide such advice. The Scientific Committee recommended that research proposals should be based on the minimum catch required to collect the data necessary to develop an assessment and not a target exploitation rate.

3.160 The Scientific Committee agreed that evaluating appropriate research catches as a proportion of estimated current biomass is generally not strongly affected by uncertainty regarding current status (e.g. Welsford, 2011), but estimates of current biomass and corresponding exploitation rates associated with research catches remain uncertain.

3.161 Scientific Committee agreed that using approaches such as that developed in Welsford (2011) could provide a basis to develop a way forward and that management strategy evaluation could be a useful approach for exploring sustainable catch limits for research conducted in data-poor areas. The Scientific Committee requested Members develop such approaches for consideration by WG-SAM at its 2013 meeting to provide input to its consideration of research proposals.

3.162 The Scientific Committee noted the advice of WG-FSA regarding the use of fine-scale rectangles to focus research in data-poor fisheries (Annex 7, paragraph 5.135). It agreed that using fine-scale rectangles was unnecessary as long as research plans were constrained to areas where tags have been released and are likely to be available for recapture.

3.163 The Scientific Committee requested that the Commission consider Japan's request for additional flexibility to conduct research outside the designated research blocks if sea-ice conditions are unfavourable.

3.164 The Scientific Committee noted that where the priority of research is recapturing tags, research should be focused in areas where there is a high likelihood that vessels could recapture tags in future seasons.

3.165 The Scientific Committee agreed that information on sea-ice conditions should be included with future research proposals, because such information had been provided with the Russian proposal for research in Subarea 48.5 and had been valuable in assessing the feasibility of conducting research in areas affected by sea-ice.

3.166 The Scientific Committee noted that analysis of research implementation and vessel performance was important for evaluation of research proposals (Annex 7, paragraphs 5.141 to 5.143). It agreed that the methods developed by New Zealand to assess vessel tagging performance could be used to evaluate vessel performance. The Scientific Committee endorsed the advice of WG-FSA that a framework to enable this evaluation be developed, and requested that the conveners of WG-FSA and SCIC work intersessionally to develop such a framework.

3.167 The Scientific Committee noted the development of tools to evaluate the importance of tagging data quality in integrated assessment, modelling toothfish spatial population dynamics and assessing the relative performance of vessels conducting tagging in exploratory *Dissostichus* spp. fisheries (Annex 7, paragraphs 5.159 to 5.166). It encouraged Members to continue to develop these tools. It endorsed the advice of WG-FSA that the data-quality selection algorithms used to select trips for use in the Ross Sea assessments be revised and presented at the next meeting of WG-SAM (Annex 7, paragraph 5.165).

3.168 The Scientific Committee noted the progress in refining tagging programs in exploratory fisheries (Annex 7, paragraphs 5.167 to 5.184). It endorsed the advice of WG-FSA that fish do not need to be weighed prior to being tagged and released (Annex 7, paragraph 5.171). It also endorsed the advice of WG-FSA that the L11 and L12 forms be modified (Annex 7, paragraphs 5.174 and 5.184). It further endorsed the development of a tag lottery and requested that COLTO develop a paper intersessionally considering the advice in Annex 7, paragraphs 5.178 to 5.180, for consideration by the Scientific Committee at its next meeting.

3.169 The Scientific Committee agreed that a summary of the research proposals be provided to the Commission (Table 4), including:

(i) the notifying Members
(ii) ASDs and research blocks
(iii) expected tagging rate
(iv) proportion of lines that are to be set as research hauls
(v) catch limits proposed
(vi) where available, the ratio of the proposed catch limit to estimated current biomass.

3.170 Some Members agreed that the advice of WG-FSA in these areas (Annex 7, paragraphs 5.56, 5.72, 5.81 and 5.94) could be used to set catch limits in these areas.

3.171 The Scientific Committee agreed that a map also be provided indicating the research blocks where tagging efforts had been concentrated in 2011/12 and recommended by WG-FSA, based on the maps provided in WG-FSA-12/60 Rev. 1 (Figure 1), and agreed that research in 2012/13 should be concentrated within these blocks to maximise the likelihood of recapturing tags that had been released in the previous season.

3.172 The Scientific Committee agreed that in all research activities contributing to the development of assessments in data-poor fisheries to be conducted by Members in 2012/13, the following requirements should apply:

(i) combined catches for all vessels conducting research set out in Table 4 should not substantially exceed the catch limits set for data-poor fisheries subareas and divisions in 2011/12

(ii) Members provide a commitment to complete the research plans they propose in 2012/13, including data collection, analysis of data and otoliths and development of preliminary assessments where possible

(iii) all hauls to be conducted would be research hauls as designated under CM 41-01, Annex B, paragraphs 4(ii) and (iii)

(iv) tagging should be conducted at a rate of at least five tags per tonne, and fish should be tagged and released according to CM 41-01/C.

3.173 The Scientific Committee was unable to achieve consensus as to the minimum separation between research hauls as described in CM 41-01/B, paragraph 4(i). The Scientific Committee requested the Commission consider this issue.

3.174 The Scientific Committee noted that, in areas where more than one Member had proposed to conduct research, providing at least some allocation of catch to vessels would assist with ensuring that Members can conduct the research they have committed to in 2012/13. However, the Scientific Committee noted that it was not in a position to advise on the level of allocation to the notified vessels, and requested the Commission consider this matter.

3.175 The Scientific Committee agreed that it was important that Members provide a commitment to complete research once commenced. It agreed that a table summarising what research had been proposed by Members, and where research had actually been active (e.g. Table 5), should be provided to the Scientific Committee and its working groups each year, to enable tracking of which research proposals had been pursued.

3.176 The Scientific Committee noted that the change to having Members provide more detailed research plans for research under CM 21-02 had occurred only last year. It also noted that focused tagging efforts in Divisions 58.4.1 and 58.4.2 and the southern SSRUs of Subarea 48.6 had yet to yield many tag recaptures. It noted it was therefore likely that it would take until 2012/13 to provide evidence that the research proposals in these areas are likely to achieve their objectives.

3.177 The Scientific Committee agreed that its advice on research and sampling in data-poor fisheries would be reviewed based on the results of research conducted during 2012/13. The Scientific Committee also agreed that a procedure be developed to enable efficient presentation of the objectives, design, catch requirements and timeline for delivery of management advice from research proposals, the annual review of the progress of research once commenced, and the development of an overall strategy for developing data collection plans for data-poor exploratory fisheries. The Scientific Committee requested that such a procedure be developed in the intersessional period, so it is available at the next meeting of WG-SAM for its consideration.

INCIDENTAL MORTALITY ARISING FROM FISHING OPERATIONS

Incidental mortality of seabirds and marine mammals associated with fisheries

4.1 The Scientific Committee recalled the outcomes of discussions at WG-IMAF last year that, while the number of seabirds being killed in CCAMLR fisheries had reduced, there remained a need for a routine review of incidental mortality and of the implementation of conservation measures associated with mitigation. Accordingly, Dr Belchier presented the review of WG-FSA (Annex 7, paragraphs 8.27 to 8.32), since WG-IMAF did not meet during the intersessional period.

4.2 During 2011/12 there were two seabird mortalities in Subarea 48.3. In the French EEZs, 16 seabird mortalities were observed in Subarea 58.6 (extrapolated total of 65 seabirds) and 41 in Division 58.5.1 (with an extrapolated total of 157). In addition, a single bird was recorded dead in the krill fishery in Subarea 48.1. There were two marine mammal mortalities reported in longline fisheries – one sperm whale entangled in the main line in Subarea 48.3 and one southern elephant seal hooked/entangled and drowned in Division 58.5.2. There were no recorded mortalities of seabirds or mammals in finfish trawl fisheries.

4.3 The Scientific Committee acknowledged the continued low level of seabird by-catch. It also noted that the by-catch rate in the French EEZs had stabilised in recent years after a substantial reduction in previous seasons and reiterated that the target for seabird by-catch should be zero. It recommended that France continue to take additional steps to mitigate seabird by-catch.

4.4 Prof. Duhamel advised the Scientific Committee that the French action plan still intends to reduce the seabird by-catch to zero inside the EEZs. He pointed out that, while the action plan has already allowed a substantial reduction of seabird by-catch in the French

EEZs, serious problems for seabirds breeding in the Convention Area still exist in fisheries just to the north of the Convention Area. France will submit additional data for Area 51 to next year's WG-FSA meeting.

Marine debris

4.5 The Scientific Committee noted the reports on debris surveys in the Convention Area which have been part of the CCAMLR marine debris monitoring program in Subareas 48.1, 48.2, 48.3 and 58.7. Results indicate that there has been no trend (either up or down) in the amount of debris in beach surveys, in nests of seabirds and in the incidence of marine mammal entanglements in the last decade.

4.6 The Scientific Committee encouraged Members to establish collection of marine debris data in areas where there was currently no marine debris monitoring, but where there was an active fishery (e.g. the Ross Sea).

4.7 Prof. Pin informed the Scientific Committee that Uruguay has collected marine debris data over the past years in Drake Passage on King George Island and that it will continue to monitor the effects of both fishing and non-fishing shipping traffic. These data could be made available to CCAMLR.

Advice to the Commission

4.8 The Scientific Committee recommended that relevant experts be asked to review during 2013 the results of the Australian research trial on seabird by-catch in the coming season which aims at an extension of the fishing season in Division 58.5.2. This consultation could be coordinated in a similar manner to SG-ASAM, such as having a meeting in conjunction with another meeting that those experts are likely to attend. The Scientific Committee requested that the Secretariat, in conjunction with the Convener of WG-FSA, coordinate such a consultation and that the results be reviewed by WG-FSA next year.

SPATIAL MANAGEMENT OF IMPACTS ON THE ANTARCTIC ECOSYSTEM

Bottom fishing and vulnerable marine ecosystems

5.1 The Scientific Committee considered the Report on Bottom Fisheries and VMEs and advice on progress in the implementation of CMs 22-05, 22-06, 22-07, 22-08 and 22-09 and other matters pertaining to CCAMLR's actions with respect to bottom fishing and vulnerable marine ecosystems. The Secretariat presented CCAMLR-XXXI/BG/06 for 2011/12 with notifications under CMs 22-06 and 22-07.

5.2 Since 2008, the Secretariat has received a total of 34 notifications of encounters with VMEs arising from research surveys (CM 22-06): 17 notifications in Subarea 48.1; 13 in Subarea 48.2; 2 in Division 58.4.1; and 2 in Subarea 88.1. For 2012, 12 new notifications were endorsed (5 from Subarea 48.1 and 7 from Subarea 88.1) for addition to the VME registry (Annex 6, paragraphs 3.81 to 3.93). All VMEs are currently afforded protection through specific area closures in Subarea 88.1 (CM 22-09), and general closures to bottom fishing activities in Subareas 48.1 and 48.2 (CMs 32-02 and 32-03), and in SSRU 5841H (CM 41-11).

5.3 Since 2008, the Secretariat has received a total of 150 VME-indicator notifications from exploratory bottom fisheries (CM 22-07): 29 notifications in 2008/09; 24 in 2009/10; 59 in 2010/11; and 38 so far in 2011/12. These notifications were made by vessels operating in the exploratory longline fisheries in Subareas 48.6 (2 notifications), 88.1 (103 notifications) and 88.2 (44 notifications), as well as one notification from the exploratory crab fishery in Subarea 48.2. No notifications have been received from exploratory fisheries in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b.

5.4 These VME-indicator notifications have led to the declaration of 63 VME risk areas; 47 risk areas in Subarea 88.1 and 16 risk areas in Subarea 88.2. In addition, six VME fine-scale rectangles in Subarea 88.1 and one in Subarea 88.2 have been identified.

5.5 The Scientific Committee asked the Commission to consider whether it is necessary to review the data requirements in paragraphs 3 and 8 of CM 22-07. Paragraph 3 states that ‘Members shall require their vessels to collect segment-specific data on the number of VME indicator units’. However, the extent to which this requirement is implemented is moderated by paragraph 8, which states that vessels must report VME indicator units for each line segment, including zero catches ‘to the extent possible’.

5.6 A total of 1 990 longlines have been hauled in the exploratory fisheries for *Dissostichus* spp. in 2011/12, and segment-specific VME data have been reported for 1 862 lines (94% of the lines; this compares with 66% in 2010/11, 93% in 2009/10 and 42% in 2008/09). Since 2008/09, a total of 7 760 longlines and 17 potlines have been hauled in the exploratory bottom fisheries and segment-specific data have been reported for 73% of these lines.

5.7 The Scientific Committee recommended that the five stations proposed in WG-EMM-12/51 based on VME by-catch in excess of the proposed threshold be added to the VME registry. The Scientific Committee agreed that appropriate survey stratification to identify thresholds to aid VME identification are scale-dependent and area-specific, and that thresholds derived in particular subareas or divisions, or within particular depth strata, may not be applicable in other areas.

5.8 It was recommended (Annex 6, paragraph 3.90) that WG-EMM-12/51, which proposed VME areas, be included to indicate the presence of black coral (Antipatharia), a CITES Appendix II listed taxon.

5.9 The Scientific Committee further agreed that the locations with high abundances of the Antarctic scallop (*Adamussium colbecki*) adjacent to Terra Nova Bay be added to the VME registry.

5.10 The Scientific Committee acknowledged the progression related to questions on VMEs and encouraged collaborations with other organisations such as SCAR and encouraged, for example, the contribution of Members to the Biogeographic Atlas of the Southern Ocean, an initiative lead by Prof. C. de Broyer (Belgium) and Prof. Koubbi.

5.11 The Scientific Committee noted the research undertaken comparing the probabilities of observing VME by-catch with different longline gear types (Autoline and Spanish) (Annex 7, paragraphs 6.1 to 6.3). This research concluded that autolines have a higher impact on VME taxa relative to Spanish longlines. However, the levels of VME taxa recorded on the surface may not reflect the impact occurring to VMEs on the seafloor and therefore could not support the conclusions of the paper regarding relative levels of impact. The Scientific Committee suggested that in situ observations of the behaviour of longline interactions with the seafloor may help evaluate relative impacts of different gear types.

5.12 Dr L. Pshenichnov (Ukraine) suggested that the risks to VMEs as a result of specific fishing gears do not extend to the use of other fishing gears which have a lesser impact on VMEs.

5.13 The Scientific Committee agreed that, as the potential for bottom fisheries to cause significant adverse impacts to VMEs could be evaluated with available fishing data, and does not require information on proposed effort for the upcoming season, the preliminary assessments submitted via CM 22-06, Annex A, would no longer be required and Annex A could be removed.

5.14 The Scientific Committee expressed concerns that there is insufficient information available on the impact of various gears on the seafloor and that there is a major benefit to using cameras for determining impacts on VME taxa and also for studying the impact of different fishing gear types on the seafloor. For example, some areas are closed because of observations from one fishing gear type, such as bottom trawls. The Scientific Committee recommended the continuation of research to estimate effects on VMEs of different fishing gear types. The Scientific Committee noted that Australia has two camera systems available for Members to utilise to investigate the impact of fishing gears on benthic organisms, and encouraged their use.

Marine Protected Areas

MPA technical workshops

5.15 The Scientific Committee reviewed outcomes from the three MPA technical workshops held during the intersessional period (SC-CAMLR-XXX, paragraph 5.20; Annex 6, paragraphs 3.43 to 3.58; SC-CAMLR-XXXI/BG/16) to evaluate progress towards the implementation of a representative network of MPAs in the CAMLR Convention Area. The workshops concerned Domain 1 (Antarctic Peninsula), Domain 5 (Del Cano–Crozet), and Domains 3 (Weddell Sea), 4 (Bouvet and Maud) and 9 (Amundsen and Bellingshausen Sea).

Domain 1

5.16 The Scientific Committee thanked the Co-conveners, Drs Arata and Marschoff, of the CCAMLR Technical Workshop on Planning Domain 1 (Antarctic Peninsula–South Scotia Arc), held in Valparaíso, Chile, from 28 May to 1 June 2012, at the Chilean Sub-secretary for Fisheries (WG-EMM-12/69) for a successful workshop and noted that participants from seven countries (Argentina, Australia, Chile, Japan, Norway, UK and the USA), as well as the

Secretariat, had contributed to this successful work. The planning domain includes parts of Subareas 48.1, 48.2 and 88.3. Domain 1 already contains one CCAMLR MPA (CM 91-03, South Orkney Islands), five marine (and four partially marine) ASPAs and three ASMAs.

5.17 The Scientific Committee noted that the workshop had agreed to a comprehensive list of MPA objectives, which were consistent with the guidance of CM 91-04. Further, the Scientific Committee noted the significant opportunity afforded in this region to compare reference and fished areas, by comparing data collected within the LTER Program and the US AMLR Program and that other activities besides krill fishing, in particular tourism activities, should be evaluated in terms of potential impacts. These analyses should reflect costs and benefits to both conservation and fisheries objectives.

5.18 The Scientific Committee noted the future plans to progress work on the MPA planning activities for Domain 1. The plan is:

(i) Dr Arata will coordinate the collation and submission of data layers and associated metadata to WG-EMM-13

(ii) qualitative protection targets (e.g. 'high', 'medium' and 'low' rather than quantitative targets describing how much of an area to protect) will be discussed at WG-EMM and brought to the Scientific Committee in 2013

(iii) because protection targets reflect both scientific considerations and value judgments, it was envisaged that Members could present candidate MPAs to the 2014 meeting of WG-EMM.

Further planning could proceed via a second Domain 1 workshop or via correspondence to come to agreement on a unified MPA proposal, which would be prepared and submitted for review during 2015.

5.19 The Scientific Committee agreed that Dr Arata will continue to act as the coordinator of the Planning Domain 1 initiative until the completion of the first phase of this work and endorsed the work plan for Domain 1.

5.20 A discussion ensued in the Scientific Committee, where all Members agreed that WG-EMM will be the point of coordination for all future developments on Domain 1 (and other MPA planning efforts). Some Members were concerned about qualitative, rather than quantitative, targets being set as the goals. The workshop coordinator suggested that this is still open for discussion in WG-EMM. The need to target areas that were sufficiently large to maintain their long-term viability and dynamic nature was noted.

Domain 5

5.21 The CCAMLR Technical Workshop on Planning in Domain 5 (del Cano–Crozet) (WG-EMM-12/33 Rev. 1) was held in St Pierre, Réunion Island, France, from 15 to 18 May 2012, at the Headquarters of TAAF (French Southern and Antarctic Territories). Prof. Koubbi and Dr R. Crawford (South Africa) served as Co-conveners. Scientists from five countries contributed to the writing of the report (Australia, France, New Zealand, Norway and South Africa). The Scientific Committee noted the significant progress made by the workshop with respect to planning within Domain 5, by describing categories of research, collating data layers for pelagic and benthic species and on seabirds and mammals. A brief history of fishing in the domain was also provided, in reflection for achieving the Systematic Conservation Planning (SCP) for this area.

5.22 The Scientific Committee agreed that Prof. Koubbi will continue to act as the coordinator of the Planning Domain 5 initiative until completion of the first phase of this work, which consists of compiling and submitting GIS data layers and associated metadata by mid-2013. A synthesis concerning Planning Domain 5 will then be proposed to WG-EMM and the Scientific Committee in 2013. Prof. Koubbi pointed out that the work plan for getting GIS layers is included in the French Ecoregionalisation Programme in the Southern Ocean that will be completed in July 2013. The work plan will be achieved in tight collaboration with South African researchers and with the cooperation of all Members.

5.23 The data layers will be available for the use of WG-EMM in 2014 for undertaking SCP. It was proposed that WG-EMM considers an SCP process for the high-seas part of Domain 5, whereas the time frame for the South African and French EEZs will be different and the work will be conducted at a finer spatial scale.

5.24 The Scientific Committee recommended that the Commission consider collaboration with other regional initiatives in the southern Indian Ocean, particularly concerning the conservation of seabirds that breed in the Convention Area but forage in the subtropical and tropical zones to the north that are threatened by fisheries that operate under different conservation objectives compared to CCAMLR.

5.25 The Scientific Committee endorsed the work plan for planning Domains 1 and 5 and recommended that WG-EMM coordinate this work and evaluate the progress of development in each planning domain.

Domains 3, 4 and 9 – Circumpolar Gap Analyses Workshop

5.26 The Scientific Committee thanked the organisers of the Circumpolar Gap Analysis Marine Protected Areas technical workshop, Drs van de Putte and Danis, which was held in Brussels, Belgium, 10 to 14 September 2012. This workshop dealt with three planning domains (Domain 3 – Weddell Sea, Domain 4 – Bouvet–Maud Region and Domain 9 – Amundsen and Bellingshausen Sea). This workshop was unique in that approximately one-third of its participants participated via teleconferencing, which was deemed very successful and financially efficient. The workshop succeeded in identifying protection objectives, specific regional conservation objectives and commenced the compilation of data layers (SC-CAMLR-XXXI/BG/16, Table 2).

5.27 The Scientific Committee noted that the results of this workshop, which was held following WG-EMM's 2012 meeting, should be presented to WG-EMM in 2013. It was also noted that more work is needed to develop MPAs within these domains.

5.28 Dr S. Hain (Germany) informed the Scientific Committee that Germany offered to take the lead on the MPA planning in Domain 3 (Weddell Sea). This offer was heartily welcomed by the Scientific Committee.

5.29 Dr I. Yeon (Republic of Korea) reported that Korea is considering compiling data for Domain 9 (Amundsen and Bellingshausen Sea) and perhaps may also collect new data. Prof. B. Fernholm (Sweden) reported that Sweden would be interested in taking the lead in the MPA planning for this region. Likewise, Dr Penhale, referring to the joint work with the US vessel *Nathaniel B Palmer* and the Swedish vessel *Oden*, suggested that the USA was willing to participate in advancing the planning for this area. All of these expressions of interest were welcomed by the Scientific Committee, that noted that this is a great example of the CCAMLR community working together. ASOC supported this multinational advancement of the planning for this region and others.

5.30 Prof. Koubbi suggested that MPA workshop progress should be compiled in a combined report to help ensure that our approaches are as similar as possible and Dr Constable noted that further discussions about the mechanisms by which we will share expertise needs to take place. The Scientific Committee noted that a joint MPA report could be the way of achieving this.

Tools for MPA planning and reporting

5.31 New Zealand has developed a custom GIS-based marine spatial planning tool designed to aid the development of MPA scenarios. The tool was originally developed for the Ross Sea but is now customised to allow its use in any planning domain. The tool and documents can be obtained from the CCAMLR website. Dr Sharp offered to provide tutorials and pointed out that the tool does not have an underlying operating model, but rather facilitates a sequence of GIS manipulations. Feedback from Members who use this tool are welcomed by New Zealand.

5.32 A web-based GIS tool is under development by the British Antarctic Survey (BAS) to aid the management by the Secretariat of spatial data, including spatial data relevant to MPA planning. The Scientific Committee agreed with the conclusion of WG-EMM (Annex 6, paragraph 3.66) supporting the need to develop this tool and to encourage collaborative approaches among Members, in particular for the development of MPA proposals. The proposed GIS tool would allow for effective dissemination of a range of spatial information to Members, as well as to other organisations, including the CEP.

5.33 The Scientific Committee agreed to establish MPA reports (Annex 6, paragraphs 3.73 to 3.75) to help provide a standardised format to consolidate and maintain detailed scientific information in a readily accessible document through the CCAMLR website which could be updated regularly by Members and managed by the Secretariat. It was recommended that MPA reports be organised according to MPA planning domains.

5.34 WG-EMM would be the appropriate working group for primary responsibility with respect to reviewing and updating the content of MPA reports.

5.35 The Scientific Committee recognised that technical consideration of MPAs would benefit from interpretation. It requested the Commission to consider arrangement of simultaneous interpretation in CCAMLR's official languages or other appropriate mechanisms to support this work.

5.36 Mr L. Yang (China) stated that threat analysis is as important as protection objectives that have to be considered for the establishment of MPAs and should be listed as one of the elements in the MPA report. He considered that the format is not acceptable without the item of threat analysis.

5.37 The Scientific Committee agreed that analysis of the extent to which current or future activities may threaten the objectives of the MPA was a valid scientific question to inform the design and/or management of MPAs.

5.38 The development of the MPA report would also allow Members to contribute data and information to the review in 2014 of CM 91-03 which established the South Orkney Islands southern shelf MPA. Dr Trathan informed the Scientific Committee of scientific elements that the UK plans to bring forward for this area, including studies on bathymetry, oceanography and foraging behaviour of predators and benthos.

Other MPA discussions

Protection of areas near Akademik Vernadsky

5.39 The Scientific Committee noted that the area near Akademik Vernadsky Station, Argentine Island Archipelago, had high scientific value due to its benthic diversity and agreed that the area warranted protection and thanked Ukraine for its work from 2005 to 2011 in developing ideas regarding the first MPA network in the Akademik Vernadsky Station region (WG-EMM-12/25; SC-CAMLR-XXXI/BG/04 Rev. 1).

5.40 Some Members questioned the rationale for seeking MPA protection for this area on a research value basis under CCAMLR, as compared to an ASPA or ASMA under the ATCM. It was noted that both the ATCM and CCAMLR have provisions for the establishment of protected and managed areas, but the Scientific Committee agreed that this subject will be more appropriately discussed at the Commission on a case-by-case basis.

5.41 The Scientific Committee expressed its hopes that Ukraine would continue this important work and wished it success, but supported Ukraine’s own suggestion that this work was preliminary and that further work must take place in the next few years, before this proposal is ready to go to the Commission or ATCM. Although this is in Domain 1, the Ukrainian proposal was not part of the technical workshop for that area.

Marine areas following ice-shelf retreat or collapse

5.42 The Scientific Committee considered WG-EMM’s discussion on the establishment of precautionary spatial protection to facilitate the scientific study of habitats and communities in case of the collapse of ice shelves in the future, noting that the recently exposed areas of ocean uncovered by the collapse of the Larsen A and Larsen B ice shelves were not included in the proposal (Annex 6, paragraphs 3.26 to 3.33).

5.43 The Scientific Committee recognised that the proposal was designed to be proactive and future-looking. Further that, should the areas already uncovered by the collapse of the

Larsen ice shelves be considered worthy of protection, this could be achieved through a separate proposal for protection, or incorporated into the current proposal (Annex 6, paragraph 3.28).

5.44 The Scientific Committee noted that the proposal to protect areas and habitats under ice shelves following ice-shelf collapse was inherently different in nature from those MPA proposals being developed for the various MPA planning domains (SC-CAMLR-XXX, Annex 6, paragraph 6.6).

5.45 Consensus was not reached within the Scientific Committee on the points above. Dr V. Bizikov (Russia) indicated that it was unclear how you would be conferring protection for an under-ice ecosystem when the ice was gone. He suggested that we cannot stop global warming and that an MPA was not an appropriate tool to protect such an area for scientific study purposes.

5.46 Dr Trathan recalled the recommendation of the Scientific Committee during 2011, requesting that the Commission provide advice about the manner (precautionary or reactive) in which spatial protection should be afforded to ice shelves, ice tongues and glaciers, and further stated that there had been no decision by the Commission on this issue.

5.47 Some Members considered that the proposed areas are currently well protected by the ice in the shelves, tongues and glacier masses, where no vessels can access these areas, and they are thus not under immediate threat. Mr Yang suggested that it was better to consider this proposal as a scientific research program rather than an MPA proposal.

5.48 The Scientific Committee had previously agreed that research and monitoring plans for the areas under ice shelves should be developed and that this research was important. The Scientific Committee (SC-CAMLR-XXX, paragraphs 5.76 and 5.77) and the Commission (CCAMLR-XXX, paragraph 7.32) had also previously noted that the ability to acquire the necessary science from under ice shelves was limited because the areas to be protected were currently inaccessible.

5.49 Dr Zhao questioned the necessity to protect, and the capacity to monitor, so many areas. As the aim of the protection is for scientific study in the case of the ice-covered areas, especially monitoring of colonisation processes within the benthic community, a concrete scientific research plan should be in place, submitted with the proposal, so that prompt action could be carried out when an ice-shelf collapse happens.

5.50 The Scientific Committee discussed the divergent views on the floor at some length.

5.51 Dr Constable noted that this proposal was aimed at providing the Scientific Committee with an opportunity to acquire important information for advising the Commission on rapid changes arising from climate change impacts on the continental shelf in the region as well as estimating the productivity of species and the ecosystem before any exploitation occurs. This will help ensure that the Commission will be able to meet the objectives of Article II under climate change in the future.

5.52 Dr Bizikov noted that the necessity to carry out research on exposed shelf ecosystems does not imply the necessity to establish an MPA in this area.

5.53 Dr Trathan reminded the Scientific Committee that the proposal to protect ice-shelves is in accord with Recommendation 26 from the 2010 Antarctic Treaty Meeting of Experts on Climate Change which recommended the automatic interim protection to newly exposed areas such as marine areas exposed through ice-shelf collapses (SC-CAMLR-XXIX, paragraphs 8.3 to 8.7) so that if they collapse valuable scientific opportunities would be available with a potential to understand climate change.

5.54 Dr Trathan noted that the current total area extent of marine areas covered by ice shelves is approximately 165 000 km^2, equivalent to 3.9% of Subarea 48.1, 0.2% of Subarea 48.5 and 2.8% of Subarea 88.3.

5.55 Dr Zhao expressed the view that there is no scientific bearing between the proposed percentage of protection and the necessity to protect an area.

5.56 The Scientific Committee had received no advice from the Commission last year regarding whether to work with a precautionary or a reactive approach concerning the collapse of ice shelves; nevertheless it agreed that areas revealed by retreating glacial ice were unique and of considerable scientific interest.

Research and monitoring plans

5.57 There is currently no agreed structure and content for such plans required under CM 91-04. New Zealand and the USA have developed two drafts (WG-EMM-12/46 and 12/57) that were submitted to WG-EMM of potential plans for the Ross Sea region. The drafts were different in structure and focus.

5.58 The Scientific Committee endorsed the conclusions of WG-EMM (Annex 6, paragraph 3.42) which agreed that the research and monitoring plan should identify research activities within various regions or spatial areas within the MPA consistent with the specific objectives of the MPA in that area (according to CM 91-04). It was agreed that the research and monitoring plan should be organised geographically and would ideally identify research that relates to the achievement of multiple objectives simultaneously. The Scientific Committee concluded that plans should contain research that is achievable in practice. The final research and monitoring plan would identify research and monitoring activities, and mechanisms and timescales for review.

5.59 The research and monitoring plans have to be coordinated amongst Members and include systematic efforts that are based on scientific design and sampling procedures. Within this context, scientific fishing within MPAs could facilitate collection of data relevant to assessment of protection objectives, within a suite of observation methodologies that in combination work towards assessing impacts of climate change in combination with stressors such as fisheries.

ASPAs and ASMAs, and coordination with the ATCM

5.60 In accordance with ATCM XXVIII, Decision 9 (2005), the approval of CCAMLR is required for proposals for ASPAs or ASMAs which contain marine areas in which there is actual harvesting, or the potential capability of harvesting, or for which there are provisions specified in a draft management plan which might prevent or restrict CCAMLR-related activities.

5.61 Three revised ASPA management plans were submitted to ATCM XXXV by Chile (WG-EMM-12/40, 12/41 and 12/42). All three of the areas concerned are small, no deeper than 200 m, and were designated due to their value as important areas for benthic research.

5.62 The Scientific Committee endorsed the importance of these areas for scientific research and noted that these areas were unlikely to be subject to harvesting, and recommended approval of the management plans for ASPA No. 144 (Discovery Bay, Greenwich Island, South Shetland Islands), ASPA No. 145 (Port Foster, Deception Island) and ASPA No. 146 (South Bay, Doumer Island, Palmer Archipelago).

5.63 The Scientific Committee considered a management plan submitted by the USA and Italy to ATCM XXXV for a new ASPA at Cape Washington and Silverfish Bay, Terra Nova Bay, Ross Sea. The main values to be protected include one of the largest emperor penguin colonies known, as well as the associated marine ecosystem which is a nursery area for the Antarctic silverfish (*Pleuragramma antarcticum*). The total area of the proposed ASPA is 282 km^2, 98% of which is marine. The draft management plan has no provision for harvesting within the proposed ASPA (which is located within SSRU 881M), which currently has a catch limit of 0 tonnes. The region is less than 500 m deep, and was often ice-covered, and thus there should be little CCAMLR interest in harvesting within the area. Noting the importance of Cape Washington and Silverfish Bay for scientific research and the fact that these areas were unlikely to be subject to harvesting, the Scientific Committee endorsed approval of the draft management plan for a new ASPA in this area.

5.64 The Scientific Committee discussed ASMA No. 1, Admiralty Bay, King George Island, South Shetland Archipelago, which is a 360 km^2 area, 50% of which is generally ice-covered, noting its high scientific value (because of the long-term ecosystem studies that have been conducted). It was thought that no harvesting should take place within the ASMA in order to achieve the goals of the management plan. Another option would be prior consultation between those planning to harvest within the ASMA and the Management Group in order to minimise impacts to ongoing research. There was broad support for no harvesting within the ASMA, though it was noted that a formal review and recommendation would not occur until the draft management plan was submitted to CCAMLR in 2013.

Fishing vessels in ASPAs

5.65 The Scientific Committee was informed that krill fishing vessels have recently been observed within ASPA No. 153, Eastern Dallmann Bay, off the northwest coast of Brabant Island. The management plan of the ASPA, which is approximately 676 km^2, does not allow for harvesting as a permitted activity (Annex 6, paragraph 3.16).

5.66 The Scientific Committee noted that, based on catch data reported to the CCAMLR Secretariat, krill fishing had occurred in ASPA No. 153 in 2010 (two vessels conducted 31 hauls) and in 2012 (three vessels conducted 121 hauls).

5.67 It was suggested by some Members that the recent appearance of krill fishing vessels within ASMA No. 1 and ASPA No. 153 probably occurred due to a lack of awareness of the existence of these designated areas among those responsible for fishing vessels. Noting that the Convention (Articles V and VIII) provided for close cooperation between CCAMLR and the Antarctic Treaty, the Scientific Committee observed that there was a lack of informative and timely communication between the ATCM and CCAMLR with regard to the location and management plans of ASPAs and ASMAs containing marine areas.

5.68 The Scientific Committee endorsed the need to improve communication, perhaps by linking the management plans of relevant ASPAs and ASMAs to CCAMLR conservation measures so that management plans (with maps) could be readily accessed by fishing vessels. The Scientific Committee also encouraged Members to be proactive in passing on information to fishing vessels under their jurisdiction.

5.69 Concern was expressed by several Members regarding the impacts of harvesting that has occurred in some of these protected areas in recent years and the fact that there is very limited ability to detect when this occurs.

5.70 Dr Barrera-Oro noted that in summer 2010 penguin diets had little krill in them following an incursion by krill fishing vessels in the previous winter season in Admiralty Bay (paragraph 3.4). He requested that any additional information from the surrounding areas, where several science bases operate, be reported to WG-EMM.

5.71 The Scientific Committee had further discussions of ASMAs and ASPAs, reflecting on whether they affect the Commission’s ability to do its business. They are declared by the ATCM, and have no affiliated conservation measures. It was, however, noted that the CEP looks to CCAMLR for approval.

5.72 Dr Bizikov felt that this issue should be addressed by SCIC because it was a compliance issue, while Dr Constable thought it a matter for the CEP and ATCM because of the absence of affiliation with conservation measures.

5.73 The Scientific Committee concluded that the link between conservation measures and the ATCM needs to be strengthened and recommended that the Commission look at this issue.

General issues

5.74 SC-CAMLR-XXXI/07 from the Russian Delegation was presented to the Scientific Committee by Dr A. Petrov (Russia). The main conclusions of this submission are that (i) the Scientific Committee should consider alternatives to MPAs when protection is required to deal with threats, (ii) designation of marine areas and sites of special scientific interest used by CCAMLR in the past could be among others, possible alternatives instead of establishment of MPAs, (iii) depending on the protection objectives for particular sites, commercial and scientific fishery activities should be allowed in some protected zones as these activities represent important sources of valuable scientific information, and (iv) MPAs (and other important CCAMLR matters) should not be discussed at working groups when the CCAMLR languages are not provided to people in attendance.

5.75 This paper stimulated considerable discussion in the Scientific Committee. It was noted that the fishing fleet is often one of several important sources of valuable management data and that dialogue is important between science and the industry in order to facilitate the best collection and use of data acquired using the fleet. Research fishing could be used in MPAs to collect data as long as the objectives of the MPA under consideration would not be undermined. Some discussion of the scale of protected areas necessary to preserve ecosystem processes took place.

5.76 Some Members noted that Sites of Special Scientific Interest are a mechanism under the Antarctic Treaty set up to protect terrestrial fauna and flora prior to the Protocol on Environmental Protection. They also noted that the CCAMLR Integrated Study Regions were adopted soon after the establishment of CEMP. These three study regions were set up at a spatial scale appropriate to encompass krill-based food-web processes, necessary for fulfilling the purposes of CEMP.

5.77 There was general agreement in the Scientific Committee that its pace of work is often challenging, even when translation is available, and that it must ensure that all Members are able to participate fully in its deliberations and work. The Scientific Committee fully supported cooperation among all Members; it is vital to the proper functioning of the Scientific Committee.

5.78 Mr Yang supported the general issues raised by Russia regarding the language issues. He also reiterated the need for a thorough analysis of threat (or risk) in the planning of MPAs and called the Members to pay attention to the lessons drawn from some national MPAs fail to address the threats. Furthermore, Mr Yang suggested that benchmark data and an evaluation mechanism for the effectiveness of MPAs should be incorporated in the design of MPAs. Mr Yang also believed that CCAMLR has had great achievements in the conservation of Antarctic marine living resources and the management of fishing activities for more than two decades, which should be borne in mind before, and throughout, the design and establishment of MPAs.

5.79 In agreement with the Russian Delegation on having interpretation when fundamental CCAMLR issues such as MPA planning are being discussed, Dr Zhao further stated that an appropriate forum, which can address both language problems and wider participation would be desirable, and asked that the Scientific Committee put this issue forward to the Commission.

5.80 The Chair of the Scientific Committee concluded that the language issue should be brought to the Commission as a general issue, not solely an MPA issue.

5.81 IUCN presented CCAMLR-XXXI/BG/18 to inform the Scientific Committee on the new protected area management categories to describe MPAs. An MPA, as defined by IUCN, describes a precise set of management approaches within certain boundaries, and must have conservation as a primary aim to prevent or eliminate any exploitation or management practices that might be harmful to the objectives of designation. For IUCN, MPAs should be managed in perpetuity, not as short-term or temporary management strategies. MPAs can include reference areas that will allow study of how marine life is reacting to climate change in the absence of other human stressors. To ensure monitoring of MPAs, IUCN encouraged the Scientific Committee to take the opportunities to deploy fishing vessels as research vessels if this is done in collaboration with national research programs to determine and measure whether the conservation objectives of an MPA are being met.

IUU FISHING IN THE CONVENTION AREA

6.1 The Scientific Committee noted the review of IUU effort within the Convention Area undertaken by WG-FSA (Annex 7, paragraphs 3.12 to 3.19). The Scientific Committee noted that three vessels were sighted in Division 58.4.1 and Subarea 58.6. The Scientific Committee also noted that information had been provided to the Secretariat that seven vessels appear to be consistently engaged in IUU fishing activities, and sighting information in 2010, 2011 and 2012 indicated that these vessels have operated in conjunction with at least one support vessel.

6.2 The Scientific Committee noted that estimating IUU catch is extremely important and provides a key input to stock assessments in assessed fisheries and research requirements and stock status in data-poor exploratory fisheries. The Scientific Committee further noted that the information currently provided to the Secretariat is insufficient to provide sightings-based estimates of IUU catches, or to apportion it to SSRUs. Given the absence of data on surveillance effort with which to effort-correct the number of sightings and number of days fished, it is not possible to provide an estimate of uncertainty and it is difficult to evaluate trends in IUU catches.

6.3 The Scientific Committee noted the potential utility of other sources of information such as commercial satellite systems to detect IUU fishing, market-based information to help quantify the IUU level and genetic studies to determine the provenance of toothfish. The Scientific Committee noted the benefit of engaging COLTO to assist with market-based analyses of IUU fishing.

6.4 Dr Petrov noted that sightings of IUU vessels are only possible in areas where legal fishing vessels operate. The IUU vessels are therefore likely to target closed areas to avoid detection. The Scientific Committee recalled that in 2011 an IUU vessel continued to send VMS data to the Secretariat and that in this case the vessel remained in Division 58.4.4, an area where CCAMLR research activities were taking place.

6.5 The Scientific Committee requested that the Secretariat produce a map of historical IUU fishing activity, noting that such a map would be helpful to both SCIC and the Scientific Committee, but noted that such a map might be biased by surveillance effort in different areas.

6.6 The Scientific Committee considered the types of gear used by IUU vessels and noted that in WG-FSA-12/11 Rev. 1 three of the four IUU vessels sighted in Division 58.4.1 and Subarea 58.6 were reported to use gillnets. The Scientific Committee noted that some information on the recovery of gillnets by licensed vessels operating in the Convention Area may be available in observer reports and requested that the Secretariat review information available from these reports, particularly recent reports from Russian observers. Dr Welsford noted that the retrieval of gillnets by vessels that are not suitably equipped could be dangerous.

6.7 The Scientific Committee recommended that the Commission consider developing an intersessional work plan to include SCIC, ad hoc TASO and COLTO, noting that SCIC can provide expertise on the dynamics of IUU fishing, TASO can provide expertise on operational issues and COLTO can provide advice on market-related matters.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

7.1 Information collected by scientific observers for finfish on board longline and trawl cruises was summarised by the Secretariat in WG-FSA-12/66 Rev. 2 and 12/70 Rev. 2, and for krill trawl cruises in WG-EMM-12/60, 12/64 Rev. 1 and 12/65.

7.2 The Scientific Committee acknowledged the contribution that the data collected by scientific observers has made towards an understanding of the functioning of the Southern Ocean ecosystem and particularly the contribution made by the increased coverage of the krill fleet in 2011/12. The Scientific Committee thanked all scientific observers and technical coordinators.

7.3 The Scientific Committee considered the advice contained in the WG-FSA report (Annex 7, paragraphs 7.1 to 7.8) and endorsed the recommendations of WG-FSA for a peer review of the CCAMLR Scheme of International Scientific Observation (Annex 7, paragraphs 7.4 to 7.6).

7.4 The Scientific Committee recommended that the review panel should have available to it all relevant documentation related to the deployment of scientific observers during the course of their observations, e.g. the *Scientific Observers Manual*, identification guides etc., as well as the data that had been collected by the observers. Only data collected as part of the CCAMLR Scheme of International Scientific Observation should be included in the review. Data collected by national programs will not form part of this review.

7.5 The Scientific Committee further recommended that, where possible, the review should include input from the fishing industry.

7.6 The Scientific Committee noted that the budget for the review proposed by WG-FSA catered for the external invited experts only and recommended that the budget should cover the costs of all members of the review panel. It was agreed that the proposed budget contained in Annex 7, paragraph 7.8, should be increased to A$30 000.

7.7 Dr Petrov informed the Scientific Committee that Russia holds an annual two-day seminar for training scientific observers for deployment in the CCAMLR region. The training program includes lectures on the Antarctic Treaty System, CAMLR Convention, Madrid Protocol, CCAMLR conservation measures, compliance and implementation, CCAMLR Scheme of International Scientific Observation and other related issues. Russia strictly observes the practice of deploying only those observers who have successfully passed the training program and achieved the appropriate national accreditation to work in the CCAMLR region.

7.8 Dr Bizikov informed the Scientific Committee that the Russian Federal Research Institute for Fisheries and Oceanography (VNIRO) has published an *Illustrated Guide of Decapod Crustaceans for Atlantic Sector of the Antarctic and Surrounding Waters*. This book summarises the results of Russian crab research fishery in Area 48 in 2009/10, representing the first Decapoda identification key for the Atlantic sector of the Antarctic. The book is intended for CCAMLR scientific observers and experts on VMEs and Antarctic benthic fauna.

7.9 The Scientific Committee thanked Russia for developing a comprehensive guide to the decapod Crustacea from the Atlantic sector and complimented Russia on the high quality of the work. The Scientific Committee noted that such a guide would further facilitate research of benthic ecosystems and VMEs and will be a valuable resource for the CCAMLR Scheme of International Scientific Observation.

7.10 The Scientific Committee formally requested that Russia lodge an electronic version of the decapod Crustacea guide on the CCAMLR website.

7.11 The Scientific Committee endorsed the recommendation of WG-SAM (Annex 5, paragraph 2.26) that weighing of fish to be tagged was not necessary.

7.12 The Scientific Committee endorsed the recommendation of WG-FSA (Annex 7, paragraph 5.174) that the L11 tag deployment form should only record the fate of tagged fish if the tag deployment was observed to fail. In that case the reason for failure should be noted (e.g. attacked by predator, the type of predator identified).

7.13 The Scientific Committee endorsed the recommendation of WG-FSA for the development of a tag-recovery lottery system having the characteristics noted in Annex 7, paragraph 5.178, and recommended that COLTO also be involved in the development of such a scheme.

7.14 The Scientific Committee considered the advice contained in the report from WG-EMM (Annex 6, paragraphs 2.38 to 2.49).

7.15 The Scientific Committee noted that 80% of krill vessel-months were observed during 2011 and 90% in 2012, substantially exceeding the minimum requirement of 50% specified in CM 51-06, and urged that this level of observer coverage be maintained.

7.16 The Scientific Committee endorsed the advice of WG-EMM to increase sampling flexibility for observers on board krill fishing vessels. Greater flexibility for observers will increase by-catch sampling. The Scientific Committee recommended that:

(i) the requirement for sampling 20% of the hauls or haul units described in paragraph 3(ii) of CM 51-06 be replaced by a new sampling requirement to collect krill length measurements at three-day intervals between November and February and five-day intervals between March and October and increase the frequency of finfish (and other species) by-catch sampling; these new requirements would have to be revised and updated in the *Scientific Observers Manual*

(ii) only the most recent version of the e-logbook and the K10 forms should be used, and that the old K5 form should be removed from the e-logbook to avoid confusion over the reporting protocol (Annex 6, paragraph 2.43).

7.17 The Scientific Committee also recommended that all gear types in the krill fishery should be observed and that observer coverage should be distributed throughout the fishing season and across all areas that are fished.

7.18 The Scientific Committee noted that 2012 marked the end of a two-year trial period of observer coverage for the krill fishery. The trial was a resounding success and a substantial amount of valuable data was collected and the Scientific Committee thanked all those involved.

7.19 The Scientific Committee reiterated its satisfaction with the high level of observer coverage achieved in 2010/11 and 2011/12 (paragraph 7.15), and recommended that the target level of vessel coverage in CM 51-06 be maintained.

7.20 Accordingly, with the expectation that the target level of coverage specified in CM 51-06 will maintain levels actually achieved in 2010/11 and 2011/12, the Scientific Committee advised that CM 51-06 be maintained for two more fishing seasons, subject to adoption of recommendations in paragraphs 7.16 and 7.17.

CLIMATE CHANGE

8.1 The Scientific Committee noted it had discussed climate change issues in relation to krill in paragraph 3.19.

8.2 Dr Trathan presented SC-CAMLR-XXXI/BG/05, which provides an overview of RACER – Rapid Assessment of Circum-Arctic Ecosystem Resilience – a new conservation planning tool developed by WWF. It aims to identify and map places of conservation importance on the basis of their ecosystem resilience. In that context, he recalled that one of the objectives for MPAs in CM 91-04 is ‘the protection of areas to maintain resilience or the ability to adapt to the effects of climate change’. RACER has been brought to the attention of the Scientific Committee to highlight it as one possible approach amongst others to identify areas in the Southern Ocean that may be of strategic conservation importance because of their ecosystem resilience to a changing climate. As such, RACER might assist the Scientific Committee to underpin its ecosystem-based management approaches in the context of climate change. Dr Trathan recommended that CCAMLR remain alert to a trial of the RACER methodology which was endorsed by the CEP for trialling in the terrestrial environment. This could be used as the basis for assessing whether a similar trial might also be appropriate in the future within the Convention Area.

8.3 Dr Constable drew the attention of the Scientific Committee to the continued work of the ICED Southern Ocean Sentinel program to estimate the ecological status of the Southern Ocean by 2020, to form the foundation for estimating change in Southern Ocean ecosystems as a whole (Annex 6, paragraphs 2.82 and 2.83). He also drew its attention to the continued work of ICED in developing food-web and end-to-end ecosystem models for Southern Ocean ecosystems. These models will be spatially structured and useful for discussions of feedback management procedures for krill fisheries and climate change impacts on the region. ICED experts would be available to contribute their expertise and modelling efforts to WG-EMM in its discussions in the future.

8.4 The Scientific Committee welcomed this work of ICED and encouraged ICED experts to submit work to contribute to discussions next year in WG-EMM. It further encouraged the collaboration between ICED modellers and CCAMLR experts collecting field data for better development of models explaining the dynamics of systems relevant to CCAMLR. Such collaboration will be very useful for validating the models.

8.5 CCAMLR-XXXI/BG/14 considered the impact of climate change in the Antarctic environment and the role of CCAMLR to ensure that management strategies take climate change into account to effectively conserve Southern Ocean marine ecosystems. The Scientific Committee noted that the paper included a number of strategies available to CCAMLR to increase the adaptability and resilience of Antarctic marine ecosystems to climate change.

SCIENTIFIC RESEARCH EXEMPTIONS

9.1 The Scientific Committee considered information regarding research undertaken, and notifications received, in accordance with CM 24-01. Research fishing undertaken as part of exploratory fisheries with overall catch limits greater than zero, conducted in accordance with CM 41-01, is considered under Item 3.

9.2 The Scientific Committee noted that WG-FSA addressed research proposals to inform current or future assessments and fishing using commercial vessels and considered the advice of WG-FSA regarding research undertaken during 2011/12 and research notified for 2012/13 set out in Annex 7, paragraphs 5.99 to 5.132.

Proposals for research fishing under CM 24-01 in closed fisheries or fisheries with zero catch limits

9.3 There were two proposals for research fishing under CM 24-01 in closed fisheries or fisheries with zero catch limits:

(i) in the closed *Dissostichus* spp. fisheries in Subarea 48.5 submitted by Russia (WG-FSA-12/12)

(ii) in the closed *D. eleginoides* fishery in Divisions 58.4.4a and 58.4.4b submitted by Japan (Ob and Lena Banks) (WG-FSA-12/58 Rev. 1).

9.4 The evaluation of the extent to which each proposal addressed the general principles for CCAMLR-sponsored research and the advice and specific recommendations provided by WG-FSA is set out in Annex 7, Tables 9 and 13. Several changes were made to the research design arising from discussions in WG-FSA and the evaluation in Annex 7, Tables 9 and 13, refers to the research proposal, including these changes.

Subarea 48.5 *Dissostichus* spp.

9.5 The Scientific Committee noted that there had been no commercial fishing for *Dissostichus* spp. in Subarea 48.5 and that, on this basis, fishing was prohibited in 1997 (CM 120/XVI, CM 32-09). The Scientific Committee recalled how such fisheries have been considered in the past (CCAMLR-XVIII, paragraph 7.15) and therefore agreed that the fishery should be considered an exploratory fishery. The Scientific Committee agreed that, while the proposal was submitted under CM 24-01, it was consistent with the requirements of CM 21-02 for exploratory fisheries.

9.6 Some Members noted that the opening of new areas to fishing, such as Subarea 48.5, needed to be considered in conjunction with a broader spatial management assessment of such areas, including the broader conservation considerations, such as MPAs.

9.7 The Scientific Committee noted that the research in Subarea 48.5 proposed by Russia is for a 3 to 5-year period.

9.8 Several Members of the Scientific Committee were concerned that the heavy sea-ice in the Weddell Sea, and uncertainty in ice conditions (often changing on a daily basis), could impede efforts to return to the same research areas in subsequent seasons in order to recapture tags, thereby seriously compromising the ability to achieve the research objectives.

9.9 Some Members were concerned about vessel safety in the Weddell Sea, given heavy sea-ice conditions. Although it was recognised that vessel safety in the Weddell Sea, given heavy sea-ice conditions, was not a science question, the Scientific Committee agreed that this should be taken into consideration by the Commission during deliberation of this research proposal.

9.10 The Scientific Committee agreed that sea-ice conditions in Subarea 48.5 could be highly variable from year to year. The research plan proposed three different spatial options where research fishing could be undertaken within the subarea, with the intention to enable research fishing depending on where ice conditions would allow in the eastern and/or western area. If conditions were favourable, the research could potentially proceed in all three proposed areas in a single season.

9.11 The Scientific Committee noted the advice from WG-FSA that of the three survey areas proposed, option 2 (restricted eastern area, WG-FSA-12/12, Figure 6) likely had the highest probability to achieve the objective of the research, given the recent sea-ice charts provided. Whilst the Scientific Committee noted that the survey designs of all options were similar, it was concerned that tag-based research designs are less likely to be successful for the spatial options 1 and 3, because it may not be possible to revisit the same locations in multiple years due to the more frequent occurrence of severe sea-ice conditions in these areas.

9.12 Russia made the following statement:

> 'Russia's scientific research plan fully meets the requirements of CM 21-02, paragraph 6(iii), and the requirements of the Scientific Committee (SC-CAMLR-XXX, Annex 5, paragraph 2.35). Russia will follow the advice of the Scientific Committee to focus its research on option 2 (WG-FSA-12/12, Figure 6) with a catch limit of 50 tonnes. However, Russia would like to emphasise that during discussion at

the Scientific Committee no objections other than ice-condition uncertainty were made regarding two other options (1 and 3) and all three options fully meet the requirements of CM 21-02 and CM 24-01 as reflected in Table 9 of the WG-FSA report. In this regard, Russia wishes to have its proposition better considered that if in the forthcoming 2012/13 season the areas in options 1 and 3 become free of sea-ice, its intention in that proposal was to conduct research in these areas, with a catch limit 60.6 tonnes for option 1 (based on 50 longline stations × 6.0 km × 0.202 tonnes), and 111.84 tonnes for option 3 (based on a combined catch limit 'Eastern zone' + 'Western zone'). These catch limits are calculated based on advice contained in SC-CAMLR-XXX, Annex 5, Table 2.'

9.13 The Scientific Committee noted that it remained unclear to what extent the results of a tagging experiment in an area would be impacted if the research area cannot be revisited annually. Some Members considered that, given the highly variable ice conditions, an adaptive survey design may be preferable to improve the understanding of the fish stocks in the area.

9.14 While the Scientific Committee recognised that the first component of this research could lead to indicative estimates of CPUE for the surveyed region and potentially an indicative estimate of biomass, it noted that development of a rigorous stock assessment would include considerably more information, such as gear selectivity, productivity and information on age and growth.

9.15 The Scientific Committee endorsed the advice of WG-FSA (Annex 7, paragraph 5.103) that the survey design be modified such that it is based on a more grid-like or cluster-based survey design so that adjacent sets in a cluster would span a range of depths, as this would provide considerably more information about relative fish abundance as a function of depth and would increase the likelihood of tag recaptures in the survey area.

9.16 The Scientific Committee noted that, because there has been no fishing in this subarea, there was no basis to estimate an indicative stock biomass or catch limit, but that, because the research is effort-limited rather than catch-limited, and predicted catches are based on estimates using commercial CPUE from an area with high toothfish abundance (SSRU 881H), actual catches are likely to be lower, unless the abundance of fish in the research area is similarly high. On this basis the Scientific Committee supported a catch limit of 50 tonnes in the eastern research block (option 2).

Division 58.4.4 (Ob and Lena Banks) *Dissostichus* spp.

9.17 The Scientific Committee noted the consideration by WG-FSA of the research conducted in 2011/12 in Divisions 58.4.4a and 58.4.4b (Ob and Lena Banks) and a proposal to continue the survey in 2012/13 (Annex 7, paragraphs 5.108 to 5.132).

9.18 The Scientific Committee welcomed the development of a preliminary stock assessment for *D. eleginoides* in SSRU 5844C using CASAL. It agreed that this assessment model was in a preliminary state but could be further developed to provide management advice in the future.

9.19 The Scientific Committee agreed that it was likely that depredation was having a detrimental effect on the achievement of the research objectives by decreasing the potential for retrieving tags and creating considerable uncertainty in the estimation of total removals. On this basis, the Scientific Committee recommended that research fishing in SSRU 5844B should be discontinued.

9.20 The Scientific Committee agreed that estimates of unaccounted mortality arising from killer whale depredation should be taken into consideration in future assessments, and encouraged all Members to conduct further research to develop effective mitigation of depredation, paying also attention to methods developed outside the CCAMLR area.

9.21 The Scientific Committee recommended that the research design proposed in WG-FSA-12/58 Rev. 1 and development of the CASAL-based assessment in SSRU C continue. However, the Scientific Committee was unable to agree as to whether the proposed research should also be undertaken in SSRU D.

9.22 The Scientific Committee agreed that, if the research is extended into SSRU D, the research design proposed in WG-FSA-12/58 Rev. 1 is appropriate, but that the continuation of research in SSRU C is the highest priority. The Scientific Committee recommended that if research occurs in both SSRUs, then in the coming year all planned research sets in SSRU C should be completed before research in SSRU D is initiated.

9.23 At the time of report adoption, Japan requested that, should the proposal for research in SSRUs C and D be accepted and research in SSRU C is adversely affected by depredation, then the vessel would move to SSRU D for a short period of time in order to avoid predators.

9.24 The Scientific Committee recalled the advice by which catch limits were set in 2011 and the method by which these limits were judged to be appropriate (SC-CAMLR-XXX, paragraph 9.26) but noted that the survey design is effort-limited, such that actual catches are expected to be much lower. The Scientific Committee noted the advice of WG-FSA (Annex 7, paragraph 5.132) to consider a catch limit in the range of 50 to 70 tonnes for this research in 2012/13, and that the catch limit be revisited in further years on the basis of new information from this research.

Results of research in Subarea 88.3 and SSRU 882A

9.25 The Scientific Committee discussed the consideration by WG-FSA of the results of two years of research fishing by Russia in Subarea 88.3 and SSRU 882A (Annex 7, paragraphs 5.144 to 5.152).

9.26 The Scientific Committee thanked Russia for its research which provided indicative estimates for stock biomass in Subarea 88.3 which were based on the comparative CPUE method, and agreed that these should be used when developing further research proposals in this area. The Scientific Committee noted that, because no tagged fish have been recovered during the research, these estimates of biomass are uncertain.

9.27 Dr Petrov noted that research fishing in Subarea 88.3 and SSRU 882A were carried out in accordance with SC-CAMLR-XXX, Annex 5, paragraph 2.40(ii). Taking into account recommendations of WG-FSA-12/13, Russia recommended that SSRUs 883B and C be opened as an exploratory fishery with a catch limit of 343 tonnes. He noted that these data represent the best available information for this subarea, and requested that this recommendation be considered by the Scientific Committee. This request was supported by Dr Pshenichnov.

9.28 Given the lack of a stock assessment for these areas, the Scientific Committee did not consider that it was appropriate to open an exploratory fishery in SSRUs 883B and C. Although the comparative CPUE method is recommended for use in providing initial estimates of abundance for proposed research surveys, it is not considered sufficiently reliable for deriving catch limits for an exploratory fishery using the CCAMLR decision rules (SC-CAMLR-XXX, Annex 5, paragraph 2.33).

9.29 Dr Petrov noted that based on the result of WG-FSA-12/15, Russia recommended that SSRU 882A be opened as an exploratory fishery with a catch limit of 286 tonnes. He also noted that these data represent the best available information for this SSRU and that the area should be opened for rational use. Since SSRU 882A belongs statistically to Subarea 88.2 and is regulated by CM 41-10, the opening of this SSRU should be part of this conservation measure. Dr Petrov also noted that if this area were opened, then this would relieve some of the pressure in SSRUs 881H, I and K. He requested that this recommendation be considered by the Scientific Committee. This request was supported by Dr Pshenichnov.

9.30 The Scientific Committee agreed that SSRU 882A could potentially be opened and managed as part of the Ross Sea fishery. It discussed uncertainty as to fish movements between SSRU 882A and the adjacent SSRUs 881K and L, whether additional research should be undertaken given the paucity of information from this region, and how catch limits from the Ross Sea assessment could be applied to this SSRU.

9.31 However, the Scientific Committee was unable to agree whether the proposal of opening and managing SSRU 882A as part of the Ross Sea fishery should be pursued this year or requires further evaluations. The Scientific Committee noted that the SPM described in paragraph 3.120 may prove useful in evaluating alternative spatial management configurations in this area and how these would affect the stock assessment.

9.32 The Scientific Committee recalled that the original proposal for research in Subarea 88.3 was for three years of research (SC-CAMLR-XXIX, paragraphs 9.17 to 9.20), which would have allowed for at least two years of tag recaptures. Dr Petrov explained that Russia was unable to complete the third research survey because no vessels with the same fishing gear and experience were available for 2012/13.

9.33 The Scientific Committee noted that the research had provided information with respect to fish distribution and size frequencies, and had tagged 163 fish. The Scientific Committee encouraged Members to complete the research program in this subarea.

9.34 The Scientific Committee also noted that a Member-independent, multi-vessel and/or multinational research proposal may have provided a more robust approach and enabled three years of research to be completed.

Research in Subarea 88.1

9.35 The Scientific Committee endorsed the New Zealand proposal to carry out the second pre-recruit survey of *D. mawsoni* in the southern Ross Sea under CM 24-01, noting that this was an effort-limited survey comprising 65 longline sets with an upper catch limit of 49 tonnes (paragraph 3.129).

COOPERATION WITH OTHER ORGANISATIONS

Cooperation with Antarctic Treaty System

10.1 The Scientific Committee noted the Secretariat's report on the Thirty-fifth Antarctic Treaty Consultative Meeting (ATCM, June 2012; CCAMLR-XXXI/BG/03), including the status of the Antarctic Treaty, activities of the CEP (see also paragraphs 10.2 to 10.4), the status of the SOOS, and consideration of climate change and biological prospecting. The Scientific Committee also noted the discussions relating to search and rescue involving fishing vessels for which CCAMLR Members are responsible, vessel safety in the Antarctic, coordination of search and rescue and matters relating to hydrographical surveys and charting.

Committee for Environmental Protection

10.2 Dr P. Penhale (USA) presented the annual Report of the CEP Observer to SC-CAMLR (SC-CAMLR-XXXI/BG/02). Increased cooperation between the two bodies resulted in the development of a list of five topics of mutual interest and a common reporting format. The topics of Climate Change, Biodiversity and Non-native Species and Species Requiring Special Protection were mostly focused on terrestrial issues.

10.3 The topic of Spatial Management and Area Protection included notice that four ASPAs were reviewed and forwarded to CCAMLR for approval. These included a revised management plan for ASPA Nos 144, 145 and 146 (Chile) and a proposed new ASPA at Cape Washington (USA and Italy). The CEP welcomed a report on the 2011 CCAMLR Marine Protected Area Workshop (SC-CAMLR-XXX/06). The CEP expressed concern on learning that there was krill fishing in ASMA No. 1 (Admiralty Bay) during 2009/10. CEP members expressed concern that the 40-year history of long-term research in this area might have been compromised by commercial fishing.

10.4 Under the topic of Ecosystem and Environmental Monitoring, the CEP noted that great progress has been made in the use of remote sensing to estimate penguin populations. The CEP had also expressed its strong support for the SOOS program.

Scientific Committee for Antarctic Research

10.5 The SCAR Observer to SC-CAMLR (Prof. M. Hindell) presented several papers (SC-CAMLR-XXXI/BG/07 to BG/11) detailing the ongoing activities of the committee.

10.6 The annual report (SC-CAMLR-XXXI/BG/07) outlined the benefits of a more strategic partnership between SCAR and CCAMLR. SCAR and CCAMLR have agreed to hold a one- or two-day Action Group meeting immediately prior to the 2013 Treaty Meeting in Brussels, Belgium, to develop a more strategic approach to their relationship.

10.7 The SCAR Observer to SC-CAMLR highlighted the aims of the SOOS in order to 'provide long-term monitoring and sustained observations of the Antarctic environment and the associated data management, to enable the detection, and underpin the understanding and forecasting of the impacts of environmental and climate change'.

10.8 The Scientific Committee noted the renewal of the SCAR Executive Committee. Prof. J. López-Martínez is the new SCAR President. SCAR also has two new Vice-Presidents: Prof. K. Lochte from the AWI in Germany and Prof. B. Storey from the University of Canterbury, New Zealand. The Life Science Standing Group has a new Chief Officer – Dr G. Hosie of the AAD.

10.9 The Scientific Committee noted that SCAR will hold its four-yearly biology symposium in Barcelona, Spain, from 15 to 19 July 2013. The title of the meeting is 'Life in Antarctica: Boundaries and Gradients in a Changing Environment'.

10.10 The SCAR Observer to SC-CAMLR further discussed SC-CAMLR-XXXI/BG/09, a document providing several products that support the work of SCAR scientists but are also made widely available to others, including CCAMLR Members. Among these products the Scientific Committee noted the next as of potential interest:

- the Continuous Plankton Recorder Database (CPR)
- the Antarctic Biodiversity Information Facility (ANTABIF) and the SCAR Marine Biodiversity Information Network (SCAR-MarBIN)
- the International Bathymetric Chart of the Southern Ocean (IBCSO) is to be finalised in late 2012.

10.11 The SCAR Observer to SC-CAMLR presented SC-CAMLR-XXXI/BG/10, in which an update to the SCAR Antarctic Climate Change and the Environment (ACCE) is given. The original ACCE document from 2009 contained 80 'key points' that highlighted important climatic events affecting the Antarctic. The SCAR ACCE Advisory Group has been working on an update to these 80 key points, incorporating material included in previous updates, making use of results emerging from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, and also rectifying some omissions identified in the original ACCE report, such as consideration of the impact of solar variability on the Antarctic climate. This update, which is much more comprehensive than previous updates, is currently being finalised for submission to a peer-reviewed journal. Once published, the SCAR Secretariat will ensure CCAMLR is kept informed.

10.12 The Scientific Committee noted that implementing the SCAR climate change communications plan will be led by the SCAR Secretariat in partnership with national Antarctic programs, and other organisations including the ATS, COMNAP, CCAMLR, IASC and APECS. An important objective is to establish a robust network for communications that leverages limited SCAR funds through partnerships. The Climate Communications Plan should also be a primary target for the SCAR Development Council for soliciting external funds.

Reports of observers from other international organisations

ASOC

10.13 The ASOC Observer to SC-CAMLR (Dr R. Werner) presented CCAMLR-XXXI/BG/15 and highlighted the importance for CCAMLR Members of respecting ASMAs and ASPAs, while paying special attention to the management plans of those areas. He noted that the fishing activities that took place in ASMA No. 1 and ASPA No. 153 show that these situations are taking place in the Convention Area, and could happen in the future again.

10.14 ASOC recommended that CCAMLR:

(i) encourages Members to impose conditions on CCAMLR permits for vessels flagged to fish in CCAMLR waters that give effect to management objectives in relevant ASMAs and ASPAs

(ii) encourages Members to notify vessels flagged to their State that are licensed to fish in CCAMLR waters of the location of ASPAs and ASMAs and the management restrictions that apply for fishing and other activities, as applicable

(iii) ensures clear information on the specific boundaries and management plans of the marine component of all ASPAs and ASMAs is available.

10.15 In this context, ASOC recommended that CCAMLR adopts some type of mechanism to ensure that this would not happen again in the future.

IUCN

10.16 The IUCN Observer to SC-CAMLR (Ms D. Herr) presented CCAMLR-XXXI/BG/18 summarising the guidelines for Applying the IUCN Protected Area Management Categories to Marine Protected Areas (supplementary to the 2008 Guidelines). These supplementary guidelines were developed to increase the accuracy and consistency of the assignment and reporting of the IUCN categories to marine and coastal protected areas. IUCN hoped that CCAMLR Members find this useful in their future deliberations on MPAs, to possibly strengthen the management systems and help implement the general conservation measure on MPAs over the coming years.

10.17 The Scientific Committee noted that the IUCN held its World Conservation Congress from 5 to 16 September 2012 in Jeju, Republic of Korea. IUCN members voted on a motion on Antarctica and the Southern Ocean, including recommendations to all CCAMLR Members. It will be available on the IUCN website.

CCSBT

10.18 The Scientific Committee noted the report in CCAMLR-XXXI/BG/27 and thanked Australia for this information in regard to CCSBT.

ARK

10.19 The ARK Observer to SC-CAMLR (Dr S. Nordrum) presented SC-CAMLR-XXXI/BG/17 reporting the most recent activities of the association. The aim of ARK is to assist the krill fishing industry to work with CCAMLR to ensure the sustainable management of the fishery through:

(i) cooperating with CCAMLR on the provision of research and information on krill, and the krill fishery and its impact on the ecosystem

(ii) assisting with the conduct of research on Antarctic krill, the Antarctic krill fishery and its impact on the ecosystem

(iii) supporting the scientific research and educational initiatives of CCAMLR.

10.20 The members of ARK recognise that there is great potential to utilise the fishing fleet in a more directed way to obtain data that will help with our understanding of krill ecology and will improve management of the krill fishery. ARK would welcome a dialogue with WG-EMM to explore possible scientific studies that could be carried out on, or by, krill fishing trawlers. In particular, ARK would welcome the opportunity to bring together experts from the scientific community and the fishing operators to discuss scientific problems that could be solved together.

10.21 ARK noted CCAMLR’s discussion of the issue of ‘green weight’ calculations and recognised the importance of obtaining accurate measurements of total removals of krill. ARK members will assist CCAMLR in the collection and provision of data to improve estimates of total krill catch.

10.22 ARK members recognised the value of ASPAs and ASMAs, and the need to avoid fishing in areas which have been agreed to be closed to the fishery. To assist with this, CCAMLR should ensure that all Members fishing for krill (and other species) have accurate indications of the location of such areas and of the activities prohibited in them.

COLTO

10.23 The COLTO Observer to SC-CAMLR (Mr M. Exel) noted the hugely positive results from CCAMLR measures, and collaborative efforts between industry, conservation groups, science and CCAMLR Members to limit seabird by-catch. COLTO recalled that it was only 15 years ago that CCAMLR was discussing seabird by-catch levels in the order of tens of thousands of seabirds killed annually. That compares to this year, when recorded seabird mortalities in the entire region were 57 birds.

FAO

10.24 The Scientific Committee noted the Secretariat's report on a FAO VME database workshop, and meetings of the Steering Committee of FIRMS and the CWP (SC-CAMLR-XXXI/BG/03).

10.25 The Scientific Committee noted that the data elements of the FAO VME database were similar to those being developed for CCAMLR's VME registry, and that the database developments would include a web portal, VME-related fact sheets and tools for mapping and a search function. This work is being conducted under FAO's program for deep-sea high seas fisheries (SC-CAMLR-XXXI/BG/13).

10.26 The Scientific Committee recognised the benefits of developing the VME database and the broader objectives of FAO's program for deep-sea high seas fisheries. The Scientific Committee encouraged the CCAMLR and FAO Secretariats to explore opportunities for collaboration and for the CCAMLR Secretariat to continue contributing to aspects of this work.

10.27 The FAO Observer to SC-CAMLR presented SC-CAMLR-XXXI/BG/13 (which relates to SC-CAMLR-XXXI/BG/03 and CCAMLR-XXXI/09), providing information on ongoing and upcoming activities under FAO's deep-sea program and highlighting some of the activities that could be of interest to CCAMLR. In particular, the next topics were noted by the Scientific Committee:

- the development of a global VME database to compile information related to VMEs from regional organisations

- the ongoing update of the publication 'Worldwide review of bottom fisheries in the high seas'. FAO stated its hope that CCAMLR and its Members will be interested in contributing to the updating and strengthening of this report

- with regards to the ABNJ Programme (cf. Annex of SC-CAMLR-XXXI/BG/13), FAO stated its hope that all deep-sea RFMOs and CCAMLR will support its development and implementation.

10.28 The Scientific Committee noted the Secretariat's report on the 30th session of COFI (July 2012; CCAMLR-XXXI/09), including preparation of the Report on the State of World Fisheries and Aquaculture (SOFIA), review of the Code of Conduct for Responsible Fisheries, and consideration of fish trade, ocean governance, the outcomes of Rio+20, IUU fishing and FAO's program of work.

10.29 The Scientific Committee encouraged Members to engage with FAO on matters of mutual interest as appropriate. It requested the Secretariat to continue its collaboration with FAO, including in respect to FAO's program for deep-sea high seas fisheries, and keep the Committee informed of developments.

10.30 The Observer from FAO declared that FAO was looking forward to a continued fruitful collaboration with CCAMLR and its Members on the abovementioned activities as well as in other areas of work.

10.31 The IWC Observer to SC-CAMLR (Dr Kock) reported that after almost a decade of divergent opinions on the abundance of minke whales in the Southern Ocean, the SC-IWC was able to agree on estimates for the two circum-Antarctic cruises CP2 and CP3. The two estimates were CP2 = 720 000 (512 000–1 012 000) and CP3 = 515 000 (361 000–733 000). Five hypotheses were presented to explain the difference between the two surveys:

(i) there were more minke whales in the pack-ice during CP3 than during CP2

(ii) extensive longitudinal migrations of minke whales which were better captured during CP2

(iii) a greater number of minke whales were north of 60°S and were not counted during the survey

(iv) migrations inside the survey area within a year which were not adequately captured by the surveys

(v) a decrease in the abundance of minke whales.

NAFO

10.32 The CCAMLR Observer to NAFO (Dr Bizikov) reported that the 34th Annual Meeting of NAFO was held from 17 to 21 September 2012 in St Petersburg, Russia. NAFO adopted a range of conservation and management measures for the fish stocks in international waters under its purview based on the precautionary approach, defined national fishing limits and continued to conduct its long-term policy of the protection of VMEs. NAFO adopted a comprehensive action plan to follow up on the recommendations of the Performance Review carried out last year. The next Annual Meeting of NAFO will take place in September 2013, in Halifax, Canada.

Future cooperation

10.33 The Scientific Committee noted the calendar of meetings of relevance to the Scientific Committee for 2012/13 and encouraged those Members who are likely to attend such meetings to inform the Secretariat and provide appropriate reports to the next meeting of the Scientific Committee.

FUTURE DIRECTIONS

Performance Review Panel

11.1 Although there were no papers tabled to this agenda item this year, the Chair recalled the successful development of the CCAMLR Scientific Scholarship Scheme in response to the request for building capacity within CCAMLR Members in the Performance Review Panel report. However, the Chair noted that less progress had been made in addressing the recommendations made by the Performance Review on sharing the burden of the increasing amount of work undertaken by the Scientific Committee.

11.2 The Scientific Committee reflected on the increasing number of issues that it has to address each year and suggested that, rather than consider every proposal brought to the Committee, it should discuss the main goals for the coming years and then prioritise the work of the working groups, including emerging issues and gaps arising from current tasks. The Scientific Committee should discuss longer-term plans, focusing on emerging issues and not submerge itself in the current issues arising from its working groups. In order to facilitate this process of long-term prioritisation, the Scientific Committee invited all Members to make proposals in this direction for the next meeting.

11.3 The Scientific Committee also reflected on the way Members undertake their work and the challenges faced today. Members usually work on their own programs, but current issues are demanding more collaboration among Members. Also, new challenges are requesting new technologies which stresses the need for CCAMLR to engage with the wider scientific community.

Scholarship Fund

11.4 The Scientific Committee noted the contribution of the first recipient of the CCAMLR Scientific Scholarship, Dr R. Wiff (Chile), to the work of WG-SAM-12 and WG-FSA-12, conducting a valuable analysis on the toothfish fishery data in Subarea 48.6 and recommended the continuation of this scholarship next year. On behalf of Dr Wiff, Dr Arata thanked both working groups for the support received and expressed his confidence that Dr Wiff will continue making fruitful contributions to CCAMLR.

11.5 This year the Scientific Committee received five applications from five Members for the scholarship scheme. The call for these applications was distributed as COMM CIRC 12/72–SC CIRC 12/38 and was also disseminated through other appropriate organisations such as SCAR and APECS.

11.6 These applications were reviewed by a Scholarship Review Panel, chaired by the senior Vice-Chair of the Scientific Committee (Prof. Koubbi) and comprising the other Vice-Chair (Dr Zhao) and the following members of the Scientific Committee: Drs Belchier, Kawaguchi, Barrera-Oro, Hanchet, Prof. M. Vacchi (Italy) and the CCAMLR Science Officer (Dr Reid). Drs Penhale and Dr Watters also provided reports.

11.7 The Scholarship Review Panel noted that the changes made to the selection process followed last year, in particular the need for applications to provide more details about the specific scientific contribution that they seek to make to the working groups. The Scholarship Review Panel commented on the need to clarify what elements are required with the application, such as the CV and letter of support of his/her Scientific Committee representative.

11.8 The Scholarship Review Panel followed a selection process that included general questions about the aims of the scheme, a review of the background information of the candidates, their current contract status and a consideration of the current level of engagement of the candidates' Member delegation in working groups. Only the members of the Scholarship Review Panel who were not associated with an application voted for the first candidate they wanted to promote, then for the second. Lastly, it was discussed if other remaining candidates should be promoted. The Review Panel reflected on the presentation of the proposals and the background information of the different candidates, which was in different formats and levels of detail, making the selection process more difficult. The Panel agreed that, in general, the quality of the applications had improved substantially since last year.

11.9 The Convener of the Scholarship Review Panel was pleased to announce that two candidates were selected this year: Lic. Mercedes Santos (Argentina) and Mr Xingliang Wang (China). These two candidates are both early career scientists, who presented scientific proposals in line with the objectives identified by the Scientific Committee, for which the Review Panel considered they would make a good contribution to the work of the Scientific Committee.

11.10 Lic. Santos is finishing her PhD. She presented her application with two objectives that interest WG-EMM, especially the CEMP program on population ecology of penguins. The requested budget is relevant and well estimated to participate in WG-EMM. The Review Panel encouraged this application because of the value of the applicant and to reinforce the representation of Argentina in WG-EMM.

11.11 Mr Wang is a PhD student. His field of research is on acoustics to detect krill concentrations. He has developed a proposal which also includes the use of fishing vessels in the acquisition of data. The application is well presented with clear objectives. The Review Panel considered that this application is important for SG-ASAM and WG-EMM, the budget is well estimated with intersessional exchanges and will benefit both working groups by reinforcing the presence of China in them.

11.12 Drs Barrera-Oro and Zhao thanked the Scholarship Review Panel for its wise decisions and, on behalf of their respective candidates, thanked the panel for the opportunity provided through this program for these promising scientists to contribute to the general work of CCAMLR.

11.13 The Observer from SCAR informed the Scientific Committee that it also operates a scholarship program and invited Members to submit candidates to this program.

CCAMLR outreach and education

11.14 SC-CAMLR-XXXI/BG/12 outlined the outreach and education activities by the Secretariat. The Scientific Committee acknowledged the improvements in the impact factor and quality of *CCAMLR Science* and encouraged Members to present the results of their research to the journal.

11.15 The Secretariat informed the Scientific Committee about the launch of the Antarctic and Southern Ocean Internship in September 2012. This internship offers international opportunities for Antarctic undergraduate and postgraduate multi-disciplinary education by sharing teaching resources between international partner universities.

Management of the CEMP Fund

11.16 The CEMP Special Fund was established to support ecosystem management as a central component of the management of the krill fishery. At CCAMLR-XXX the Commission endorsed the establishment of an ad hoc CEMP Fund Correspondence Group to develop the terms of reference for use of the fund. A draft was provided in SC-CAMLR-XXXI/08. This draft approach for managing the special fund was advanced during the meeting to provide details of the administrative process that would be used to administer the fund. The established procedure in the use of the CDS Fund (CM 10-05, Annex B) was used to facilitate the development of a procedure for managing the CEMP Special Fund. The draft procedure is given in Annex 8.

11.17 The Scientific Committee also considered possible projects/concepts that could be developed to draw on the CEMP Special Fund. These included:

(i) A workshop to explore revision of CEMP data collection methods to integrate new technologies (TDRs, cameras, remote sensing) and improve accuracy of data collection – while maintaining the value of time series – i.e. applying the adaptive monitoring concept (A$100 000).

(ii) Conduct data ‘mining’ activities relevant to CEMP. Currently a lot of data is held in communities not directly reporting to CCAMLR. The MPA workshops viewed some of these data sources, but they are not integrated into CEMP files (A$80 000).

(iii) Construction of remotely operating cameras for use at multiple sites within the CAMLR Convention Area. The AAD has developed and successfully trialled remotely operating cameras for predator monitoring over the past six years and proved their utility at several sites in east and west Antarctica. Others are also starting to use or assess cameras in the peninsula. The units have operated successfully for six years with minimal maintenance. Equipment costs A$2 000 + labour A$1 000 (A$3 000 × 40 = A$120 000).

11.18 The Scientific Committee considered other projects that could provide explanatory power to CEMP findings, such as a comparison of overwinter habitat and diet of Adélie penguins from Hope Bay and Laurie Island (A$20 000).

11.19 The Scientific Committee agreed that the procedure for managing the CEMP Special Fund be adopted. In so doing, it also agreed that:

(i) WG-EMM be asked to provide advice on the priorities (Annex 8, paragraph 2) and strategic plan for CEMP, which can be used as a foundation for proponents applying to use money from the special fund

(ii) a CEMP Special Fund Management Group be established by electing a Convener, Senior Vice-Chair and Junior Vice-Chair for two-year terms with the view that the procedure in Annex 8 begin after two years

(iii) the CEMP Special Fund Management Group consult, as appropriate, with the Scientific Committee to develop a brief pro forma for applications for use of the special fund and to have this distributed to Members.

BUDGET FOR 2012 AND FORECAST BUDGET FOR 2013

12.1 The Scientific Committee recalled that the provision of technical and logistic 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 (e.g. attendance of staff at meetings, production and translation of reports) (SC-CAMLR-XXX, paragraph 12.1).

12.2 The Scientific Committee agreed to focus its budget discussion on consideration of the requirement for additional funding to support the following activities:

- review of the CCAMLR Scheme of International Scientific Observation
- proposal to digitise former Soviet fishing data (paragraph 3.18).

12.3 The Scientific Committee also agreed to fund two scholarships of up to A$30 000 under the General Science Capacity Fund.

ADVICE TO SCIC AND SCAF

13.1 The Chair transmitted the Scientific Committee's advice to SCIC and SCAF during the meeting. The advice to SCAF is summarised in Item 12. The advice to SCIC was derived from the Scientific Committee's consideration of information provided by WG-EMM, WG-FSA and WG-IMAF.

SECRETARIAT SUPPORTED ACTIVITIES

14.1 The Scientific Committee noted that the work of the Secretariat undertaken in the intersessional period is described in CCAMLR-XXXI/06. In particular, the Scientific Committee welcomed the launch of the new CCAMLR website, noting that this also reflected the implementation of a revised contents management system in the Secretariat.

14.2 The Scientific Committee also welcomed the Secretariat's work on the following:

- delivery of reports and website material in the four official languages of the Commission

- ongoing development of data analysis and visualisation techniques

- review of database architecture and data quality assurance processes

- improved IT infrastructure, including virtualised servers.

SCIENTIFIC COMMITTEE ACTIVITIES

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

15.1 The Scientific Committee discussed the range of tasks to be considered by the working groups with reference to SC-CAMLR-XXX, Table 6, and discussed both the work included and the process by which this work should be prioritised and undertaken.

15.2 The Scientific Committee recognised the importance of spatial models and asked the Conveners of WG-SAM and WG-EMM to prepare terms of reference for a symposium to be held in 2014 to provide adequate time to ensure clarity in the aims and objectives of such a symposium to maximise engagement of CCAMLR scientists and outside experts.

15.3 The Scientific Committee agreed that there was a need to balance the priorities of individual Members with those of the Scientific Committee and invited Members to present papers in 2013 on a strategy to agree on, and address, a long-term work plan for the Scientific Committee.

15.4 The Scientific Committee Chair undertook to correspond with the working group conveners to develop a list of topics and priorities for their meetings in 2013 and to communicate the outcomes of these discussions via a Scientific Committee circular in early December.

15.5 The Scientific Committee warmly welcomed the offer from Germany to host the working group meetings in 2013 and the offer from Chile to host those meetings in 2014.

15.6 The Scientific Committee agreed to the following meetings in 2013:

- WG-SAM (Bremerhaven, Germany, 24 to 28 June) (Convener: Dr Hanchet)
- WG-EMM (Bremerhaven, Germany, 1 to 12 July) (Convener: Dr Kawaguchi)
- WG-FSA (CCAMLR Headquarters, Hobart, Australia, 7 to 18 October) (Convener: Dr Belchier).

15.7 In recognising that there is no interpretation at working group meetings and that this is an important consideration in ensuring broad engagement in the working groups, the Scientific Committee requested the Secretariat to seek input from Members and review the use of new technologies to facilitate and improve support processes that enhance engagement in the work of the Scientific Committee.

15.8 The Scientific Committee agreed that the subject of biology, ecology and conservation was central to its work and that a mechanism should be found to ensure that this is retained in the considerations of the working groups.

Invitation of Observers to the next meeting

15.9 The Scientific Committee agreed that all Observers invited to the 2012 meeting would be invited to participate in SC-CAMLR-XXXII.

Invitation of experts to the meetings of working groups

15.10 The Scientific Committee recalled its Rules of Procedure (Rules 19 and 21) in respect of the invitation of experts to its meetings and recalled that, when the Scientific Committee had identified the need for experts at meetings of working groups or workshops, the selection of experts to be invited to those meetings was delegated to the respective conveners in consultation with the Scientific Committee Chair.

15.11 The Scientific Committee agreed that it was essential to have clarity in both terminology and procedures in respect to the invitation of both experts and Observers to meetings and the management of them at those meetings. In recognition of the importance of this issue, the Scientific Committee Chair undertook to develop a discussion paper on how to resolve these issues.

ELECTION OF CHAIR AND VICE-CHAIR

16.1 Prof. Koubbi's term as Vice-Chair ended with this meeting and the Scientific Committee sought nominations for a new Vice-Chair. Dr Zhao nominated Dr Arata and this nomination was seconded by Dr Darby. Dr Arata was unanimously elected to the position for a term of two regular meetings (2013 and 2014). A very warm welcome was extended to the incoming Vice-Chair who thanked the Committee for this honour.

16.2 The Scientific Committee Chair thanked Prof. Koubbi for his support throughout the meeting, especially in dealing with the Scholarship Scheme and his excellent service for the last two years.

OTHER BUSINESS

17.1 The Scientific Committee recognised the tremendous long-term contribution of Dr Kock and Prof. Duhamel to its work. Both are world-renowned scientists who have provided inspiration and leadership in fish biology and ecology as well as mentoring a generation of Antarctic fish biologists.

17.2 The Scientific Committee also recognised the contributions of Drs G. Parkes and D. Agnew (UK) to its work, noting that these scientists were no longer part of the UK Delegation.

17.3 On behalf of the Scientific Committee, Dr Kawaguchi thanked Dr Watters as the outgoing Convener of WG-EMM and thanked him in particular for his help during the handover period co-convening the working group meeting in 2012. Dr Watters replied that he looked forward to contributing to the work of WG-EMM in the future.

17.4 The Scientific Committee noted that Argentina conducted the second consecutive cruise monitoring krill larvae in the South Orkney Islands and the Weddell–Scotia Confluence. As in the previous cruise, the abundance of krill larvae was relatively low. During the survey the vessel provided support in the fire incident at Ferraz Station.

17.5 The third and last cruise of the series will be conducted in 2013 along the Weddell–Scotia Confluence, reaching its northeast extreme, sampling zooplankton and adult krill.

17.6 The Chair noted that Chile and Uruguay also provided support to Brazil at the time of the fire. In 2013, Brazilian research programs in the field will be continued with support from Argentina, Chile and Uruguay. The Chair noted that this was an excellent example of collaboration in the Antarctic and hoped that this spirit of collaboration could be extended to the development of research proposals in exploratory fisheries.

ADOPTION OF THE REPORT

18.1 The report of the Thirty-first meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

19.1 At the close of the meeting, Dr Jones warmly thanked members of all delegations for their engagement and participation that was essential to the strength of the Scientific Committee. He thanked the rapporteurs for their excellent work in preparing the report and all of the Secretariat for their tremendous support.

19.2 Dr Jones noted that the concurrent sessions of the Commission and the Scientific Committee this year had impacted the work of the Committee as it had meant that many scientists, and key Secretariat staff, had been engaged in other discussions and had been unable to participate (and rapporteur) in the Scientific Committee. He assured the Scientific Committee that these issues would be brought to the attention of the Commission when it considers its plans for next year.

19.3 On behalf of the Scientific Committee, Dr Zhao thanked Dr Jones for his excellent chairmanship of the meeting, in particular for the wisdom and patience that had led the meeting to a successful conclusion.

REFERENCES

Parkes, G., C.A. Moreno, G. Pilling and Z. Young. 1996. Use of the Leslie stock depletion model for the assessment of local abundance of Patagonian toothfish (*Dissostichus eleginoides*). *CCAMLR Science*, 3: 55–77.

Welsford, D.C. 2011. Evaluating the impact of multi-year research catch limits on overfished toothfish populations. *CCAMLR Science*, 18: 47–55.

Table 1: Preliminary total catch (tonnes) of target species reported in 2011/12. (Source: catch and effort reports unless indicated otherwise.) Note: The season started on 1 December 2011 and closes on 30 November 2012, and catches are those reported to the Secretariat to 24 September 2012, unless indicated otherwise.

Species	Country	Subarea or division																		Total
		48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	
Icefish	Australia													4						4
Champsocephalus gunnari	Chile			<1*																0
	Korea			<1*																0
	UK			546																546
Total (icefish)		0	0	546	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	550
Toothfish	Australia													1 832						1 832
Dissostichus eleginoides	Chile			268																268
	EU – Spain			245																245
	France**								31				2 810		450					3 291
	Japan					1				5		28								35
	Korea																1			1
	New Zealand			346	32												2	<1		380
	Russia																1	<1		1
	South Africa					4		<1							29	31				64
	UK			985	23															1 008
Dissostichus mawsoni	EU – Spain																523			523
	France								4											4
	Japan					244				4										248
	Korea						157	40									874	25		1 096
	New Zealand				6												789	152		947
	Norway																172			172
	Russia																498	33	4	536
	South Africa					132		13												144
	UK				16												313	204		534
Total (toothfish)		0	0	1 844	77	381	157	53	34	9	0	28	2 810	1 832	479	31	3 175	414	4	11 329

(continued)

Table 1 (continued)

Species	Country	Subarea or division																		Total
		48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	
Krill	Chile	4 572	2 864	3 291																10 727
Euphausia superba	China	3 642	576																	4 218
	Japan	13 151		3 107																16 258
	Korea	21 894	219	1 009																23 122
	Norway	31 173	25 579	45 212																101 965
Total (krill)		74 432	29 238	52 619	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	156 289

* Taken as by-catch
** EEZ catch reported in fine-scale data to July 2012

Table 2: Catches (tonnes) of target species reported in 2010/11 (December 2010 to November 2011). (Source: STATLANT data.)

Species	Country	Subarea or division																		Total
		48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	
Icefish	Australia													<1*						<1*
Champsocephalus gunnari	China		<1*																	<1*
	Korea	<1*																		<1*
	Norway		<1*																	<1*
	UK			12																12
Total (icefish)		<1*	<1*	12	0	0	0	0	0	0	0	0	0	<1*	0	0	0	0	0	12
Toothfish	Australia													2 564						2 564
Dissostichus eleginoides	Chile			273																273
	EU – Spain						<1										<1			<1
	France												5 235		703					5 938
	Japan					<1			4	2		35								41
	Korea					11											1			12
	New Zealand			383	19												<1			402
	Russia																1			1
	South Africa					21									33	92				146
	UK			1 092	20															1 112
	Uruguay			14																14
Dissostichus mawsoni	Australia													<1						<1
	China		<1*																	<1*
	EU – Spain						75										427			502
	Japan					197				8										205
	Korea					156	139	136									681	76		1 189
	New Zealand			<1	5												889	244		1 138
	Russia																318	132	5	455
	South Africa					6														6
	UK				10												522	122		655
	Uruguay																	15		15
Total (toothfish)		0	<1*	1 763	54	392	214	136	4	11	0	35	5 235	2 564	735	92	2 839	590	5	14 669

(continued)

Table 2 (continued)

Species	Country	Subarea or Division																		Total
		48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	
Krill	Chile		13	2 423																2 436
Euphausia superba	China	2 088	13 932																	16 020
	EU – Poland	489	2 555																	3 044
	Japan	222	19 467	6 701																26 390
	Korea	4 999	17 469	8 175																30 642
	Norway	1 417	62 560	38 483																102 460
	UK			<1*																<1*
Total (krill)		9 215	115 995	55 782	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180 992

* Taken as by-catch

Table 3: Information provided in the notifications for krill fisheries in 2012/13.

Member	Vessel	Expected level of catch (tonnes)	Months during which fishing will proceed												Subareas and/or divisions where fishing will take place						Fishing technique
			2012	2013											Subarea				Division		
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	48.1	48.2	48.3	48.4	58.4.1	58.4.2	
Chile	*Betanzos*	20 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Ila	6 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
China	*Long Teng*[a]	15 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Kai Fu Hao	5 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Kai Xin	13 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Lian Xing Hai	15 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
Germany	*Jan Maria*	75 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			TCP
	Maartje Theadora	75 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			TCP
Japan	*Fukuei Maru*[b]	30 000		x	x	x	x	x	x	x	x				x	x	x				T
Korea	*Insung Ho*	18 000			x	x	x	x	x	x	x				x	x	x				T
	Kwang Ja Ho	12 000			x	x	x	x	x	x	x				x	x	x				T
	Maestro	43 700			x	x	x	x	x	x	x	x	x	x	x	x	x				T
Norway	*Antarctic Sea*	65 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			C
	Juvel	30 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Saga Sea	65 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			C
Poland	*Alina*[c]	75 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
	Sirius	75 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			T
Ukraine	*Graf Vorontsov*	20 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			TPB
	More Sodruzhestva	15 000				x	x	x	x	x						x	x	x			T
Total	19 vessels	672 700	14	15	18	19	19	19	19	19	18	15	15	15	18	19	19	15	0	0	

Fishing technique: T – traditional; C – continuous fishing system; P – pumping to clear codend; O – other approved methods; B – beam trawling.

[a] Vessel *An Xing Hai* was replaced as advised on 18 October 2012 (COMM CIRC 12/139).

[b] Vessel was reflagged to China and renamed *Fu Rong Hai* as advised on 18 October 2012 (COMM CIRC 12/135).

[c] Vessel *Alina* withdrawn on 20 August 2012. Expected level of catch was 75 000 tonnes. This vessel may be replaced.

Table 4: Summary of research plans notified by Members under CM 21-02 for 2012/13 reviewed by the Scientific Committee.

	SSRU										
	486A and G	486D and E	5841B	5841C	5841D	5841E	5841G	5841H	5842E	5843A	5843B
Research block design											
South Africa	Y	Y	-	-	-	-	-	-	Y#	Y#	-
Japan	Y	Y	-	Y	-	Y	Y	-	Y	Y	Y
Korea	-	-	-	Y	-	Y	Y	-	-	-	-
France	-	-	-	-	-	-	-	-	-	Y	-
Research blocks	3	2	-	2	-	2	1	-	1	1	1
Catch limit (tonnes)*	200	200	-	100	-	50	60	-	40	32	28
Catch limit as proportion of estimated local biomass inside research blocks	1.0–5.1%	0.4–0.7%	-	0.4%	-	0.3–0.4%	0.7%	-	0.3%	5.1%	?
% of research hauls	100	100	-	100	-	100	100	-	100	100	100
Tag rate (per tonne)	5	5	-	5	-	5	5	-	5	5	5
Depletion experiments											
Spain	-	-	Y	Y	Y	-	Y	Y	Y	-	-
Catch limit (tonnes)	-	-	50	50	50	-	50	50	50	-	-
Tag rate (per tonne)	-	-	5	5	5	-	5	5	5	-	-

* See Figure 1 and WG-FSA-12/60 Rev. 1, Table 9, for catch limit split between research blocks in each SSRU.
\# South Africa withdrew these notifications after WG-SAM.

Table 5: Research notified in closed and exploratory fisheries in 2011 and activated in 2011/12.

ASD	Proposed	Activated (Annex 7, Table 4)
48.4	- (CM 41-03)	New Zealand, UK
48.6	Japan, Korea, Norway, Russia, South Africa (CM 41-04)	Japan, South Africa
58.4.1	Japan, Korea, New Zealand, Russia, South Africa, Spain (CM 41-11)	Korea
58.4.2	Japan, Korea, New Zealand, South Africa, Spain (CM 41-05)	Korea, South Africa
58.4.3a, Elan Bank	France, Japan and South Africa (CM 41-06)	France
58.4.3b, BANZARE Bank	Japan (CM 41-07)	Japan (only 22 of the planned 48 research hauls were completed in 2012 due to operational difficulties and poor weather (Annex 7, paragraph 5.156))
58.4.4, Ob and Lena	Japan (CM 24-01)	Japan
88.1, Ross Sea	Japan, Korea, New Zealand, Norway, Russia, Spain, UK (CM 41-09)	Korea, New Zealand, Norway, Russia, Spain, UK
88.1 SSRUs J, L	New Zealand (CM 24-01)	New Zealand
88.2, Ross Sea	Korea, New Zealand, Norway, Russia, Spain, UK (CM 41-10)	Korea, New Zealand, Russia, UK
88.2 SSRU A	Russia (CM 24-01)	Russia
88.3	Russia (CM 24-01)	Russia

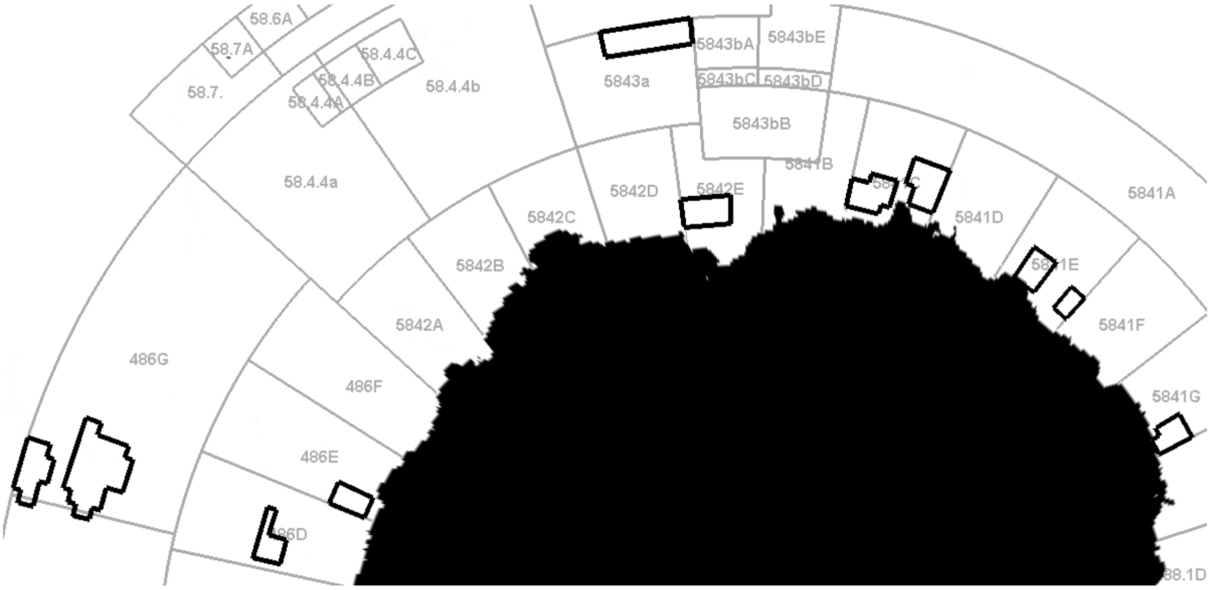

Figure 1: Research blocks for proposed research in data-poor fisheries in 2012/13. Proposals by Spain for a depletion experiment in SSRU 5841H and by Japan in Division 58.4.3b not shown.

Annex 1

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Annex 2

List of documents

LIST OF DOCUMENTS

SC-CAMLR-XXXI/01	Provisional Agenda for the Thirty-first Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXXI/02	Provisional Annotated Agenda for the Thirty-first Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXXI/03	Report of the Working Group on Ecosystem Monitoring and Management (Santa Cruz de Tenerife, Spain, 2 to 13 July 2012)
SC-CAMLR-XXXI/04	Report of the Working Group on Fish Stock Assessment (Hobart, Australia, 8 to 19 October 2012)
SC-CAMLR-XXXI/05	Report of the Working Group on Statistics, Assessments and Modelling (Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)
SC-CAMLR-XXXI/06	Report of the Sixth Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Bergen, Norway, 17 to 20 April 2012)
SC-CAMLR-XXXI/07	Designation of Marine Protected Areas in Antarctic waters Delegation of Russia
SC-CAMLR-XXXI/08	CCAMLR Ecosystems Monitoring Program Fund Draft Terms of Reference Chair of the Scientific Committee

****

SC-CAMLR-XXXI/BG/01	Catches in the Convention Area 2010/11 and 2011/12 Secretariat
SC-CAMLR-XXXI/BG/02	Committee for Environmental Protection: 2012 Annual report to the Scientific Committee of CCAMLR CEP Observer to SC-CAMLR
SC-CAMLR-XXXI/BG/03	Report on the FAO VME Database Workshop, and the meetings of FIRMS and CWP Secretariat

SC-CAMLR-XXXI/BG/04 Rev. 1	On Marine Protected Area network in the Akademik Vernadsky Station region Delegation of Ukraine
SC-CAMLR-XXXI/BG/05	RACER[1] – 'Rapid Assessment of Circum-Arctic Ecosystem Resilience': a tool from the Arctic to assess ecosystem resilience and areas of conservation importance, and its possible application to the Southern Ocean Delegation of the United Kingdom
SC-CAMLR-XXXI/BG/06	Marine debris and entanglements at Bird Island and King Edward Point, South Georgia, Signy Island, South Orkneys and Goudier Island, Antarctic Peninsula 2011–2012 Delegation of the United Kingdom
SC-CAMLR-XXXI/BG/07	The Scientific Committee on Antarctic Research (SCAR) Annual Report 2011/12 Submitted by SCAR
SC-CAMLR-XXXI/BG/08	The Southern Ocean Observing System (SOOS) Submitted by SCAR
SC-CAMLR-XXXI/BG/09	SCAR Products of potential interest to CCAMLR Members Submitted by SCAR
SC-CAMLR-XXXI/BG/10	Antarctic climate change and the environment: an update Submitted by SCAR
SC-CAMLR-XXXI/BG/11	Communicating the science of climate change Submitted by SCAR
SC-CAMLR-XXXI/BG/12	CCAMLR outreach and education Secretariat
SC-CAMLR-XXXI/BG/13	Summary of FAO's programme for deep-sea high seas fisheries Submitted by the FAO Secretariat
SC-CAMLR-XXXI/BG/14	Calendar of meetings of relevance to the Scientific Committee in 2012/13 Secretariat
SC-CAMLR-XXXI/BG/15	Estimation of total removals (green weight) Co-conveners of the Working Group on Ecosystem, Monitoring and Management

SC-CAMLR-XXXI/BG/16	Report of the CCAMLR Circumpolar Gap Analysis Marine Protected Areas (MPAs) Technical Workshop (Brussels, Belgium, 10 to 14 September 2012) Delegation of Belgium
SC-CAMLR-XXXI/BG/17	Report to the Scientific Committee of CCAMLR by the Association of Responsible Krill Fishing Companies (ARK) Submitted by ARK
SC-CAMLR-XXXI/BG/18	Observer's Report from the 64th Annual Meeting of the Scientific Committee of the International Whaling Commission (IWC) (Panama City, Panama, 11 to 23 June 2012) CCAMLR Observer (K.-H. Kock, Germany)

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CCAMLR-XXXI/01	Provisional Agenda for the Thirty-first Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXXI/02	Provisional Annotated Agenda for the Thirty-first Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXXI/03	Examination of the audited financial statements for 2011 Executive Secretary
CCAMLR-XXXI/04	Review of the 2012 budget, draft 2013 budget and forecast budget for 2014 Executive Secretary
CCAMLR-XXXI/05	Singapore's status as a non-Contracting Party (NCP) cooperating with CCAMLR by participating in the Catch Documentation Scheme (CDS) Secretariat
CCAMLR-XXXI/06	Executive Secretary's report to SCAF, 2012 Executive Secretary
CCAMLR-XXXI/07	CCAMLR staffing and salary strategy Implementation report: 2012 Secretariat
CCAMLR-XXXI/08	Staff regulations Secretariat

CCAMLR-XXXI/09	Executive Secretary’s summary report Committee on Fisheries Thirtieth Session (Rome, Italy, 9 to 13 July 2012) Executive Secretary
CCAMLR-XXXI/10	EU proposal Fishing capacity and effort in CCAMLR exploratory fisheries Delegation of the European Union
CCAMLR-XXXI/11	Notifications for krill fisheries in 2012/13 Secretariat
CCAMLR-XXXI/12 Rev. 1	Notifications for new and exploratory fisheries in 2012/13 Secretariat
CCAMLR-XXXI/13 Rev. 1	Review of CCAMLR’s Vessel Monitoring System (VMS) Secretariat
CCAMLR-XXXI/14 Rev. 1	Preliminary assessment of known and anticipated impacts of proposed bottom fishing activities on VMEs in 2012/13 Secretariat
CCAMLR-XXXI/15	Consolidation of closely related conservation measures Secretariat
CCAMLR-XXXI/16 Rev. 1	A proposal for the establishment of a Ross Sea region Marine Protected Area Delegations of New Zealand and the USA
CCAMLR-XXXI/17 Rev. 4	Implementation of Conservation Measures 10-06 and 10-07 IUU Fishing Activity and CCAMLR IUU Vessel Lists 2011/12 Secretariat
CCAMLR-XXXI/18	Notification of France’s intention to conduct an exploratory longline fishery for *Dissostichus* spp. in 2012/13 Delegation of France
CCAMLR-XXXI/19	Notifications of Japan’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of Japan
CCAMLR-XXXI/20 Rev. 1	Notifications of the Republic of Korea’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of the Republic of Korea

CCAMLR-XXXI/21 Rev. 1	Notifications of New Zealand's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of New Zealand
CCAMLR-XXXI/22	Notifications of Norway's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of Norway
CCAMLR-XXXI/23 Rev. 1	Notifications of Russia's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of Russia
CCAMLR-XXXI/24	Notifications of South Africa's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of South Africa
CCAMLR-XXXI/25	Notifications of Spain's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of Spain
CCAMLR-XXXI/26 Rev. 1	Notifications of Ukraine's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of Ukraine
CCAMLR-XXXI/27	Notifications of the United Kingdom's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2012/13 Delegation of the United Kingdom
CCAMLR-XXXI/28	Report of the SCAF Correspondence Group Review of the CCAMLR Financial Regulations Convener, SCAF-CG
CCAMLR-XXXI/29	Proposal for a CCAMLR Compliance Evaluation Procedure Delegation of Australia
CCAMLR-XXXI/30	EU proposal for spatial protection of marine habitats and communities following ice shelf retreat or collapse in Subarea 88.3, Subarea 48.1 and Subarea 48.5 Delegation of the European Union
CCAMLR-XXXI/31	EU proposal for a conservation measure concerning the adoption of market-related measures to promote compliance Delegation of the European Union
CCAMLR-XXXI/32	EU proposal for amendment to the CCAMLR Conservation Measure 51-06 on scientific observation in krill fisheries Delegation of the European Union

CCAMLR-XXXI/33	EU proposal for amendment to the CCAMLR Conservation Measure 21-03 to introduce the assessment of uncertainty and variability in the estimation of green weight in notifications of intent to participate in krill fisheries Delegation of the European Union
CCAMLR-XXXI/34	EU proposal for amendment to the CCAMLR Conservation Measure 23-06 to introduce the assessment of uncertainty and variability in the estimation of catches of green weight in krill fisheries Delegation of the European Union
CCAMLR-XXXI/35	Information on illegal fishing in Statistical Area 58 Assessment of illegal fishing in French waters around Kerguelen and Crozet Islands Report of observations and inspections in the CCAMLR Area 2011/2012 season (1 July 2011 – 15 July 2012) Delegation of France
CCAMLR-XXXI/36	Proposal for a conservation measure establishing a representative system of marine protected areas in the East Antarctica planning domain Delegations of Australia, France and the European Union
CCAMLR-XXXI/37	African IUU capacity-building workshop and expenditure from the CDS fund – Report to CCAMLR-XXXI Delegations of Australia, South Africa, the United Kingdom and the Secretariat
CCAMLR-XXXI/38	A proposal to enhance and clarify CCAMLR’s Catch Documentation Scheme Delegation of the USA
CCAMLR-XXXI/39	A proposal to strengthen CCAMLR’s Port Inspection Scheme to prevent, deter and eliminate illegal, unreported and unregulated fishing Delegations of the USA and the European Union
CCAMLR-XXXI/40	A proposal for the Ross Sea region Marine Protected Area Delegation of the USA
CCAMLR-XXXI/41	Arrangement between the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean and the Commission for the Conservation of Antarctic Marine Living Resources Secretariat

CCAMLR-XXXI/42	Communication from CCSBT regarding a proposed cooperative arrangement between CCSBT and CCAMLR Secretariat

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CCAMLR-XXXI/BG/01	List of documents
CCAMLR-XXXI/BG/02	List of participants
CCAMLR-XXXI/BG/03	Executive Secretary's summary report Thirty-fifth Antarctic Treaty Consultative Meeting (Hobart, Australia, 11 to 20 June 2012) Executive Secretary
CCAMLR-XXXI/BG/04	Description of the General Fund budget Secretariat
CCAMLR-XXXI/BG/05	Report from the CCAMLR Observer (Republic of Korea) to the 8th annual meeting of the SEAFO Commission (10 to 14 October 2011, Windhoek, Namibia) CCAMLR Observer (Republic of Korea)
CCAMLR-XXXI/BG/06	Implementation of fishery conservation measures in 2011/12 Secretariat
CCAMLR-XXXI/BG/07	Submission in support of Singapore's request for the reinstatement of its status as a non-Contracting Party (NCP) cooperating with CCAMLR by participating in the Catch Documentation Scheme (CDS) Submitted by Singapore
CCAMLR-XXXI/BG/08	Report from the CCAMLR Observer to the Sixteenth Session of the Indian Ocean Tuna Commission (22 to 26 April 2012, Fremantle, Australia) CCAMLR Observer (Australia)
CCAMLR-XXXI/BG/09	Antarctic Ocean Legacy: a vision for circumpolar protection Submitted by ASOC
CCAMLR-XXXI/BG/10	Antarctic Ocean Legacy: protection for the East Antarctic coastal region Submitted by ASOC
CCAMLR-XXXI/BG/11	Antarctic Ocean Legacy: a marine reserve for the Ross Sea Submitted by ASOC

CCAMLR-XXXI/BG/12 Rev. 1	Monitoring, control and surveillance of Protected Areas and Specially Managed Areas in the Marine Domain Submitted by ASOC
CCAMLR-XXXI/BG/13	Establishing proper fishing vessel governance and control in the CCAMLR Area Submitted by ASOC
CCAMLR-XXXI/BG/14	CCAMLR's role in addressing climate change Submitted by ASOC
CCAMLR-XXXI/BG/15	Protecting the values of Antarctic Specially Managed and Protected Areas Submitted by ASOC
CCAMLR-XXXI/BG/16	Old challenges, new leadership: CCAMLR and the fight against IUU fishing in the Southern Ocean and beyond Submitted by ASOC
CCAMLR-XXXI/BG/17	Penguins and krill: life in a changing ocean Submitted by ASOC
CCAMLR-XXXI/BG/18	A summary of the guidelines for applying the IUCN protected area management categories to Marine Protected Areas (supplementary to the 2008 Guidelines) Submitted by IUCN
CCAMLR-XXXI/BG/19	Calendar of meetings of relevance to the Commission in 2012/13 Secretariat
CCAMLR-XXXI/BG/20	Heard Island and McDonald Islands Exclusive Economic Zone 2011/12 IUU catch estimate for Patagonian toothfish Delegation of Australia
CCAMLR-XXXI/BG/21 Rev. 2	Implementation of the System of Inspection and other compliance related measures in 2011/12 Secretariat
CCAMLR-XXXI/BG/22 Rev. 1	Implementation and operation of the Catch Documentation Scheme for *Dissostichus* spp. in 2011/12 Secretariat
CCAMLR-XXXI/BG/23	Report of the Depositary Government for the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) Delegation of Australia

CCAMLR-XXXI/BG/24	Observer’s report from the Eighty-first Meeting of the Official Forum Fisheries Committee CCAMLR Observer (New Zealand)
CCAMLR-XXXI/BG/25	Observer’s report from the Fourth Session of the Meeting of the Parties to the Agreement for the Conservation of Albatrosses and Petrels CCAMLR Observer (New Zealand)
CCAMLR-XXXI/BG/26	Observer’s Report from the Eighth Session of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean CCAMLR Observer (New Zealand)
CCAMLR-XXXI/BG/27	Report from the CCAMLR Observer to the Meeting of the Extended Commission for the 19th Annual Session of the Commission for the Conservation of Southern Bluefin Tuna (1 to 4 October 2012, Takamatsu City, Japan) CCAMLR Observer (Australia)
CCAMLR-XXXI/BG/28 Rev. 1	Implementation of Conservation Measure 31-02 Delegation of New Zealand
CCAMLR-XXXI/BG/29	Report from the CCAMLR Observer (Chile) to the Third Session of the Preparatory Conference for the Commission of the South Pacific Regional Fisheries Management Organisation CCAMLR Observer (Chile)
CCAMLR-XXXI/BG/30	Implementation of Conservation Measure 31-02 Delegation of the United Kingdom
CCAMLR-XXXI/BG/31	Report of the CCAMLR Observer to the 34th NAFO Annual Meeting (17 to 21 September 2012, St Petersburg, Russia) CCAMLR Observer (Russia)
CCAMLR-XXXI/BG/32	Vessel Monitoring System (VMS) and its registry in the Catch Document (DCD) Delegation of Chile
CCAMLR-XXXI/BG/33	Report of the European Union – CCAMLR Observer to the 22nd Regular Meeting of ICCAT (Istanbul, Turkey, 11 to 19 November 2011) CCAMLR Observer (European Union)

CCAMLR-XXXI/BG/34	Report of the European Union – CCAMLR Observer to the 30th Session of COFI (Italy, Rome, 9 to 13 July 2012) CCAMLR Observer (European Union)
CCAMLR-XXXI/BG/35	Commercial fishing in the Ross Sea Submitted by COLTO

Annex 3

Agenda for the Thirty-first Meeting of the Scientific Committee

AGENDA FOR THE THIRTY-FIRST MEETING OF THE SCIENTIFIC COMMITTEE

1. Opening of meeting

    1.1 Adoption of agenda
    1.2 Chair's Report

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

    2.1 Statistics, assessments and modelling
    2.2 Acoustic survey and analysis methods
    2.3 Advice to 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 Commission

    3.2 Fish resources
        3.2.1 Status and trends
        3.2.2 Advice from WG-FSA
        3.2.3 Advice to Commission

    3.3 Fish and invertebrate by-catch
        3.3.1 Status and trends
        3.3.2 WG-FSA advice

    3.4 New and exploratory finfish fisheries
        3.4.1 Exploratory fisheries in 2011/12 season
        3.4.2 Notifications for new and exploratory fisheries in 2012/13 season
        3.4.3 Advice to 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 Commission

5. Spatial management of impacts on the Antarctic ecosystem

    5.1 Bottom fishing and vulnerable marine ecosystems
        5.1.1 Advice to Commission

    5.2 Marine Protected Areas
        5.2.1 Advice to Commission

6. IUU fishing in the Convention Area

7. CCAMLR Scheme of International Scientific Observation

   7.1 Scientific observations
   7.2 Advice to Commission

8. Climate change

9. Scientific research exemption

10. Cooperation with other organisations

    10.1 Cooperation with 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. Future Directions

    11.1 CCAMLR Scientific Scholarships Scheme

12. Budget for 2013 and forecast budget for 2014

13. Advice to SCIC and SCAF

14. Secretariat supported activities

15. Scientific Committee activities

    15.1 Priorities for work of Scientific Committee and its working groups
    15.2 Intersessional activities
    15.3 Invitation of experts to meetings of working groups
    15.4 Next meeting

16. Election of Vice-Chair

17. Other business

18. Adoption of report of Thirty-first Meeting

19. Close of meeting.

Annex 4

Report of the Sixth Meeting of the Subgroup on Acoustic Survey and Analysis Methods
(Bergen, Norway, 17 to 20 April 2012)

CONTENTS

REPORT OF THE SIXTH MEETING OF THE SUBGROUP ON ACOUSTIC SURVEY AND ANALYSIS METHODS

(Bergen, Norway, 17 to 20 April 2012)

INTRODUCTION

1.1 The sixth meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held at the Institute of Marine Research (IMR), Bergen, Norway, 17 to 20 April 2012. The Co-conveners, Drs R. Korneliussen (Norway) and J. Watkins (UK), welcomed the participants (Appendix A) and outlined local arrangements for the meeting and the work ahead.

1.2 The terms of reference for the meeting focused on the use of fishing-vessel-based acoustic data to provide qualitative and quantifiable information on the distribution and relative abundance of Antarctic krill (*Euphausia superba*) and other pelagic species such as myctophiids and salps (SC-CAMLR-XXX, paragraphs 2.9 and 2.10). Specifically, SG-ASAM was requested to provide advice on survey design, acoustic data collection, and acoustic data processing.

1.3 The meeting's provisional agenda was discussed and adopted without change (Appendix B).

1.4 Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Subgroup thanked all the authors of papers for their valuable contributions to the work presented to the meeting.

1.5 This report was prepared by meeting participants. Sections of the report dealing with advice to the Scientific Committee are highlighted (see also 'Advice to the Scientific Committee').

THE SCIENTIFIC USE OF ACOUSTIC DATA COLLECTED ON FISHING VESSELS

Possible research objectives for fishing vessel acoustic data

2.1 The Subgroup discussed the type of research studies that could be undertaken using acoustic data collected from fishing vessels and how this could contribute to the management of the krill fishery.

2.2 The Subgroup recognised that the use of acoustic data from fishing vessels to produce an absolute krill abundance estimate that could be used as part of a stock assessment process was tractable and desirable. There was also the potential to produce indices of comparative abundance of krill that could provide a temporal context to large biomass estimation surveys or interannual scientific studies. Furthermore, there was considerable additional information that could be provided by acoustic data that could contribute to an improved understanding of the operation of the fishery.

2.3 The integration of acoustic data from fishing vessels with existing scientific surveys conducted in Subareas 48.1, 48.2 and 48.3 was essential in order to maximise the benefit to CCAMLR of those data collected on fishing vessels operating in Area 48.

2.4 The Subgroup agreed that the collection of acoustic data by fishing vessels could provide a mechanism for those that are active in the fishery but do not have the capacity to undertake scientific research surveys in the fishing areas to contribute to CCAMLR's management processes.

2.5 In order to clearly define research questions that encompass a range of operational scenarios and are achievable through the collection of acoustic data from fishing vessels, the Subgroup focused on the two following research objectives:

1. abundance of krill at a defined temporal and spatial scale, e.g. management area (or subarea) or fishing zone (referred herein as 'biomass estimation')

2. spatial organisation of krill, e.g. distribution (horizontal and vertical), swarm density or structure.

2.6 The Subgroup recognised that the survey design, equipment specifications, acoustic data quality (e.g. calibration, noise, interference) and ancillary data collection appropriate to achieve research objective 1 were likely to differ from those required to address research objective 2. The requirements for each of these objectives are given in Tables 1 and 2.

2.7 In recognising the large amount of work that has already been invested in methods for using acoustic data from fishing vessels, particularly in ICES, the Subgroup adopted the terminology introduced in the ICES report on the collection of acoustic data from fishing vessels (ICES, 2007) in respect of data collection strategies. These terms are:

- undirected monitoring – acoustic observations collected during normal fishing operations

- directed surveys – acoustic data collected following an agreed survey design

- supervised data collection – performed by a scientist on board the vessel

- unsupervised data collection – performed by the vessel's crew.

2.8 The Subgroup agreed that research objective 1 would only be achievable when undertaking directed surveys, whilst research objective 2 could be achieved using undirected monitoring as well as directed surveys. The Subgroup identified that within each of these two major research objectives there would be operational differences in the design, equipment and metadata requirements.

2.9 The Subgroup discussed how acoustic data from fishing vessels can be incorporated into an overarching ocean observing system. These data could be used to inform long-term trends (decadal) in ecosystems over basin scales and provide metrics for the development of ecological indicators. As an example the Australian integrated marine observing system (IMOS) has incorporated acoustic data from fishing vessels (www.imos.org.au/bioacoustics). This application of acoustic data was not specifically addressed at the meeting.

2.10 Whilst discussion of the collection of acoustic data during the meeting was restricted to the use of downward-looking echosounders, the Subgroup recognised that fishing vessels can also carry sonars that are capable of providing information on the three-dimensional structure of krill swarms that are not obtainable from downward-looking echosounders.

2.11 Dr M. Cox (Australia) presented a statistical technique that, with further development, may enable krill density to be estimated using data collected from fishing vessels equipped with scanning or multi-beam sonars (SG-ASAM-12/05). The Subgroup encouraged further development of the technique to address krill density estimation from directed and undirected surveys, and the analysis of avoidance using horizontal scanning sonars.

Survey design

2.12 The Subgroup noted that there were developments in stock assessment methods since the CCAMLR synoptic survey (CCAMLR-2000 Survey) that indicated that methods other than Jolly and Hampton (1990) can be used to address issues associated with the spatial distribution of krill when producing biomass estimates (e.g. Løland et al., 2007; Harbitz et al., 2009). The Subgroup encouraged continuing investigation into different survey designs for scientific and/or fishery vessels that can provide estimates of krill biomass and associated uncertainty that could be used for stock assessment.

2.13 The Subgroup agreed that an appropriate survey design would depend on the research objective (biomass estimation (1) versus spatial organisation of krill (2) above) and the equipment and sampling effort that could be allocated by the fishing vessel.

2.14 The Subgroup agreed that collecting acoustic data from fishing vessels along transects defined as part of previous/ongoing krill surveys has the potential to add significant value to the interpretation of fisheries acoustic data including to:

- (i) take advantage of existing survey design and planning
- (ii) compare the results of krill surveys at other times of year
- (iii) provide replicate data to allow comparison of vessel noise and acoustic properties between vessels.

2.15 SG-ASAM-12/04 described how US AMLR datasets for acoustic and net data were used to simulate data that might be collected by fishing vessels to develop indices of krill biomass from a generalised linear modelling framework. Models designed for the different areas (West Shelf and Elephant Island) using single frequencies (38 or 120 kHz) produced estimates of krill biomass that were similar to those produced by the CCAMLR protocol.

2.16 The Subgroup identified four levels of survey effort that could deliver information to address one or both research objectives:

- Level 1 (directed survey) – Acoustic survey along multiple transects in a defined area with a survey effort commensurate with current scientific biomass surveys. An example of such a survey would be the five-day Norwegian collaboration (WG-EMM-11/23) occupying a former scientific survey grid around the South Orkney Islands.

- Level 2 (directed survey) – Acoustic survey along a single existing scientific transect, where vessels were unable to dedicate Level 1 effort to a survey.

- Level 3 (directed survey) – Acoustic survey of fishable aggregations, opportunistically undertaken during normal fishing operations. For example, a star- or spiral-shaped search pattern or a line transect through an acoustic target to provide information on research objective 2 (spatial organisation of krill).

- Level 4 (undirected monitoring) – Collection of acoustic data during normal fishing operations. For example, transiting to, searching for and fishing for krill in fishing grounds.

2.17 The Subgroup recognised the value of fishing vessels re-occupying transects from national research programs and noted that the fishing areas overlapped significantly with the location of these transects (Figure 1). The Subgroup recommended that the national programs lodged the waypoints from research transects with the Secretariat so that they could be distributed to the fishing vessels to encourage use of these transects.

2.18 The Subgroup agreed that in order to provide a krill biomass estimate for inclusion in a stock assessment for an area, a directed survey would need to be undertaken. This could be achieved by a single vessel undertaking multiple transects (level 1) or from multiple vessels undertaking single transects (level 2) to achieve the same level of transect coverage. Where multiple vessels were involved, an appropriate measure of uncertainty would have to include any differences in instrument performance, krill detection thresholds between vessels and other factors that are required to ensure estimates of krill biomass were comparable between vessels (ICES, 2007).

2.19 The Subgroup agreed that for biomass estimates for a given area, the expectation would be that the survey was operated with the same intensity of sampling effort commensurate with existing scientific surveys.

Acoustic data collection

Instrumentation

2.20 The Subgroup discussed the different manufacturers and frequencies of acoustic instruments currently mounted on krill fishing vessels (SG-ASAM-12/06 Rev. 1) and agreed on a set of recommendations of instrumentation requirements related to the different research objectives (Tables 1 and 2).

2.21 The Subgroup noted that the 38 kHz ES60 echosounder was used in 7 out of the 13 fishing vessels (SG-ASAM-12/06 Rev. 1) and therefore there was the potential for inter-vessel comparisons.

2.22 Based on the current methods of acoustic target identification and biomass assessment within the CCAMLR protocol, the Subgroup encouraged fitting multiple frequencies to the fishing vessels should opportunity arise. The Subgroup recommended including combinations based on 38, 70, 120 and 200 kHz.

2.23 The Subgroup agreed that calibration was a fundamental component of acoustic data collection, and that currently a standard sphere calibration (Foote et al., 1987) should be used whenever the acoustic equipment was to be used for quantitative krill biomass estimates.

2.24 The Subgroup recognised that the opportunity to undertake standard sphere calibration can be limited by, for example, location, weather conditions and availability of technical expertise. Alternative calibration methods, such as the comparison of seabed backscatter from a standard sphere-calibrated instrument and that from an uncalibrated instrument, could be appropriate for use in quantitative krill biomass estimates if the uncertainty associated with the procedures is quantified. The Subgroup strongly recommended that further research into these alternative calibration methods be carried out.

2.25 The Subgroup recognised that an ongoing assessment of system performance relative to factory settings and equipment performance expectations was a minimum requirement for usable acoustic data collection. It was recognised that comparison with non-acoustic data, such as catch data, could provide an independent validation of system performance.

Ancillary data requirements

2.26 The Subgroup discussed two levels of ancillary data requirements: fundamental and important. Fundamental ancillary data requirements are listed in Table 3. Meteorological data, such as sea state, and oceanographic data, such as temperature and salinity, were considered important but not essential.

Vessel requirements

2.27 The Subgroup recognised that vessel design and noise characteristics could have a significant effect on the quality of acoustic data collected. The Subgroup identified that examples of acoustic data from the current fishing fleet would provide a good indication of what quality of acoustic data could currently be expected.

2.28 The Subgroup recognised that interference from other acoustic instrumentation on the fishing vessels could also strongly influence data quality and recognised that attempts to minimise acoustic interference (through either turning instruments off or using synchronisation instrumentation) should be undertaken if the acoustic data are collected for a quantifiable krill biomass estimate.

Data collection protocols for krill biomass estimates

2.29 The Subgroup agreed a set of minimum requirements for the collection of acoustic data for quantifiable krill biomass estimation data:

- Survey design – directed surveys (that can be supervised or unsupervised) are required to produce quantifiable krill biomass estimates. Further research on the use of undirected monitoring surveys to estimate krill biomass and associated estimates of uncertainty is required.

- Calibration – a standard sphere calibration is required (see also paragraphs 2.23 and 2.24).

- Vessel instrument settings and metadata requirements for biomass estimation – see Table 3.

Target identification and TS estimation

2.30 The Subgroup agreed that the CCAMLR standard procedures for target identification and target strength (TS) estimation were applicable for multi-frequency surveys carried out by fishing vessels (SC-CAMLR-XXVIII, Annex 8, Appendix E). For single-frequency surveys, additional net verification of acoustic targets will be required.

2.31 The current TS model used to produce krill biomass estimates by CCAMLR is the SDWBA parameterised according to the SG-ASAM 2010 meeting. A krill length-frequency distribution representative of the krill in the surveyed area is needed to appropriately parameterise this TS model (see paragraph 2.35).

Biological sampling

2.32 The Subgroup agreed that the net used for biological sampling should be described in a manner similar to the gear specifications required in the notification to fish for krill in CCAMLR areas (CM 21-03, Annex B).

2.33 Krill length measurements should be collected according to the method described in the *Scientific Observers Manual*.

Requirements for collection of data on pelagic species other than krill

2.34 The Subgroup did not have sufficient time to consider this agenda item in detail, but it agreed that the acoustic data collection protocols recommended for krill are relevant for other pelagic species. However, target identification methods and density estimation will be dependent on the target species and require further discussion.

Collection of biological and other non-acoustic data required for acoustic interpretation and target identification

2.35 The Subgroup considered whether there was a need to collect additional samples of krill to characterise the length-frequency distribution of krill in the survey area at the time of the survey or whether the data collected according to the requirements of CM 51-06 were sufficient. The Subgroup noted that WG-EMM will consider the spatio–temporal variability in the krill size-frequency data collected by observers and requested that this analysis include an examination of an unbiased estimator of the length-frequency distribution of krill populations.

Proof of concept

2.36 In considering the terms of reference agreed by the Scientific Committee (SC-CAMLR-XXX, paragraphs 2.9 and 2.10), and in particular the request to provide a detailed list of instructions or protocols, it was not possible to provide a prescriptive set of requirements suitable for a range of vessels that might have quite different acoustic equipment and vessel noise characteristics.

2.37 Based on the description of the approach taken by the IMOS program (paragraph 2.39) to use unsupervised acoustic data collection from a range of vessels (including resupply, longline and trawl fishing vessels) the Subgroup discussed establishing a proof of concept program to work through the issues that will need to be resolved when implementing surveys from fishing vessels using different acoustic equipment. Issues that need to be addressed included whether the echo sounders on the vessels could be logged and what type of data quality was available from these instruments. Based on the data quality of the instruments it would be possible to evaluate if further data collection, surveys and post-processing should be done.

2.38 The objectives of this proof of concept would be to:

- request vessels collect digital data geo-referenced and time-referenced with associated instrument metadata suitable for evaluation of data quality
- if possible, collect acoustic data along existing transects shown in Figure 1
- take photographs of the echosounder echogram when observing a krill aggregation/target
- if possible, provide a summary geo-referenced S_v data file
- request Members to supply the Secretariat with example data from the vessels prior to the next meeting of SG-ASAM to further develop protocols.

2.39 Based on the submission of the trial datasets, future SG-ASAM meetings could develop data-screening routines that could be implemented in a consistent manner. Development of these routines could be based on filtering routines and expert data quality evaluations used in IMOS to evaluate acoustic data streams from multiple vessels.

2.40 The Simrad echosounding equipment is commonly used for both scientific research surveys and by commercial fishers, hence protocols have been developed to collect and process its digital data (ICES, 2007).

2.41 Where other echosounder devices are used in the collection of the trial datasets, the Subgroup recognised that there may be a greater overhead (e.g. in time spent developing appropriate protocols) to process the data.

RECOMMENDATIONS TO THE SCIENTIFIC COMMITTEE

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

- Research objectives (paragraph 2.8)
- Levels of survey effort (paragraphs 2.17 to 2.19)
- Proof of concept (paragraphs 2.37 to 2.39).

ADOPTION OF REPORT

4.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

5.1 In closing the meeting, the Co-conveners thanked the participants for their expert contributions to the development of protocols for the collection and use of acoustic data collected on board fishing vessels. They also thanked Dr R. Kloser (Australia) for his participation in the meeting as an invited expert. This collective effort, together with the generous hospitality of IMR and the excellent facilities, had fostered detailed discussions and a successful meeting.

5.2 Dr X. Zhao (China), on behalf of the Subgroup, thanked Drs Korneliussen and Watkins for co-convening the meeting and guiding the Subgroup's work.

REFERENCES

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

Harbitz, A., E. Ona and M. Pennington. 2009. The use of an adaptive acoustic-survey design to estimate the abundance of highly skewed fish populations. *ICES J. Mar. Sci*., 66: 1349–1354.

ICES. 2007. Collection of acoustic data from fishing vessels. *ICES Cooperative Research Report*, 287: 83 pp.

Jolly, G.M. and I. Hampton. 1990. A stratified random transect design for acoustic surveys of fish stocks. *Can. J. Fish Aquat. Sci.*, 47: 1282–1291.

Korneliussen, R.J., N. Diner, E. Ona, L. Berger and P.G. Fernandes. 2008. Proposals for the collection of multifrequency acoustic data. *ICES J. Mar. Sci*., 65: 982–994.

Løland, A. M. Aldrin, E. Ona, V. Hjellvik and J.C. Holst. 2007. Estimating and decomposing total uncertainty for survey-based abundance estimates of Norwegian spring-spawning herring. *ICES J. Mar. Sci*., 64: 1302–1312.

Table 1: Research objective for biomass estimation (this also includes estimates of quantitative variables such as S_v or NASC).

Objective	Calibration	Echosounder frequencies	Digital logging required	Estimate of measurement uncertainty	Comments
Quantitative biomass estimate: absolute estimate of S_v or NASC	Standard sphere[1]	≥2	Yes	Best	CCAMLR acoustic protocol uses frequencies 38, 120 and 200 kHz for target identification. 70 kHz also recommended by SG-ASAM. CCAMLR acoustic protocol recommends biomass estimation using 120 kHz. Results will be comparable between vessels and surveys. Krill length-frequency distribution required.
Quantitative biomass estimate: absolute estimate of S_v or NASC	Standard sphere[1]	1	Yes	Good (provided identification addressed)	Target identification will need to depend totally on non-acoustic methods, e.g. net-based identification. Results will be comparable between vessels and surveys depending on frequency used. Krill length-frequency distribution required.
Comparative biomass estimate	Other, e.g. bottom reference or inter-ship	≥1	Yes	Poorest	Results may be comparable with other vessels if a suitable measure of uncertainty is estimated (see paragraph 2.24). Target identification may also be compromised even with multi-frequency systems if no absolute calibration. Krill length-frequency distribution required.

[1] Standard sphere technique, Foote et al. (1987)

Table 2: Research objective for spatial organisation of krill.

Objective	Calibration method	Echosounder frequencies	Digital logging required	Estimate of measurement uncertainty	Comments
Aggregation internal density, morphological and distribution parameters	Standard sphere[1]	≥2	Yes	Best	Quantitative and qualitative aggregation parameter estimation achievable. Krill length-frequency distribution required.
Aggregation internal density, morphological and distribution parameters	Standard sphere[1]	1	Yes	Good (provided identification addressed)	Quantitative and qualitative aggregation parameter estimation achievable and requires a higher level of non-acoustic sampling than above.
Aggregation and distribution parameters	Reference to external measurement: e.g. bottom comparison, or inter-ship calibration	≥1	Yes	Poorer	Estimates will be less certain than above. A sonar is also a suitable instrument.
Aggregation and distribution parameters	Reference to factory setting only	≥1	No	Poorest	Estimates will be less certain than above. A sonar is also a suitable instrument.

[1] Standard sphere technique, Foote et al. (1987)

Table 3: Fundamental ancillary data requirements.

Type	Item	Setting	Comments
Voyage details	Start and end location; vessel name	na	
Instruments	Echosounder/sonar equipment		Manufacturer, model, serial number
	Per-instrument frequency		Single- or split-beam or sonar
Transducer specifications	Transducer depth		
	Transducer arrangement diagram		Location of transducers on hull/drop keel
	Software versions		Echosounder control software version
	Beam angle		Ideally 7° for echosounders Preferably identical for all frequencies
Settings	Power settings	25 kW m^{-2} active transducer area or less	See Korneliussen et al., 2008. Trying to avoid cavitation and non-linear loss of energy. Valid for approximately 60% transducer efficiency.
	Preferable to have identical pulse duration for all frequencies	1 ms	
	Depth settings	500 m	Maximum depth to which data is recorded and displayed, reference required
	Any noise removal settings		Periodic recording of deep data for noise characterisation (CCAMLR recommends no noise removal at data collection)
	Logging interval (ping rate)	1 to 2 s	SG-ASAM report 2010 (SC-CAMLR-XXIX, Annex 5)
	Synchronisation		Appropriate synchronisation of instrumentation is recommended to reduce acoustic interference
	Calibration details and calibration settings		E.g. gain and any correction applied to echosounder or sonar
	Absorption coefficient and speed of sound settings		Ocean water properties to estimate the absorption coefficient and sound speed may be obtained from CSIRO Atlas of Region Seas (CARS), see www.marine.csiro.au/~dunn/cars2009/
	Data format		Electronic acoustic data should be provided together with documentation of formats. The submitted data (including appropriate metadata) and data documentation must be sufficient to allow the generation of geo-referenced, depth-dependent calibrated S_v data
	GPS position		Ideally for each acoustic instrument ping and linked to instrument settings
	Instrument settings		Initial instrument settings and record of any changes to instrument settings and time when changed
	Time synchronisation		The time on all instruments should be synchronised and referenced to UTC

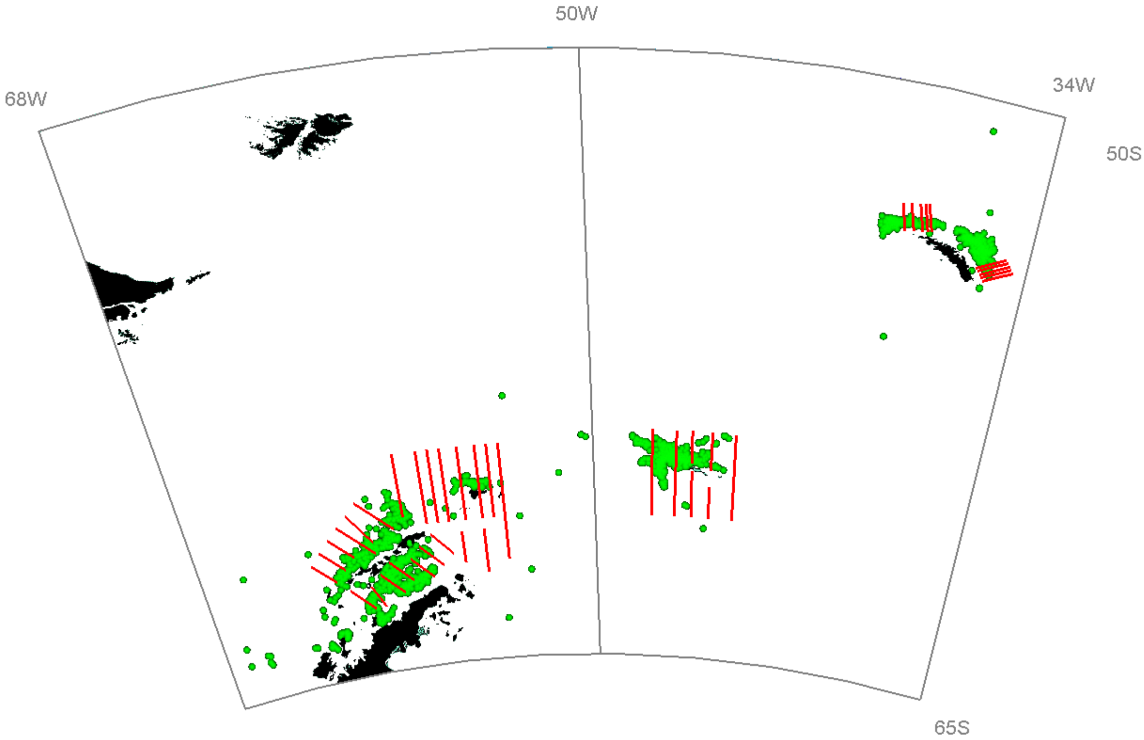

Figure 1: Location of the krill fishery in Subareas 48.1, 48.2 and 48.3 between 2009 and 2011 (green-shaded areas) and repeated acoustic transects (red lines) surveyed by Norway, the UK and the USA.

LIST OF PARTICIPANTS

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(Bergen, Norway, 17 to 20 April 2012)

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Appendix B

AGENDA

Subgroup on Acoustic Survey and Analysis Methods
(Bergen, Norway, 17 to 20 April 2012)

1. Introduction

   1.1 Opening of meeting
   1.2 Meeting terms of reference and adoption of the agenda

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

   2.1 Possible objectives for fishing vessel acoustic data

   2.2 Survey design
      2.2.1 Practical survey designs for fishing vessel acoustics

   2.3 Acoustic data collection
      2.3.1 Instrumentation requirements
      2.3.2 Ancillary data requirements
      2.3.3 Vessel requirements
      2.3.4 Data collection protocols
         2.3.4.1 Minimum requirements and protocols for collection for krill data
         2.3.4.2 Requirements for collection of data on pelagic species other than krill

   2.4 Collection of biological and other non-acoustic data required for acoustic interpretation and target identification

   2.5 Acoustic data processing
      2.5.1 Calibration
      2.5.2 Target identification
      2.5.3 Biomass estimation and associated uncertainty
      2.5.4 Data management and formats

   2.6 Recommended objectives for fishing vessel acoustic data

3. Recent work on acoustics relevant to CCAMLR

   3.1 Target strength modelling
   3.2 Equipment developments

4. Recommendations to the Scientific Committee

5. Adoption of report

6. Close of meeting.

Appendix C

LIST OF DOCUMENTS

Subgroup on Acoustic Survey and Analysis Methods
(Bergen, Norway, 17 to 20 April 2012)

SG-ASAM-12/01	Draft Agenda Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)
SG-ASAM-12/02	List of participants
SG-ASAM-12/03	List of documents
SG-ASAM-12/04	Semi-empirical acoustic estimates of krill biomass derived from simulated commercial fishery data based on single-frequency acoustics A.M. Cossio, G.W. Watters, C.S. Reiss, J. Hinke and D. Kinzey (USA)
SG-ASAM-12/05	Estimating Antarctic krill density from multi-beam observations using distance sampling methods M.J. Cox (Australia)
SG-ASAM-12/06 Rev. 1	Information provided by Members on acoustic equipment on krill fishing vessels Secretariat

Annex 5

Report of the Working Group
on Statistics, Assessments and Modelling
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

CONTENTS

REPORT OF THE WORKING GROUP ON STATISTICS, ASSESSMENTS AND MODELLING
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

INTRODUCTION

Opening of the meeting

1.1 The 2012 meeting of WG-SAM was held at the Centro Oceanográfico de Canarias (COC), Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain, from 25 to 29 June 2012. The meeting was convened by Dr S. Hanchet (New Zealand) and local arrangements were coordinated by Mr L. López Abellán (COC).

1.2 Dr Hanchet welcomed participants (Appendix A) and outlined the work schedule for the meeting. The Scientific Committee had identified three main areas of work for WG-SAM in 2012 (SC-CAMLR-XXX, paragraphs 15.3 and 15.4):

(i) a focus topic on tagging which could include implementation of the tagging program, alternative tagging technologies, experiments to examine tagged fish mortality rates and tag detectability, tag-based stock assessment issues, review of tagging protocols, and development and provision of a training module for vessel operators

(ii) evaluation of research plans from Members notifying to fish in exploratory fisheries in Subareas 48.6 and 58.4 in 2012/13

(iii) review of research proposals for closed areas, areas with zero catch limits and other areas not included in (ii).

Adoption of the agenda and organisation of the meeting

1.3 The agenda was adopted without change (Appendix B). Item 2 was the focus topic which reviewed the CCAMLR tagging program (paragraph 1.2i).

1.4 Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all the authors of papers for their valuable contributions to the work presented to the meeting.

1.5 In this report, paragraphs that provide advice to the Scientific Committee and its working groups have been highlighted. A list of these paragraphs is provided in Item 7.

1.6 The report was prepared by Dr M. Belchier (Convener WG-FSA), Mr C. Heinecken (South Africa), Drs C. Jones (Chair of the Scientific Committee), A. Petrov (Russia), D. Ramm (Data Manager), K. Reid (Science Manager), Mr R. Sarralde (Spain), Drs B. Sharp (New Zealand), K. Taki (Japan), D. Welsford (Australia) and P. Ziegler (Australia).

REVIEW OF THE CCAMLR TAGGING PROGRAM

Overview

2.1 Toothfish tagging programs have existed in CCAMLR fisheries since 1998, and have been used to estimate movement, growth and mortality rates and abundance. Tagging of toothfish from fishing vessels in new and exploratory fisheries started in 2000/01 and became mandatory in 2003/04. More than 50 000 toothfish have been tagged and released and 1 878 tagged individuals have been recaptured over this period. However, in the exploratory fisheries in Subareas 48.6 and 58.4 recapture rates have been much lower than expected given the number of tagged fish released in those fisheries. Hence, the Scientific Committee tasked WG-SAM with addressing the issues of design, implementation and analysis of tag-recapture research programs as a focus topic for its 2012 meeting.

2.2 WG-SAM-12/26 highlighted that CCAMLR tagging programs have many unique characteristics in comparison to other programs conducted in fisheries around the world. For example, CCAMLR is unique in:

- using tagged fish released and recaptured from commercial vessels as an index of absolute abundance in stock assessments
- having supply of standardised tags and tagging equipment and data management centralised within the Secretariat
- routinely double-tagging all fish, thereby allowing estimates of tag shedding and increasing the probability that tagged fish are detected when recaptured
- requiring tagging as a routine feature of data collection plans in research and exploratory fisheries
- having observer coverage on all fishing vessels.

The paper also made several recommendations for improving the performance of CCAMLR tagging programs.

2.3 The Working Group endorsed the following recommendations for improving the performance of CCAMLR tagging programs:

(i) developing methods to minimise errors during data recording and data entry, e.g. the use of data checking algorithms and conditional formatting in the e-forms and cameras or voice recorders at sea

(ii) reporting program-level diagnostics, such as the proportion of unmatched tags, and the number of missing data values for tagged fish

(iii) conducting simulations to evaluate sensitivity to incomplete overlap in spatial distribution of tagged fish and recovery effort, and vessel-specific tag loss or post-tagging survival, and tag-detection rates

(iv) developing methods for generating summaries of tagged fish releases and recoveries to facilitate interpretation of input parameters used for abundance estimation. For example, graphs of the spatial overlap of tagging events and fishing effort could be generated for inclusion in the Fishery Reports.

2.4 WG-SAM-12/23 described the different processes that may occur in a tag-recapture program (i) during the initial capture, tagging and release, (ii) when the fish is at liberty, and (iii) when a tagged fish is recaptured, that may affect the accuracy of an abundance estimator such as using the Lincoln-Petersen equation. It reviewed the existing measures that have been employed in CCAMLR tagging programs to mitigate bias (i.e. practical measures employed at sea to avoid bias) and remediate bias (i.e. modelling approaches to adjust for bias), and the priority issues that still remain to be addressed in CCAMLR tag-recapture experiments.

2.5 The Working Group noted that tag detection and scanning rates are likely to be high, due to the fact that every toothfish on all fishing vessels is handled several times between being brought on board, processed and frozen. However, the Working Group agreed that scanning and detection is unlikely to be 100% for all vessels or fisheries.

2.6 The Working Group noted that the tables in WG-SAM-12/23 provided a useful summary of factors to be considered in assessing the priority of issues that remain to be resolved when implementing tagging programs and producing abundance estimates from tag recaptures (Tables 1 to 4).

2.7 The Working Group agreed that several issues remain of high priority to be addressed in the use of tag-based abundance estimates. It therefore encouraged Members to conduct research on:

(i) the development of spatially explicit models that account for the distribution of tag releases, recapture effort and toothfish movement while at liberty

(ii) estimation of potential effects of decreased post-release survival of tagged fish in areas where depredation occurs (e.g. Division 58.4.4)

(iii) estimation of fishery- and vessel-specific tag-shedding rates, including the effect of fish size

(iv) estimation of fishery- and vessel-specific scanning and tag-detection rates

(v) estimation of fishery- and vessel-specific post-release survival rates.

Design of programs

2.8 WG-SAM-12/25 proposed tagging fish at a constant number per number of fish caught as an alternative to the current requirement of tagging toothfish at a constant number of fish per tonne because of concerns that this may cause a disproportionate tagging rate in areas where catches are dominated by small fish or large fish.

2.9 In practice, when selecting fish for tagging, many vessels already use a 'tag every *n*th fish' approach and adjust *n* based on the size of fish being landed; this appears to be effective in achieving both the required tagging rate and tag overlap. However, the Working Group suggested that Members developing research proposals consider the approach described in WG-SAM-12/25, particularly in areas where very small or very large fish dominate the catch where there is a risk that a tagging rate per tonne may not be optimal.

Implementation of programs

2.10 WG-SAM-12/31 reviewed current information provided by CCAMLR to participants in fisheries that include tagging programs for skates and toothfish. It included recommendations for improved tagging protocols and the development of training packages for distribution to observers and vessel crew to improve tagging operations at sea. An outline of a proposed training module for toothfish tagging, and videos of crew tagging on board a New Zealand vessel in the Ross Sea, were also presented.

2.11 The Working Group agreed that the skate and toothfish tagging information currently included in the *Scientific Observers Manual*, observer logbooks and C2 forms be reviewed and repackaged to more effectively target their intended audience, and be made available via the CCAMLR website and Secretariat.

2.12 The Working Group noted that CM 41-01 clearly specifies that the responsibility for undertaking tagging, tag recovery and correct reporting lies with the vessel and that the fishing vessel shall cooperate with the CCAMLR scientific observer in undertaking the tagging program.

2.13 The Working Group recalled the advice of the Scientific Committee that the lack of assessment in the data-poor fisheries in Subareas 48.6 and 58.4 may be a consequence of research implementation, rather than research design (SC-CAMLR-XXX, paragraph 3.123). The Working Group agreed that the information and training provided to participants in tagging programs is likely to influence their performance. Therefore, it recommended development of a tagging training package, including:

(i) a description of the roles and responsibilities of designating and receiving Members, vessel crew, technical coordinators, and CCAMLR and national observers participating in tagging programs

(ii) stepwise descriptions and diagrams of correct tagging procedures, including illustrations or photographs of tagging station layouts and tagging equipment

(iii) instructions for identifying fish suitable for tagging, including videos and photos (see Table 5)

(iv) a quick reference guide and checklist for use at the tagging stations on board vessels in a simple graphical format to minimise translation needs

(v) videos and photographs of handling, measuring, tagging and releasing of toothfish on board fishing vessels

(vi) description of the importance, and use by CCAMLR, of the results from toothfish and skate tagging programs.

2.14 The Working Group requested that those Members with experience in tagging programs work with the Secretariat to update current tagging protocols, collate material for the training package, and modify existing documentation as shown in Appendices 1 to 3 of WG-SAM-12/31, for consideration by WG-FSA-12. It also recommended that, when complete, the training package be translated into all languages used on board vessels operating in CCAMLR exploratory fisheries.

2.15 The Working Group agreed that the proposed criteria in WG-SAM-12/27 would be valuable for use in tagging programs in CCAMLR fisheries to identify fish that are suitable for tagging, and for collecting data in a standardised way on factors that influence suitability, such as the different gear types. The Working Group requested that Members provide diagrams or photographs to augment the table, and that the authors of WG-SAM-12/27 and the Secretariat provide a revised version of the table to WG-FSA for review with a view to using it in the coming fishing season.

2.16 The Working Group agreed that, in general, it was best to attempt to tag and return fish to the water immediately. However, the Working Group agreed that in areas where depredation of released fish was likely, or where toothfish are caught in batches by trawl, use of a holding tank with flow-through seawater was recommended. It also encouraged the use of holding tanks for experiments to determine the effects of handling and tagging post-release survival, similar to those conducted in Subarea 48.3 in the past (Agnew et al., 2006).

2.17 It was noted that, when tagging small toothfish caught in research trawls in Subarea 48.3, an enclosed chute was developed to release fish below the surface of the water to ensure fish escape seabird depredation.

2.18 The Working Group also noted that difference in ambient light levels at fishing depths and at the surface mean that toothfish captured during the day were vulnerable to eye damage, and recommended that minimising exposure of the fish to full sunlight during the tagging process would be desirable.

Analysis of results

2.19 Several papers discussed different aspects of data quality control and data analysis from tagging programs.

2.20 WG-SAM-12/32 detailed the development of a domestic Argentinian toothfish tagging program designed to collect information on growth and movement rates. Locations of recaptures are generally near the release location, however, several tagged fish have made large-scale movements and have been recaptured in the fisheries off Chile. Individuals who report tagged fish receive a wrist watch with the logo of the research program, proving an incentive to scan for tags. It was also noted that in areas where cachaloteras are used as mitigation against toothed whale depredation, fish are generally unsuitable for tagging due to abrasion injuries.

2.21 The Working Group thanked the authors for providing the paper, and encouraged other CCAMLR Members in the region to forward the details of any tags recaptured by their vessels to INIDEP.

2.22 The Working Group noted that reward schemes are part of the domestic toothfish tagging program in Argentina (WG-SAM-12/32) as well as the fishery in Subarea 48.3. However, estimates of the effect of introducing a reward system after a tagging program has been established are likely to be confounded with changes in abundance or many of the other processes noted in Tables 2 to 5. Furthermore, providing a reward for every tag, as tagging programs mature and tag-recapture numbers increase, may become prohibitively expensive. Therefore, the Working Group agreed that incentive systems to report tags may be difficult to implement generally across CCAMLR tagging programs.

2.23 WG-SAM-12/19 presented an analysis of Patagonian toothfish (*Dissostichus eleginoides*) movement rates in Subarea 48.3, and the Working Group encouraged further analyses of this kind as it has the potential to allow evaluation of potential biases in tag-based assessments, as well as inclusion of movement rates in spatial models. The Working Group noted that some of the directional aspects of movement detected in this study could be a function of the stratification used in the analysis and also encouraged an evaluation of the potential effects of season, and other factors such as length or maturity stage, on movement.

2.24 WG-SAM-12/22 provided an update on the tag-link status used to assess the level of confidence in the links made between tag releases and recaptures in the CCAMLR database. In response to the request from WG-FSA to develop threshold levels for use in assigning ‘Status 2’, where the tag numbers match but there are inconsistencies in the biological data (including length and weight), an analysis of within-year recaptures showed the variability of weight was much greater than for length for repeat measurements of individual fish.

2.25 The Working Group agreed that using weight change as a criteria may not be appropriate for link status characterisation and that the use of length should include both process and measurement error.

2.26 The Working Group recommended that, to reduce additional handling of fish, a weight measurement should no longer be a requirement when tagging fish.

2.27 WG-SAM-12/24 described a simulation study to evaluate the effects of the number of fish tagged, size of tagged fish, the duration of the tagging program and the type of auxiliary data available on bias and precision of an integrated assessment. The study used a modelling framework to simulate fish populations, fishing, data collection and stock assessments using CASAL.

2.28 The Working Group welcomed the development and application of this model framework, but noted the need for validation of the operating model used. It also recommended evaluating the effect of using different prior distributions for B_0 and year-class strength (uniform-log for B_0 and lognormal for year-class strength), since the use of uniform priors for these parameters in WG-SAM-12/24 could be the cause for some of the estimated biases observed in this study.

2.29 It was noted that the scenarios with a 60% tag size-overlap achieved assessments of similar bias and precision as those with a 100% tag size-overlap. The Working Group encouraged the investigation of the influence of the levels of tag size-overlap with the goal of determining the relationship between this parameter and bias and model performance.

2.30 WG-SAM-12/30 described a method to evaluate the relative tagging performance of a vessel or vessel trips with respect to the tag-detection rate of recaptured fish and the post-tagging survival of released fish. While controlling for the confounding effect of spatial and temporal variability of fishing effort associated with release and recapture events of tagged fish, the approach analysed tagging performance at the individual vessel level relative to all other fishing vessels in the fleet using a pair-wise case-control approach in which every haul by the 'case' vessel is paired with a corresponding control haul in the same time and location.

2.31 The Working Group noted that this method may be useful for evaluating tagging performance of vessels within CCAMLR tagging programs, and may provide an alternative means of selecting quality tagging data for inclusion in stock assessments. The Working Group encouraged further development of the method and sensitivity testing, including sensitivity analyses of the size of the reference area within which case hauls and control hauls are paired, and aggregating vessel data across different time periods to discern temporal trends. Using a simulated dataset would improve the understanding of the approach, e.g. in respect to the effects of rare events when scanning small numbers of fish. The Working Group also encouraged the authors to repeat the analysis at a wider geographical scale, including across other CCAMLR fishing areas.

EVALUATION OF RESEARCH PLANS FROM MEMBERS NOTIFYING TO FISH IN EXPLORATORY FISHERIES

3.1 WG-SAM-12/06 summarised the deployment of research hauls in data-poor exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a. The Working Group recalled the changes in requirements of vessels conducting research fishing within these data-poor fisheries during 2011/12 with respect to fishing in designated fine-scale rectangles and corresponding research haul requirements.

3.2 With respect to the requirement to complete at least one research haul for every three commercial hauls after the first 10 research hauls, the Working Group noted that in all cases, except for one vessel, this requirement was met. However, on several occasions the requirement to conduct research hauls at a distance of ≥3 n miles apart was not met.

3.3 The Working Group agreed it would be useful to examine maps of these deployments that include depth, catches, mark-recapture information and a distance scale, and recommended that this information be made available for WG-FSA this year to make further progress on refining the 3 n mile requirement if the interim requirements of CM 41-01 are retained for 2012/13.

3.4 The Secretariat provided a demonstration of 3D mapping of fishing locations and bathymetry and advised that it could investigate a range of suitable mapping and visualisation tools to assist with the spatial analysis of effort distribution and present the results to WG-FSA. This offer was welcomed by the Working Group.

3.5 WG-SAM-12/07 described the two sets of requirements for reporting data from vessels undertaking research fishing: (i) that conducted under CM 24-01 (scientific research), which requires data to be reported using data form C4; and (ii) that conducted under CM 41-01 (exploratory fisheries), which requires data to be reported using data form C2, as well as data collected by scientific observers using cruise reports and logbooks.

3.6 WG-SAM-12/07 proposed that fishing vessels undertaking research use form C2 throughout their research, with scientific observers continuing to use cruise reports and logbooks; any supplementary data requirements for research fishing would be reported on a separate form (i.e. form C4). The Working Group agreed that this proposal would simplify the process of data reporting from research fishing activities, and recommended that it be endorsed by the Scientific Committee. It was further agreed that reporting data from fishery-independent research trawl surveys under CM 24-01 would not be impacted by this change, but would continue to use the current survey data reporting system (i.e. form C4).

Evaluation of research plans from Members notifying to fish in exploratory fisheries in Subareas 48.6 and 58.4

3.7 A requirement to submit research fishing plans in notifications for data-poor exploratory fisheries was adopted by the Commission at its 2011 meeting (CCAMLR-XXX, paragraph 12.9). WG-SAM was tasked to review these research plans to provide advice on whether they meet the requirements for CCAMLR-sponsored research as laid out in SC-CAMLR-XXX, Annex 5, paragraphs 2.25 and 2.26, and CM 21-02.

3.8 The Working Group reviewed research plans submitted by five Members wishing to conduct research fishing in data-poor exploratory *Dissostichus* spp. fisheries in Subareas 48.6 and 58.4:

- WG-SAM-12/09 by Japan for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a
- WG-SAM-12/10 Rev. 1 by the Republic of Korea for Division 58.4.1
- WG-SAM-12/12 Rev. 1 by South Africa for Subarea 48.6 and Divisions 58.4.2 and 58.4.3a
- WG-SAM-12/13 by Spain for Divisions 58.4.1 and 58.4.2
- WG-SAM-12/14 by France for Division 58.4.3a.

3.9 In order to carry out an evaluation of the submitted research fishing plans against the criteria agreed by WG-SAM-11 (SC-CAMLR-XXX, Annex 5), the agreed format in CM 24-01, and noting the discussion of the Scientific Committee (SC-CAMLR-XXX, paragraphs 3.136 to 3.138, 9.5 and 9.6), the Working Group developed a preliminary evaluation table (Table 6) and evaluated each proposal following the criteria in that table.

3.10 The Working Group noted that the purpose of the preliminary evaluation was to provide feedback and advice on how plans could be modified and developed to ensure that they were best able to achieve CCAMLR's objectives (as outlined in SC-CAMLR-XXX, Annex 5, paragraph 2.25) and that modified plans would be resubmitted to WG-FSA for re-evaluation. During the course of the preliminary evaluation of research plans, the Working Group identified issues for which generic and specific advice could be provided.

3.11 The Working Group noted that no plan provided sufficient detail concerning how the proposed research would address CCAMLR's objectives (Table 6). The collection of data from a fishery survey was frequently cited as the main objective of the research with little consideration given to how the collection of such data would ultimately lead to the provision of a robust estimate of stock status (and precautionary catch limits) for *Dissostichus* spp. within a given area or time frame. The Working Group recommended that the ultimate objectives of any planned research should be stated explicitly within the research plan and consistent with the advice of SC-CAMLR-XXX, Annex 5, paragraphs 2.25 to 2.27.

3.12 The Working Group noted that the provision of detailed survey and data collection plans within the evaluated research plans (Table 6) was generally sufficiently detailed. However, the rationale for the collection of specific datasets was frequently not provided and the intended use of these data was unclear in many cases.

3.13 The Working Group assessed the consideration within research plans of the key requirements to achieve an estimate of stock status as outlined in Table 6 (3i to 3iii) namely:

(i) an index of stock abundance
(ii) a hypothesis of relationship of fish in the research area to the overall stock
(iii) estimates of biological parameters relating to productivity (i.e. maturity, growth, recruitment and natural mortality).

3.14 The Working Group concluded that all research plans would benefit from the provision of a complete account of how an index of stock abundance would be derived. Whilst this was identified as an objective in many cases, the provision of more detail on the methods used, and an assessment of their appropriateness, is necessary to enable the evaluation of the likelihood the research plan could achieve CCAMLR objectives. For example, as most research involved tagging, plans should present comprehensive information on how abundance estimates from tagging will be derived, rather than use of CPUE data, in order to assist with the development of a more robust assessment.

3.15 Details of stock hypotheses were largely absent from the research plans. The Working Group recommended that more detail relating to the population structure and distribution for each 'stock' under consideration should be included. Information on the presence of different life-history stages in the research area, and their relationship with other populations of the target species, should also be added to research plans. If this information is unavailable, a review of the demographics of neighbouring populations could provide information that is indicative of the demographics of the stock, and a stock hypothesis could be developed from this.

3.16 The Working Group noted that research plans frequently state that a considerable amount of biological information would be collected. However, they rarely indicated how this information would be processed and analysed and how the information would ultimately contribute to a stock assessment, nor do they indicate how the existing data would be enhanced by further data collection.

3.17 The Working Group recommended that details are provided on the rationale underlying the collection of specific datasets. In addition, greater detail should be provided on how and when age determination to assess growth or age structure would be conducted. The

Working Group agreed that research fishing plans should be more explicit about the rationale behind the collection of additional biological data. Information on the purpose and use of datasets of sex, maturity and diet should be clear.

3.18 The Working Group noted that the degree of detail in the information on tagging performance (Table 6) varied considerably between research plans. Greater detail on how high tagging performance will be achieved with respect to the identified tagging metrics should be provided in all proposals.

3.19 The Working Group noted that some proposals provided no indication as to whether the research fishing was intended to be a multi-year effort. As most proposals were tag-recapture experiments intended to provide data for use in an assessment, it is important that research proponents commit to research fishing to be conducted over the course of several years to ensure the opportunity to recapture tags. The Working Group agreed that this information is required in the proposal for the evaluation process.

3.20 The Working Group recommended that WG-FSA follow the research fishing proposal evaluation process that was undertaken by the Working Group using the criteria laid out in Table 6 and CM 24-01, Format 2.

3.21 Noting that more than one Member had submitted research plans for some subareas and divisions, the Working Group discussed the potential for the coordination of research plans between Members to better achieve the objectives of research fishing. A coordination of research plans was likely to provide more extensive temporal and spatial coverage of research planned for data-poor exploratory fisheries in Subareas 48.6 and 58.4, and could prevent unnecessary duplication of research effort. It was also highlighted that the development of full stock assessments for a subarea or division was a major task that could be made easier by the coordination of research effort and assessment expertise and resources between Members.

3.22 Since it is now a requirement that research plans be submitted to the Secretariat by 1 June in advance of, and for consideration by, WG-SAM, there would be an opportunity for Members to discuss and coordinate research prior to the resubmission of the research plans to WG-FSA after preliminary evaluation at WG-SAM.

3.23 The Working Group recommended that an intersessional correspondence group be established to facilitate the coordination of research effort and plans between Members. Dr Belchier, in his capacity as Convener of WG-FSA, indicated that he would be willing to act in this role with the assistance of the Secretariat. The Secretariat recommended that, in line with other correspondence groups, a dedicated area of the website be established to facilitate the exchange of information between Members.

3.24 WG-SAM-12/09 provided a research fishing proposal for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a. The Working Group noted a considerable amount of information was provided in this paper which provided a useful context to assist with the appraisal. In addition to the generic points advised in paragraphs 3.11 to 3.24, a number of other issues were raised by the Working Group:

(i) The Working Group discussed the impact of operational constraints, such as ice, which could prevent access to designated fine-scale rectangles. This issue was raised in WG-SAM-12/09 and a method described for spatial allocation of effort for the 2012/13 research effort, should the designated fine-scale rectangles be inaccessible. A number of alternative methods to reallocate effort were discussed and it was agreed that there was still a requirement for the research fishery to be spatially constrained, and that the focus should be on areas where tags were already released. The Working Group recommended that this issue be further discussed at WG-FSA, recalling that fine-scale rectangles were an interim measure pending the development of satisfactory research plans in 2012/13.

(ii) The Working Group recommended that where CPUE × seabed area comparisons are used to provide an initial estimate of plausible biomass within the proposed research area, care should be taken to ensure that the reference area from an assessed stock used in the comparison contains the same toothfish species as occur in the research area (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii).

3.25 WG-SAM-12/10 Rev. 1 provided a research fishing proposal for Division 58.4.1. In addition to the generic comments in paragraphs 3.11 to 3.24, the Working Group also advised that only fish that had been hooked by a single hook (see Table 5) from the trotline gear should be selected for tag and release in order to maximise the potential for recapture.

3.26 WG-SAM-12/12 Rev. 1 provided research fishing proposals for Subarea 48.6 and Divisions 58.4.2 and 58.4.3a. The Working Group agreed that additional information on hook injuries sustained by fish and an assessment of fish 'vitality' presented at the Working Group was very useful and should be submitted to WG-FSA.

3.27 Mr Heinecken indicated that he had found the appraisal process to evaluate a research proposal against the metrics indicated in Table 6 to be extremely useful and that it would greatly assist with the development of research fishing plans that were better suited to meet CCAMLR's objectives.

3.28 WG-SAM-12/13 presented a research fishing proposal for Divisions 58.4.1 and 58.4.2. This proposal was intended primarily as a multi-year depletion experiment to be carried out sequentially in different SSRUs in subsequent years, and included three SSRUs in Division 58.4.1 that are currently closed to fishing. The Working Group noted that the proposed depletion experiment requires systematic fishing in small areas for a considerable period of time to estimate correlation between CPUE and catch to estimate abundance.

(i) The Working Group recalled that there had been other depletion analysis studies for toothfish fisheries in the Convention Area undertaken in the past, but that these had failed to achieve their objective of leading to an assessment. However, it was also noted that the previous experiments used data from various fishing vessels engaged in commercial fishing operations, and not a controlled experiment (e.g. WG-FSA-94/24).

(ii) The Working Group noted that it would be useful to combine the depletion experiment with tagging that would be undertaken during the research, as this would increase the power of the experiment to estimate local abundance. It also noted that revisiting the same location to recapture tags in the year(s) subsequent to the depletion experiment would be useful, as this would enable comparison of local abundance estimates generated by two different methods.

(iii) The Working Group agreed that there may be some fish that move into, or out of, the study area, and that this may affect the experiment. In addition, it requested that previous depletion experiments (both CCAMLR and international) be reviewed and that consideration of the power to detect a depletion which would result in an estimate of local biomass be presented to WG-FSA.

3.29 The proposal in WG-SAM-12/14 to conduct research fishing in Division 58.4.3a did not contain a detailed description of a research plan to indicate how the collected data would develop an estimate of abundance. There was no detailed survey design, no maps of the distribution of catch or tagging effort and, therefore, it was not possible for the Working Group to evaluate the potential for the research to lead to an estimate of abundance or to an assessment. The Working Group encouraged resubmission of a revised proposal to WG-FSA, taking into account Table 6 and the advice provided in paragraphs 3.11 to 3.24.

REVIEW OF SCIENTIFIC RESEARCH PROPOSALS FOR OTHER AREAS (E.G. CLOSED AREAS, AREAS WITH ZERO CATCH LIMITS, SUBAREAS 88.1 AND 88.2)

4.1 The Working Group reviewed reports from previous research fishing and considered scientific research proposals for new research fishing in closed areas, areas with zero catch limits and areas with stock assessments under CM 24-01. Proposals were evaluated for new or ongoing research fishing in Subareas 48.5 and 88.1 and Divisions 58.4.3b and 58.4.4. The Working Group also reviewed reports for research fishing already completed in Subareas 88.1, 88.2 and 88.3 and Divisions 58.4.3b and 58.4.4 in 2011/12.

4.2 The Working Group noted that, in general, the quality of new research fishing proposals submitted under CM 24-01 was improved from previous years, and thanked the proponents for their work. Evaluation of new proposals for research fishing in closed or zero-catch limit data-poor areas (i.e. WG-SAM-12/04, 12/11, 12/15 Rev. 1, 12/16 and 12/17), consistent with the advice of the focus topic on data-poor fisheries at WG-SAM-11 (SC-CAMLR-XXX, Annex 5), is summarised in Table 7. Evaluation of research proposals in areas with assessments (WG-SAM-12/28 and 12/29) proceeded separately.

Weddell Sea (Subarea 48.5)

4.3 The Working Group discussed WG-SAM-12/04 and 12/11, describing a proposal to conduct a five-year research fishing program to achieve an estimate of stock status for Antarctic toothfish (*D. mawsoni*) in Subarea 48.5. The Working Group agreed that the proposal was generally consistent with the advice of the focus topic on data-poor fisheries at WG-SAM-11 (Table 7). The Working Group noted that the success of a tag-based research program relies on the ability of the research vessel to revisit previously fished locations to recapture tags, and that it may not be possible to conduct multi-year research in the proposed locations due to difficult and variable ice conditions in the area, particularly in the western portion of Subarea 48.5. Working Group participants reported that areas in the western Weddell Sea that appear ice-free in WG-SAM-12/04, Figures 2 and 4, are known to have been inaccessible to an ice-breaking research vessel during the same month in 2012. The proposed set locations in the eastern portion of Subarea 48.5 are likely to be more accessible, but potentially still subject to difficult or variable ice conditions.

4.4 The Working Group recommended that the authors resubmit WG-SAM-12/04 to WG-FSA, and provide additional details of the planned analytical methods identified in the annual research program leading to an assessment of stock status, including 'areal methods' (in years 2 and 3) and CASAL models (in years 4 and 5) mentioned in the paper. The Working Group also requested additional details regarding planned analyses of data from biological sampling (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity. Additional analyses of ice conditions, and operations potentially affecting research feasibility, would also be important for the evaluation of this proposal.

BANZARE Bank (Division 58.4.3b)

4.5 The Working Group discussed WG-SAM-12/15 Rev. 1, describing the results of research by Japan in Division 58.4.3b in 2012 and a proposal to continue that research in 2013. Due to operational difficulties and poor weather, only 22 of the planned 48 research hauls were completed in 2012 and no tagged fish were recaptured. The Working Group noted that, despite several years of research fishing in this location, there was still insufficient information (tag returns) to enable progress towards an estimate of stock status. This may be due to the combined effects of inconsistent spatial research design, variable research seasonality and/or low catches resulting in lower than anticipated numbers of fish being scanned.

4.6 The Working Group recommended that the authors resubmit this paper to WG-FSA and include additional information about what analyses are planned to lead to an assessment of stock status and on what time frame these analyses will occur. The Working Group also recommended additional details be provided regarding planned analyses of biological sampling (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity. To estimate the likely time required to collect this information, the Working Group recommended that in addition to the analysis of required tagging and catch rates to achieve a target CV, the proponents also estimate the number of tag recaptures that would be expected each year as a function of scanning rate (catch).

4.7 The Working Group recalled the advice of the Scientific Committee in 2011 (SC-CAMLR-XXX, paragraphs 9.33 to 9.36) that consideration of future research in this area should also be informed by a larger analysis and review of available information indicative of current and historical factors affecting stock status.

4.8 The Working Group noted that the authors of WG-SAM-12/15 Rev. 1 had incorrectly applied the precautionary exploitation rate of 0.01 (corresponding to an assumption of a stock depleted to 30% B_0, from the formula of WG-FSA-10/42 Rev. 1) with reference to the estimated B_{current} rather than B_0. A correct application of the formula would yield a higher precautionary catch level; this should be recalculated and evaluated by WG-FSA.

4.9 Comparative analyses of different Spanish and trotline fishing gear configurations described in WG-SAM-12/15 Rev. 1 (and also WG-SAM-12/16, below) indicate that the modified trotline configurations adopted in 2012 resulted in a higher proportion of captured fish suitable for tagging without an apparent reduction in CPUE per km of line. The Working Group recommended that these analyses be submitted for consideration by WG-FSA.

4.10 The Working Group considered proposed modifications to the assignment of longline set locations, to allow the research vessel flexibility to adjust precise set locations by up to 5 n miles in response to weather and sea conditions. The Working Group noted that adhering to a fixed spatial grid vs. allowing limited flexibility in set locations has implications for CPUE comparisons in particular locations between years, but the effect on tag-returns at this scale is unknown. The Working Group recommended that the implications of spatial research designs be carefully considered with respect to the actual purpose of the research and the way in which research results will be analysed (i.e. using CPUE vs. tag-based indices of abundance).

Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b)

4.11 The Working Group discussed WG-SAM-12/16, describing the results of research by Japan in 2012 in Divisions 58.4.4a and 58.4.4b, and also WG-SAM-12/17, describing a proposal to continue that research in 2013. The Working Group noted that in SSRU C additional tag-recaptures were obtained in 2012, potentially providing information sufficient to lead to an estimate of current stock status, but that in SSRU B observed levels of killer whale depredation may have compromised the success of research in this area.

4.12 The Working Group discussed the potential influence of killer whale depredation on abundance estimates from a tagging program. It noted that killer whale depredation at the haul may result in fewer tag recaptures, and would need to be taken into account when estimating total removals, but is not expected to bias tag-based abundance estimates. In contrast, if killer whales are present when tagged fish are released, this would be expected to bias tag-based abundance estimates. Noting that the *Shinsei Maru No. 3* utilised a holding tank to retain tagged fish until hauling was completed and killer whales were no longer visible in the area, the Working Group requested that additional information be provided on the distances moved by the vessel before releasing tagged fish. The Working Group also requested higher-resolution data on what proportion of the research hauls were attended by killer whales, killer whale abundance, and the proportion of the hauls with evidence of depredation observed on the line.

4.13 The Working Group welcomed reports that more than 1 000 photographs had been taken of killer whales in SSRU B during 2012 and that these were being analysed by French researchers to compare with photos of individual whales depredating lines elsewhere in the Indian Ocean sector. The Working Group encouraged researchers to continue this work and submit it for consideration by WG-FSA and WG-EMM.

4.14 The Working Group considered an option presented by Dr Taki to discontinue research fishing in SSRU B due to potential difficulties arising from killer whale depredation, and to instead continue research in SSRU C and initiate research in SSRU D where killer whales have not in the past been seen in high numbers. The Working Group requested that this proposed change should be considered by WG-FSA in light of the information requested in paragraph 4.12.

4.15 The Working Group suggested that the authors provide revised papers to WG-FSA, including additional information about what analyses are planned, and on what time frame, to lead to a stock assessment, noting that tag recaptures to date within SSRU C may be sufficient to inform a preliminary estimate of stock status. The Working Group also requested additional details regarding planned analyses of biological samples (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity, noting the advice of SC-CAMLR-XXX, Annex 5, paragraphs 2.27 to 2.29.

Subarea 88.3

4.16 The Working Group considered WG-SAM-12/05, describing the results of two years of research fishing by Russia in Subarea 88.3, noting that there is no proposal to continue this research in 2012/13. The Working Group noted that there were no tag returns from this research, most likely due to low catches and inconsistent spatial overlap arising from difficult ice conditions, but that other biological and demographic information collected in the course of this research would contribute substantially to our knowledge of this poorly studied area. The Working Group thanked the authors of this paper for providing this report, and recommended that this paper be resubmitted to WG-FSA.

Subarea 88.2

4.17 The Working Group considered WG-SAM-12/08, describing the results of two years of research fishing by Russia in SSRU 882A, noting that there is no proposal to continue this research in 2012/13. The Working Group noted that there were no tag returns from this research, most likely due to low catches. The Working Group thanked the authors of this paper for providing a detailed and thorough report, and recommended that this paper be resubmitted to WG-FSA.

4.18 The Working Group noted that in WG-SAM-12/05 and 12/08, a much higher proportion of fish caught by the *Sparta* using trotlines were suitable for tagging, in comparison with fish caught using trotlines by the *Shinsei Maru No. 3* described in WG-SAM-12/15 Rev. 1 and 12/16. The authors of WG-SAM-12/08 noted that the trotline configuration used on board the *Sparta* has been described in the CCAMLR Gear Library (WG-FSA-06/05) but that, due to changing use of terminology, this configuration originally referred to as a 'deep-water Spanish longline' would now be more accurately classified as a type of trotline. The Working Group requested that Russian scientists provide an updated gear description paper for deposition in the CCAMLR Gear Library that clearly describes this particular trotline configuration (i.e. specifying bundle placement, bundle spacing, hook numbers per bundle, snood lengths etc.) to enable determination of the various factors affecting availability of fish suitable for tagging by different gear types.

Subarea 88.1

4.19 The Working Group considered WG-SAM-12/28 and 12/29, describing the results of the first year of a CCAMLR-sponsored survey to monitor the abundance of pre-recruit

Antarctic toothfish in the southern Ross Sea in 2012, and a proposal to continue the survey in 2013. The 2012 survey successfully demonstrated the feasibility of using a standardised longline survey to monitor trends in abundance of the target size range of Antarctic toothfish (<100 cm). The survey achieved a target CV of less than 10% for the main survey strata, and successfully defined depth ranges within which fish of the target size classes were concentrated, to better define target strata in subsequent years.

4.20 Dr Hanchet noted that the time series arising from this survey could be used to inform the existing stock assessment for the Ross Sea toothfish fishery, including providing an index of recruitment variability, indications of recruitment autocorrelation, and information on life-cycle movements, including to parameterise spatially explicit stock models.

4.21 The Working Group noted additional analyses comparing catch rates during the 2012 season with commercial catch rates recorded by the same vessel using the same fishing gear configuration in 1999 and 2001. Standardised CPUE analysis revealed no change in catch rates in this period, in contrast to reported declining catch rates by researchers in McMurdo Sound using handlines to capture Antarctic toothfish over the same period.

4.22 The Working Group supported the proposed design of the repeat survey in 2013, including the assignment of approximately 15 sets outside the core strata to explore, and potentially define, new strata in the Glomar–Challenger trough, which includes areas characterised by high catch rates of pre-recruit toothfish and which may constitute a biologically important migration corridor between pre-recruit settlement areas in the southern Ross Sea and adult feeding areas on the Ross Sea slope in SSRU K.

4.23 The Working Group recommended that the authors submit a revised proposal to WG-FSA, including additional analyses of the extent to which commercial fishing occurred inside the survey strata prior to the completion of the survey in 2012, and length-frequency distributions of fish caught by those vessels. The Working Group discussed the appropriateness of the term ‘pre-recruits’ to refer to the size range of fish captured to date by the survey noting that this size range overlaps with that of fish captured by the fishery. It was suggested that perhaps ‘subadult’ would be a more appropriate term.

METHODS FOR ASSESSING FINFISH STOCKS IN ESTABLISHED FISHERIES

5.1 WG-SAM-12/18 presented a ‘break and burn’ method for ageing Antarctic toothfish otoliths collected by Russian vessels in the Ross Sea. The Working Group noted that a large number of otoliths (more than 6 000) were aged in the study and that the data has the potential to be included in a stock assessment model.

5.2 The Working Group recalled the discussion about ageing toothfish otoliths (SC-CAMLR-XXX, Annex 7, paragraphs 6.81 and 6.82) and the intention to set aside an afternoon during the next WG-FSA meeting to facilitate otolith reading work of *D. mawsoni*. The Working Group recommended that the focus of this meeting be on the ageing of both *Dissostichus* species, since the conclusions are expected to be applicable more widely across species. The Working Group encouraged all Members with an interest in ageing *Dissostichus* to be involved in this meeting to facilitate otolith reading work, multiple readings of otoliths for estimating ageing error by individual readers, an otoliths exchange (prepared otoliths and images) and comparisons of different ageing techniques.

5.3 The Working Group welcomed the first comprehensive characterisation of the toothfish fishery in Subarea 48.6 that was presented in WG-SAM-12/33. This report summarised catch, effort, timing, depth, location, size structure and maturity of toothfish and by-catch from the fishery. The main topics discussed by the Working Group included the catch per unit of effort as abundance index and differences in fishing location between toothfish species and the associated by-catch. The Working Group noted that the analysis would benefit from a separate analysis of catch and effort information by gear type reflecting, for example, the shift from Spanish longline to trotline over time, and a standardisation of catch rate data.

5.4 The Working Group recommended that WG-SAM-12/18 and 12/33 be resubmitted to WG-FSA.

5.5 WG-SAM-12/20 presented a biomass estimation of *D. mawsoni* in Subarea 88.3 based on a spline approximation of catch-per-unit effort data and an assumed 3 n mile attraction distance. The Working Group noted that the estimation of biomass density extended spatially up to 150 n miles beyond the range of locations sampled, and recalled its concern that spatial predictions may be difficult if the fished areas are not well spread across the range of environmental variation in the multivariate space (SC-CAMLR-XXX, Annex 7, paragraphs 4.39 to 4.42). The Working Group considered that the analysis would benefit from a grid design to estimate fish density across the bathymetric range, although it recognised that fishing may be restricted in some locations due to heavy ice conditions.

5.6 The Working Group noted that the spline analysis presented in WG-SAM-12/20 was conducted with the program 'Chartmaster' which has not been considered previously by WG-SAM and recalled the advice of WG-FSA on evaluating new methods (SC-CAMLR-XXVI, Annex 5, paragraph 4.27) and suggested that such an evaluation should include, inter alia, the analysis of simulated (theoretical) data for a number of fish stock scenarios and a description on how uncertainty is treated by the model. The Working Group recommended that the authors provide such an evaluation to future meetings of WG-SAM.

OTHER BUSINESS

Focus of future meetings

6.1 The Working Group noted the increased level of participation at its 2012 meeting, with a number of first-time participants and 33 papers submitted for consideration. This increased level of participation in the work of WG-SAM was encouraging, and had contributed to a very full agenda requiring a full five-day meeting.

6.2 The Working Group recognised that the evaluation of research plans in exploratory fisheries and research proposals in other data-poor areas that are designed to lead to an assessment would likely be standing agenda items at meetings for the next few years, while the continued use of focus topics would provide opportunities to address other priorities as determined by the Scientific Committee.

6.3 The Working Group requested that the Scientific Committee consider the following items as possible future focus topics:

- Improvement of research proposals – to review progress in developing research plans in exploratory fisheries and evaluate the application of recommendations and advice provided by working groups and the Scientific Committee.

- Multinational collaboration and research plans – to facilitate the development of collaborative research protocols in data-poor exploratory fisheries.

- Development of spatial population models – to develop spatially explicit modelling approaches, including in exploratory fisheries and krill fisheries.

Preview of the new CCAMLR website

6.4 The pre-release version of the new CCAMLR website was made available to participants for evaluation and feedback. The new website features:

- modern design with expandable menus, quick links and related pages
- fully indexed search engine consistent with access security rules
- comprehensive document archive
- delegated access control using individual email addresses
- online meeting registration
- internal framework and work flow for authoring, review and translation.

The Working Group looked forward to the launch and continued development of the new website.

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.

7.2 WG-SAM provided advice to the Scientific Committee and WG-FSA on the following items:

(i) Review of the CCAMLR tagging protocol –

(a) error trapping, sensitivity analyses and simulations (paragraphs 2.3 and 2.31)

(b) tag-based abundance estimates (paragraph 2.7)

(c) tagging information kit (paragraph 2.11)

(d) training package (paragraphs 2.13 to 2.15)

(e) experiments on the effect of handling and tagging on viability (paragraph 2.16)

(f) minimising exposure of fish to full sunlight during tagging (paragraph 2.18)

(g) tag-release programs in other regions (paragraphs 2.21 and 2.22).

(h) removing the requirement to weigh fish during tagging (paragraph 2.26).

(ii) Research plans for exploratory fisheries in Subareas 48.6 and 58.4 in 2012/13 –

(a) maps of research haul deployments (paragraph 3.3)
(b) data reporting requirements during research fishing (paragraph 3.6)
(c) evaluation of revised and future research plans (paragraph 3.20)
(d) correspondence group to facilitate coordination of research effort (paragraph 3.23).

(iii) Future meetings of WG-SAM –

(a) focus topics (paragraph 6.3).

(iv) Other advice –

(a) ageing workshop at the 2012 meeting of WG-FSA (paragraph 5.2)
(b) papers referred to WG-FSA for further consideration (paragraph 5.4)
(c) evaluation of 'Chartmaster' (paragraph 5.6).

7.3 In addition, the Working Group provided specific advice to Members engaged in research fishing in closed areas and Subareas 88.1 and 88.2:

(i) proposed research in Subarea 48.5 (paragraph 4.4)
(ii) research in Division 58.4.3b (paragraphs 4.6 and 4.10)
(iii) research in Divisions 58.4.4a and 58.4.4b (paragraph 4.15)
(iv) research in Subarea 88.1 (paragraph 4.23)
(v) research in Subarea 88.2 (paragraph 4.18)
(vi) research in Subarea 88.3 (paragraph 4.16).

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

8.1 The report of the meeting of WG-SAM was adopted.

8.2 In closing the meeting, Dr Hanchet thanked the participants for their contributions to the meeting and their work during the intersessional period, the rapporteurs for preparing the report, and the Secretariat for its support. Dr Hanchet also thanked the Centro Oceanográfico de Canarias for hosting the meeting, and Mr López Abellán and colleagues for their kind hospitality and assistance during the meeting.

8.3 The Working Group also thanked Dr R. Wiff (Chile) for his contribution to the meeting. Dr Wiff was the first recipient of a CCAMLR Scholarship, and his work on characterising the exploratory fishery in Subarea 48.6 (WG-SAM-12/23) was an important step towards developing assessments for exploratory fisheries in Subareas 48.6 and 58.4.

8.4 Dr Reid, on behalf of the Working Group, thanked Dr Hanchet for facilitating discussions in a convivial atmosphere which had resulted in a successful meeting.

REFERENCES

Agnew, D.J., J.M. Clark, P.A. McCarthy, M. Unwin, M. Ward, L. Jones, G. Breedt, S.D. Plessis, J.V. Heerdo and G. Moreno. 2006. A study of Patagonian toothfish (*Dissostichus eleginoides*) post-tagging survivorship in Subarea 48.3. *CCAMLR Science*, 13: 279–289.

Table 1: Schema for assessing the priority for addressing potential sources of bias in tag-recapture programs based on their likelihood of occurrence and impact on $\hat{N}$ derived from the Lincoln-Petersen equation.

Likelihood	Impact on $\hat{N}$	
	$\hat{N} > N$	$\hat{N} < N$
Low	Medium priority	Low priority
High	High priority	Medium priority

Table 2: Impact of processes that may occur during the initial capture, tagging and release of fish on a Lincoln-Petersen estimate (LPE) of abundance, assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation in CCAMLR toothfish fisheries. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; $\hat{M}$ – the estimate of M used for an LPE.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Transcription errors	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Data-checking/tag-matching methods at sea	Photo-matching recaptures	2.3(i, ii, iv), 2.10 to 2.14
Duplicate tag numbers released	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Use standard tags from a single source		
Selection of fish that are not representative of the catch	$\hat{M} > M$	$\hat{N} > N$	Low	Medium	Tag fish that are representative of the catch	Estimate area-/size-specific $\hat{M}$	2.3(iv), 2.10 to 2.14
Release rate of tagged fish higher in areas of low density relative to the overall population	$\hat{M} > M$	$\hat{N} > N$	High	High	Tag fish in proportion to the catch, spread tags across the experimental area	Use spatially explicit model	2.3(iii), 2.7(i)
Release rate of tagged fish higher in areas of high density relative to the overall population	$\hat{M} < M$	$\hat{N} < N$	High	Medium	Release fish at a constant proportion to the catch, spread tags across the experimental area	Use spatially explicit model	2.3(iii), 2.7(i)

Table 3: Impact of processes that may occur during the period a tagged fish is at liberty on a Lincoln-Petersen estimate (LPE) of abundance, assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation in CCAMLR toothfish fisheries. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; R – the number of tagged fish recaptured; $\hat{M}$ and $\hat{R}$ – the estimate of M and R used for an LPE; PIT – passive integrated transponder.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Tagged fish have a lower survivorship than the overall population due to release condition	$\hat{M} > M$	$\hat{N} > N$	High	High	Select fish suitable for tagging	Adjust $\hat{M}$ based on estimated post-capture mortality	2.3(iii), 2.10 to 2.14, 2.15 to 2.18
Fish are depredated post-release	$\hat{M} > M$	$\hat{N} > N$	High[a]	High[a]	Avoid areas with high depredation	Adjust $\hat{M}$ based on estimated depredation rate	2.6(ii), 2.15
Tag shedding	$\hat{M} > M$	$\hat{N} > N$	High[b]	High[b]	Double tagging, PIT tagging	Adjust $\hat{M}$ based on estimated tag-shedding rate	2.6(iii)
Tagged fish grow out of the size range selected by the fishery	$\hat{M} > M$	$\hat{N} > N$	Low	Medium		Estimate size-specific $\hat{M}$, include growth of tagged fish in model	
Tagged fish conduct large-scale movements out of the area of recapture effort	$\hat{M} > M$	$\hat{N} > N$	Low	Medium		Adjust $\hat{M}$ to account for movement out of the area of recapture effort, include fish movement in spatially explicit models	2.3(iii), 2.6(i)
Tagged fish do not have sufficient time to mix through the total population in the time between release and recapture	$\hat{R} > R$	$\hat{N} < N$	High	Medium	Spread tags across the experimental area	Adjust $\hat{R}$ to exclude recaptures with short times at liberty, include fish movement in spatially explicit models	2.3(iii), 2.6(i)

[a] Depredation of longline-caught fish has been reported in Subareas 48.3, 58.6 and 58.7 and Divisions 58.5.1 and 58.4.4.

[b] Some tag shedding is likely in all programs and may differ for larger fish where anchoring the standard size of CCAMLR tags between pterygiophores may be more difficult than for smaller fish, or where cacheloteras (used to minimise depredation) may cause tag shedding.

Table 4: Impact of processes that may occur during recapture on a Lincoln-Petersen estimate (LPE) of abundance, including assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; R – the number of tagged fish recaptured; C – total number of fish caught and scanned for tags; $\hat{M}$, $\hat{R}$ and $\hat{C}$ – the estimate of M, R and C used for an LPE; PIT – passive integrated transponder.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Not all tagged fish are detected	$\hat{R} < R$	$\hat{N} > N$	High	High	Make crew aware of need to check all fish, provide incentives to report tags, use automatic PIT tag detectors	Adjust $\hat{R}$ to account for undetected tags	2.10 to 2.14
Not all fish are scanned	$\hat{C} > C$	$\hat{N} > N$	High	High	Make crew aware of need to check all fish, use automatic PIT tag detectors	Adjust $\hat{C}$ to account for unscanned fish	2.10 to 2.14
Tagged fish are poorly selected by recapture effort	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Overlap recapture effort with areas where tagged animals have been released, use same gear for recaptures as for releases	Include estimates of area-/size-specific $\hat{R}$, growth and movement in models	2.3(iii), 2.6(i)

Table 5: Recommended categories and criteria for assessing the suitability of toothfish prior to tagging. Supporting text and diagrams will be provided to assist in clarifying the specific criteria.

Assessment category	Suitable for tagging	Do not tag
Hook injuries	One or more in mouth area only*	Hook injury anywhere else in the body
Gills	Gills bright blood red	Gills pink or white
Bleeding	No visible bleeding from gill arches None or only minor bleeding from hook injury elsewhere (e.g. broken fin rays)	Any visible bleeding from gill arches, or excessive bleeding elsewhere
Trunk	No visible damage to the fish trunk that penetrates skin exposing flesh	Visible damage to fish trunk with open wounds
Skin	No visible damage penetrating skin, eye, body cavity. No visible inner organs	Visible damage penetrating skin, eye or body cavity, including by crustaceans (amphipods/lice)
Skin	No significant abrasion or recent scale loss that is equal to, or exceeding, the area equivalent to the fish tail	Abrasions or recent scale loss equal to, or exceeding, the area equivalent to the fish tail
Movement	Active movement (e.g. body flexing, fin waving, gill cover clamping)	No movement detected

* Mouth area is defined as inside lips, jaw, or cheek, but not the back of the mouth.

Table 6: Preliminary evaluation template for research plans in data-poor fisheries. Evaluation criteria are as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (SC-CAMLR-XXX, Annex 5, paragraph references are included in the criteria) and as set out in CM 24-01, Format 2.

CM 24-01, Format 2, Evaluation criteria	WG-SAM-12/___ Preliminary evaluation
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	
(i) index of abundance	
(ii) stock hypothesis/population structure	
(iii) biological parameters.	
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)	
(i) tag overlap	
(ii) spatial overlap	
(iii) temporal overlap	
(iv) fish suitable for tagging	
(v) depredation.	
5. Is the initial design for a data-poor area complete? (paragraph 2.40)	
(i) appropriate spatially restricted area	
(ii) preliminary plausible estimate of *B*	
(iii) total catch and tag rates to achieve a target CV	
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	
7. Is there future planned research leading to an assessment along with a corresponding time frame?	

Table 7: Preliminary evaluation of a research proposal. Evaluation criteria are as agreed by the focus topic on data-poor fisheries at WG-SAM-11 (paragraph references refer to corresponding paragraphs of SC-CAMLR-XXX, Annex 5). Where individual evaluation criteria are labelled 'N' the information is not provided in the research proposal; proponents are requested to provide it in their updated proposals to WG-FSA. Where criteria are labelled * information is provided but proponents are requested to provide more detailed descriptions or further information as described in the text.

CM 24-01, Format 2. Evaluation criteria	WG-SAM-12/04 and 12/11	WG-SAM-12/15	WG-SAM-12/16 and 12/17
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	*	N	N
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y	Y
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)			
(i) index of abundance	Y	Y	Y
(ii) stock hypothesis/population structure	N	N	N
(iii) biological parameters.	*	*	*
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)			
(i) tag overlap	Y	Y	Y
(ii) spatial overlap	*	Y	*
(iii) temporal overlap	Y	Y	Y
(iv) fish suitability for tagging	Y	Y	Y
(v) depredation.	Y (n/a)	Y (n/a)	*
5. Is the initial design for a data-poor area complete? (paragraph 2.40)			
(i) appropriate spatially restricted area	*	Y	Y
(ii) preliminary plausible estimate of *B*	(n/a)	Y	Y
(iii) total catch and tag rates to achieve a target CV	(n/a)	Y	Y
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	Y	Y
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	*	N	N
7. Is there future planned research leading to an assessment along with a corresponding time frame?	*	N	N

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(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

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Appendix B

AGENDA

Working Group on Statistics, Assessments and Modelling
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

1. Introduction

    1.1 Opening of the meeting
    1.2 Adoption of the agenda and organisation of the meeting

2. Focus topic: review of the CCAMLR tagging program

    2.1 Design of program
    2.2 Implementation of program
    2.3 Analysis of results

3. Evaluation of research plans from Members notifying to fish in new and exploratory fisheries in Subareas 48.6 and 58.4

4. Review of scientific research proposals for other areas (e.g. closed areas, areas with zero catch limits, Subareas 88.1 and 88.2)

5. Methods for assessing finfish stocks in established fisheries, notably *Dissostichus* spp.

6. Other business

7. Advice to the Scientific Committee

    7.1 WG-FSA
    7.2 General

8. Adoption of report and close of meeting.

Appendix C

LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

WG-SAM-12/01	Draft Preliminary Agenda for the 2012 Meeting of the Working Group on Statistics, Assessments and Modelling (WG-SAM)
WG-SAM-12/02	List of participants
WG-SAM-12/03	List of documents
WG-SAM-12/04	Plan of research program of the Russian Federation in Subarea 48.5 (Weddell Sea) in season 2012/13 A.F. Petrov, V.A. Tatarnikov and I.I. Gordeev (Russia)
WG-SAM-12/05	Results of Phase I and II of the research program for toothfish fishery in Subarea 88.3 during the 2010/11–2011/12 seasons A.F. Petrov, V.A. Tatarnikov, K.V. Shust, I.I. Gordeev, E.F. Kulish (Russia)
WG-SAM-12/06	Deployment of research hauls in the exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 in 2011/12 Secretariat
WG-SAM-12/07	Data requirements for research fishing Secretariat
WG-SAM-12/08	Report of the 1st and the 2nd stage of research fishing conducted by Russian Federation in SSRU 882A in 2010–2012 E.F. Kulish and I.I. Gordeev (Russia)
WG-SAM-12/09	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a Submitted on behalf of Japan
WG-SAM-12/10 Rev. 1	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Division 58.4.1 Submitted on behalf of the Republic of Korea
WG-SAM-12/11	Notification for multi-year research in Subarea 48.5 Submitted on behalf of Russia

WG-SAM-12/12 Rev. 1	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Subarea 48.6 and Divisions 58.4.2 and 58.4.3a Submitted on behalf of South Africa
WG-SAM-12/13	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Divisions 58.4.1 and 58.4.2 Submitted on behalf of Spain
WG-SAM-12/14	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Division 58.4.3a Submitted on behalf of France
WG-SAM-12/15 Rev. 1	Preliminary reports on abundance and biological information of toothfish in Division 58.4.3b by *Shinsei Maru No. 3* in the 2011/12 and proposal of the consecutive survey in the 2012/13 K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-SAM-12/16	Reports on abundance and biological information on toothfish in Divisions 58.4.4a and 58.4.4b by *Shinsei Maru No. 3* in 2011/12 season K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-SAM-12/17	Research plan for toothfish in Divisions 58.4.4a and 58.4.4b by *Shinsei Maru No. 3* in 2012/13 Delegation of Japan
WG-SAM-12/18	Method of age determination for Antarctic toothfish (*Dissostichus mawsoni*) E.N. Kyznetsova, A.F. Petrov and V.A. Bizikov (Russia) (*CCAMLR Science*, submitted)
WG-SAM-12/19	Movement of Patagonian toothfish (*Dissostichus eleginoides*) in Subarea 48.3 T. Peatman, S.M. Martin, J. Pearce and R.E. Mitchell (United Kingdom)
WG-SAM-12/20	Estimation of toothfish distribution and population size in Subarea 88.3 by results of research longline fishing in 2011–2012 V.A. Tatarnikov, I.G. Istomin and V.V. Akishin (Russia)
WG-SAM-12/21	Finfish research proposals for Subarea 48.6 and Divisions 58.5.2; 58.4.3a by *Koryo Maru 11* for 2012/13 R. Ball (South Africa)
WG-SAM-12/22	CCAMLR tagging program: tag link status update Secretariat

WG-SAM-12/23	Measures to avoid bias in abundance estimates of *Dissostichus* spp. based on tag-recapture data D.C. Welsford and P.E. Ziegler (Australia) (*CCAMLR Science*, submitted)
WG-SAM-12/24	Influence of tag numbers, size of tagged fish, duration of the tagging program, and auxiliary data on bias and precision of an integrated stock assessment P.E. Ziegler (Australia)
WG-SAM-12/25	Are tagging targets set in appropriate terms? R.W. Leslie and C. Heinecken (South Africa)
WG-SAM-12/26	Drawing on international experience to improve performance of CCAMLR tagging programs S. Parker and S. Mormede (New Zealand)
WG-SAM-12/27	Viability criteria for tagging toothfish S. Parker (New Zealand)
WG-SAM-12/28	Proposal to continue the time series of research surveys to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea in 2013 S.M. Hanchet, S. Mormede, S.J. Parker and A. Dunn (New Zealand)
WG-SAM-12/29	Results of a research survey to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea, February 2012 S.M. Hanchet, S. Mormede, A. Dunn (New Zealand) and H.-S. Jo (Republic of Korea)
WG-SAM-12/30	The development of spatially and temporally controlled measures of survival and tag-detection for the CCAMLR tagging program S. Mormede and A. Dunn (New Zealand)
WG-SAM-12/31	Recommendations for CCAMLR tagging procedures S. Parker, J. Fenaughty (New Zealand), E. Appleyard (Secretariat) and C. Heinecken (South Africa)
WG-SAM-12/32	Preliminary results from the Argentine tagging program for the Patagonian toothfish in the south-western Atlantic P.A. Martínez, J.A. Waessle and O.C. Wöhler (Argentina)
WG-SAM-12/33	A characterisation of the toothfish fishery in Subarea 48.6 from 2003/04 to 2011/12 R. Wiff (Chile), M. Belchier (United Kingdom) and J. Arata (Chile)

Report of the Working Group on Ecosystem Monitoring and Management
(Santa Cruz de Tenerife, Spain, 2 to 13 July 2012)

CONTENTS

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Santa Cruz de Tenerife, Spain, 2 to 13 July 2012)

INTRODUCTION

Opening of the meeting

1.1 The 2012 meeting of WG-EMM was held at the Centro Oceanográfico de Canarias (COC), Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain, from 2 to 13 July 2012. The meeting was co-convened by Drs S. Kawaguchi (Australia) and G. Watters (USA) and local arrangements were coordinated by Mr L. López Abellán (COC).

1.2 Drs Kawaguchi and Watters welcomed the participants (Appendix A) and outlined the work plan agreed by the Scientific Committee (SC-CAMLR-XXX, Table 6). The agenda focused on the krill-centric ecosystem and management of the krill fishery and MPAs, including the outcomes from two technical workshops held earlier in 2012.

1.3 The pre-release version of the new CCAMLR website was available during the meeting. The new website features:

- modern design with expandable menus, quick links and related pages
- fully indexed search engine consistent with access security rules
- delegated access control using individual email addresses
- online meeting registration
- internal framework and work flow for authoring, review and translation
- comprehensive document archive, including listing of meeting papers by agenda items.

1.4 The Working Group congratulated the Secretariat for the extensive redevelopment of this online resource, and looked forward to the launch and continued development of the new website.

Adoption of the agenda and organisation of the meeting

1.5 The Working Group discussed the provisional agenda and agreed to expand Item 3 to include consideration of VMEs, and add an item on other ecosystem consideration, including fish-based interactions. The revised agenda was adopted (Appendix B).

1.6 Ten subgroups addressed detailed aspects of the agenda:

- Fishing activities (coordinator: Dr J. Arata, Chile)
- Scientific observations (coordinator: Dr G. Milinevskyi, Ukraine)
- Krill biology, ecology and management (coordinator: Dr A. Constable, Australia)
- Feedback management strategy (coordinator: Dr P. Trathan, UK)
- CEMP and WG-EMM-STAPP (coordinator: Dr C. Southwell, Australia)
- Integrated assessment model (coordinator: Dr Trathan)

- Fishing vessel surveys (coordinator: Dr J. Watkins, UK)
- MPAs (coordinator: Dr S. Grant, UK)
- VMEs (coordinator: Dr B. Sharp, New Zealand)
- Other ecosystem consideration (coordinator: Dr S. Hill, UK).

1.7 Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all authors of papers for their valuable contributions to the work presented to the meeting.

1.8 In this report, paragraphs that provide advice to the Scientific Committee and its working groups have been highlighted; these paragraphs are listed in Item 5.

1.9 The report was prepared by Drs L. Emmerson (Australia), Hill, J. Hinke (USA), T. Ichii (Japan), Prof. P. Koubbi (France), Drs P. Penhale (USA), D. Ramm (Data Manager), K. Reid (Science Officer), Sharp, G. Skaret (Norway), V. Siegel (EU), Southwell and Prof. M. Vacchi (Italy).

THE KRILL-CENTRIC ECOSYSTEM AND ISSUES RELATED TO MANAGEMENT OF THE KRILL FISHERY

Issues for the present

Fishing activities

Summary report on the fishery

2010/11

2.1 Thirteen vessels from six Members fished for krill in Area 48 during the 2010/11 fishing season and the total catch of krill was 180 992[1] tonnes. The largest catch of krill was taken off the South Orkney Islands in Subarea 48.2 where a total of 111 472 tonnes of krill was taken from the SOW SSMU; this was the highest catch reported from that SSMU since 1990/91. The other main area fished during the season was South Georgia, where 53 112 tonnes were taken from the SGE SSMU. The remainder of the catch was taken predominantly at the Antarctic Peninsula in Subarea 48.1, including 7 970 tonnes from the APDPE SSMU (WG-EMM-12/05, Table 5).

2.2 Two vessels used the continuous fishing system (*Saga Sea* and *Thorshøvdi*, now renamed *Antarctic Sea*) and accounted for approximately 49% of the total catch. Norway reported the largest catches of krill with a total of 102 460 tonnes, the Republic of Korea reported 30 642 tonnes, Japan reported a catch of 26 390 tonnes, the People's Republic of China reported 16 020[1] tonnes, Poland reported 3 044 tonnes and Chile reported 2 436 tonnes.

2.3 The catches of krill in 2010/11 did not trigger any closures in the fishery.

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[1] Revised by the Secretariat during the meeting

2011/12

2.4 Nine vessels licensed from five Members (Chile, People's Republic of China, Japan, Republic of Korea and Norway) have fished for krill in Area 48 up to May 2012. The total catch reported to May 2012 was 78 468 tonnes, mostly taken from Subarea 48.1 in December, April and May. Approximately 60% of the catch reported so far this season has been taken by a single vessel (*Saga Sea*) using the continuous fishing system and pelagic beam trawls.

2.5 Based on the catch reported to May 2012, the equivalent catch reported to May in the previous five seasons, and the total catches in those seasons, forecast of the total catch for the current season falls within the approximate range of 108 000 to 151 000 tonnes. The trajectory of the cumulative catch in 2011/12 is currently in the lower range of the catch trajectories observed in the past five seasons.

2.6 The Working Group noted that the forecasted total catch of krill should be interpreted cautiously since the trajectory pattern of monthly cumulative catch in 2011/12 indicated a linear monthly increase in catches and is very different to the sigmoidal increase in catches from the previous five seasons. In addition, the sea-ice coverage in winter 2012 was unusually low in Subarea 48.1 (see also SC-CAMLR-XXX, Annex 4, paragraph 2.6).

Notifications for the 2012/13 fishing season

2.7 Eight Members submitted notifications for a total of 19 vessels intending to participate in krill fisheries during the 2012/13 fishing season. Six new vessels are intending to enter the fishery: two vessels from each of Germany and Ukraine and one vessel from each of Chile and Poland. The notifications are for trawl fisheries for krill in Subareas 48.1, 48.2, 48.3 and 48.4. No notifications were submitted for exploratory krill fisheries in Subarea 48.6 or elsewhere. The total notified catch for 2012/13 was 672 700 tonnes, the highest notified catch in Area 48 so far (WG-EMM-12/05, Figure 6).

2.8 The Working Group noted that Germany has notified, for the first time, its intent to harvest a total of 150 000 tonnes of krill with two vessels, and Poland, which is a long-standing krill fishing nation with recent catches of 3 000–8 000 tonnes, has notified as much as 150 000 tonnes with two vessels.

2.9 Dr Siegel informed the Working Group that a meeting between the fishing companies and relevant scientists is scheduled in Germany for late July 2012 and further information will be available to the Scientific Committee. The Working Group noted that Poland had submitted a notification to fish for krill in 2012/13 but was not represented at the meeting, and reiterated its request for all Members engaged in the fishery to provide scientists to the relevant working group.

2.10 The Working Group noted that the notified catch for Area 48 in 2012/13 is the highest on record and in excess of the trigger level of 620 000 tonnes, but considering the discrepancy between notified and actual catches in the past, the notifications are likely to be more indicative of the total capacity of the vessels rather than their actual expectations to achieve those catches.

2.11 The Working Group reviewed all notifications received and confirmed that all basic information have been provided. However, the Working Group did note the following in respect of the inconsistencies between notifications:

- in many cases, the indications of proposed catches, fishing areas and dates do not necessarily provide the information on their exact plans regarding spatial and temporal fishing patterns

- notifications from four Members were using a previous version of the notification form in CM 21/03, Annex 21-03/A, which was revised by the Commission in 2010 (as provided by the Secretariat in COMM CIRC 12/45).

Green weight

2.12 The Working Group recalled the Scientific Committee's previous advice that all methods for estimating green weight of krill have associated uncertainty, and that the absolute uncertainty in catch estimates increases in proportion to the catch (SC-CAMLR-XXX, paragraph 3.14). It noted that this uncertainty is not accounted for in the current management process which uses an estimate of total catch without any uncertainty associated with that estimate, and that the Scientific Committee requested that the Working Group characterise such variability and uncertainty to investigate their impacts on krill management advice.

2.13 The Working Group agreed that total removals of krill should not exceed the total allowable catch, that reported catches have errors in their estimation and the level of error in reported catches is dependent on the process by which the reported catch is estimated, which may vary between product types, vessels and inherent attributes of krill in a given time of year.

2.14 Given the errors in determination of the reported catch, a fishery may need to be closed when the reported catch is less than the total allowable catch in order that the total removals have no more than an agreed probability of exceeding the total allowable catch. The acceptable level of risk that the total removals exceed the total allowable catch needs to be determined by the Commission.

2.15 Notifications to fish for krill in the 2012/13 fishing season contained descriptions of a range of different methods for estimating green weight (i.e. conversion factors, codend estimate, cubic metre of the holding tank, flow scale, flow meter) (WG-EMM-12/06 to 12/13). However, these notifications did not include sufficient details of the methods to estimate the green weight of krill caught and the exact method of how each of the conversion factors were derived.

2.16 The Working Group recognised that it did not currently have the necessary detailed information and data to estimate the uncertainty associated with green weight reported by vessels or for understanding the underlying variability in the constants used for making these estimations. A more detailed description of this issue and a process by which the required information and data could be acquired is described in Appendix D.

2.17 The Working Group recommended that the information presented in Table 2 of Appendix D provided a clear indication of what should be included in the 'description of the exact detailed method of estimation of the green weight of krill caught' required in the notifications for the krill fishery (CM 21-03, Annex 21-03/A) and that Members submitting notifications should refer to this table as a guide when completing the notification.

2.18 The Co-conveners of WG-EMM agreed to forward Appendix D and the relevant recommendations of the Working Group to all Members who had submitted a notification under CM 21-03 for the 2012/13 season in order to prepare a paper, based on Appendix D, for the Scientific Committee to progress the issue of green weight estimation arising from the discussions held at WG-EMM.

2.19 The Working Group encouraged Members to further explore the relationship between estimates of catch from the same haul as derived at different points along the production line (e.g. flow meter vs. conversion factors or codend estimates vs. conversion factors) as suggested in SC-CAMLR-XXX, Annex 4, paragraph 2.56, in order to understand accurately the different conversion factors for different production lines.

2.20 The Working Group agreed that the catch reporting form C1, used to submit catch data as required in CM 23-06, should be updated to facilitate the submission of the following relevant information:

- indicate the method used for estimating the green weight (i.e. as in Appendix D, Table 2)

- report haul-by-haul the measurement of the haul-specific attribute (i.e. the 'H_h' height of the krill catch in the holding tank) and other constants used.

2.21 The Working Group requested that the multipliers used to convert the measured component of the catch to an estimate of green weight should be estimated at least once every reporting period where those reporting periods are specified in CM 23-06.

2.22 Arising from the analysis of the descriptions of the methods for estimating green weight, the Working Group agreed that a parameter common to all methods and which is likely to vary throughout the fishing season, but is currently not reported in any of the notifications, is the estimation of the volume to weight conversion factor (parameter Rho (ρ) in Appendix D, Table 2). The Working Group agreed that the method for estimating Rho provided in Appendix D could be suitable for providing the necessary information on volume to weight conversion.

2.23 Recognising that the reporting of catch is a Flag State responsibility, the Working Group recognised that this process could be done by, or with the aid of, the scientific observer. Likewise, scientific observers could aid in providing detailed descriptions of the method(s) used on the vessels to estimate each parameter in the relevant equation in Appendix D, Table 2, including an evaluation of the associated uncertainty.

Data from former Soviet krill fishing expeditions

2.24 In 2009, Drs Milinevskyi and L. Pshenichnov (Ukraine) initiated a project to digitise haul-by-haul catch and effort data from 54 former Soviet krill fishing expeditions between 1973 and 1992. These data were uploaded to the CCAMLR database in 2011.

Drs Milinevskyi and Pshenichnov then proposed processing of the biological data from these expeditions, should the funding allow. These data, when available, would be integrated in the CCAMLR database. Drs Milinevskyi and Pshenichnov noted that the funding arrangement for processing the biological data had not eventuated.

2.25 The Working Group asked whether the Scientific Committee is able to consider potential ways for allocating funding for supporting the continuation of the project to digitise the historical biological data (see also SC-CAMLR-XXVIII, paragraphs 13.8 to 13.10).

Krill fishery analysis

2.26 WG-EMM-12/15 examined the distribution of spatial management and Antarctic krill (*Euphausia superba*) catch across pelagic bioregions in the Southern Ocean by developing a GIS. Krill fishing activity in Area 48 from 1995 to 2010 was identified to occur in only 26% of the area open to krill fishing and was concentrated in three of the seven bioregions found in this area (see also paragraphs 3.69 and 3.70).

2.27 WG-EMM-12/35 presented a description of krill distribution in the Indian sector of the Southern Ocean (Divisions 58.4.1 and 58.4.2) based on commercial fishing data from the former Soviet fleet from 1977 to 1984. Fishable krill aggregations occurred off the continental shelf (i.e. depths deeper than 1 000 m). The fishery in the sector ceased due to operational impediments arising from remoteness of the area from the ports as well as the availability of alternative fishing areas.

2.28 WG-EMM-12/30 described krill fishing activities in Subareas 48.1, 48.2 and 48.3 by the Chilean-flagged vessel *Betanzos* during June 2011 and April 2012. It highlighted the distributions of effort, catches, trawl depths and fishing yields and length-frequency distribution of krill. The Working Group noted that if the vessel operates in similar areas and months during 2012/13, this would provide an opportunity to examine potential changes in fishing proficiency of new fishing operators.

2.29 WG-EMM-12/50 analysed the space–time dynamics of the krill fishery in Area 48 and its relation to climate variability using the CCAMLR fishery data and a time series of the Antarctic Oscillation Index (AAO) as an indicator of climate variability between 1986 and 2011. Changes in seasonal distribution of krill catch from 1996 to 2011 compared with previous seasons (1986–1995) were observed; this seasonal shift of the fishing period towards autumn–winter months had been associated with climate variability. The most significant shift of the fishery regime occurred in 2006, when fishery transferred to the state of high CPUE from 2006 to 2011. This period is characterised by the highest values of CPUE index and AAO index reached in Area 48 for the whole 1986–2011 observation period. The significant positive correlation coefficients between CPUE and AAO trends provide evidence that the ongoing climate changes are one of the reasons for the revealed changes in the fishery regime. At the same time, the lack or weakness of correlation between the trends of interannual CPUE dynamics between Subareas 48.1, 48.2 and 48.3, and increasing of the Subarea 48.1 contribution to the total dynamics of fishery in Area 48 in the recent years, were observed.

2.30 The Working Group welcomed the analysis as an important contribution to improve our understanding of the krill fishery dynamics in relation to climate change. With regard to the high CPUE regime from 2006 to 2011, the Working Group postulated that this may have arisen from an increase in the catch rates of vessels using the continuous fishing system. The shift of the fishing season towards autumn–winter may have resulted from changes in the krill fishing operation and market-related considerations and strategies. The Working Group encouraged the authors to consider how much of the changes observed in recent years can be attributed to changes in fishing technology.

Krill escape mortality

2.31 A preliminary observation on krill escape mortality through trawl nets was made using an underwater video camera attached on the trawl net of the Japanese commercial trawler *Fukuei Maru* in 2011 (WG-EMM-12/66). Few krill were observed to escape from the posterior part (mesh size of 70 mm) of the trawl net, but a high proportion of krill was observed to escape from the anterior part (mesh size of 150 mm) of the net. Video footage from the anterior part of the trawl net showed that krill swam actively after they escaped through the net, suggesting that their escape mortality may be low. The Working Group noted that a higher rate of krill passing through the larger mesh may be associated with a lower rate of krill being killed as a result of collision with the net, whereas the opposite has been shown for 60 mm mesh sizes in previous years; e.g. WG-EMM-11/15 reported that the equivalent of 2% to 3% of the retained catch passed through the net, of which 60% to 70% were killed.

2.32 WG-EMM-12/43 described methods for the investigation of krill escape mortality, building on the Russian history of research on interactions of krill with trawls. The paper described the use of small-mesh catchers (chafers) on the outside of trawl nets to collect and retain krill that pass through the mesh during towing. The description of chafer construction and its installation on trawl nets was shown. The survival rate of krill after they passed through the trawl net was determined by monitoring survival rates of those krill in a seawater aquarium for over 24 hours.

2.33 The Working Group noted potential difficulties in defining an objective criterion for krill survival after passing through the trawl net in the aquarium and therefore encouraged authors to submit further information and results obtained from this experiment. The Working Group noted that this study provides useful information for developing a standard methodology to quantify escape mortality in the krill fishery.

2.34 WG-EMM-12/24 described a three-year project (commenced in 2012) to apply a mathematical modelling tool (FISHSELECT), designed to investigate the relationship between morphology of marine organisms and net design in order to predict basic selective characteristics of different trawls. Results will be used to quantify the theoretical catch efficiency and escapement of krill for different net designs, and also to construct design guides to minimise escape mortality. The Working Group looked forward to seeing the results of the project.

Finfish by-catch

2.35 WG-EMM-12/28 analysed variables influencing finfish by-catch in the krill fishery in Area 48 using a delta-lognormal modelling approach based on scientific observer data collected on the *Saga Sea* between 2007 and 2012. There was a wide disparity in the influence of the explanatory variables, i.e. time of day, krill catch, sea-surface temperature (SST), bottom depth and fishing depth and season, on the presence of finfish in by-catch, which varies markedly by taxonomic grouping to the family level (the lowest level of identification that could be achieved) and CCAMLR subarea. There were, however, some trends which persisted across subareas and taxonomic families, the most notable observed trend being the reduced by-catch ratio for all families of finfish investigated in dense krill aggregations, which is consistent with the literature.

2.36 WG-EMM-12/29 used the model as described in WG-EMM-12/28 to estimate total finfish by-catch by the *Saga Sea*. The methodology provided quantitative analysis of the impact of the krill fishery on finfish species at a family level, as well as for individual species. Estimates of total unrealised spawning biomass of the by-catch (i.e. the spawning biomass that the small fish caught in the krill fishery would have contributed to the population) from the *Saga Sea* suggested that finfish by-catch rates of the vessel are unlikely to impact on the finfish stock biomass in Area 48.

2.37 The Working Group noted that these two studies are useful to understand the potential impact of the krill fishery on finfish stocks. The Working Group requested the methodologies and assumptions of these two papers be reviewed by WG-FSA.

Scientific observation

2.38 Analyses of the scientific observer coverage during the 2010 and 2011 fishing seasons were presented in WG-EMM-12/60, 12/64 Rev. 1 and 12/65. In 2010 there were 10 vessels in the fishery and there were observers on nine of these vessels with an overall rate of vessel × month coverage (i.e. the number of months when observer data were collected as a percentage of the months when fishing occurred) of 80%, in 2011 there were 13 vessels of which 12 carried observers with an overall rate of vessel × month coverage of 90%. The Working Group appreciated this level of coverage and noted that scientific data had been collected in all months and subareas where the fishery had operated and had greatly exceeded the minimum requirements in CM 51-06.

2.39 The Working Group agreed that the improvements in coverage and quality of data collected on krill length measurements were evident in the analyses presented in WG-EMM-12/60 and 12/67. Both of these analyses indicated that variability in the length-frequency distribution of krill was predominantly at the scale of subarea and month, suggesting that aggregating krill length data at those scales was appropriate for analysing krill population processes. The analysis of the remaining between-haul variability, having accounted for the spatio–temporal factors, indicated that, while there remained an effect of vessel, there was no effect of fishing method.

2.40 The between-haul variability in krill length-frequency distributions showed a distinct seasonal pattern and was greatest during the period November to February. The Working Group recommended that the sampling frequency should be increased between November and February to collect samples at three-day intervals, while continuing sampling at the current five-day periods between March and October, noting that this sampling frequency would be reviewed in future when more data become available.

2.41 The Working Group thanked the authors of WG-EMM-12/60 and 12/67 and encouraged further collaboration between the Secretariat and Members in developing these types of analyses.

2.42 In contrast to the similarity between vessels in the krill length measurements there were substantial differences in the reported fish by-catch between vessels. The Working Group recognised that conducting a fishery-wide analysis of fish by-catch was confounded by variability in the data quality and quantity between vessels. However, noting also the analysis in WG-EMM-11/39 and WG-EMM-12/28 and 12/29, the Working Group agreed that improving the overall quality of fish by-catch data should be a priority for scientific observers.

2.43 The Working Group discussed a proposal for a three-year study to provide an improved understanding of the magnitude, species and size composition of fish by-catch in the krill fishery. This study would require the collection of fish by-catch data in all months and areas that the fishery operates and would require clarity in the sampling protocols to be used. The Working Group recalled the decision to remove the old K5 fish by-catch form from the observer logbook and stressed the importance of using the most recent version of the e-logbook and the K10 forms in order to avoid any confusion over the reporting protocol of fish by-catch.

2.44 The identification of fish that occur as by-catch in the krill fishery at the level of species (including larval fish) is a specialist task, and the availability of technically qualified observers may mean that it is not possible to collect high-quality data on all vessels throughout the entire period of the fishery. In order to address this, the Working Group agreed that there was a need to improve observer training, possibly through workshops hosted by Members, as well as development of field guides (possibly similar to the CCAMLR VME taxa classification guide – www.ccamlr.org/node/74322) and suitable data collection protocols that allowed data collection at appropriate taxonomic levels.

2.45 Feedback from observers suggested that there are contradictory instructions in the *Scientific Observers Manual* and the logbooks that cause confusion, and the Working Group noted the discussion of sampling requirements for observers in all CCAMLR fisheries by the Scientific Committee (SC-CAMLR-XXX, paragraph 7.15). The Working Group encouraged simplifying the observer logbooks to make them more efficient for observers on krill fishing vessels.

2.46 The Working Group recalled the request from the Scientific Committee to consider the potential conflict between the sampling flexibility allowed in the instructions in the *Scientific Observers Manual* and the precise requirements of paragraph 3(ii) of CM 51-06. The number of hauls per day ranged from 3 to 20 between vessels in the krill fishery in 2010 and 2011, therefore specifying a fixed target coverage rate would result in uneven data collection between vessels.

2.47 The Working Group recommended that the target coverage of at least 20% of hauls or haul units be removed from paragraph 3(ii) of CM 51-06, noting that the sampling rates for the priority items of krill length measurement and fish by-catch are specified as a sampling requirement on a per-fishing-day basis rather than as a haul-based rate.

2.48 In reviewing the potential future requirements for the collection of scientific observer data in the krill fishery, the Working Group agreed that it was desirable to maintain the rate of observer coverage that had been achieved in the 2010 and 2011 fishing seasons (paragraph 2.38) as this had been shown to provide a large improvement in quantity and quality of data required by the Scientific Committee to achieve its objectives. However, noting the potential constraints arising from the availability of suitably qualified observers, the Working Group agreed that in revising CM 51-06 it will be important to specify a rate of vessel coverage that maintains the current level of coverage and allows flexibility in the deployment of observers to ensure that data quality is not compromised.

2.49 The Working Group recommended that those vessels that do not carry observers for all of their fishing operations should have an observer on board during some period of their fishing activity in each year. However, the Working Group suggested that a decision on the required level of observer coverage rate (time period when observer data is collected as a proportion of the time period that the vessel is fishing) that is specified in the conservation measure is a matter for the Commission.

Krill ecology and management

Krill biology

2.50 WG-EMM-12/32 presented preliminary results of the impacts of ocean acidification due to elevated seawater pCO_2 and reduced pH levels on the activity, mortality and moulting of post-larval krill. The experimental system was set up at pCO_2 levels of 380, 1 000 and 2 000 μatm. Krill activity levels were recorded and growth rate was measured using the instantaneous growth rate (IGR) method, and seawater carbonate chemistry was measured in detail:

(i) Results showed that in general, krill mortality was greater in animals exposed to increased levels of pCO_2 compared to controls. At the same time neither the IGR nor the inter-moult period (IMP) were significantly influenced by exposure to the increased pCO_2 levels. Krill activity levels were found to be significantly reduced when exposed to increased pCO_2. Other qualitative observations indicated bacterial growth on poor-conditioned animals, unconsumed phytoplankton, and increasing inability to properly complete the moulting cycles.

(ii) Projection for the year 2100 suggested that pCO_2 maxima could approach close to 1 400 ppm, although its distribution will be highly variable in space and depth. The authors therefore concluded that krill could be negatively affected by elevated CO_2 within the range projected for 2100 in some regions of the Southern Ocean.

(iii) Furthermore, the authors stressed that ocean warming and acidification, together with other environmental change, are likely to occur concurrently. They therefore argued for the establishment of a physiology-based krill growth and a life-history model which must be responsive to climate change scenarios, including ocean acidification.

2.51 The Working Group welcomed these new research activities as being of high relevance, because there is an increased body of evidence showing the impact of climate change on biological and ecological traits in the Southern Ocean which will need to be considered in its advice to the Scientific Committee on managing the krill stocks as soon as possible.

2.52 In this regard the Working Group also noted the very recent publication of the report of the EU/NL-sponsored workshop on climate change impacts on the krill-centric ecosystem in *Marine Ecology Progress Series* in which many CCAMLR scientists were actively involved.

2.53 WG-EMM-12/38 reviewed approaches to assess productivity of krill and what will be needed to account for its regional variation and long-term trends when establishing sustainable catch limits for krill. It reviewed the models available in the literature for growth and reproduction. A growth model is proposed that is based on observed instantaneous growth rates and takes account of the physiological response of krill to the amount of food consumed, the temperature and the investment in reproduction.

2.54 The new model in WG-EMM-12/38 aims to facilitate adaptation of production models to changing environments. The energetic moult-cycle model presented here utilises field observations of growth and can take account of important factors that vary in space and time, notably temperature and food. A great challenge for all models will be to take account of movement of krill during their life cycle between areas under spatially and temporally varying environmental and ecological conditions.

2.55 The Working Group welcomed the growth model presented in WG-EMM-12/38 and noted that the proposed model represents a revision and further development of the model presented to WG-EMM at its 2006 meeting. The Working Group regarded the progress made as an important step forward and realised that results of the model outputs well reflect published data on krill growth. Furthermore, it regarded the flexibility of the model as a great improvement to take account of reproduction, difference between males and females and changes in primary production due to climate change.

2.56 The Working Group recalled that results based on the von Bertalanffy growth function (VBGF) are acceptable for short-term predictions, however, continued use of these models would require a re-estimation of the parameters for different regions and periods.

2.57 The Working Group therefore recommended the proposed new growth model for Antarctic krill based on energetics and knowledge of the moult cycle should be submitted to WG-SAM for review to be incorporated into future assessments of yield for krill and in developing feedback management procedures.

Krill-based food web

2.58 WG-EMM has developed and used ecosystem models to evaluate options for spatially allocating the krill catch in Subareas 48.1 to 48.3. The Working Group is likely to use such models for evaluating feedback management options and other future tasks. WG-EMM-12/20 Rev. 1 proposed a formal and strategic framework for assessing uncertainty in ecosystem models, provided a general sensitivity analysis for the FOOSA model (WG-EMM-06/22), and described an algorithmic calculation of initial steady-state parameters.

2.59 The study considered multiple output variables, which had previously been used by WG-EMM and which differed markedly in their sensitivity to perturbations to input variables. Results indicated that overall FOOSA is stable, but results are sensitive to parameters estimated in the conditioning process.

2.60 The Working Group welcomed the presentation of results as wheel plots. It agreed that sensitivity analyses are important to future applications of models. Such analyses may also be useful for guiding data collection. For example, WG-EMM-12/20 Rev. 1 highlighted the importance of parameters describing penguin winter mortality, and the krill population response to environmental forcing. The Working Group noted that there are trade-offs in terms of the prioritisation of effort between model development, model evaluation and data collection for model validation.

Krill assessment

2.61 WG-EMM-12/31 presented a recalculation of krill biomass for the 2006 BROKE-West summer survey in Division 58.4.2, applying the advice from SG-ASAM. Four data processing updates were applied. Two amendments were related to the calculation of mean volume backscattering strength within elementary distance sampling units and the integration interval. The other changes were related to revised krill target strength estimation and subsequent acoustic target identification.

2.62 The Working Group noted that the analysis could be improved by using the parameterisation of krill orientation distribution in the target strength model derived at SG-ASAM-10 for the reanalysis of the CCAMLR-2000 Survey. Consequently, the assessment of WG-EMM-12/31 was updated during the WG-EMM meeting with that krill orientation distribution.

2.63 The Working Group estimated B_0 in Division 58.4.2 during 2006 to be 24.48 million tonnes (CV 0.20). On the subdivision level, the revised estimates were 14.87 million tonnes (CV 0.22) for the western area, and 8.05 million tonnes (CV 0.33) for the eastern area.

2.64 The Working Group noted that the revision of the assessment resulted in smaller biomass estimates than used for the yield estimates in 2010. However, the Working Group expressed the opinion that it would not recommend a recalculation of the potential yield and a change of the existing CM 51-03 (2008) this year because of work needed to improve parameterisation of recruitment variation in the GYM and the work in progress on this matter (see paragraphs 2.69 to 2.71). The Working Group also noted that there are no pending notifications for the krill fishery in the area for the 2012/13 season, which would allow time for work on the GYM.

2.65 WG-EMM-12/26 presented an analysis of krill sampling data which were supplied to the GYM as the 'vector of recruitments' input option to simulate the population dynamics of krill in the Antarctic Peninsula region (Subarea 48.1) under various assumptions. Simulations were run for 21 years with either no fishing, or with fishing at yields representing either the trigger level (gamma = 0.0103), the current precautionary catch limit (gamma = 0.093) or half the precautionary catch limit (gamma = 0.0465). Natural mortalities were set at either the ‘base-case’ value (M = 0.8), ‘variable mortality’ (M with a uniform distribution between 2 and 0.8) and ‘high mortality’ (M = 3). CVs of either 0%, 10%, 20% or 30% were added to the observed recruitment values.

2.66 Past modelling studies on the effects of different harvest levels on the Antarctic krill population using the CCAMLR decision rules have been based on the Beta distribution or ‘proportional’ option for recruitment. However, when levels of variance in proportional recruitment above 0.176 were assigned, the GYM projections started terminating prematurely, so the effects of higher values of recruitment variability were not able to be consistently assessed (SC-CAMLR-XXIX, Annex 6, paragraphs 2.76 and 2.77). The current study therefore used a data series for recruitment in the GYM based on the observed size frequencies in net samples rather than on a theoretical distribution.

2.67 The base-case study (natural mortality set to 0.8 with no additional CV on the recruitment vector) showed that catch levels up to half the precautionary catch level did not trigger either decision rule. At the highest level of catch, the precautionary catch level (gamma ≈ 0.09), two of the four recruitment vectors triggered the depletion rule. This indicates that populations would not support sustained catches of about 9% of unfished biomass under the depletion rule.

2.68 In general, as the values for natural mortality and additional recruitment variability were increased beyond the base-case values, fewer of the simulation scenarios were able to achieve the CCAMLR ‘depletion’ decision rule. The results indicated that, as gamma was increased, the distribution of spawning stock biomasses shifted towards having more trials that ended with lower biomass.

2.69 Another important aspect of the current analysis indicated that for most years the size distributions in the AMLR database have either a high proportion or a low proportion of recruits, with fewer years having intermediate proportions of recruits rather than the continuous decline assumed by the Beta distribution. There is also some indication from the integrated model (paragraphs 2.159 to 2.161) that recruitment might be serially correlated over time, with good recruitment periods of a year or two occurring on approximately a five-year cycle.

2.70 The Working Group welcomed the progress made on the recruitment variability and recalled that the high variation in recruitment of the icefish stocks around South Georgia triggered the recruitment criteria even without fishing. As a consequence, the GYM is only used for short-term predictions in the assessment and the decision rules were modified to reflect conditions relative to a no-fishing scenario rather than B_0.

2.71 The Working Group pointed out that the current analysis indicated areal differences in the sensitivity of the gamma level when mortality and recruitment variability was to be increased. In the past the GYM has always been applied to Area 48 as a whole. Areal differences in recruitment had not been considered.

Future assessments, timetable, work plan

2.72 The Working Group agreed that its future work plan shall focus on:

- accommodating krill recruitment better in current assessments
- review the decision rules for the krill fishery in light of climate change.

2.73 The Working Group advised the Scientific Committee that it does not recommend changes to the current conservation measures related to krill catch limits (CM 51-01, 51-02 and 51-03) this year, and reiterated that for Area 48 (CM 51-07) and Division 58.4.2 (CM 51-03) the existing subdivisions of catch limits and trigger levels should remain in force. However, the Working Group also highlighted to the Scientific Committee that the catch limit for Division 58.4.1 is subdivided into two subdivisions (CM 51-02), but that there is no trigger level that can be regarded as a safeguard until new assessment approaches will be developed.

Issues for the future

Feedback management strategy

Introduction

2.74 The Working Group recalled its plan for future work concerning the development of a feedback management strategy for the krill fishery (SC-CAMLR-XXX, Annex 4, paragraphs 2.149 to 2.192), which included:

1. development of a list of candidate feedback management approaches, including consideration of any operational implications for the fishery and for monitoring

2. identification of an agreed suite of indicators appropriate to candidate feedback management approaches

3. review of spatial and temporal structure in the ecosystem in which the current Area 48 fishery operates and consideration of the implications for monitoring and management

4. development of agreed decision-making mechanisms for the candidate feedback management approaches, including decision rules which identify how fishing strategies and/or monitoring are to be adjusted on the basis of the indicators

5. provision of advice on operationalising the objectives of Article II in the context of a changing ecosystem

6. evaluation of candidate feedback management approaches.

2.75 The Working Group noted that the Scientific Committee had considered the proposed work schedule (SC-CAMLR-XXX, paragraphs 3.33 to 3.35) and had agreed that WG-EMM should consider elements 1 and 2 of feedback management development in 2012, elements 3 to 4 in 2013 and elements 5 to 6 in 2014.

2.76 The Working Group structured its discussion of feedback management elements 1 and 2 by considering:

(i) general monitoring issues
(ii) land-based predator monitoring issues
(iii) krill-related monitoring issues
(iv) candidate feedback management approaches.

General monitoring issues

2.77 The Working Group recognised that the current precautionary approach for krill management uses the GYM and projections based on the results from the CCAMLR-2000 Survey. The Working Group noted that the current management approach could be extended by utilising more frequent assessments of krill biomass, and that this would thus become a feedback management approach. The Working Group recalled (SC-CAMLR-XXX, Annex 4, paragraphs 2.149 to 2.192) that various other indicators could also be used in feedback management, including indicators of predator status and trends and indicators from the krill fishery.

2.78 The Working Group considered three papers (WG-EMM-12/P04, 12/P05 and 12/P06) that respectively describe: prior development of the precautionary approach to fisheries management; the development of CEMP; and ongoing work to consider how monitoring data, such as that collected by CEMP, could be used to implement a feedback management strategy for the krill fishery in Area 48. Important issues that arise from these papers relate to how a new management strategy would be formed, what indicators would be required for that strategy, how monitoring of the ecosystem would provide those indicators, and how decision rules would be developed to facilitate decision making.

2.79 WG-EMM-12/P04, 12/P05 and 12/P06 suggested that (i) estimates of predator production derived from consumption of a target species, (ii) predator abundance, and (iii) predator recruitment, all provide useful indices for the development of a candidate feedback management approach. The Working Group agreed that such indices, with either proximate or ultimate relationships to variability in krill stocks, may provide important information for CCAMLR to take necessary management actions.

2.80 The Working Group also recognised that CCAMLR may wish to take action in managing the krill fishery, regardless of the causal mechanism involved. For example, if monitoring data were to indicate that predators were decreasing in Area 48, possibly because of ecosystem changes related to climate change, CCAMLR may wish to alter the distribution and intensity of harvesting.

2.81 WG-EMM-12/P06 reviewed CCAMLR's experience in the development of ecosystem-based fisheries management. The paper considered how food-web models and simulation approaches can be used as operating models to evaluate alternative feedback management approaches and how they could be used as assessment models. The Working Group noted that food-web models can be used to examine broad-scale changes in the dynamics of components of the ecosystem, particularly those due to effects of climate change.

The Working Group agreed that a combination of monitoring data and food-web models that use such monitoring data provide useful information on ecosystem status and trends and that both would be useful in the development of a feedback management approach.

2.82 The Working Group next discussed WG-EMM-12/45 and 12/59, which highlighted the potential for international collaborative work with the SCOR Working Group for Identifying Ecosystem Essential Ocean Variables for Measuring Change in the Biological Properties of Marine Ecosystems and the ICED Southern Ocean Sentinel (SOS) program for measuring and monitoring the status and trends of Southern Ocean ecosystems. The programs are currently considering plans for data collation and coordination and plans for large-scale surveys to provide estimates of the biological status of the Southern Ocean on a circumpolar scale.

2.83 The Working Group noted that the SOS included a program of work to estimate the ecological status of the Southern Ocean by 2020. The program of work includes the development of a set of ecosystem indicators by 2016, evaluating designs of the multinational proposal to benchmark Southern Ocean ecosystems by 2017, development of methods for assessing status and change of Southern Ocean ecosystems based on the indicators by 2015, and finalising an implementation plan for benchmarking by 2017. The Working Group noted that the time frames for implementing these two international programs might not align with CCAMLR's plans for the development of feedback management. However, the Working Group recognised that these programs provide valuable opportunities to collaborate with experts outside CCAMLR with regard to issues related to indicators for feedback management, and encouraged Members to develop collaborations with such international programs to the extent possible.

2.84 The Working Group recognised that Members contributing time series of monitoring data for management purposes, such as CEMP data or mesoscale krill surveys, continually face challenges in securing the resources needed for maintaining their programs. The Working Group therefore wished to bring to the attention of the Scientific Committee the value of these programs, and their potential utility in feedback management.

2.85 The Working Group noted that candidate management approaches that depend on monitoring data that are collected on a voluntary basis should include a consideration of the consequences of that monitoring data becoming unavailable in the future.

Land-based predator monitoring issues

2.86 The Working Group considered several papers related to the monitoring of land-based predators and potential indicators arising from such monitoring activity that could be used to inform a candidate feedback management approach. These papers included WG-EMM-12/04, 12/16, 12/17, 12/18, 12/22, 12/39, 12/58 and 12/71. These papers reviewed topics relevant to monitoring the status and trends of krill-dependent predators, including:

(i) expansion of current monitoring methods to new monitoring sites
(ii) development of new monitoring methods
(iii) theoretical models of changes in population abundance

(iv) reviews of CEMP data in terms of interannual variability
(v) measurement of functional responses
(vi) mechanistic relationships between indicator and indicated variables.

The Working Group focused its discussion of these papers on their role in identifying candidate feedback monitoring indicators.

2.87 The Working Group noted that these papers, as well as those discussed in paragraphs 2.118 to 2.120 focused on a restricted set of predator indices that could be used in a candidate feedback management approach. Specifically, the papers included options for the use of predator abundance, offspring fledging mass, reproductive success, diet composition and combined indices as potential indicators for use in a feedback management approach.

2.88 The Working Group agreed that a particular indicator for a feedback management approach need not necessarily constitute a single predator index and that multiple indices could be combined via a statistical procedure to derive a single composite indicator of ecosystem status for use in a candidate feedback monitoring approach. For example, reproductive success and fledging mass could be combined to provide an indicator of per capita reproductive success as an index of predator fitness, or multiple indices could be integrated as a combined standardised index (Boyd and Murray, 2001; de la Mare and Constable, 2000).

2.89 The Working Group noted that multiple indicators, either analysed independently or as a combined index, potentially integrate over different temporal and spatial scales, and thus reflect different ecological properties; it agreed such analyses are useful when developing some types of feedback management approach. However, interpreting multiple indicators simultaneously requires thorough analyses of each dataset to understand probable causes or drivers of variability. Such analyses would be helpful for reducing uncertainty in decision-making processes that utilised integrated indices.

2.90 The Working Group agreed that estimates of functional relationships, such as those presented in WG-EMM-12/17 and 12/22, require sufficient temporal coverage to build plausible relationships. In some instances, identifying such relationships may not be possible with current data. The Working Group agreed that estimation of functional relationships, although desirable, may not be necessary for advancing some feedback management approaches.

New or expanded monitoring programs

2.91 The Working Group noted that a candidate feedback management approach for the krill fishery may require the development of a new or extended monitoring program for krill-dependent species. Such expansion may be warranted especially if the krill fishery is to operate over large spatial scales and in areas where no existing monitoring, including CEMP monitoring, is present. In particular, the Working Group noted that individual areas may differ in their underlying patterns of variability such that predator responses measured in one local area would not represent predator responses at a larger spatial scale (WG-EMM-12/P04 and 12/P05). The Working Group agreed that if monitoring data were available only in one particular region, then there would be higher uncertainty associated with establishing an appropriate feedback management response at a regional level.

2.92 The Working Group recalled that there may be monitoring data analogous to CEMP data collected at sites around Antarctica that have not been reported to CEMP. The Working Group encouraged Members to prepare and submit such data in order to help expand the spatial extent of current CEMP data holdings, recognising that this would help facilitate the development of feedback management approaches.

2.93 The Working Group considered some of the issues associated with the development of a new or expanded monitoring program based on WG-EMM-12/04, noting that the costs of such monitoring must be evaluated relative to the benefit derived from the availability of additional data. WG-EMM-12/14 suggested that one plausible method to increase availability of data on predator abundance throughout Area 48 combines the use of satellite remote-sensing aerial surveys, opportunistic visits to penguin breeding colonies using ships of opportunity, and remote cameras to provide broad-scale information on the size and trends of regional predator populations. Such information could be collected: (i) in areas where CEMP sites already exist, (ii) in areas close to where the krill fishery already operates, but no CEMP monitoring occurs, (iii) in areas where the krill fishery has operated in the past, and/or may operate in the future, and (iv) in areas where no krill fishing will be allowed and which could be used as reference sites to help understand the confounding impacts of climate and harvesting.

2.94 The Working Group noted that any new monitoring method will require a program of work to underpin the technique. WG-EMM-12/71 provided an evaluation of remote-sensing methods documented in recent publications (e.g. Fretwell et al., 2012; Lynch et al., 2012; Mustafa et al., 2012) and recommended that such methods could serve as a starting point for future efforts to monitor penguin population changes at a regional or continental scale.

2.95 The Working Group agreed that ground truthing of remote-sensing or photogrammetry-based methods would be critical for ensuring continuity with ongoing ground-based counts conducted by individual Members in accordance with CEMP protocols.

2.96 The Working Group noted further that remote sensing of predator abundance is not the only option for informing a feedback management approach and encouraged Members to provide alternative proposals for other candidate indices so that WG-EMM can explore the relative capabilities and trade-offs of such alternatives in future work (paragraph 2.74).

2.97 The Working Group further agreed that maintaining existing CEMP monitoring is critically important, particularly in this era of rapid environmental change and expansion of fishing capacity (paragraphs 2.7 to 2.11). However, by itself, the current CEMP may not allow the detection of fishery-induced change in a timely manner, although the ability to eventually detect change may improve as harvesting levels increase.

2.98 The ability to detect fishery-induced change in the ecosystem may benefit from experimentally designed structured fishing. The Working Group agreed that structured fishing, envisioned as large-scale fishing experiments in localised regions, would necessarily require a careful design phase to identify the scale of structured fishing experiments, the likely impacts of such fishing that could be assessed, and clear expectations of outcomes from such a work plan. The Working Group noted that reference areas without fishing would provide a key element of such structured fishing to help differentiate fishery- and climate-based impacts. Such reference areas may arise as part of the Domain 1 MPA planning process.

2.99 The Working Group also discussed the temporal scale over which monitoring might need to occur in order to establish a feedback management approach. The Working Group noted that the feedback response time of potential feedback monitoring candidates differed, and the trade-off between indicators with differing lag times (fast or slow) was an important consideration for a feedback approach. The Working Group agreed that relevant timescales for monitoring and management would depend on the indicators selected for monitoring and the frequency with which adjustments to the fishery were needed.

Krill-related monitoring issues

2.100 The Working Group considered two papers (WG-EMM-12/50 and 12/52) relating to the effect of environmental variation on the distribution and trends in krill availability in Area 48.

2.101 WG-EMM-12/50 suggested a relationship between fishery CPUE and large-scale atmospheric indices, with a transition to relatively high CPUE occurring in 2006. The authors inferred that climate impacts may be influencing krill populations and, indirectly, fishery performance. Such variation in krill populations would have implications for how feedback management strategies are implemented and so forecasts of environmental variability would be useful for understanding future fishery performance (paragraph 2.29).

2.102 The Working Group noted that forecasting environmental regimes, such as variation in the Antarctic oscillation index, remained a major goal of atmospheric and climate scientists. Developing such forecasts for the purpose of feedback management, while desirable, were considered unlikely to be operational in the near term.

2.103 WG-EMM-12/52 recalled that current synoptic data on the status of the krill population in Area 48 is now over 12 years old and in need of updating. WG-EMM-12/52 proposed that consideration be given to planning future synoptic surveys.

2.104 The Working Group agreed that there is a lack of up-to-date information on the spatial distributions and trends in krill biomass, fishable biomass and the magnitude of advective movements of krill throughout Area 48. The Working Group recalled that the last synoptic survey of krill biomass was conducted in 2000 and that all krill from that original survey were now dead.

2.105 The Working Group noted that such a synoptic survey would be useful, but agreed that several new methods for providing management information across Area 48 now exist. Development of such methods may provide timely, cost-effective and adequate data for establishing updated management information on krill biomass and distribution in Area 48. In particular, the Working Group noted that survey data provided by fishing vessels (see paragraphs 2.163 to 2.173) or from autonomous gliders could provide much of the data necessary for assessing the status of the krill population. Assessments of these or other approaches in conjunction with research acoustic surveys would be useful.

2.106 The Working Group also noted that an integrated assessment of krill (paragraphs 2.158 to 2.161) would benefit from a variety of datasets. Data on krill distributions and density derived from dedicated research cruises may be necessary to expand the spatial coverage of data outside the traditionally fished areas. The Working Group recalled earlier discussions (paragraph 2.83) about the SOS program and the proposal to benchmark the Southern Ocean ecosystem via large-scale surveys in 2020. The Working Group agreed that such a coordinated circumpolar research effort may provide an opportunity to collect data on krill biomass and distribution on a large spatial scale.

2.107 The Working Group agreed that a feedback management approach would require assessments of krill biomass, and that an updated assessment of krill biomass in Area 48 was a priority.

Candidate feedback management approaches

2.108 The Working Group identified eight candidate feedback approaches. Tables 1 and 2 compare specific components of each approach. The Working Group noted that the existing management approach, used to set the current long-term precautionary catch limit for krill, is a useful control against which to evaluate candidate feedback management approaches.

2.109 WG-EMM-12/P05 described simulation procedures for evaluating candidate feedback management approaches. It considered the need to develop performance measures to compare how well the different approaches achieve multiple objectives. WG-EMM-12/P06 reviewed progress towards developing feedback management approaches in WG-EMM.

2.110 WG-EMM-12/P05 reviewed five ecosystem-based management approaches for the krill fishery that were proposed before 2002 and identified, for each, the objective, decision rule, indicator, monitoring and assessment method. Three of these approaches use an index of krill biomass or density as the indicator and two use characteristics of predators. One of the approaches reviewed in WG-EMM-12/P05 requires the closure of the fishery when krill density falls below a critical density required to maintain predator fitness. The others set specific harvest strategies based on the state of indicators. These approaches can be modified to achieve different feedback management systems in response to specific objectives.

2.111 WG-EMM-12/P06 reviewed an approach proposed in 2008 based on a statistical ecosystem model. This ecosystem assessment model is equivalent to a single-species stock assessment model in that it can be used to estimate parameters, through fitting to spatially resolved time series of krill and predator data; assess the current state of the ecosystem; and project the state of the system for use with decision rules to select appropriate harvest tactics. This requires regular ecosystem assessments, possibly including an integrated krill stock assessment, and could make use of new data methods as they become available.

2.112 WG-EMM-12/44 proposed a feedback strategy based on CEMP data. It included a candidate adjustment method, candidate indicators and candidate reference points. The adjustment method, described as a hockey stick, changes area-specific catch limits in direct proportion to an indicator metric, provided that metric is within a specified range below which catch is zero and above which it is a precautionary maximum. Candidate indicators include an estimate of krill population status from an integrated stock assessment model, penguin fledging mass and five-year trends in penguin abundance. The approach sets regional catch limits on the basis of krill population status, adjusts regional catch limits on the basis of five-year trends in penguin abundance, and adjusts catch limits within penguin foraging areas on the basis of penguin fledging mass. The proposal distinguishes between 'trailing' and 'leading' indicators, the first of which provide the primary information for adjusting catch limits prior to a fishing period, and the second of which are based on information collected after this primary adjustment and allow further in-season adjustment. The authors suggested that the spatial scale of management should be linked to the scale of indicators.

2.113 WG-EMM-12/19 described a feedback management approach based on control theory, which aims to identify the requirements of, and trade-offs involved in, feedback management. The proposed feedback approach optimises a sequence of future catch limits based on objectives defining the desirable state of the ecosystem in terms of targets (e.g. 0.75 of B_0 for the target stock) and limits. These limits can be soft, which means that there is an agreed level of risk that the specific objective will not be met (e.g. the krill decision rule concerning the maintenance of spawning stock biomass). The paper demonstrated that this optimisation approach is more likely to meet CCAMLR's objectives than a fixed catch limit. The paper demonstrated how candidate feedback management approaches can be evaluated in a simulation framework that specifically considers the trade-offs between objectives, and the implications of uncertainty. It identified specific trade-offs between the range of options available to managers versus the implied level of risk; catch limit versus the implied level of risk; and catch variability versus ecosystem variability. The paper identified the following requirements for optimisation-based feedback management: a reliable model of uncertainty about future ecosystem states; an understanding of the autocorrelation structure of indicator time series; a state estimation method to distinguish signal from noise; and clarity about the target and limit states associated with the management objectives. The authors proposed that such reference points should be developed through an iterative process of evaluating candidate reference points.

2.114 The Working Group welcomed the candidate feedback approaches and thanked the authors for their thoughtful contributions. It noted that together they offer a range of candidate approaches, some of which may be feasible to implement in the near term, but which might require increased precaution in local catch limits. Near-term implementation may require precautionary controls on catch limits to account for uncertainties about the relationship between indicators and objectives. The candidate approaches could be developed to allow higher catch limits in the longer term if these uncertainties are reduced. The approaches also provide useful means of identifying trade-offs and data requirements.

2.115 The Working Group recalled its extensive discussion of feedback approaches during 2011 (SC-CAMLR-XXX, Annex 4, paragraphs 2.149 to 2.192) and commended the progress that has been made in the first two elements of the six-step process for developing and evaluating feedback management approaches. In particular, the Working Group recalled that feedback management could be developed as a staged approach where the first stage could include directed fishing designed to increase knowledge about ecosystem responses. Noting that work on all elements of the six-step process would be welcome, the Working Group also recalled that elements 3 and 4 are to be addressed next year. It therefore encouraged the developers of candidate approaches to continue developing their approaches and to prioritise questions of spatial scale, and the relationship between indicators and objectives. The

Working Group also recommended that the developers of different candidate feedback management approaches engage with WG-SAM so that technical and modelling aspects of each approach might be considered.

2.116 Recognising the impending need to evaluate different candidate feedback approaches, the Working Group noted that it has previously developed and used simulation-based approaches for evaluating management procedures. The Working Group has also discussed a number of candidate operating models, and the framework provided in WG-EMM-12/19 might be useful in such evaluations. A framework for evaluating operating models is discussed in paragraphs 2.58 to 2.60.

CEMP and WG-EMM-STAPP

Analyses of CEMP data

2.117 The Working Group considered the following papers under this agenda item: WG-EMM-12/16 and 12/17 both of which used data from over two decades of multi-species monitoring at Bird Island, South Georgia; WG-EMM-12/22 (noting that this is the same as WG-EMM-12/48) that reviewed data on Adélie penguin (*Pygoscelis adeliae*) monitoring in East Antarctica; and WG-EMM-12/62 that presented an analysis of data in the CEMP database held by the Secretariat. All of these papers presented analyses of CEMP data and provided a review of the expectation of responses to krill availability and to the covariance of CEMP parameters within and between sites.

2.118 The analyses presented in WG-EMM-12/16 examined the relationships between CEMP variables for four krill-eating species and derived a combined index using a principal component analysis, which in this implementation is equivalent to the combined standardised index. The approach demonstrates the mechanistic links between the combined index and proximate indicators of krill availability. Consistent with previous analyses, negative anomalies occurred at approximately three-year intervals, however, there was no evidence of ongoing trends in krill availability. The results presented in WG-EMM-12/17 indicated that the euphausiid content of the diet of macaroni penguins (*Eudyptes chrysolophus*) was the strongest predictor of fledging mass. The authors suggested that it is appropriate to describe macaroni penguins at Bird Island as krill-dependent, available evidence strongly suggests that macaroni penguins have a sigmoidal functional response to krill availability and that their diets may usefully indicate krill availability.

2.119 The analysis of macaroni penguin diet showed that the use of energy content of the diet components improved understanding of the impact of diet on fledging mass. The Working Group agreed that extending this approach in the analysis of diet from CEMP may be productive but noted that the availability of energy content data may be limited for many prey species.

2.120 WG-EMM-12/22 examined interannual fluctuations of Adélie penguin breeding success, foraging trip duration, meal mass and fledgling weights at Béchervaise Island. Breeding success was correlated with early breeding season foraging trip durations and fledgling weights with later trip durations. There was a lack of concordance between early and late breeding season response parameters. Because the amount of prey available to predators is a function of the underlying distribution and abundance of prey as well as its accessibility in areas where there is extensive sea-ice during the summer months, a key component of the functional relationship between predator response parameters and prey availability relates to prey accessibility. The paper suggested that significant changes in predator response would only be evident when krill availability falls below a given threshold. Results highlight the need to take into account the changing behaviours of birds in the context of life-history requirements, changes in prey accessibility as well as any temporal variability in the amount of prey present when interpreting predator response parameters.

2.121 WG-EMM-12/62 presented the report from the Secretariat that described the ongoing data-checking and validation process for the data held in the CEMP database. An outcome from this process was to provide an opportunity to examine the temporal patterns in the available time series as well as inter-site and inter-species comparisons. The Working Group agreed that this was a useful process that was designed to improve the understanding of the characteristics of different CEMP parameters and how best these should be presented in future.

2.122 In the presentation of penguin population size (A3) data in WG-EMM-12/62 where CEMP data are submitted as multiple colony counts within a single site, in particular where data from all colonies are not provided each year, the Working Group noted that the use of a combined standardised index of population data from a site (as presented in WG-EMM-12/62) allows the inclusion of more data in the index. However, the Working Group noted that this approach may produce a different time-series response than does a simple sum of all colonies where colonies are very different in size and the same weighting factor is given to changes in all colonies regardless of colony size. The Working Group encouraged continued discussion between the Secretariat and Members submitting CEMP data to improve data interpretation and comparability between sites. The Working Group also encouraged further exploration of ways of presenting the results from the CEMP time series and the use and interpretation of a combined standardised index for single parameters across sites.

2.123 The Working Group agreed that in submitting A3 data from sites where the colonies within a site were in fact convenient counting units, rather than discrete colonies, that it may be more appropriate to submit a single value for the population surveys from that site.

2.124 The Working Group considered the potential impacts of inter-observer difference in the collection of meal mass data (Penguin diet A8) on its comparability both within and between sites as a CEMP parameter. Dr Trathan informed the Working Group that after a review of animal welfare and logistic issues, the UK had stopped the collection of gentoo penguin (*Pygoscelis papua*) diet samples at Bird Island in 2010 and was planning to cease collection of all diet samples (gentoo, Adélie and chinstrap penguins (*P. antarctica*)) from Signy Island in the near future. Dr Southwell indicated that diet sampling at Béchervaise Island had not been undertaken since 2003 for similar reasons. However, the Working Group noted that there are also active programs undertaking diet sampling of penguins as part of CEMP where the data collected also provide important krill population indices from measurement of krill size in the diet.

CEMP Fund

2.125 The Working Group welcomed the establishment of the CEMP Fund in 2011 (SC-CAMLR-XXX, paragraphs 11.1 and 11.2) and recalled that the Scientific Committee Chair, the WG-EMM Co-conveners and the contributors to the fund were engaged in the development of terms of reference for the use of the CEMP Fund.

2.126 The Working Group agreed that operating a program to collect CEMP data was very expensive and well in excess of what could be provided for from the CEMP Fund in its current form, and recognised that considering the use of the CEMP Fund would probably involve a trade-off between investing in new approaches which might be applied over broad scales at relatively low cost and supporting monitoring at new sites using existing methods.

2.127 The Working Group noted that the CEMP Fund could be used to undertake short-term work such as an initial evaluation prior to the initiation of CEMP monitoring at new sites or developing new methods with broad application.

Priority analyses

2.128 The discussion of priority analyses of CEMP data was focused on the examination of relationships between parameters and the spatial and temporal design of future monitoring programs as they relate to the implementation of feedback management in the krill fishery. The Working Group agreed that the candidate procedures for feedback management would guide the priorities for future analyses and design as these approaches are further developed.

2.129 In order to provide advice on candidate management procedures that use CEMP parameters, the Working Group agreed that an analysis of the spatial correlations between indices was important for identifying those parameters that might reflect local- versus regional-scale changes in krill abundance.

Other monitoring data

2.130 A number of papers were submitted on monitoring data not currently submitted to CEMP.

2.131 WG-EMM-12/21 and 12/P01 described work by Ukrainian researchers on aspects of the biology of seals in the Argentine Islands region in the West Antarctic Peninsula. The weight of seven Weddell seal (*Leptonychotes weddellii*) pups was measured at three-day intervals from birth to 21 days of age to determine growth, and the contents of faecal samples of five seal species (Antarctic fur seal (*Arctocephalus gazella*), crabeater seal (*Lobodon carcinophagus*), Weddell seal, leopard seal (*Hydrurga leptonyx*) and southern elephant seal (*Mirounga leonina*)) were examined to determine diet. The Working Group noted that the diet of Weddell seals was in excess of 70% krill whereas the literature suggests that they are predominantly fish predators. Dr Milinevskyi indicated that Ukraine hopes to continue predator monitoring in this area and establish two new monitoring sites at which CEMP data will be collected and submitted to the Secretariat. The Working Group supported Ukraine's intention for further monitoring work, noted that there is currently little monitoring in this area, and urged Ukraine to consider how the new monitoring could best contribute to priority future monitoring programs such as for feedback management.

2.132 WG-EMM-12/36 linked population trends of Antarctic shags (*Phalacrocorax bransfieldensis*) in the South Shetland Islands with changes in the abundance of inshore demersal fish. Data showing declines in the shag population are presented from the early 1990s and compared with data on the fishery from Marschoff et al. (2012). The paper concluded that declines of shag populations is most likely due to the decrease in the abundance of their main two prey items *Notothenia rossii* and *Gobionotothen gibberifrons*, and that this decline was a consequence of intensive industrial fishing in the area in the late 1970s and early 1980s.

2.133 WG-EMM-12/58 presented results of population counts of chinstrap and gentoo penguins at a number of breeding sites on the Danco coast in 2010/11 and compared the data with previous counts in 1997/98. Overall, the counts of chinstrap penguins at seven sites were 43% higher in 2010/11 than in 1997/98. However, population trends varied between sites, with populations at three small colonies disappearing and populations at the larger colonies increasing. Counts of gentoo penguins increased at all of the four breeding sites studied, and overall the counts were 103% higher in 2010/11 than in 1997/98. The increase in chinstrap populations in this area is not consistent with a declining trend found for the wider Antarctic Peninsula region, indicating that local-scale population trends may not always reflect regional-scale trends. Count data were also presented for some sites from the 1970s and 1980s and suggest there may have been a decline in populations at those sites over this time. However, interpretation of historical counts needs to take into account the time in the breeding season at which they were made, which are not reported in the paper. The results emphasise the need to provide a temporal context for population changes.

2.134 WG-EMM-12/18 presented results from population models to evaluate the effect of exogenous (climatic conditions and krill abundance) and endogenous (intra- and inter-specific competition) factors on the population dynamics of Adélie, chinstrap and gentoo penguins in the Antarctic Peninsula region. Results indicate that intra-specific competition and combined effects of krill abundance and sea-ice cover are the relevant factors underlying the penguin population dynamics with different relevant factors for the different species. The modelling approach differed from other penguin population modelling studies in using simple theoretical-based population models and by including endogenous factors such as intra- and inter-specific competition. The paper highlighted the importance of climatic factors (sea-ice coverage and SST) in predicting the dynamic of these species. The Working Group welcomed this new modelling approach to understanding the factors driving penguin populations and encouraged further work on this approach.

Potentials and priorities for expanding CEMP

2.135 The Working Group recognised that CCAMLR's requirement for ecosystem monitoring is likely to increase in support of feedback management of the krill fishery and MPAs. It was noted that this could be achieved by:

(i) considering additional monitoring data that is currently being collected but is not submitted to CCAMLR as part of CEMP

(ii) starting CEMP monitoring programs at locations where no such monitoring is under way

(iii) developing and applying methods, other than current CEMP methods, that allow appropriate monitoring at more sites in a cost-effective way.

2.136 In relation to additional monitoring data, a number of papers considered at the meeting (WG-EMM-12/18, 12/21, 12/36, 12/58 and 12/P01) contained data that are not currently submitted to the CEMP database. The Working Group noted that there may be a substantial amount of data currently being collected that is compatible with the currently agreed species, parameters and methods used by CEMP, and that consideration should be given to whether these data could be used to augment the current CEMP. The Working Group acknowledged that there may have been a false perception that in order to contribute to CEMP it was necessary to submit data on all of the CEMP parameters from a site. The Working Group agreed that this was not the case and encouraged Members to contribute data to CEMP from a site even if they are unable to collect data on all CEMP parameters.

2.137 In relation to new methods, the Working Group recognised the potential for new methods to allow broad-scale monitoring of some parameters. WG-EMM-12/04 and 12/71 outlined some potential methods, including satellite technology, aerial surveys and opportunistic surveys for monitoring abundance, and cameras and audio-recording devices for monitoring breeding success and phenology. While some of these methods are still under development and require validation, they may be ready to apply in 2–3 years when more specific monitoring needs in support of feedback management and MPAs are known.

2.138 While the Working Group supported in principle the inclusion of additional data to augment the current CEMP, it also agreed that there was a need to identify the priority types and locations of such data in order to support priority needs of CCAMLR. These priorities will become clearer in the next few years as the monitoring and analysis requirement for feedback management and MPAs are developed.

2.139 The Working Group emphasised that while new data and methods offer the potential to expand CEMP, additional data would need to be collected using methods that had been endorsed by the Working Group to ensure that data quality and comparability of CEMP data are maintained.

2.140 The Working Group noted the initiatives described in WG-EMM-12/45 and 12/59 to undertake new monitoring and bring together available datasets for Southern Ocean ecosystem status and change, and indicated that any expansion of CEMP should be considered in the context of other international programs to ensure that the greatest synergies are achieved and to avoid duplication of effort.

WG-EMM-STAPP

Progress on estimating overall predator abundance and krill consumption in Area 48

2.141 Work by the UK to estimate abundance of Antarctic fur seals breeding at South Georgia is ongoing. Initial analysis of aerial images obtained in 2002 is almost complete, and a statistical modelling framework is being developed. It is expected that fur seal abundance estimates for South Georgia, combined with results of recent fur seal surveys in the South Shetland Islands, will allow estimates of fur seal abundance and krill consumption for Area 48 to be completed by 2014.

2.142 WG-EMM-12/P02 described a sensitivity analysis to identify those known penguin breeding sites that contribute most to uncertainty in estimates of penguin abundance for Area 48. The analysis utilised the penguin count database developed by WG-EMM-STAPP. The approach ensures that future surveys to reduce uncertainty in estimates of penguin abundance, and subsequently estimates of krill consumption by penguins, are prioritised and targeted towards the sites of greatest need. The paper identified 14 locations where high-quality surveys would reduce uncertainty in population estimates by approximately 72%. For example, if high uncertainty at a site identified by this process is related to the large size of the colony and related difficulty in counting, a reduction in uncertainty may be possible if new methods are available for reliable estimation of abundance in large colonies.

2.143 Penguin survey work in priority locations by a number of national programs and the Oceanites Antarctic Site Inventory is continuing with the aim of achieving up-to-date penguin abundance estimates for Area 48. The researchers undertaking this work are aiming to submit penguin abundance estimates, and a database of count data that these estimates are based on, to CCAMLR as soon as possible. Two recent published papers by researchers attending the meeting potentially provide important contributions to this effort. The authors were encouraged to submit these papers to a relevant WG-EMM agenda item in the future.

2.144 There has been no progress on estimating flying seabird abundance in Area 48. The USA indicated that data on flying seabirds collected during US AMLR at-sea surveys could contribute to this goal. The Working Group recognised that further progress is unlikely without substantial additional resources for data collation and analysis. As krill consumption by flying seabirds is likely to be significant, a lack of abundance estimates for this group would mean that krill consumption for land-based predators will be underestimated.

Progress on estimating overall predator abundance and krill consumption in East Antarctica and the Ross Sea

2.145 Although the priority region for WG-EMM-STAPP's work is Area 48, WG-EMM-STAPP is also developing estimates of predator abundance and krill consumption for East Antarctica and the Ross Sea. Dr Southwell reported on progress of this work in these regions:

(i) Estimates of pack-ice seal abundance for these regions are available from APIS surveys conducted in 1999/2000 (WG-EMM-05/23 for East Antarctica).

Application of the consumption model developed by the UK for crabeater seals (WG-EMM-PSW-08/06) to these abundance estimates will allow estimation of krill consumption.

(ii) Work to estimate Adélie penguin abundance in East Antarctica is continuing. Australia is planning to conduct new surveys in the Windmill Islands in 2012/13. This region has not been surveyed since 1989/90. In combination with recent surveys described and summarised in WG-EMM-11/31 and 11/32, all the major Adélie penguin populations in the Mawson, Davis and Casey regions will have been surveyed recently. Japan and France have agreed to contribute Adélie penguin count data for the Lützow–Holm Bay and Adélie Land regions of East Antarctica. Work is under way to synthesise all these data and derive a current abundance estimate for Adélie penguins across East Antarctica.

(iii) New Zealand is processing aerial photographs of all Adélie penguin populations along the Victoria Land coast of the Ross Sea taken in recent years and plans to derive an Adélie penguin abundance estimate for the Ross Sea.

(iv) Australia and New Zealand are aiming to submit revised estimates of Adélie penguin abundance for East Antarctica and the Ross Sea, and a database of count data that these estimates are based on, to CCAMLR in 2013 or 2014.

(v) Australia has been working to adapt the crabeater seal consumption model developed by the UK for use on Adélie penguins. In combination with abundance estimates, this will allow estimates of krill consumption by Adélie penguins. The adapted consumption model is nearly complete. Australia and New Zealand plan to use the abundance estimates and consumption model for Adélie penguins to derive estimates of krill consumption by Adélie penguins for East Antarctica and the Ross Sea.

Progress on partitioning krill consumption estimates using foraging data

2.146 WG-EMM-12/37 provided a synopsis of US AMLR satellite telemetry data obtained over a 14-year period for three species of penguins and three species of pinnipeds breeding at the South Shetland Islands. The data highlight species and seasonal differences in the patterns of foraging distribution. The Working Group noted that these data are an important contribution to the development of foraging models for understanding krill consumption estimates in Area 48.

2.147 The Working Group recognised that further modelling effort would be required to predict foraging effort and at-sea distribution for colonies where no tracking data were available. Foraging distribution data, modelled in relation to environmental data, will be necessary to partition estimates of overall krill consumption by predator populations in Area 48 into smaller spatial units. An important part of this work will be predictions for colonies where no tracking data exist, or colonies where tracking data are temporally constrained.

2.148 The Working Group recognised that modelling foraging distribution provided a number of challenges and was a substantial body of work, given that tracking instruments have been deployed at a restricted number of breeding sites, some species have small ranges while others travel long distances, and foraging distributions may vary substantially across seasons and between life-history stages.

2.149 At the request of WG-EMM in 2011, Dr Trathan liaised with representatives from BirdLife International and the SCAR Expert Group on Birds and Marine Mammals during the intersessional period to assess areas of common interest and expertise that may expedite this work. BirdLife International and SCAR were both keen to be involved, but BirdLife International indicated that they did not currently have the ability to incorporate dive data into their analysis framework which had been developed for flying seabirds. Both groups indicated that they did not currently have the capacity or resources to focus the work specifically needed for CCAMLR.

2.150 The Working Group recognised that the synthesis of dive data and location data was an important consideration when modelling the spatial and temporal distribution of consumption; however, it agreed that it may be possible to use location data as a proxy for foraging distribution but that the inclusion of diving data would greatly enhance this work.

2.151 The Working Group recognised that collaboration with groups in the wider scientific community had the potential to facilitate work on distribution of krill consumption by predators. However, it agreed that it would be important that any such collaborations were clearly focused on delivering outcomes that addressed priorities identified by WG-EMM.

2.152 The Working Group reiterated the need for WG-EMM-STAPP to maintain its existing focus on work on the overall estimation of predator abundance and krill consumption, and that the work on modelling foraging data should not detract from this task. The work on the abundance of fur seals and penguins and their consumption of krill are expected to be complete by 2014, but the Working Group indicated that WG-EMM-STAPP should consider any feasible means for developing estimates of abundance and krill consumption by flying seabirds.

2.153 The Working Group noted that Dr Southwell had indicated that he would like to step down from leading WG-EMM-STAPP after the work on estimating penguin and fur seal abundance and krill consumption is completed in 2014. The Working Group therefore asked Dr Trathan to liaise with those members of WG-EMM-STAPP with relevant experience in telemetry, to progress work on modelling foraging distribution data, including further liaison with other relevant groups, and to present a paper for consideration by WG-EMM in 2013. The Working Group recommended that WG-EMM-STAPP also consider how other relevant work, including the feasibility of estimating flying seabird abundance, is undertaken in the future.

2.154 In 2011 the Working Group indicated that the work of WG-EMM-STAPP in understanding the interactions between air-breathing predators and krill might be extended to include the role of fish as krill predators. The Working Group recommended that WG-FSA review this issue.

New methods

2.155 The work of WG-EMM-STAPP has led to the consideration and development of a number of new methods for estimating predator abundance.

2.156 WG-EMM-12/04 and 12/71 discussed the potential for remote-sensing methods to contribute to regional-scale estimation and monitoring of predator abundance. Recent studies have demonstrated that satellite technology can be used to estimate circumpolar abundance of emperor penguins, but application to smaller land-breeding species is likely to be more difficult and requires validation work. It will be important to take a coordinated approach to validation work and utilise existing land-based work for ground-truthing. Existing work is based on the use of satellites that record visible light and closely allied frequencies; however, the Working Group recognised that other satellites that use microwave sensors may have utility, especially as these may not be limited by cloud cover.

2.157 WG-EMM-12/14 summarised improvements to a previous version of the ICESCAPE software (WG-EMM-09/20). ICESCAPE is a suite of routines in R that implements a parametric bootstrap model for standardising counts of colonial-breeding animals at sub-optimal times of the breeding season to a common point in the breeding chronology. The Working Group welcomed the improvements and noted the utility of the software for standardising population counts and estimating penguin abundance and its uncertainty.

Integrated assessment models

2.158 The Working Group considered two papers that reported work related to integrated assessment models for Antarctic krill.

2.159 WG-EMM-12/27 presented details of an integrated model for krill that is under development by US AMLR. The model follows individual cohorts of krill as they are sampled through time and can estimate a number of parameters representing krill recruitment, mortality and productivity, as well as parameters representing survey selectivity. The model can be configured to estimate movement but in its current form does not converge when movement is estimated. The authors reported that high estimates of natural mortality produced by the model could be partially due to the model being unable to distinguish between mortality and movement of krill out of the sampling area.

2.160 The Working Group noted that configuration of the model can be varied depending on whether acoustic data or net data are used as model inputs. Modifications are continuing to improve the estimation of selectivity parameters when multiple sources of biomass survey data are available. Additional data sources from krill fisheries, krill predators and other krill surveys in the region will be incorporated into the model in the future as development progresses.

2.161 The Working Group recognised the potential value of the model for estimating krill production and for its use in different candidate feedback management approaches, and encouraged the authors to continue their work, particularly by including data sources from outside the US AMLR study area.

2.162 The Working Group also considered WG-EMM-12/38 as part of its discussions on krill integrated assessment models; this paper presented details of a growth model for krill that is currently under development by Australian scientists (see paragraphs 2.53 to 2.57 for further discussion of this paper). The Working Group noted that errors in the growth model used for stock assessments of Antarctic krill, particularly growth rates higher than occur naturally, could inadvertently lead to over-exploitation of the krill stock with potential impacts on krill-dependent species. The Working Group recognised the potential value of the model for estimating krill growth rates and for use in assessments of the precautionary yield for krill, including through feedback management approaches. The Working Group therefore encouraged the authors to continue their work and provide updates to WG-EMM in the future.

Fishing vessel surveys

Scientific use of acoustic data collected from krill fishing vessels

2.163 Scientific research vessels provide high-quality estimates of biomass with quantified levels of uncertainty associated with the data. However, it is recognised that these research vessel surveys are relatively limited in terms of areal and temporal coverage and are also expensive and resource-intensive to undertake. Therefore, developing the use of alternatives to such intensive research-based surveys should form part of an overall strategy of collecting acoustic data in the future.

2.164 In contrast, there is an increasing number of commercial fishing vessel notifications and given the year-round fishery operation, their importance as potential platforms from which to collect acoustic data is likely to increase.

2.165 Last year the Scientific Committee asked SG-ASAM to consider the use of krill fishing vessel-based acoustic data to provide qualitative and quantifiable information on distribution and abundance of Antarctic krill and other pelagic species such as myctophiids and salps (SC-CAMLR-XXX, paragraph 2.10). In particular, SG-ASAM was requested to provide advice on survey design, acoustic data collection and acoustic data processing.

2.166 SG-ASAM considered that there are two broad research objectives that are likely to be achievable through the collection of acoustic data from fishing vessels:

(i) abundance of krill at a defined temporal and spatial scale
(ii) spatial organisation of krill, e.g. horizontal and vertical distribution, swarm density or structure.

2.167 The Working Group noted that SG-ASAM agreed:

(i) that biomass estimates (research objective 1) would only be achievable when collecting data which followed an agreed survey design (Annex 4, paragraph 2.8). Furthermore, SG-ASAM agreed that collecting acoustic data along existing transects defined as part of national research program krill surveys will add significant value to the interpretation of fisheries acoustic data (Annex 4, paragraphs 2.14 and 2.17)

(ii) that abundance estimates could be generated either from a single fishing vessel undertaking a multi-transect survey or from multiple vessels undertaking single transects to achieve the same level of transect coverage (Annex 4, paragraph 2.18)

(iii) that calibration was a fundamental component of acoustic data collection and that currently a standard sphere calibration should be used if the acoustic equipment is to be used for quantitative krill biomass assessments (Annex 4, paragraph 2.23). However, it was recognised that opportunity to undertake a standard sphere calibration could be limited by a range of factors, including, for example, location, weather conditions and availability of technical expertise. Therefore, it strongly recommended the development of alternative or secondary calibration approaches (Annex 4, paragraph 2.24)

(iv) a set of high-level instrument requirements in terms of acoustic data collection, related to the two main research objectives (Annex 4, paragraph 2.20, Tables 1 and 2). It also provided outline recommendations for data collection protocols (Annex 4, paragraph 2.29 and Table 3). However, it was not possible to provide a detailed, prescriptive set of requirements suitable for a range of vessels that might have quite different acoustic equipment and vessel noise characteristics (Annex 4, paragraph 2.36)

(v) a proof of concept program to work through the issues that will need to be resolved when implementing surveys from fishing vessels using different acoustic equipment (Annex 4, paragraph 2.37).

Working group discussion of SG-ASAM report

2.168 The Working Group agreed that acoustic data collected by commercial fishing vessels could form a very valuable data source for use in the work of WG-EMM, in particular in the context of providing inputs to the developing feedback management strategies. The collection and use of such data would also increase the opportunity of the fishing industry to participate in CCAMLR data collection and to increase the collaboration between scientists and fishers.

2.169 The Working Group recognised that a range of different research questions, other than quantitative regional biomass estimation (research objective 1 in paragraph 2.167i), could be answered with the acoustic data from the fisheries. For instance, information on the temporal variability in the density and spatial organisation (research objective 2 in paragraph 2.167i) of krill aggregations targeted by the commercial vessels could provide key insights into the operation of the fishery.

Proof of concept

2.170 The Working Group agreed that the proof of concept as proposed by SG-ASAM was a valuable first step in developing the scientific use of acoustic data collected from fishing vessels.

2.171 The Working Group recommended that the acoustic sample data requested from fishing vessels should be acquired under different weather conditions and during different vessel activities. In particular, it was emphasised that data should include some periods when the ship was steaming at a constant speed (in the region of 10 knots) and on a steady course that would be representative of acoustic survey conditions.

2.172 The Working Group noted that many vessels have observers on board and recommended that the acoustic data collection should be accompanied by krill length-frequency data collected by the observer.

2.173 The Working Group noted that, while a standard sphere calibration was presently required to derive absolute abundance estimates, in the context of the proof of concept it was impractical to require the vessels to undertake such a calibration prior to submitting proof of concept data. However, any information provided by the vessels on the practicalities of undertaking such standard sphere calibrations would be extremely useful in developing future protocols for calibration of fishing vessels.

Future development beyond the proof of concept stage

2.174 To take the use of acoustic data collected from fishing vessels beyond the proof of concept stage, the Working Group recognised that it would need a longer-term research plan that takes into account the broader development of the work of WG-EMM. The Working Group recognised that in developing this plan, consideration would need to be given to the following broad issues:

(i) What are the sources of data that can be obtained? How might data from many sources be combined if they are not calibrated according to standard methods? Would there be a minimum standard required, with perhaps an accreditation system, to control data quality?

(ii) Where are data going to be collected? The Working Group noted that future consideration should be given to whether it was feasible to request data from areas that are not presently sampled, for instance data from the pelagic areas between the present main fishery areas.

(iii) How will data be analysed? The Working Group noted that one method is that being developed by Norway where there is a direct collaboration between scientists and fishing companies covering design, data collection and analysis. However, other arrangements could be developed where some form of centralised analysis could be coordinated through CCAMLR. Whatever arrangements were developed for analysis of these fishing data, the Working Group noted that these analyses were complex and would be likely to require involvement of the appropriate experts in the CCAMLR community.

2.175 The Working Group recognised that it is at the first stage in the process of implementing acoustic data collection from the commercial krill fishing vessels. The Working Group emphasised that there is still a strong requirement to undertake scientific surveys and recommended that there should be no reduction in the conventional scientific survey activity.

2.176 Given the future potential and importance of this field of work to WG-EMM, the Working Group strongly encouraged Members to develop methods and plans for collection and use of such data to be presented at future meetings.

2.177 WG-EMM-12/63 presented an example of what acoustic and ancillary data can be obtained from a commercial vessel during normal fishing operations. A basic comparison with data collected by the same vessel during a directed scientific survey in the same period showed that the vessel operated consistently in the locations of highest krill concentrations during the period of fishing operations, and that catch rates were correspondingly very high. Krill length data collected by the observer in parallel with the acoustic data collection were highly variable between hauls.

2.178 The Working Group welcomed the approach presented in WG-EMM-12/63 and noted the large haul-to-haul variation in length-frequency distribution but also noted the analysis presented in paragraphs 2.38 to 2.40.

SPATIAL MANAGEMENT

Marine protected areas

ASPAs and ASMAs, and coordination with the ATCM

3.1 Dr Grant introduced a discussion of revised and new management plans for ASPAs or ASMAs which contain marine areas. In accordance with ATCM XXVIII, Decision 9 (2005), the approval of CCAMLR is required for proposals for ASPAs or ASMAs which contain marine areas in which there is actual harvesting, or the potential capability of harvesting, or for which there are provisions specified in a draft management plan which might prevent or restrict CCAMLR-related activities.

3.2 Dr Arata presented three revised ASPA management plans which were submitted to ATCM XXXV by Chile (WG-EMM-12/40, 12/41 and 12/42). All three areas are small, no deeper than 200 m, and were designated due to their value as important areas for benthic research. Dr Arata clarified that the management plans do not allow for harvesting as a permitted activity within the areas and he reported that anchoring is also not allowed.

3.3 The Working Group, noting the importance of these areas for scientific research and that these areas were unlikely to be subject to harvesting, recommended approval of the management plans for ASPA No. 144 (Discovery Bay, Greenwich Island, South Shetlands), ASPA No. 145 (Port Foster, Deception Island) and ASPA No. 146 (South Bay, Doumer Island, Palmer Archipelago) by the Scientific Committee.

3.4 WG-EMM-12/47 proposed a management plan submitted by the USA and Italy to ATCM XXXV for a new ASPA at Cape Washington and Silverfish Bay, Terra Nova Bay, Ross Sea. The main values to be protected include one of the largest emperor penguin colonies known, as well as the associated marine ecosystem which is a nursery area for the Antarctic silverfish (*Pleuragramma antarcticum*). The total area of the proposed ASPA is 282 km^2, 98% of which is marine. The draft management plan has no provision for harvesting within the proposed ASPA, which is located within SSRU 881M which currently has a catch limit of 0 tonnes.

3.5 In response to questions regarding the depth of the area, Prof. Vacchi confirmed that the majority of the marine area was less than 500 m deep, and that it was often ice-covered, and thus there should be little CCAMLR interest in harvesting within the area.

3.6 Dr Grant noted that the proposed ASPA lies within the areas proposed by New Zealand and the USA for a Ross Sea MPA. She recalled that the 2011 MPA Workshop (SC-CAMLR-XXX, Annex 6, paragraph 4.4) noted that a harmonised approach in the Antarctic Treaty System to spatial protection may result in having ASPAs and ASMAs designated by the ATCM within CCAMLR MPAs. This multi-level approach to area management could harmonise decisions made at the ATCM and CCAMLR, and allow for detailed consideration of activities not normally considered by CCAMLR; thus more comprehensive protection might be provided for such areas (SC-CAMLR-XXX, Annex 6, paragraph 6.17).

3.7 The Working Group, noting the importance of Cape Washington and Silverfish Bay for scientific research and that these areas were unlikely to be subject to harvesting, recommended approval of the draft management plan for a new ASPA in this area by the Scientific Committee.

3.8 Dr Penhale, on behalf of Brazil, chair of the Management Group of ASMA No. 1, Admiralty Bay, King George Island, South Shetland Archipelago, outlined the process for the revision of the management plan by Brazil, Poland, Ecuador, Peru and the USA (WG-EMM-12/61). The management plan is currently being revised and will be presented to the ATCM in May 2013. The plan will then be submitted to CCAMLR for approval per ATCM Decision 9 (2005).

3.9 The values to be protected include a diverse marine ecosystem which has been the subject of long-term scientific research going back nearly 40 years. These long-term studies include research on predator–prey dynamics of penguin–krill populations conducted at a CEMP site and detailed studies of the benthic invertebrate communities. During the IPY, there was a focus on marine biodiversity under the Census of Antarctic Marine Life program. The area of the ASMA is 360 km^2, of which 50% is generally ice-covered.

3.10 SC-CAMLR-XXX (paragraphs 3.24 to 3.26) reported that in 2009/10 the krill fishery operated in Admiralty Bay. At its last meeting, the Scientific Committee was unsure whether such fishing activity was compatible with the management plan and noted that at the time when this management plan was established, the effects of fishing in the region were not considered.

3.11 WG-EMM-12/61 explicitly proposed that the Working Group should discuss potential harvesting within the ASMA, and how best to minimise human impacts on the long-term scientific research. The Management Group of ASMA No. 1, noting the high scientific value of the long-term ecosystem studies, would prefer that no harvesting take place within the ASMA in order to achieve the goals of the management plan. Another option would be prior consultation between those planning to harvest within the ASMA and the Management Group in order to minimise impacts to ongoing research.

3.12 Dr Arata, noting that the ASMA area is quite small with regard to the total area available for krill fishing in Area 48, recommended that no harvesting take place within the ASMA.

3.13 Mr T. Kawashima (Japan) stated that, should the ASMA be proposed as a no-take area, then the objectives of the ASMA should be clearly stated, information on how fishing would be detrimental to the objectives should be described, and a description of the monitoring program to study the effects of no harvesting should be provided. It was agreed that the provisions of the ASMA adequately addressed these requirements.

3.14 There was broad support for the idea of no harvesting within the ASMA; however, the Working Group noted that a formal review and recommendation would occur when the draft management plan was submitted to CCAMLR in 2013.

3.15 The Working Group encouraged Dr Penhale to communicate the deliberations of WG-EMM, and subsequently of the Scientific Committee, to the Management Group of ASMA No. 1 for consideration as the revised management plan is produced.

3.16 The Working Group was informed that krill fishing vessels were recently observed within ASPA No. 153, Eastern Dallmann Bay, off the northwest coast of Brabant Island. The management plan of the ASPA, which is approximately 676 km^2, does not allow for harvesting as a permitted activity.

3.17 The Working Group suggested that the recent appearance of krill fishing vessels within ASMA No. 1 and ASPA No. 153 probably occurred due to a lack of awareness of the existence of these designated areas among those responsible for fishing vessels.

3.18 Noting that the Convention (Articles V and VIII) provided for close cooperation between CCAMLR and the Antarctic Treaty, the Working Group observed that there was a lack of informative and timely communication between the ATCM and CCAMLR with regard to the location and management plans of ASPAs and ASMAs containing marine areas.

3.19 A number of suggestions were made to improve communication, such as linking the management plans of relevant ASPAs and ASMAs to CCAMLR conservation measures so that a link to the management plans with maps could be readily accessed. Members were encouraged to be proactive in passing on information to fishing vessels under their jurisdiction. In June 2012, COMM CIRC 12/79–SC CIRC 12/42 was issued to call Members' attention to the issue of harvesting within ASPAs and ASMAs.

3.20 The Working Group noted that information on the locations and provisions of all ASPAs and ASMAs (including maps, management plans and GIS shapefiles) is available on the Antarctic Treaty Secretariat website. Figure 1 was prepared using data from the ATS website, and shows marine and partially marine ASPAs and ASMAs located in Subareas 48.1 and 48.2.

MPA proposals

3.21 WG-EMM-12/25 proposed the establishment of an MPA near Akademik Vernadsky Station, Argentine Island Archipelago, in order to protect the highly diverse benthic community in the area. A video presentation of a diver-conducted benthic survey illustrated this diversity. While the paper presented the location of one MPA, Dr Milinevskyi stated that the intent is to formally propose a network of MPAs within the area along the Antarctic Peninsula from Petermann Island to Bertholot Islands within the next two years.

3.22 The Working Group noted that the area near Akademik Vernadsky Station, Argentine Island Archipelago, had high scientific value due to its benthic diversity and agreed that the area warranted protection.

3.23 Some Members questioned the rationale for seeking protection of the scientific values as an MPA under CCAMLR as compared to an ASPA or ASMA under the ATCM. The Working Group, noting that both the ATCM and CCAMLR have provisions for the establishment of protected and managed areas, agreed that this subject was more appropriately discussed at the Commission on a case-by-case basis. It was also noted that communication within the ATS was important in order for goals for marine spatial protection and management to be achieved.

3.24 The Working Group, noting that this proposed MPA network is within Planning Domain 1, observed that there were already several marine ASPAs and two ASMAs within the domain (paragraph 3.6).

3.25 Several members recalled that a joint meeting of SC-CAMLR and the CEP was held in 2009 (ATCM XXXII WP 55). Progress on topics of mutual interest in areas such as climate change research, spatial marine management and protected areas, as well as ecosystem and environmental monitoring, would provide a solid agenda for discussions aimed at increased cooperation. The Working Group recommended that the Scientific Committee consider another joint meeting to be held in the near future.

3.26 WG-EMM-12/34 is a revised version of WS-MPA-11/17 presented to the 2011 CCAMLR MPA Workshop and subsequently to SC-CAMLR-XXX (SC-CAMLR-XXX/13) on a proposal for establishing precautionary spatial protection to facilitate the scientific study of habitats and communities under ice shelves in the context of recent, rapid, regional climate change. Dr Trathan reported that the current paper incorporates points arising from previous discussions and that two major changes were that the paper now more clearly articulates the scientific rationale for protection and that the boundaries of the proposed areas for protection are changed in order to focus on those areas where rapid regional climate change was occurring. The paper highlighted that rapid climate change has been documented in the Antarctic Peninsula region, indicated by the retreat of 87% of the Peninsula’s glaciers. Ice-sheet collapse leads to the destruction of existing under-ice habitats with the creation of new habitats. The paper proposed that the study of colonisation processes in these habitats is scientifically important and that this is best undertaken in the absence of human impact.

3.27 The Working Group recognised that the proposal in WG-EMM-12/34 to protect areas and habitats under ice shelves was consistent with the protection objectives agreed by the 2005 CCAMLR Workshop on Marine Protected Areas (SC-CAMLR-XXIV, Annex 7, paragraphs 62 and 63). It also recognised that the proposal was consistent with the recommendations of the Antarctic Treaty Meeting of Experts on the Impacts of Climate Change for Management and Governance of the Antarctic Region (ATCM XXXIII – CEP XIII Document WP063) which recommended (Recommendation 26) the precautionary protection of areas under ice shelves (SC-CAMLR-XXIX, paragraphs 8.3 to 8.7).

3.28 The Working Group noted that the recently exposed areas of ocean uncovered by the collapse of the Larsen A and Larsen B ice shelves were not included in the proposal. It recognised that the proposal was designed to be precautionary and forward-looking to future ice-shelf collapse. Further, that should the Commission consider areas already uncovered by collapse of the Larsen ice shelves be worthy of protection, this could be achieved through a separate MPA proposal, or incorporated into the current MPA proposal.

3.29 Mr Kawashima observed that the area of protection was quite large and wondered whether the scientific community had the capacity to conduct the necessary scientific research and monitoring activities. Dr Trathan agreed that the area might appear to be large, but he emphasised that it was extremely unlikely that all ice shelves in the defined area would collapse at a single time and that a more likely scenario was that ice shelves might recede gradually, with only some collapsing catastrophically. He suggested, therefore, that the actual area set aside as a no-take zone might be quite small. Further, it was difficult to exactly predict when and where ice shelves might collapse, so a precautionary approach was necessary. Finally, he noted that the area of protection covered a large latitudinal range, so the defined area had the potential to protect different habitats as they were exposed by ice-shelf retreat or collapse.

3.30 Mr Kawashima also suggested that the area might be protected via means other than designation as an MPA. Dr Trathan noted that the areas under ice shelves could be protected under Article IX.2(g) or in accord with the MPA general measure (CM 91-04) and that the authors had preferred to follow designation in accord with the latter.

3.31 The Working Group considered that the proposal to protect areas and habitats under ice shelves was inherently different in nature from those MPA proposals being developed by those focusing on the various MPA planning domains (SC-CAMLR-XXX, Annex 6, paragraph 6.6), yet it was consistent with the provisions of the MPA general measure (CM 91-04).

3.32 The Working Group noted that draft outline research and monitoring plans for the areas under ice shelves should be developed and presented to the Scientific Committee; however, it recognised that more detailed plans would only need to be developed once an ice shelf had actually collapsed. The Working Group recognised that the review period of 10 years after ice-shelf collapse would enable the Scientific Committee to determine whether the scientific community had begun to implement research and monitoring activities. As the objective of interim protection for areas and habitats under ice shelves was to facilitate scientific research, it was recognised that continuation of such protection might not be warranted if no research had been initiated or was envisaged.

3.33 The Working Group noted that the Scientific Committee (SC-CAMLR-XXX, paragraphs 5.76 and 5.77) and the Commission (CCAMLR-XXX, paragraph 7.32) had previously noted that the ability to acquire the necessary science from under ice shelves was limited because the areas to be protected were currently inaccessible. The Working Group, therefore, agreed that the scientific basis for protection was adequate and that no further scientific justification would be required from the authors.

Research and monitoring plans for the Ross Sea region

3.34 While the requirement and general guidance for research and monitoring plans was established in CM 91-04, an agreed structure and content for such plans does not yet exist.

Two draft research and monitoring plans (WG-EMM-12/46 and 12/57) for potential application in the Ross Sea region were submitted to WG-EMM for its consideration.

3.35 WG-EMM-12/46 presented a draft research and monitoring plan to support an MPA in the Ross Sea region. Priorities for research and monitoring are discussed in terms of three general categories of sampling strategies. These are research from space (e.g. remote sensing, telemetry), from land (e.g. CEMP-style approaches, predators as indicators of ecosystem status, food web analysis) and at sea (e.g. oceanographic surveys, benthic and pelagic surveys, fisheries research). Multiple tools are recommended for analysing data to provide more robust advice. The results of this research and monitoring will be synthesised to provide advice on the degree to which the objectives of the MPA are being achieved and whether specific management actions would improve the performance of the MPA with respect to achieving these objectives.

3.36 WG-EMM-12/57 presented a preliminary research and monitoring plan for the Ross Sea region. The plan was structured by linking research and monitoring activities to eight general conservation objectives, with 27 specific conservation objectives embedded within the general objectives. Research and monitoring activities for each objective were designed to: (i) ensure that the boundaries of the priority feature remain accurate and to determine to what extent those boundaries may be moving; (ii) understand the importance and ecosystem role of the priority feature and to understand processes that affect it (including potential threats from fishing); and (iii) demonstrate the extent to which achievement of the specific objectives is being met. While for some objectives the design of the research and monitoring activities aimed to demonstrate whether identified threats are being effectively mitigated by the MPA, it was noted that when representativeness was the objective, threat mitigation would not apply.

3.37 The Working Group observed that the plans presented in WG-EMM-12/46 and 12/57 were different in structure and focus, yet both were positive contributions to the development of a framework to achieve research and monitoring objectives. The Working Group noted that guidance will ultimately come from the Scientific Committee and the Commission on the detailed structure of research and monitoring plans.

3.38 Some Members felt that certain elements of WG-EMM-12/46, such as the utility of remote sensing as a research tool, should be further detailed in the plan. Finer-scale monitoring may be needed, particularly with regard to take and no-take zones.

3.39 The Working Group, noting the detailed list of research activities by general and specific objectives in WG-EMM-12/57, recommended that appropriate time scales and prioritisation between activities be more clearly identified.

3.40 The Working Group discussed the use of fishing vessels to deliver research as part of the research and monitoring plans. It agreed that such opportunities may be useful if compatible with the objectives of the MPA, and that for some kinds of research questions fishing vessels may constitute the best, or only, appropriate research platform.

3.41 The Working Group discussed the need to define priority elements for research and monitoring plans and the level of detail of activities that should be undertaken. It was recognised that general elements would have to be addressed clearly at the first stage of the process and that more specific elements could be identified at a later stage. One way to determine research and monitoring priorities may be to specify which activities are required to address whether objectives are being met. Some activities may be considered mandatory. Other activities may be desirable but would be considered non-mandatory.

3.42 The Working Group agreed that the research and monitoring plan should identify research activities within various regions or spatial areas within the MPA consistent with the specific objectives of the MPA in that area. The Working Group agreed that the research and monitoring plan should be organised geographically and would ideally identify research that relates to the achievement of multiple objectives simultaneously. The plan should contain research that is achievable in practice. The final research and monitoring plan would identify research and monitoring activities, and mechanisms and timescales for review. It was recognised that the proposed MPA Report (paragraphs 3.72 to 3.75) would facilitate the presentation of these elements in a common format.

Domain 1, Antarctic Peninsula

3.43 Dr Arata presented the results of the CCAMLR Technical Workshop on Planning Domain 1 (Western Antarctic Peninsula–South Scotia Arc) which was held in Valparaiso, Chile, from 28 May to 1 June 2012 at the Chilean Subsecretary for Fisheries (WG-EMM-12/69). Drs Arata and E. Marschoff (Argentina) served as Co-conveners and the workshop was partly supported by the CCAMLR MPA Special Fund. Participants from six countries (Argentina, Chile, Japan, Norway, UK and the USA) and the Secretariat contributed to the work. The planning domain includes parts of Subareas 48.1, 48.2 and 88.3. It was noted that Domain 1 contained one CCAMLR MPA (CM 91-03, South Orkney Islands), five marine (and four partially marine) ASPAs, and three ASMAs.

(i) The goals of the workshop were to identify and review existing data, to establish criteria for the analysis of the selection of MPAs (consistent with CM 91-04), to establish a methodology common to Domain 1, to address problems of monitoring and surveillance of potential MPAs, and to make progress on identifying MPA candidates for Domain 1. Finally, a strategy for future work was to be developed, based on progress made during the workshop.

(ii) The workshop, addressing the issue of data use and access, agreed that all data being used for MPA planning should be made available to the CCAMLR Secretariat to allow access for all Members wishing to participate in the process following the Rules for Access and Use of CCAMLR Data. During the workshop, a compilation of data, including GIS data layers and various datasets, was made. This process resulted in the identification of many sources of data, as well as the identification of important data gaps, either as available data which were not considered during the workshop or as data-poor regions within Domain 1.

(iii) The MPA objectives in CM 91-04 were used as a guideline for identifying 10 conservation objectives for Domain 1. For some conservation objectives, the workshop was able to discuss the target areas and protection targets (i.e. proportion to be protected) to be conferred for each objective. Following the identification of conservation objectives and data layers, the workshop discussed the potential uses and activities that could impact these objectives. These potential uses or activities, identified as 'cost' layers, included spatial distributions to represent the historic krill fishery, the potential of resumption of the finfish fishery and tourist activities. The workshop concluded that the krill fishery was the only cost layer to be incorporated into the present analysis, but noted the utility of obtaining information on tourist activities, perhaps via IAATO or the CEP, in order to understand its potential impact. For the krill fishery layer, it was necessary to analyse the fishing unit, the spatial unit and the timescale. The workshop suggested that separate analyses in relation to summer and winter may be useful due to the seasonal differences in ecosystem dynamics.

(iv) The workshop agreed to use decision-support software in the MPA planning process as an aid to identifying potential areas for protection. During the workshop, the group preferred the use of MARXAN and noted that other suitable software could be applied.

(v) Finally, the workshop prepared a list of future work tasks to move forward the development of MPAs within Domain 1. It was recognised that this will be a step-wise process, to be conducted both within the group interested in Domain 1 and in the broader context of the planning domains.

3.44 The Working Group congratulated the Co-conveners and participants for their hard work in progressing MPA planning activities within Domain 1. The Working Group noted that the workshop had agreed a comprehensive list of MPA objectives consistent with the guidance of CM 91-04. It was recognised that this domain involves a latitudinal gradient as well as on- and off-shore environments and that a number of scientific programs and fishing and tourism entities conduct work within the domain.

3.45 The Working Group noted that a good opportunity exists for comparing reference and fished areas by comparing data collected within the US LTER Program and the US AMLR Program. The Working Group, while noting that these two areas are broadly similar, agreed that both areas were subject to similar climatic impacts. Thus, their relationship should remain relatively constant over time, making comparative studies a worthy endeavour.

3.46 The Working Group offered advice on various aspects of the report in terms of structuring future work. Other activities besides krill fishing, in particular tourism activities, should be evaluated in terms of potential impacts. The consideration of benthic layers to help understand the boundaries of pelagic features was noted as an important avenue for consideration and the participants were directed to the results of SO-GLOBEC conducted in Marguerite Bay.

3.47 The Working Group agreed that the analyses should reflect costs and benefits to both conservation and fisheries objectives, which could be done in a variety of ways. For example, impacts on location of fishing or on historical catch distributions may not be the best indication of cost to the fishery; alternatives may include accessibility, future development and economic impacts. Similarly, impacts on conservation could be examined by inverting the analysis so that the importance of fishing areas is examined and the impacts on conservation are considered as costs.

3.48 Further discussion was focused on the steps to be taken to progress work on the MPA planning activities for Domain 1. The plan outlined by Dr Arata was to first finalise and submit data layers and associated metadata (see paragraph 3.50) to the Secretariat with a goal of having 80% completed by the 2012 Scientific Committee meeting and the remaining completed by the 2013 WG-EMM meeting. The next step would be a discussion of qualitative protection targets (e.g. 'high', 'medium' and 'low' rather than quantitative targets describing how much of an area to protect) at WG-EMM and the Scientific Committee at the 2013 meetings. As protection targets reflect both scientific considerations and value judgments, it was therefore envisaged that Members could present candidate MPAs to the 2014 meeting of WG-EMM. Further planning could proceed via a Domain 1 workshop or via correspondence to come to an agreement on a shared MPA proposal, which would be prepared and submitted for review during 2015.

3.49 The Working Group noted that the step-wise planning process was a logical progression, but advised that the timetable should not be viewed as restrictive, and may require adjustment based on results of the planning process. The Working Group also noted that once the objectives and corresponding data layers were agreed and assembled, the process of MPA boundary design could possibly proceed quite quickly. It was noted that other MPA-related activities within Domain 1, such as the planned review of the South Orkney MPA and the review of the draft MPA proposals for areas under ice shelves, would proceed at their own timetables.

3.50 The Working Group produced Tables 3 and 4 which include the list of the MPA objectives identified in WG-EMM-12/69 along with corresponding data layers and specific parameters required. The Working Group indicated that data layers submitted to the Secretariat must include an accompanying rationale for the data layer, the original data sources, methods applied, spatial and temporal resolutions and the metadata description. Further discussion on the tables led to the identification of potential data sources and contact information to assist in completing the production of the data layers. The Working Group encouraged Members to submit the data layers identified in Table 3 and collaborate on this effort.

3.51 It was agreed that Dr Arata will continue to act as the Coordinator of the Planning Domain 1 initiative until the completion of the first phase of this work, which will include the identification and assembly of agreed data layers for each objective for future planning activities for the MPA planning in the domain.

Domain 5, del Cano–Crozet

3.52 The CCAMLR Technical Workshop on Planning Domain 5 (del Cano–Crozet) (WG-EMM-12/33 Rev. 1) was held in St Pierre, Réunion Island, France, from 15 to 18 May 2012 at the Headquarters of TAAF (French Southern and Antarctic Territories). Prof. Koubbi and Dr R. Crawford (South Africa) served as Co-conveners, and the workshop was partly supported by the CCAMLR MPA Special Fund. Four Members participated in this work (Australia, France, Norway and South Africa).

(i) Planning Domain 5 includes Marion and Prince Edward Islands, the del Cano Rise and Crozet Archipelago in the north region. It also includes the Ob and

Lena seamounts. Protected areas already exist in the 12 n miles around the coastal zone of Prince Edward and Crozet Islands. Studies for designating MPAs are in progress within both the South African and French EEZs.

(ii) To achieve the workshop goals, research and monitoring were discussed under three headings: (i) census of biodiversity, (ii) ecoregionalisation classification and (iii) monitoring, which includes contribution to a CEMP-style approach and the use of continuous plankton recorder.

(iii) The workshop provided benthic and pelagic abiotic classifications of the planning domain. Modelled distributions of plankton (mesozooplankton and euphausiids), mesopelagic fishes and top predators were consistent with the abiotic regionalisation showing latitudinal patterns of communities for the pelagic species. Demersal ichthyofauna and benthos were described as being characteristic of the sub-Antarctic zone with some species being endemic. Marion, Prince Edward and Crozet Islands support substantial colonies of seabirds and seals, which for several species have global importance and moderate to high levels of threats. There is accumulating evidence that decreases of albatrosses and petrels have been substantially influenced by by-catch mortality in fisheries both inside and outside the Convention Area.

(iv) The northern part of the domain was initially trawled for finfish, but now supports only longline fisheries for Patagonian toothfish (*Dissostichus eleginoides*). In the southern part of Domain 5 there was a pelagic trawl krill fishery for Antarctic krill from 1974 to 2001; no recent fishing in the south has been recorded.

3.53 The Working Group congratulated the Co-conveners and participants for their hard work in progressing MPA planning activities within Domain 5. The main objective of the workshop was to study the ecological values and the use of the marine environment in Planning Domain 5. Identification of objectives for systematic conservation planning (SCP) and future research was discussed. Depending on the availability of data, the workshop aimed to map species distributions (either observed data or prediction of species or community presence/abundance based on environmental factors). South African and French data were a major focus because these CCAMLR Members have major scientific programs in this region. Norwegian data from the Bouvetøya region were also discussed.

3.54 The Working Group noted a set of preliminary strategic points essential to SCP for this region. These include accounting for ecological relationships with surrounding CCAMLR planning domains (Bouvet–Maud to the west, Kerguelen Plateau to the east and East Antarctica to the south) and also subtropical areas north of the Convention Area, because of the spatial range covered by top predators and because the northern boundary of the Convention Area cuts across the EEZs of both the Prince Edward and the Crozet Islands, as well as the del Cano Rise.

3.55 The Working Group noted the use in the Domain 5 workshop of spatial modelling methods such as boosted regression trees (BRT) to generate spatially continuous biological distributions from discontinuous biological data. It recalled that methods have been developed to validate the accuracy of modelled distributions and, if necessary, to restrict outputs to environments within the spatial planning domain that are well represented by input biological data. The Working Group further discussed potential difficulties with converting spatial data to a common grid cell size, and noted that by summarising gridded outputs as points it was possible using some tools (e.g. WG-EMM-12/56) to use data layers with different spatial resolutions without the need to convert data to a common cell size. The Working Group discussed the application of the SCP approach in data-poor areas where no biological data exist, and noted that it was possible to apply patterns observed elsewhere to subjectively define target areas for protection based on known habitat affinities or ecological first principles. The Working Group noted that all spatial planning exercises and tools are affected by the quality of the data and the accuracy of the assumptions that underlie their use, and that planning processes should always be undertaken with input from those familiar with the relevant planning domains and data sources.

3.56 It was agreed that Prof. Koubbi will continue to act as Coordinator of the Planning Domain 5 initiative until completion of the first phase of this work, which incorporates the description of the area and the collection of GIS data layers representing protection objectives, and associated metadata to be transmitted to the Secretariat. These data layers will then be available for the use of WG-EMM in undertaking SCP in the second phase. A work plan was established according to the two phases presented. The first phase to complete compilation and submission of data layers should be achieved by mid-2013 with the cooperation of all Members. A synthesis concerning Planning Domain 5 will then be proposed to the Scientific Committee in 2013. It was proposed that the second phase should be held during WG-EMM in 2014 with the opportunity for all Members interested in SCP within this region to participate. It was proposed that WG-EMM consider an SCP process for the high-seas part of Domain 5, whereas the time frame for the EEZs will be different and at a finer spatial scale. These different procedures are important as the resolution of ecological data varies among ecoregions in the Planning Domain 5 and procedures should be applied at appropriate scale for species or environmental features. The technical workshop did not work on the sea-ice zone as it considered that this area has been addressed in planning for Domain 7 at the most appropriate scale.

3.57 The Working Group also recommended that the Commission consider collaboration with other regional initiatives in the southern Indian Ocean concerning the potential designation of MPAs across the northern boundary of the Convention Area. As the northern area of Domain 5 is influenced by different fronts, discussions on how to estimate the consequences of climate change were raised. There are scientific approaches to predict changes in biogeochemical regions according to climatic scenarios. However, this has to be tested with considering also the vertical dimension as it is important for determining frontal zones and how they influence the distribution of pelagic and mesopelagic species which are important also for top predators.

3.58 The Working Group agreed that the success of the Domain 1 and Domain 5 workshops had demonstrated that the 'technical workshop' format is a useful and productive mechanism by which to progress the development of MPAs.

Tools for MPA planning and reporting

3.59 WG-EMM-12/56 described the use of a custom GIS-based marine spatial planning (MSP) tool designed to aid the development and transparent evaluation of MPA scenarios, with reference to spatially explicit protection objectives and cost layers representing rational use, in an SCP framework. The tool, originally developed by New Zealand to aid in Ross Sea MPA planning as described in WS-MPA-11/25, has been customised to allow its use by any Member in any of the nine CCAMLR MPA planning domains and to provide improved functionality. The MSP tool automates the selection, import, transformation, clipping to planning domain boundaries and re-projection of spatial data layers representing MPA protection objectives or 'costs', and provides multiple options for inputting MPA boundaries. Evaluation of MPA scenarios is achieved by calculating the percentage of the value or area of each layer that is inside the MPA, as a proportion of the total value or area for that layer in the planning domain. For any MPA, or system of MPAs, the MSP tool will produce a simple performance summary for each objective or cost layer, as in Table 1 of SC-CAMLR-XXX/10.

3.60 The Working Group noted that because the MSP tool automates the storage of GIS data layers used, its use may facilitate dialog and collaborative MPA planning between Members. For example, when input data layers are agreed for a planning domain (e.g. the finalised spatial outputs of the Domain 1 or Domain 5 workshops; paragraphs 3.43 to 3.57) then the use of the MSP tool will assemble these layers in a compact and standardised storage format and generate a corresponding Arc-GIS project file. By making this package available, all Members would have access to identical data layers by which to develop and evaluate their own MPA scenarios using the MSP tool or other planning tools such as MARXAN. However, data layers representing fishing effort distributions from the Secretariat database may need to be acquired individually by Members via a CCAMLR data request.

3.61 The Working Group noted that the tool has not been validated by the Working Group for providing advice. The Working Group considered, but did not agree, whether the MSP tool involved the type of modelling methodology that required a review by WG-SAM or WG-FSA. The tool does not have an underlying operating model but is a tool to streamline and automate a sequence of GIS layer manipulations and arithmetic calculations that are routinely undertaken individually in GIS, but that would be extremely time-consuming to perform manually. WG-SAM and WG-FSA have previously reviewed quantitative tools used to provide management advice.

3.62 The Working Group noted that the MSP tool could be complementary to other decision-support tools or software which might be used in the design of candidate MPAs and that this tool provides a platform by which to evaluate and compare different options.

3.63 The Working Group agreed that the MSP tool has the potential to contribute to MPA planning, and thanked Dr Sharp for his efforts to further develop this tool and to make it available for use by all CCAMLR Members. The Secretariat agreed to make the tool available on the CCAMLR website with links via the MPA subgroup website. The Working Group agreed it was useful to have additional documentation available to facilitate the use of the tool. Trialling the tool in other domains would also help to build more experience and guidance on best practice and facilitate its validation if appropriate. It was noted that other algorithms for summarising data, rather simple summation or counts, within polygons or proposed MPAs may be useful, particularly with respect of evaluating costs and benefits of different options.

GIS tools

3.64 WG-EMM-12/70 presented a joint UK–Secretariat proposal for the British Antarctic Survey (BAS) to develop a web-based GIS to aid the management of spatial data, including data on proposed and designated MPAs (SC-CAMLR-XXX, paragraph 5.13). The proposal includes the development of the Secretariat's capacity to handle, maintain and deliver geographic information in accessible format to support analysis, decision-making and compliance. The proposed GIS would be implemented in two sections: an open public section containing data layers which are not restricted in access, and a password-protected section providing secure access to restricted datasets related to CCAMLR's administration, science and management.

3.65 The first stage of the implementation would be for BAS to build the GIS and to populate it with primary data layers. The second stage would be to transfer and implement the system at the Secretariat, to train the Secretariat staff to use the system and to maintain it. The second stage would also consider the addition of new datasets.

3.66 The Working Group agreed that this initiative would encourage collaborative approaches among Members, in particular for the development of MPA proposals. The proposed GIS would allow for effective dissemination of a range of spatial information to Members, as well as to other organisations, including the CEP, as appropriate.

3.67 The Working Group recommended that collaboration with the SCAR Biogeographic Atlas initiative would also be useful. The Working Group noted that the development of appropriate metadata is critical. This documentation on input GIS data layers will need to include references to all the source data and the algorithm(s) used to generate data layer, a clear expression of the units of the data layer and the spatial resolution, including capacity for detailed text descriptions of methodologies used to create, summarise, or derive the data layers from the raw data.

3.68 The Working Group recognised that the development and support of a fully operational web-based GIS service will be a long-term project; therefore it was agreed that any data layers available now could be immediately shared on password-protected pages of the CCAMLR website as an interim measure. The Working Group noted that the new CCAMLR website included an outline of this type of webpage. These webpages will be particularly useful for uploading GIS layers for work being undertaken in the MPA planning domains. Coordination and management of software, metadata and data would require focused effort and resources.

3.69 WG-EMM-12/15 presented the distribution of spatial management and Antarctic krill catch across pelagic bioregions in the Southern Ocean (see also paragraph 2.26). This paper described the structure and content of a GIS which has been developed to provide standardised information on the location of spatial fisheries management measures (see also WG-EMM-12/70), and demonstrated a potential application of this tool in examining the relative spatial distribution of fishing activities, existing management and ecological characteristics.

3.70 The Working Group welcomed this analysis, noting its particular relevance in support of systematic conservation planning, and highlighted the importance of making such GIS data layers available through the CCAMLR website.

MPA Reports proposal

3.71 WG-EMM-12/49, in recalling that CM 91-04 provided guidance for the establishment of an MPA, noted that the Scientific Committee may be called upon to provide advice on topics such as the scientific basis for establishing MPAs, research and monitoring plans, and the review and revision of MPAs. It was recommended that a standardised format may be useful to consolidate and maintain scientific information in a readily accessible and current document that could be used as a basis for providing advice.

3.72 Modelled on the Fishery Reports that have been developed by the Scientific Committee in order to provide advice to the Commission in reviewing and revising conservation measures, WG-EMM-12/49 proposed an MPA Report with the following structure:

(i) description of the region, including the physical environment, biogeography and ecology

(ii) objectives to be achieved in MPAs, including objectives for the region, specific objectives of the individual MPAs and the attributes of the MPA relative to the objectives

(iii) historical activities

(iv) assessment of the MPA(s) and the effects of activities

(v) limits on activities permitted in the MPA

(vi) research and monitoring plan.

3.73 The Working Group supported the development of a standardised format and structure for scientific information pertaining to MPAs as contained in MPA Reports and noted that the format outlined in paragraph 3.72 would be useful in collecting and organising detailed information so that the Scientific Committee could readily access the data required to prepare advice to the Commission. The Working Group acknowledged that the Scientific Committee should determine the ideal format and content of an MPA Report. The Working Group considered that in future WG-EMM would be the appropriate working group with primary responsibility for reviewing and updating the content of MPA Reports.

3.74 The Working Group suggested that MPA Reports could be made available through the CCAMLR website, as living documents which could be updated on a regular basis using a similar process to that used for the publication of the Fishery Reports. Over time, as experience is gained in populating MPA Reports and the process becomes more automated, the Secretariat could take over the responsibility of managing data input into MPA Reports. It was recommended that MPA Reports be organised by MPA planning domains.

3.75 The Working Group recognised the practicality of using the format of the MPA Report to organise the documentation related to MPAs, to clearly distinguish legal text relating to MPA designation and binding measures, as distinct from supporting scientific information. The Working Group noted that this topic would be a question for the Commission. The MPA Report, approved by the Scientific Committee, would contain necessary background and supporting scientific information and analyses required to form the basis of advice to the Commission, and the research and monitoring plan. Together, these documents provide much of the information often seen in management plans.

Other issues: planning for a circumpolar technical workshop

3.76 The Working Group supported the aims and key issues to be discussed at the Circumpolar MPA Technical Workshop, prepared by Co-conveners Drs B. Davis and A. Van de Putte (Belgium). The goal of the workshop, to be held in Brussels, Belgium, from 10 to 15 September 2012, is to progress work towards the CCAMLR goal of establishing a representative system of MPAs across all CCAMLR planning domains.

3.77 Following the principles set out in the circumpolar analysis considered at the 2011 MPA Workshop (SC-CAMLR-XXX, Annex 6), the aim of this technical workshop is to examine those planning domains in which conservation planning is not currently taking place, namely Domain 3 (Weddell Sea), Domain 4 (Bouvet/Maud Rise) and Domain 9 (Amundsen/Bellingshausen Sea).

3.78 The key issues to be addressed during the workshop are to identify and review the existing data for Domains 3, 4 and 9, to identify appropriate conservation objectives based on CM 91-04, paragraph 2, to conduct a circumpolar gap analysis to consider whether there are species or features not captured in existing analyses at the individual domain level and to further progress the systematic conservation planning process by outlining a future work program.

3.79 The Working Group was supportive of the effort to address the three remaining domains in which no systematic conservation planning is currently occurring. This workshop will enable SC-CAMLR-XXXI to demonstrate progress towards the consideration of a representative system of MPAs across all planning domains by 2012.

3.80 The Working Group encouraged attendance by experts with knowledge relevant to the work described in paragraph 3.78 and also the development of a process by which those who cannot attend the workshop can submit data which can be used in the workshop's discussions. The Working Group noted that a Scientific Committee Circular had been sent to Members providing information about the workshop and how to contribute data.

VMEs

3.81 WG-EMM-12/51 provided notifications for new VMEs in Subarea 48.1 under CM 22-06 based on the presence of VME indicator taxa in trawl samples from surveys undertaken in 2003 and 2012.

3.82 The Working Group recalled that the use of abundance thresholds was intended primarily as a means of locating potential VMEs from fisheries by-catch (CM 22-07). With respect to identifying VMEs based on fishery-independent research data (CM 22-06), thresholds of this kind are not necessarily required (SC-CAMLR-XXVIII, Annex 5, paragraph 10.34). Nonetheless, in 2009 the Scientific Committee agreed that the VME trawl catch abundance threshold used in WG-EMM-09/32 was useful for identifying potential VMEs in Subarea 48.1 (SC-CAMLR-XXVIII, paragraph 4.249) at depths similar to those surveyed and considered in WG-EMM-12/51.

3.83 The Working Group recommended that the five stations proposed in WG-EMM-12/51 based on VME by-catch in excess of the proposed threshold be added to the VME registry. Latitude and longitude coordinates for these stations are provided in Table 5.

3.84 The Working Group noted the proposal in WG-EMM-12/51 to use diversity of VME indicator taxa in a sample location as a means of identifying VMEs which can include light VME taxa only. The paper proposed eight stations could be identified with respect to a diversity threshold of ≥16 VME taxa, and some Members agreed that the eight stations should also be registered.

3.85 The Working Group noted that the diversity of any biological community is dependent on the level of taxonomic aggregation assumed in the analysis, such that it would be necessary in any comparison of species richness between locations to standardise the use of taxonomic categories across all datasets included in the analysis. The authors of WG-EMM-12/51 clarified that because earlier trawl survey data (from 2003 and 2006) were recorded at a lower level of taxonomic resolution, the evaluation of species richness in WG-EMM-12/51 used only the 2012 trawl survey results (i.e. 64 bottom trawl stations).

3.86 The Working Group noted that thresholds to identify potential VMEs should be developed with consideration of the sampling design, taking care to ensure that the survey or dataset from which a threshold is derived is at a sufficiently large spatial scale, is of sufficient intensity and is well stratified across a sufficiently wide range of environmental variables potentially affecting VME community composition or abundance, to ensure that thresholds to identify potential VMEs are indicative of true high importance and are not merely an artefact of sampling design (SC-CAMLR-XXIX, Annex 6, paragraphs 3.43 to 3.46).

3.87 Dr Sharp recommended that similar considerations should apply to the derivation of diversity-based thresholds as proposed in WG-EMM-12/51 (or other thresholds). Alternately, the authors of WG-EMM-12/51 could propose a particular depth range or environmental envelope within which a diversity threshold should be applied.

3.88 The Working Group agreed that appropriate survey stratification to identify thresholds to aid VME identification are scale-dependent and area-specific, and that thresholds derived in particular subareas or divisions, or within particular depth strata, may not be applicable in other areas. The Working Group noted that a multivariate ordination analysis of community composition as a function of environmental variation may be useful to demonstrate the extent to which surveys of this kind are appropriately stratified across a suitable range of environmental variables (e.g. depth, water temperature, current speed, substrate) likely affecting VME community composition in the area. Analyses of this kind may also be useful to identify habitat associations or environmental drivers that may inform predictive spatial modelling of likely VME occurrence. The Working Group also noted that overlaying potential correlates with VME composition, such as satellite-derived estimates of primary production or modelled krill abundances, may be useful, but recognised that links between the pelagic and benthic environments in this area may be weak or confounded by horizontal advection processes.

3.89 The Working Group noted that different sampling or fishing gears have very different levels of impact, and that bottom trawls, such as those used in the surveys described in WG-EMM-12/51, are likely to have the highest impacts. Some Members felt, therefore, that VMEs should be defined with reference to a particular gear type, because habitats vulnerable to impact by one type of gear may not be vulnerable to other types of gear. Other Members noted that while impacts vary between gears, the inclusion of locations in the VME registry is not specific to particular gear types.

3.90 The Working Group recommended that WG-EMM-12/51, Figure 6, which proposed VME areas, be included in the report to indicate the presence of black coral (Antipatharia), a CITES Appendix II listed taxon deserving consideration. Inclusion of this figure (Figure 2) will also indicate areas of interest for future work to identify potential VMEs, including within extended areas surrounding multiple survey stations at which potential VME indicators have been recorded, for further consideration by the Scientific Committee, including advice on the publication of location data for this taxon.

3.91 WG-EMM-12/51 further identified an additional taxon consistent with some of the criteria for VME indicator taxa set out in SC-CAMLR-XXVIII, Annex 10, paragraph 3.5. The Working Group was unable to complete a full discussion on whether this taxon, Stauromedusae (benthic cnidarians commonly known as stalked jellyfish) should be added to the CCAMLR VME taxa classification guide, and agreed that this issue should be discussed at a future meeting.

3.92 WG-EMM-12/23 provided information regarding the presence of VME taxa in high abundances, in particular the Antarctic scallop (*Adamussium colbecki*), adjacent to Terra Nova Bay, ASPA No. 161. The Working Group noted the provision of data from multiple sources and detailed descriptions and analyses supporting the conclusion that the identified locations were of particular ecological importance. The Working Group further noted that because the analyses included time series of ongoing monitoring efforts conducted from Mario Zucchelli Station in Terra Nova Bay, the sites were also of high scientific importance, potentially providing insights regarding the ecological role of these benthic communities and environmental change. The Working Group noted the value of investigations of this kind and encouraged CCAMLR to make full use of scientific research and monitoring information from shore-based research.

3.93 The Working Group recommended that the identified locations with high abundances of the Antarctic scallop (*A. colbecki*), adjacent to Terra Nova Bay should be added to the VME registry. Latitude and longitude coordinates for these locations are provided in Table 6.

OTHER ECOSYSTEM CONSIDERATIONS, INCLUDING FISH-BASED ECOSYSTEM INTERACTIONS

4.1 WG-EMM-12/53 described a network characterisation of the food web of the Ross Sea. The analysis used the mass-balance trophic ecosystem model described in Pinkerton et al. (2010) to: (i) characterise the trophic structure and function of the Ross Sea shelf and slope ecosystem, and (ii) identify ecosystem sensitivity to perturbations to each functional group. The model characterised average trophic flows (biomass) between 35 functional groups on the Ross Sea shelf and slope, over the course of a typical year. Effects at smaller spatial and temporal scales, or involving only subsets of functional groups, are not resolved within the model and cannot be addressed using the outputs of this analysis. The current fishery for Antarctic toothfish (*D. mawsoni*) is not included as a functional group.

4.2 The Working Group agreed that ecosystem models such as these were valuable for identifying plausible ecosystem risks from foreseeable perturbations such as fishing or climate change, for informing the design of monitoring programs to detect and understand mechanisms of ecosystem change, and for generating testable hypotheses to inform future research.

4.3 The Working Group noted that the analysis suggests that Antarctic toothfish have only a moderate level of structural importance. These analyses do not support the hypothesis that changes in the abundance of toothfish in the Ross Sea will substantially alter the wider food web, but they do suggest that such changes are likely to affect the abundance of the 'medium demersal fish' functional group in WG-EMM-12/53 (e.g. *Macrourus* spp.) due to changes in predation pressure. The Working Group agreed that dedicated monitoring to detect such changes would be useful.

4.4 The Working Group noted that trophic effects on toothfish predators (Weddell seals, killer whales (*Orcinus orca*) and sperm whales (*Physeter catodon*)) are not expected to be strong at the scale of the model; however, localised effects may be possible that cannot be resolved in the analyses presented here, and the model does not distinguish between killer whale variants. Where plausible, risks from localised interactions are identified by other means, these may be amenable to mitigation by spatial management.

4.5 The Working Group noted in particular the high trophic importance of Antarctic silverfish – such that the Ross Sea shelf can be characterised as a silverfish-centric ecosystem, in contrast to krill-centric ecosystems elsewhere in the Southern Ocean – and of small demersal fishes. The Working Group agreed that further research investigating these important species should be a high priority. Prof. Vacchi noted ongoing research from Mario Zucchelli Station in Terra Nova Bay and offered to collaborate with other Members to progress this work. Other functional groups with high trophic importance include phytoplankton, mesozooplankton, *E. superba*, cephalopods and *E. crystallorophias*. The Working Group agreed that research to detect and monitor changes to the Ross Sea shelf ecosystem should perhaps prioritise these functional groups, or sensitive indicators of these groups.

4.6 The Working Group noted that the utility of the model to inform our understanding of particular mechanisms and identify ecosystem risks could be improved by dis-aggregating some of the functional groups, and encouraged the authors to progress this work. In particular: (i) dis-aggregating phytoplankton to distinguish between diatom- vs. haptophyte- (e.g. *Phaeocystis antarctica*) production would enable links with ongoing physical oceanographic research to anticipate likely food-web impacts of alternate climate change scenarios; (ii) dis-aggregating the small demersal fish group may inform ecological understanding, particularly in the coastal zone and under ice; and (iii) distinguishing between the three distinct killer whale variants in the Ross Sea will be important if food-web model outputs are used to evaluate potential trophic ecosystem impacts involving killer whales or risks of trophic overlap with fisheries.

4.7 WG-EMM-12/54, 12/55 and 12/P03 described research in the Ross Sea region characterising the diets of *P. antarcticum*, cephalopods, and *Macrourus* species respectively, using stomach content analysis and stable isotopes. For silverfish, copepods were identified as the main prey item using the Index of Relative Importance (IRI), a standardised diet metric incorporating both prey number and prey weight, but by weight alone the main prey were fishes and krill. Significant diet variation was detected with respect to silverfish size and location. Squid and octopod species were found to feed across a wide range of trophic levels with indications of both pelagic and benthic foraging. For an undifferentiated mixture of two formerly cryptic *Macrourus* species, *M. whitsoni* and *M. caml*, amphipods and copepods were the dominant prey by IRI, but fish were also important prey by mass.

4.8 The Working Group noted the value of diet studies of this kind to inform our understanding of the life cycle and ecology of these species, and to parameterise and/or validate food-web models such as described in Pinkerton et al. (2010) and WG-EMM-12/53, noting that for the latter purpose characterising diets by prey mass rather than IRI may be more appropriate. With respect to silverfish, the Working Group suggested that the term 'larval/post-larval' referring to fish >50 mm and <90 mm may be misleading, as this size range does not usually include larval fish. With respect to *Macrourus* spp., the Working Group noted their importance in the diet of Antarctic toothfish and encouraged the authors to further develop this work, for example to distinguish between the two formerly cryptic *Macrourus* spp. in future analyses.

4.9 WG-EMM-12/17 reported that macaroni penguins at Bird Island consume fish and amphipods when krill are scarce, but fledging weight is generally lower when these taxa are prominent in the diet. WG-EMM-12/16 reported some trends in predator variables at Bird Island which are not attributable to krill availability and may indicate the state of alternative prey. WG-EMM-12/36 attributed declines in the abundance of Antarctic shags at the South Shetland Islands to declines in fish stocks associated with industrial harvesting in the 1970s. These papers indicate the importance of trophic pathways that do not include krill in Area 48.

4.10 Dr Constable noted that it is difficult to provide commentary in this section when WG-FSA is the working group assigned with responsibility for fish and squid biology and ecology and not WG-EMM. As a result, he recommended that these papers and the commentary of WG-EMM be forwarded to WG-FSA for comment in order that the Scientific Committee can have input on these issues from the working groups that are expected to have the expertise on these topics. He also indicated that there should be a greater expectation of WG-EMM to engage with WG-FSA on fish-related issues rather than to work in isolation.

4.11 Dr Sharp recalled that on multiple occasions (WG-EMM-05/18, 06/14, 07/18, 08/42, 08/43 and 09/42) WG-EMM has reviewed and provided comment on scientific papers describing the development and application of the Ross Sea food-web model applied in WG-EMM-12/53. WG-FSA has not in the past reviewed papers describing this model. On previous occasions when CCAMLR has devoted specific agenda items to considering ecosystem effects of finfish fisheries, i.e. the 'Fisheries Ecosystem Models in the Antarctic' (FEMA1 and FEMA2) workshops in 2007 and 2009, these were addressed within WG-EMM. On this basis, Dr Sharp maintained that WG-EMM remains the appropriate body to review ecosystem modelling applications such as described in WG-EMM-12/53, and that transferring that responsibility to WG-FSA was inadvisable. Similarly, WG-EMM-12/55 referred to cephalopods, and 12/16, 12/17 and 12/36 described the ecosystem effects and implications of changing seabird diets; these topics are outside the traditional remit of WG-FSA. With respect to WG-EMM-12/54 and 12/P03, Dr Sharp agreed that these were of interest to WG-FSA and thanked Dr Constable for his suggestion. Dr Sharp also strongly supported Dr Constable's suggestion that WG-FSA be asked to comment on the recommendations of WG-EMM when those recommendations can be expected to directly affect, or be affected by, the work of WG-FSA.

ADVICE TO THE SCIENTIFIC COMMITTEE AND ITS WORKING GROUPS

5.1 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.

5.2 The Working Group provided advice to the Scientific Committee and other working groups on the following topics.

(i) Krill fishery –

(a) fishery notifications for 2012/13 (paragraphs 2.7, 2.8, 2.10 and 2.11)

(b) green weight estimation (paragraphs 2.13 to 2.17)

(c) additional requirements for C1 data (paragraphs 2.20 and 2.21)

(d) requirements for scientific observations (paragraphs 2.38, 2.40, 2.43 and 2.47 to 2.49)

(e) historic biological data from the Soviet fleet (paragraph 2.25).

(ii) Krill ecology and management –

(a) review by WG-SAM of a new growth model (paragraph 2.57)

(b) revised biomass estimate for Division 58.4.2 (paragraphs 2.63 and 2.64)

(c) precautionary catch limits (paragraph 2.73).

(iii) Feedback management strategy –

(a) general monitoring considerations (paragraphs 2.77, 2.80 and 2.84).

(iv) Fishing vessel surveys –

(a) proof of concept (paragraphs 2.170 and 2.171).

(v) Marine protected areas –

(a) management plans for ASPAs Nos 144, 145 and 146 (paragraph 3.3)

(b) draft management plan for a new ASPA at Cape Washington and Silverfish Bay (paragraph 3.7)

(c) krill fishing vessels observed in ASPA No. 153 (paragraphs 3.16 and 3.17)

(d) linkages between ASPAs and ASMAs and CCAMLR (paragraphs 3.18 to 3.20)

(e) proposed MPA near Akademik Vernadsky (paragraphs 3.22, 3.23 and 3.25)

(f) proposed MPA under the Larsen ice shelves (paragraphs 3.28, 3.31 to 3.33)

(g) research and monitoring plan for the Ross Sea (paragraph 3.42)

(h) MPA planning activities for Domain 1 (paragraph 3.48)

(i) MPA planning activities for Domain 5 (paragraphs 3.56 and 3.57)

(j) proposed web-based GIS to aid the management of spatial data (paragraph 3.66)

(k) development of a standard format and structure for MPA reports (paragraphs 3.73 to 3.75)

(l) addition of new VMEs in the VME registry (paragraphs 3.83 and 3.93)

(m) observations on black coral (Antipatharia) (paragraph 3.90).

(vi) Other matters –

(a) participation of observers at working group meetings (paragraphs 7.3 to 7.6)

(b) participation of IWC observers at working group meetings (paragraphs 7.7 and 7.9).

FUTURE WORK

6.1 The Working Group agreed the following future work:

(i) Notification –

(a) to further improve estimation of green weight caught by the krill fishery (paragraphs 2.13 to 2.17, 2.20 and 2.21).

(ii) Scientific observer coverage –

(a) to better understand finfish by-catch in the krill fishery, including training observers to identify fishes and simplifying observer logbooks (paragraphs 2.43 to 2.45).

(iii) Krill-based food web and krill assessment –

(a) review its current assessments of precautionary catch limits for krill (paragraph 2.72) in light of:

- recent estimates of variation in krill recruitment
- the need to account for climate change effects in decision rules for krill.

(iv) Candidate feedback management –

(a) continue to progress work on developing candidate feedback management approaches for the krill fishery according to the schedule agreed in 2011 (paragraphs 2.74 and 2.75)

(b) prepare and submit monitoring data that is analogous to CEMP data and might help to expand the spatial extent of current CEMP data holdings (paragraph 2.92 but noting also paragraphs 2.138 to 2.140)

(c) collect up-to-date information on the spatial distribution including movement, and trends in krill biomass including fishable biomass, throughout Area 48 (paragraphs 2.104 to 2.106).

(v) CEMP and WG-EMM-STAPP –

(a) continue current work by WG-EMM-STAPP to complete estimates of abundance and krill consumption for fur seals and penguins in Area 48, to consider any feasible means for developing estimates of abundance and krill consumption by flying seabirds, and to develop similar estimates for predators in East Antarctica and the Ross Sea (paragraphs 2.143 to 2.145)

(b) develop foraging distribution models to partition estimates of overall krill consumption by fur seal and penguin populations in Area 48 into smaller spatial units (paragraphs 2.152 to 2.153)

(c) priority analysis of CEMP and other monitoring data to support the evaluation of candidate procedures for feedback management (paragraphs 2.128 to 2.129).

(vi) Integrated assessment models –

(a) continue to develop an integrated assessment model and new growth model for use in feedback management of the krill fishery (paragraphs 2.106, 2.161 and 2.162).

(vii) Fishing vessel surveys –

(a) support SG-ASAM in pursuing a proof of concept program to develop the scientific use of acoustic data collected from fishing vessels (paragraphs 2.170 to 2.176).

(viii) Marine protected areas –

(a) to communicate deliberations of WG-EMM regarding a revised Management Plan for ASMA No. 1 (Admiralty Bay) (paragraph 3.15)

(b) to progress work on MPA planning activities for the Western Antarctic Peninsula–South Scotia Arc planning domain (Domain 1) (paragraphs 3.48 and 3.49)

(c) to progress work on MPA planning activities for the del Cano–Crozet planning domain (Domain 5) (paragraph 3.56).

(ix) Ship-based activities –

(a) US AMLR Program:

Dr Watters informed the Working Group about an impending change to the operational period of the US AMLR Program's annual ship-based research and monitoring effort. The ship-based work, which has historically been conducted during the austral summer, has been re-scheduled to occur during the austral winter. Although this change will provide new, important and relevant research opportunities, the change will impact the long time series of summer observations collected by the US AMLR Program. Work will therefore be conducted to provide some calibration between summer and winter observations. Dr Watters invited members of WG-EMM to consider future ship-based collaborative research with the US AMLR Program and opportunities to collect observations during the winter period.

The Working Group reiterated the important scientific contributions made by the US AMLR Program to the work of the Scientific Committee, and expressed thanks for efforts to ensure continuity of its research.

(x) Planning for activities in 2014/15 –

(a) the Working Group noted a new collaborative project involving the Institute of Marine Research (Norway) and BAS (UK). This project would involve a joint survey in 2014/15, focusing on processes in the southern Scotia Sea. Planning for this survey had begun and Dr Watkins invited members of WG-EMM to consider collaborative research and coordinated activities

(b) the Working Group noted possible opportunities for such collaboration, as reported by:

- Dr Siegel on proposed German ship-based research in the Bellingshausen Sea in 2014/15

- Dr Watters on opportunities for collaborative research with the US AMLR Program.

(c) the Working Group also noted the proposal for future synoptic surveys of krill in the Scotia Sea which was outlined by Dr S. Kasatkina (Russia) (WG-EMM-12/52, see also paragraph 2.105). This proposal aims to provide new information on the distribution and abundance of krill throughout the Scotia Sea (including pelagic areas) which will lead to the estimation of an updated B_0, and an improved understanding of the flux of krill in this region. The design of the synoptic surveys would be based on the methods established for the CCAMLR-2000 Survey, and a steering committee would be formed to plan and coordinate research effort amongst Members. The Working Group recognised that the implementation of this proposal would make a valuable scientific contribution to the development and implementation of the feedback management strategy for the krill fishery

(d) the Working Group encouraged Members to further explore these opportunities for collaborative research. Such activities may also provide contributions to other regional initiatives such as ICED, Southern Ocean Sentinel, and SOOS if conducted at a similar time to these initiatives.

Participation of observers in working group meetings

7.1 Following the Working Group's advice in 2011 regarding the participation of observers in its meetings (SC-CAMLR-XXX, Annex 4, paragraph 6.5), the Scientific Committee had requested further consideration of the relevant qualifications and expertise of observers who might participate in the meetings, the minimum standards for allowing their participation and mechanisms to ensure confidentiality (SC-CAMLR-XXX, paragraph 11.17).

7.2 In considering this matter further, the Working Group:

- recognised that its work relies on the long-term commitment of participants to undertake relevant science and provide expertise at meetings
- recognised the important contributions made by observers and invited experts at the technical MPA workshops in 2012 and other meetings
- agreed that conditions for participation at meetings should apply equally to all participants.

7.3 The Working Group noted that a mechanism to ensure confidentiality at meetings exists for invited experts and this mechanism may be applied to other experts from outside the CCAMLR membership.

7.4 The Working Group also noted that observers from SCAR and IWC had attended previous meetings where specific items of relevance to these organisations had been considered. In addition, procedures were in place in some national delegations for inclusion of industry and NGO representatives. These existing mechanisms provided opportunities for additional expert contributions as needed.

7.5 The Working Group sought further advice from the Scientific Committee on the procedure to be followed by working groups during the intersessional period in order to invite observers to their meetings. The Working Group also sought clarification on the procedure to follow for invited experts.

7.6 The Working Group agreed that observers may have two different roles: (i) facilitate the exchange of information between CCAMLR and external bodies; (ii) contribute specific expertise to the work of a meeting.

Participation of IWC observers in working group meetings

7.7 The Working Group noted the proposed participation of an observer from IWC at the 2012 meeting of WG-EMM. The Working Group did not reach consensus on the observer's participation at the meeting, and sought further guidance from the Scientific Committee on the participation of observers at working group meetings.

7.8 The Working Group recognised that the development of the feedback management strategy for the krill fishery may be of interest to the IWC Scientific Committee, and that participation in this work by the IWC may contribute additional expertise. In addition, the Working Group expressed interest in participation in the IWC's development of models of baleen whales and prey interactions.

7.9 The Working Group suggested that the Scientific Committee may wish to consider a standing invitation to IWC experts to participate at WG-EMM meetings while the feedback management strategy for the krill fishery is being developed.

Review of the format of working group meetings

7.10 The Working Group discussed a proposal by Dr Constable to revise the format of working group meetings. This proposal aimed to:

- improve the coordination of the Scientific Committee's work between WG-EMM, WG-FSA and WG-SAM
- bring together participants from these working groups to discuss and develop topics of shared interest (e.g. VMEs, fish-based ecosystem interactions, review of fishery notifications, scientific observations, feedback management procedures)
- increase the level of participation in the work of these working groups.

It included a revised meeting format that allowed for:

- WG-EMM, WG-FSA and WG-SAM to meet together, mid-year over a three-week period with sessions interleaved sequentially as much as possible, and with WG-EMM meeting over the first two weeks of the three-week period and WG-FSA meeting over the last two weeks (with one week overlap to facilitate joint sessions). Topics for WG-SAM could be interleaved as appropriate

- the agendas and timetables for the mid-year meetings would be developed by working group conveners and the Chair of the Scientific Committee, with support from the Secretariat, in order to facilitate interactions and coordination amongst working groups

- WG-FSA would also meet for less than one week immediately prior to the meeting of the Scientific Committee to review stock assessments and develop fishery management advice.

7.11 The Working Group recognised various challenges arising from such a proposal, including a higher level of coordination required amongst working groups and whether the program of work could be managed to achieve participation by small delegations. However, the Working Group noted that concurrent sessions are commonly used during meetings of WG-FSA and WG-EMM, and it recognised the benefits of greater interactions between working groups, increased flexibility in meeting agendas and work, and potential improvement in the level of participation in the work of the Scientific Committee.

Meetings in 2013

7.12 The Working Group noted that:

- the Secretariat was in preliminary discussions with several Members regarding a venue for the 2013 meeting of WG-EMM, but there are no firm offers and any Member who wishes to host WG-EMM should contact the Secretariat

- a World Conference on Stock Assessment Methods for Sustainable Fisheries will be held in Boston, USA, from 16 to 18 July 2013. The conference will mainly consider single stock approaches including data-poor fisheries but will also consider multispecies- and ecosystem-based approaches

- the SCAR International Biology Symposium will be held in Barcelona, Spain, in July 2013.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

8.1 The report of the meeting of WG-EMM was adopted.

8.2 In closing the meeting, Drs Kawaguchi and Watters thanked all participants for their contributions to the meeting, the subgroup coordinators for leading detailed deliberations, the rapporteurs for preparing the report and the Secretariat for its support. The Co-conveners also thanked the Centro Oceanográfico de Canarias for hosting the meeting, and Mr López Abellán and colleagues for their kind hospitality and assistance during the meeting. The Working Group presented Mr López Abellán with a small gift.

8.3 Dr Watters also thanked Dr Kawaguchi for co-convening the meeting this year and offering to lead the Working Group as Convener after SC-CAMLR-XXXI. WG-EMM has entered an interesting and scientifically challenging period at the cutting edge of science and policy.

8.4 Drs Kawaguchi and Reid, on behalf of the Working Group, thanked Dr Watters for his time as Convener during which he led the formative stages of the development of the feedback management procedure for the krill fishery and made expert contributions to that work. The Working Group looked forward to Dr Watters' continued involvement in the work of WG-EMM, and presented him with a small gift in recognition of his term as Convener.

REFERENCES

Boyd, I.L. and A.W.A. Murray. 2001. Monitoring a marine ecosystem using responses of upper trophic level predators. *J. Anim. Ecol.*, 70 (5): 747–760.

de la Mare, W.K. and A.J. Constable. 2000. Utilising data from ecosystem monitoring for managing fisheries: development of statistical summaries of indices arising from the CCAMLR Ecosystem Monitoring Program. *CCAMLR Science*, 7: 101–117.

Douglass, L.L., J. Turner, H.S. Grantham, S. Kaiser, R. Nicoll, A. Post, A. Brandt and D. Beaver (WWF–ASOC). 2011. A hierarchical classification of benthic biodiversity and assessment of protected areas in the Southern Ocean. Document *WS-MPA-11/23*. CCAMLR, Hobart, Australia: 28 pp.

Fretwell, P.T., M. LaRue, P. Morin, G.L. Kooyman, B. Wienecke, N. Ratcliffe, A.J. Fox, A.H. Fleming, C. Porter and P.N. Trathan. 2012. An emperor penguin population estimate: the first global, synoptic survey of a species from space. *PloS ONE* 7 (4).

Lynch, H.J., R. White, A.D. Black and R. Naveen. 2012. Detection, differentiation, and abundance estimation of penguin species by high-resolution satellite imagery. *Polar Biol.*, 35 (6): 963–968, doi: 10.1007/s00300-011-1138-3.

Marschoff, E., E. Barrera-Oro, N. Alescio and D. Ainley. 2012. Slow recovery of previously depleted demersal fish at the South Shetland Islands, 1983–2010. *Fish. Res.*, 125–126: 206–213.

Mustafa, O., C. Pfeiffer, H.-U. Peter, M. Kopp and R. Metzig. 2012. Pilot study on monitoring climate-induced changes in penguin colonies in the Antarctic using satellite images. UBA-Texte 19/2012, www.uba.de/uba-info-medien-e/4283.html.

Pinkerton, M.H., J.M. Bradford-Grieve and S.M. Hanchet. 2010. A balanced model of the food web of the Ross Sea, Antarctica. *CCAMLR Science*, 17: 1–31.

Raymond, B. 2011. A circumpolar pelagic regionalisation of the Southern Ocean. Document *WS-MPA-11/06*. CCAMLR, Hobart, Australia: 11 pp.

Table 1: Main characteristics of potential feedback management approaches reviewed in WG-EMM-12/P05.

	Management approaches previously discussed by CCAMLR				
Approach	Precautionary catch limits for target species*	Target population size for predators	Average fitness of predators	Median predator productivity arising from harvested species should not fall below 80% of the pre-exploitation level	No interference by fisheries near colonies with land-based predators
Objective	The median escapement from the fishery of the krill spawning stock should be 75% (current CCAMLR precautionary approach for krill)	Abundance of predator populations should not fall below 50% of that prior to harvesting of the prey species	Predator fitness remains unaffected by fishing	Median predator productivity attributed to the consumption of harvested species to be maintained at or above 80% of its level prior to harvesting	To eliminate the potential for interference with foraging of land-based predators by fisheries
Indicator	Biomass of krill population	Biomass of krill population	Krill density	Index of predator productivity based on predator population size, foraging success based on krill and predator weight	Foraging activity
Monitoring frequency	Single estimate of krill biomass; krill demography	Single estimate of krill biomass; krill and predator demography and functional feeding relationship between predators and krill	Annual krill density in the foraging grounds of predators; relationship between predator fitness and krill density in foraging grounds prior to harvesting	Parameters necessary for estimating predator productivity attributed to the consumption of harvested species (e.g. predator abundance, weight, diet)	Predator abundance and foraging locations
Spatial domain	Area of survey	Area of survey	Area of foraging ground survey	Area of predator monitoring	Area of predator monitoring
Adjustment frequency	n/a	Annual	Annual	Annual	Annual

* Existing management approach used to set the current long-term precautionary catch limit.

Table 2: Main characteristics of candidate feedback management approaches presented at WG-EMM-12.

Management approaches currently under consideration by CCAMLR			
Approach	WG EMM-12/44*	WG-EMM-12/P06	WG-EMM-12/19
Objective	1) Maintain precautionary management objectives for krill using escapement and depletion decision rules that include consideration of climate effects 2) Provide precautionary protection for krill-dependent predators using a decision rule that adjusts total catch 3) Provide precautionary protection to krill-dependent predators using a decision rule that adjusts the spatial distribution of catch	1) Maintain target stock appropriate to achieving target status and avoiding depletion with a specified risk 2) Maintain predators either specifically or collectively equal to or above a state that can recover within 2–3 decades if fishing was to cease 3) Maintain an agreed spatial harvest strategy	Maintain: (1) the area-specific state of the harvested stock close to target levels and within specified bounds; (2) area-specific predator populations within specified bounds; (3) overall fishery performance as required.
Indicator	1) Krill biomass estimates and size-frequency distributions 2) Trends in regional penguin abundance 3) Quantiles of penguin fledging weight distributions	Time series of krill and predator indices, in fished and unfished areas suitable to the spatial harvest strategy	Area-specific predator and prey abundance estimates.
Monitoring frequency	1) Annual 2) Annual 3) Annual	Annual	Annual
Spatial domain	1) Regional 2) Regional 3) Variable, dependent on winter foraging distributions of fledglings	Within a regional configuration determined by the preferred harvest strategy	Regional, with appropriate spatial resolution.
Adjustment frequency	1) 5 years 2) 5 years 3) Annual	Annual	Annual

* Points 1–3 refer to the three-step implementation process identified in WG-EMM-12/44.

Table 3: Status on the preparation and submission of data layers for each conservation object identified during the first workshop on Domain 1, with Members submitting data indicated in brackets. For a full list of the conservation objects identified, review WG-EMM-12/69.

MPA objectives	Bioregions, ecosystem processes etc.	Data layer(s) and specific parameter(s)	Prepared	Submitted
1. Representative examples of benthic habitats (CM 91-04, 2i)	a) Benthic environment types	Douglass et al. (2011) classification, layer derived from environmental types	Yes	Yes
2. Representative examples of pelagic habitats (CM 91-04, 2i)	a) Pelagic bioregions	Raymond et al. (2011) classification	Yes	Yes
3. Important benthic ecosystem processes (CM 91-04, 2ii and v)	a) Large-scale canyons	Douglass et al. (2011) classification	Yes	Yes
	b) Smaller-scale canyons	Specific location: - Cape Shirreff	Yes	Yes
	c) Benthic areas under ice shelves	Ice shelf locations (Antarctic Digital Database)	Yes	No (UK)
	d) Up/down-welling and mixing areas	Specific locations: - North of Elephant Island	No	No (Coord.)
4. Large-scale pelagic ecosystem processes (CM 91-04, 2ii and v)	a) Predictable highly productive areas – surface	Satellite-derived surface summer chlorophyll-a	Yes	Yes
	b) Predictable highly productive areas – water column	LTER observations Specific locations: - Downstream of Elephant Island - Seymour Island (?)	No	No (Coord.)
	c) Up/down-welling and mixing areas	Specific locations: - North of Elephant Island	No	No (USA)
	d) Frontal features	Mean frontal positions: - area between the mean positions of the southern and northern boundaries of the ACCF. Divide this into three sectors. Plus 30 km buffer on the southern boundary of the ACCF.	Yes	Yes
	e) Marginal ice zone	Ice-edge position in early summer (December)	No	No (Coord.)
	f) Polynyas	Specific locations: - Coastal polynyas (×2) south of Alexander Island	Yes	Yes
	g) Other dynamic/ important areas	Specific locations: - Southern Marguerite Bay; - Tip of Antarctic Peninsula; - Canyon northwest of South Orkney Islands (krill concentration)	No	No (USA)

(continued)

Table 3 (continued)

MPA objectives	Bioregions, ecosystem processes etc.	Data layer(s) and specific parameter(s)	Prepared	Submitted
5. Important (spatially constrained/predictable) areas for mammal and bird life-histories (CM 91-04, 2ii)	a) Foraging distributions of central-place foragers during breeding season	Breeding locations: - Chinstrap, gentoo, Adélie penguin - Antarctic fur seal To be updated with WG-EMM-STAPP data at WG-EMM-12	No	No (UK)
		Foraging range for each species	No (USA; UK)	No (Coord.)
	b) Prey distributions	Density distribution of: Krill Copepods Myctophids *Pleuragramma antarcticum*	No (USA; Germany)	No
		Survey tows: *P. antarcticum* (Kg/conservation unit)		
	c) Winter feeding grounds: Marginal ice zone: Average 10-years marginal ice zone during winter (e.g. Jun–Aug)			
	Winter distribution of top predators	Marginal ice zone	No	No (Coord.)
		Penguins + whales distribution May–June	No (USA; UK)	No (USA; UK)
6. Important (spatially constrained/ predictable) areas for fish life cycles (CM 91-04, 2ii)	a) Spawning/ recruitment areas of: *Notothenia rossii* *Gobionotothen gibberifrons*	Depth 0–100 m from 64°00'S to the north	No	No (Coord.)
7. Important (spatially constrained/ predictable) areas for zooplankton life cycles (CM 91-04, 2ii)	a) Spawning/ recruitment areas (spp?)		No (USA; Germany; Argentina; FIBEX)	No (USA)
8. Rare or unique habitats/features (CM 91-04, 2iv)	a) Geothermal features	Specific locations: - Deception Island; - Shackleton Ridge (=‘seamount ridges’ in geomorph classification)	Yes	Yes
	b) Seamounts	Douglass et al. (2011) classification – seamount categories	Yes	Yes
9. Vulnerable areas (CM 91-04, 2iv)	a) VMEs	VME data layer from scientific surveys	Yes	No (Coord.)

(continued)

Table 3 (continued)

MPA objectives	Bioregions, ecosystem processes etc.	Data layer(s) and specific parameter(s)	Prepared	Submitted
10. Reference areas for scientific study (CM 91-04, 2iii)	a) Existing study locations, e.g. CEMP sites	Study locations subject to the historical finfish fishery and recent krill fishery:		
		- Potter Cove and Potter Peninsula (Stranger Point, King George Island)	No	No (Coord.)
		- Cape Shirreff	No	No (Coord.)
		- Admiralty Bay (Copa)	No	No (Coord.)
		Study locations subject to the historical finfish fishery:		
		-Signy Island (South Orkney Islands)	No	No (Coord.)
		- Laurie Island (South Orkney Islands)	No	No (Coord.)
		Study locations not subject to any fishery:		
		- Esperanza Station (Hope Bay)	No	No (Coord.)
		- Danco Coast (Base Primavera)	No	No (Coord.)
		- Palmer	No	No (Coord.)
	b) Historically un-fished/upstream areas: LTER area, 200 to 600 transects	Polygon line of the LTER area	No	No (USA)
	c) US AMLR area, downstream, fished area	Polygon line	No	No (USA)
	d) ASPAs and ASMAs		Yes	Yes

Table 4: Human activities.

Potential uses or activities	Data layer(s) and specific parameter(s)	Prepared	Submitted
Krill fishery	Fishing effort (No. hauls)	Yes	No (Coord.)
Tourism vessels tracks	Vessels tracks (Contact IAATO)	No (USA)	No (Coord.)
Tourist Site	Frequency of use of different sites	No	No (Coord.)

Table 5: Start and end positions, depth, distance, and seabed area sampled for the proposed South Shetland, Elephant and Joinville Islands VME stations.

Date	Mean depth (m)	Distance (n miles)	Start latitude S	Start longitude W	End latitude S	End longitude W
18/03/12	63	1.89	61°20.00'	54°87.17'	61°20.50'	54°93.63'
16/03/03	169	1.26	60°55.02'	55°43.21'	60°52.95'	55°41.85'
14/03/03	125	1.42	61°14.34'	54°48.66'	61°15.03'	54°35.50'
14/03/03	198	1.09	61°03.61'	54°34.00'	61°04.01'	54°35.15'
20/03/03	86	1.21	61°27.08'	55°51.49'	61°24.31'	55°53.44'

Table 6: Location of proposed VMEs in Terra Nova Bay, Ross Sea.

Site name	Latitude S	Longitude E
Tethys Bay	74°42.140'	164°3.308'
Tethys Bay	74°41.605'	164°5.468'
Road Bay	74°41.790'	164°7.069'
Road Bay	74°41.974'	164°7.296'
Adelie Cove	74°46.234'	163°57.472'
Adelie Cove	74°46.239'	163°56.033'
Adelie Cove	74°46.504'	163°57.370'

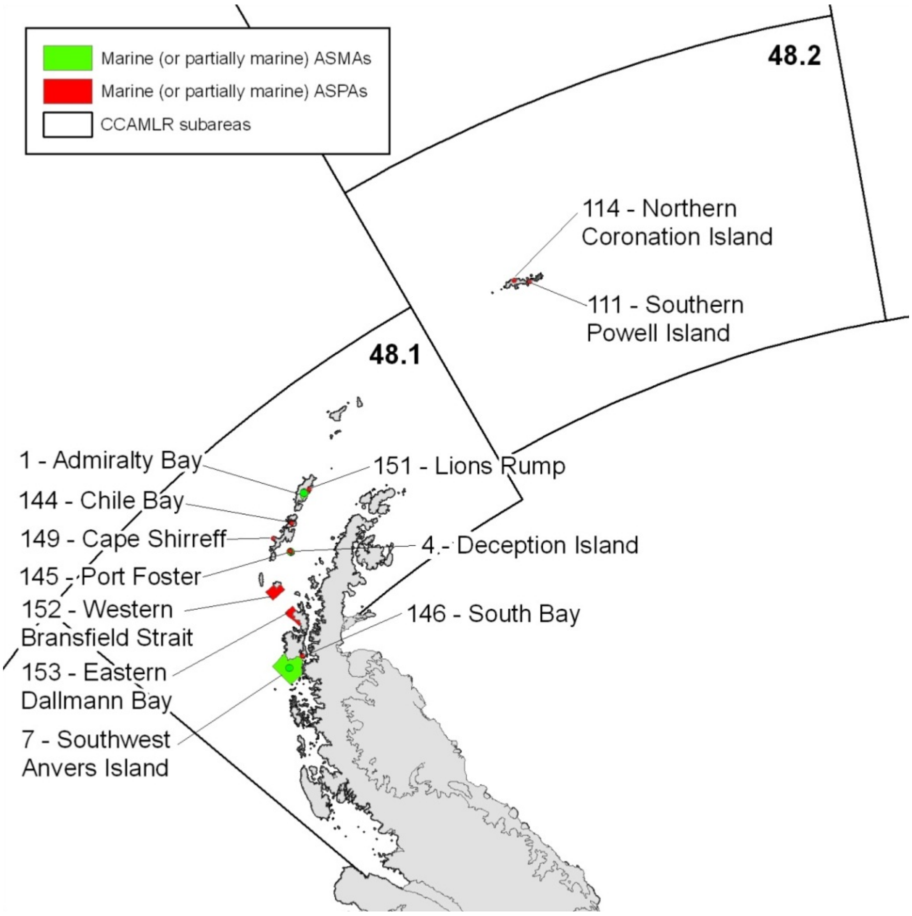

Figure 1: Marine and partially marine ASPAs and ASMAs located in Subareas 48.1 and 48.2. Sites are labelled in accordance with the ASMA and ASPA numbering system adopted by the ATCM (ASMA Nos 1, 4 and 7 and ASPA No. 111, 114, 144, 145, 146, 149, 151, 152 and 153). Map drawn using GIS shapefiles available on the Antarctic Treaty Secretariat website (www.ats.aq/devPH/apa/ep_protected.aspx) Antarctic Protected Areas Data. Source: Environmental Research and Assessment (ERA) (2011).

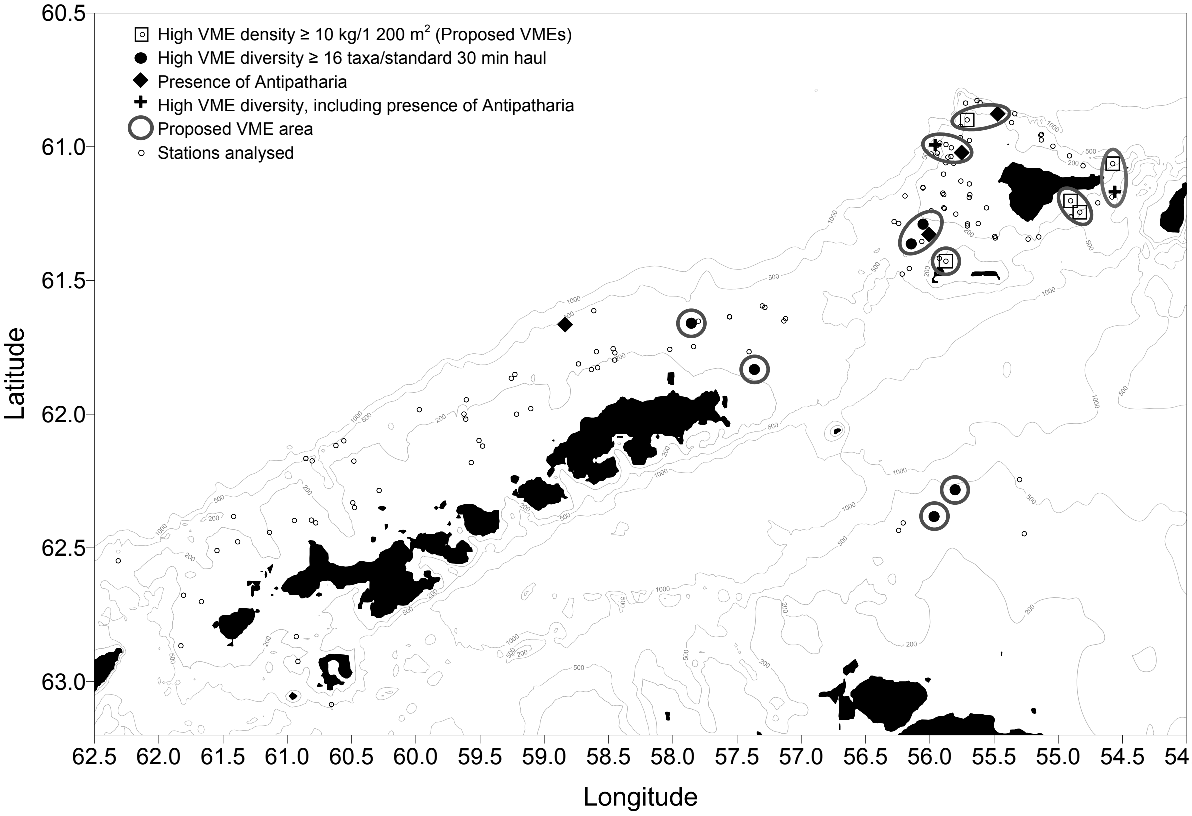

Figure 2: Proposed VMEs, locations of the presence of black coral and areas of interest for future work as identified in WG-EMM-12/51. The five locations characterised by VME by-catch in excess of 10 kg per 1 200 m^2 in 2012 are recommended for inclusion in the VME register. Other locations are identified as areas of interest for future work as in paragraph 3.90.

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Appendix B

AGENDA

Working Group on Ecosystem Monitoring and Management (WG-EMM)
(Santa Cruz de Tenerife, Spain, 2 to 13 July 2012)

1. Introduction

    1.1 Opening of the meeting
    1.2 Adoption of the agenda and appointment of rapporteurs
    1.3 Review of requirements for advice and interactions with other working groups

2. The krill-centric ecosystem and issues related to management of the krill fishery

    2.1 Issues for the present
        2.1.1 Fishing activities
        2.1.2 Scientific Observation
        2.1.3 Krill Biology, and Ecology and Management

    2.2 Issues for the future
        2.2.1 Feedback management strategy
        2.2.2 CEMP and STAPP
        2.2.3 Integrated assessment model
        2.2.4 Fishing vessel surveys

3. Spatial management

    3.1 Marine Protected Areas
    3.2 VMEs

4. Other ecosystem considerations, including fish-based ecosystem interactions

5. Advice to the Scientific Committee and its working groups

6. Future work

7. Other business

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

Appendix C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Santa Cruz de Tenerife, Spain, 2 to 13 July 2012)

WG-EMM-12/01	Draft Preliminary Agenda for the 2012 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-12/02	List of participants
WG-EMM-12/03	List of documents
WG-EMM-12/04	Extending ecological monitoring to underpin the development of feedback management approaches for the Antarctic krill fishery P.N. Trathan (UK), H.J. Lynch (USA), C. Southwell (Australia), P.T. Fretwell (UK), G. Watters (USA) and N. Ratcliffe (UK)
WG-EMM-12/05	Krill fishery report: 2012 update Secretariat
WG-EMM-12/06	Notification of Chile's intent to conduct krill fishing in 2012/13 Submitted on behalf of Chile
WG-EMM-12/07	Notification of China's intent to conduct krill fishing in 2012/13 Submitted on behalf of China
WG-EMM-12/08	Notification of Germany's intent to conduct krill fishing in 2012/13 Submitted on behalf of Germany
WG-EMM-12/09	Notification of Japan's intent to conduct krill fishing in 2012/13 Submitted on behalf of Japan
WG-EMM-12/10	Notification of Korea's intent to conduct krill fishing in 2012/13 Submitted on behalf of Korea
WG-EMM-12/11	Notification of Norway's intent to conduct krill fishing in 2012/13 Submitted on behalf of Norway
WG-EMM-12/12	Notification of Poland's intent to conduct krill fishing in 2012/13 Submitted on behalf of Poland
WG-EMM-12/13	Notification of Ukraine's intent to conduct krill fishing in 2012/13 Submitted on behalf of Ukraine

WG-EMM-12/14	Update of the ICESCAPE software routines J. McKinlay (Australia)
WG-EMM-12/15	The distribution of spatial management and Antarctic krill catch across pelagic bioregions in the Southern Ocean S.M Grant, S.L. Hill and P. Fretwell (United Kingdom) (*CCAMLR Science*, submitted)
WG-EMM-12/16	Two decades of variability in krill predators at Bird Island, South Georgia and their potential as ecosystem indicators S.L. Hill, C.M. Waluda, H.J. Peat and S. Fielding (United Kingdom)
WG-EMM-12/17	Diet variability and reproductive performance of macaroni penguins (*Eudyptes chrysolophus*) at Bird Island, South Georgia C.M. Waluda, S.L. Hill, H.J. Peat and P.N. Trathan (United Kingdom)
WG-EMM-12/18	Warming effects in the Western Antarctic Peninsula Ecosystem: the role of population dynamic models for explaining and predicting penguin trends M. Lima and S.A. Estay (Chile)
WG-EMM-12/19	A feedback approach to Ecosystem Based Management: model predictive control of the Antarctic krill fishery S. Hill and M. Cannon (United Kingdom) (*CCAMLR Science*, submitted)
WG-EMM-12/20 Rev. 1	Towards a strategic framework for assessing uncertainty in ecosystem dynamics models: objectives are sensitive too S. Hill and J. Matthews (United Kingdom) (*CCAMLR Science*, submitted)
WG-EMM-12/21	Features of growth of young Weddell seal A. Salhanskyy (Ukraine)
WG-EMM-12/22	Temporal variability in Adélie penguin CEMP parameters and their response to changes in prey availability L. Emmerson and C. Southwell (Australia)
WG-EMM-12/23	Dense populations of the Antarctic scallop (*Adamussium colbecki*) in Terra Nova Bay (Subarea 88.1J): potential VMEs adjacent to the Terra Nova Bay ASPA (No. 161) M. Chiantore and M. Vacchi (Italy)
WG-EMM-12/24	Net escapement of Antarctic krill in trawls B.A. Krafft (Norway), L.A. Krag, B. Herrmann (Denmark), A. Engås, S. Nordrum and S. Iversen (Norway)

WG-EMM-12/25	The first site of the Marine Protected Area network in the Akademik Vernadsky Station region: Argentine Islands, Skua Creek Delegation of Ukraine
WG-EMM-12/26	Effects of recruitment variability and natural mortality on Generalised Yield Model projections and the CCAMLR Decision Rules for Antarctic krill D. Kinzey, G. Watters and C. Reiss (USA) (*CCAMLR Science*, submitted)
WG-EMM-12/27	An integrated assessment model for Antarctic krill: progress update D. Kinzey, G. Watters and C. Reiss (USA)
WG-EMM-12/28	Analysis of variables influencing finfish by-catch in the krill fishery in Area 48 S.M. Martin, T. Peatman, J. Moir Clark (United Kingdom), O.R. Godø (Norway) and R.C. Wakeford (United Kingdom)
WG-EMM-12/29	A methodology for estimating total finfish by-catch of the Area 48 krill fishery T. Peatman, S.M. Martin (United Kingdom), O.R. Godø (Norway) and R.C. Wakeford (United Kingdom)
WG-EMM-12/30	Operations of Chilean vessel *Betanzos* fishing Antarctic krill (*Euphausia superba*) (June 2011 – April 2012) P.M. Arana (Chile)
WG-EMM-12/31	Recalculation of Antarctic krill (*Euphausia superba*) biomass off East Antarctica (30–80°E) in January–March 2006 M.J. Cox and S. Kawaguchi (Australia)
WG-EMM-12/32	Impacts of ocean acidification on Antarctic krill biology: preliminary results and future research directions S. Kawaguchi, T. Berli, R. King, S. Nicol, P. Virtue and A. Ishimatsu (Japan)

WG-EMM-12/33 Rev. 1	Estimating the biodiversity of Planning Domain 5 (Marion and Prince Edward Islands – Del Cano – Crozet) for ecoregionalisation P. Koubbi (France), R. Crawford (South Africa), N. Alloncle, N. Ameziane, C. Barbraud, D. Besson, C.-A. Bost, K. Delord, G. Duhamel (France), L. Douglass (Australia), C. Guinet (France), G. Hosie (Australia), P.A. Hulley (South Africa), J.-O. Irisson (France), K.M. Kovacs (Norway), R. Leslie, A. Lombard, A. Makhado (South Africa), C. Martinez (France), S. Mormede (New Zealand), F. Penot (France), P. Pistorius (South Africa), P. Pruvost (France), B. Raymond (Australia), E. Reuillard, J. Ringelstein (France), T. Samaai (South Africa), P. Tixier (France), H.M. Verheye (South Africa), S. Vigetta (France), C. von Quillfeldt (Norway) and H. Weimerskirch (France)
WG-EMM-12/34	Precautionary spatial protection to facilitate the scientific study of habitats and communities under ice shelves in the context of recent, rapid, regional climate change P.N Trathan, S.M. Grant (United Kingdom), V. Siegel and K.-H. Kock (Germany) (*CCAMLR Science*, submitted)
WG-EMM-12/35	Some peculiarities of the distribution and fishing of *Euphausia superba* in the Indian sector of the Southern Ocean (by results of USSR fleet operations in 1970–1990) L. Pshenichnov (Ukraine)
WG-EMM-12/36	Linking fish and shags population trends R. Casaux and E. Barrera-Oro (Argentina)
WG-EMM-12/37	Synopsis of data from satellite telemetry of foraging trips and migration routes of penguins and pinnipeds from the South Shetland Islands, 1997/98 to present J. Hinke, G. Watters, W. Trivelpiece and M. Goebel (USA)
WG-EMM-12/38	Modelling growth and reproduction of Antarctic krill: implications of spatial and temporal trends in temperature and food for ecosystem-based management of krill fisheries A.J. Constable and S. Kawaguchi (Australia)
WG-EMM-12/39	Assessing indicators for feedback monitoring and management of the krill fishery: data and methods for assessing predator productivity as an indicator C. Southwell, L. Emmerson and A. Constable (Australia)
WG-EMM-12/40	Management Plan for Antarctic Specially Protected Area No. 144 Delegation of Chile

WG-EMM-12/41	Revised Management Plan for Antarctic Specially Protected Area No. 145: Port Foster, Deception Island, South Shetland Islands Delegation of Chile
WG-EMM-12/42	Revised Management Plan for Antarctic Specially Protected Area No. 146: South Bay, Doumer Island, Palmer Archipelago Delegation of Chile
WG-EMM-12/43	Method for collecting of data on traumatic death of krill passed through the trawl meshes V.V. Akishin, I.G. Istomin, V.A. Tatarnikov, A.F. Petrov and R.O. Lebedev (Russia)
WG-EMM-12/44	Towards developing a feedback management procedure for the Antarctic krill fishery G. Watters and J. Hinke (USA)
WG-EMM-12/45	Proposal for a SCOR Working Group to identify Ecosystem Essential Ocean Variables for measuring change in the biological properties of marine ecosystems A. Constable (Australia)
WG-EMM-12/46	Research and monitoring to support an MPA in the Ross Sea Region G.M. Watters and C.S. Reiss (USA)
WG-EMM-12/47	Proposal for a new Antarctic Specially Protected Area at Cape Washington and Silverfish Bay, Terra Nova Bay, Ross Sea Delegations of the USA and Italy
WG-EMM-12/48	Temporal variability in Adélie penguin CEMP parameters and their response to changes in prey availability L. Emmerson and C. Southwell (Australia)
WG-EMM-12/49	A proposal for compiling information, assessments and science that underpin established CCAMLR Marine Protected Areas and provide the basis for ongoing management, science and review: an MPA Report A. Constable, M. Guest, D. Welsford (Australia), P. Koubbi (France) and L. Weragoda (Australia)
WG-EMM-12/50	Analysis of spatial and temporal structure in long-term krill fishery in the Area 48 and its relation to climate variability P. Gasyukov and S. Kasatkina (Russia)

WG-EMM-12/51	Potential VMEs around Elephant and the South Shetland Islands (Subarea 48.1) S.J. Lockhart (USA), N. Wilson (Australia) and E. Lazo-Wasem (USA)
WG-EMM-12/52	Proposals on providing international synoptic surveys for management application S. Kasatkina (Russia)
WG-EMM-12/53	Network characterisation of the food-web of the Ross Sea, Antarctica M.H. Pinkerton and J.M. Bradford-Grieve (New Zealand)
WG-EMM-12/54	Diet and trophic niche of Antarctic silverfish (*Pleuragramma antarcticum*) in the Ross Sea, Antarctica M.H. Pinkerton, J. Forman, S.J. Bury, J. Brown, P. Horn and R.L. O'Driscoll (New Zealand)
WG-EMM-12/55	The Ross Sea cephalopod community: insights from stable isotope analysis D.R. Thompson, M.H. Pinkerton, D.W. Stevens (New Zealand), Y. Cherel (France), S.J. Bury (New Zealand)
WG-EMM-12/56	A customised Marine Spatial Planning tool in Arc-GIS to facilitate development and evaluation of Marine Protected Area scenarios in the CCAMLR Area B.R. Sharp and K. Ollivier (New Zealand)
WG-EMM-12/57	Preliminary plan for research and monitoring in the Ross Sea region, in association with spatial marine protection M.H. Pinkerton and B. Sharp (New Zealand)
WG-EMM-12/58	Abundance and reproductive distribution of Pygoscelids sp. in the northern area of Danco Coast, Antarctic Peninsula M.M. Santos, E.F. Rombolá, D. González-Zevallos, M.A. Juáres, J. Negrete and N.R. Coria (Argentina)
WG-EMM-12/59	Preliminary report of outcomes of the 2nd international workshop on the ICED Southern Ocean Sentinel, held in Hobart Australia 7–11 May 2012 A. Constable (Australia)
WG-EMM-12/60	An initial analysis of data provided from the deployment of scientific observers in the krill fishery S. Thanassekos (CCAMLR Secretariat), S. Candy (Australia), E. Appleyard (CCAMLR Secretariat), S. Kawaguchi (Australia) and K. Reid (CCAMLR Secretariat)

WG-EMM-12/61	Working Plan for the Review of the Admiralty Bay Antarctic Specially Managed Area Management Plan (ASMA No. 1) Jaqueline Leal Madruga (Submitted by Brazil on behalf of the ASMA No. 1 Management Group – Brazil, Ecuador, Peru, Poland and the United States)
WG-EMM-12/62	A review and analysis of indices from CEMP data Secretariat
WG-EMM-12/63	Krill stock evaluation with data from commercial fishing vessels G. Skaret (Norway), J. Moir Clark (United Kingdom), O.R. Godø, R.J. Korneliussen, T. Knutsen, B.A. Krafft and S.A. Iversen
WG-EMM-12/64 Rev. 1	A summary of scientific observer programs undertaken during the 2011 and 2012 seasons Secretariat
WG-EMM-12/65	Results of scientific observation in Antarctic krill fishery in 2010/11: I. state of observer deployment and data collection M. Kiyota and T. Okuda (Japan)
WG-EMM-12/66	Preliminary observation about the possibility of Antarctic krill escapement from a trawl net K. Fujita and S. Hasegawa (Japan)
WG-EMM-12/67	Results of scientific observation in Antarctic krill fishery in 2010/11: II. analysis of variability of krill size and fish by-catch T. Okuda and M. Kiyota (Japan)
WG-EMM-12/68	Analysis of variability of krill size and fish by-catch in Japanese krill fishery based on scientific observer data T. Okuda and M. Kiyota (Japan)
WG-EMM-12/69	Report of the First Workshop on the Identification of Priority Areas for MPA Designation within Domain No. 1 (CCAMLR). Valparaiso 2012
WG-EMM-12/70	Outline proposal for geographic information services for CCAMLR Submitted by the Secretariat on behalf of Adrian Fox, British Antarctic Survey (United Kingdom)
WG-EMM-12/71	Penguin monitoring via remote sensing H. Herata and F. Hertel (Germany)

Other documents

WG-EMM-12/P01	The feeding peculiarities of the Antarctic seals in the region of the archipelago of Argentina Islands I. Dykyy (*Ukraininan Antarctic Journal*, 8 (2009))
WG-EMM-12/P02	Sensitivity analysis identifies high influence sites for estimates of penguin krill consumption on the Antarctic Peninsula H.J. Lynch, N. Ratcliffe, J. Passmore, E. Foster and P.N. Trathan (*Ant. Sci*., in press)
WG-EMM-12/P03	Diet and trophic niche of *Macrourus* spp. (Gadiformes, Macrouridae) in the Ross Sea region of the Southern Ocean M.H. Pinkerton, J. Forman, D.W. Stevens, S.J. Bury and J. Brown (In: Orlov, A. (Ed.). *Journal of Ichthyology, Special Issue on Grenadiers* (accepted))
WG-EMM-12/P004	The ecosystem approach to managing fisheries: achieving conservation objectives for predators of fished species A.J. Constable (*CCAMLR Science*, 8 (2001): 37–64)
WG-EMM-12/P05	CCAMLR ecosystem monitoring and management: future work A.J. Constable (*CCAMLR Science*, 9 (2002): 233–253)
WG-EMM-12/P06	Lessons from CCAMLR on the implementation of the ecosystem approach to managing fisheries A.J. Constable (*Fish and Fisheries*. 2011, doi: 10.1111/j.1467-2979.2011.00410.x)

Appendix D

ESTIMATION OF TOTAL REMOVALS (GREEN WEIGHT)

PURPOSE OF ESTIMATING TOTAL REMOVALS

1. Catch limits in CCAMLR fisheries are set at a level that is considered sustainable and will allow the Commission to satisfy the requirements of Article II of the Convention. In setting such catch limits it is assumed that the reported catch from a fishery reflects the total removals by that fishery from the exploited population. Accurate information on the total removals is essential for:

   (i) stock assessment allowing the tracking of the dynamics of the stock and the impact of the fishery

   (ii) the real-time monitoring of catches to ensure that area-based catch limits are not exceeded.

2. For the purposes of this report, green weight refers to the total weight of krill landed on the vessel and is assumed to be equivalent to total removals (the potential for escape mortality of krill to introduce a difference between green weight and total removals is not considered in this appendix).

BACKGROUND

3. In 2008 WG-EMM discussed the issue of catch uncertainty associated with the use of conversion factors in the krill fishery (SC-CAMLR-XXVII, Annex 4, paragraphs 4.34 to 4.39) and those Members engaged in the krill fishery were requested to provide information to ad hoc TASO in order to address this issue (SC-CAMLR-XXVII, paragraph 4.13 to 4.18). The issue was further considered by TASO in 2009 (SC-CAMLR-XXVIII, Annex 9, paragraph 3.6) and WG-EMM (SC-CAMLR-XXVIII, Annex 4, paragraph 3.49), including discussion of the conversion of volumetric estimate to mass of catch (SC-CAMLR-XXVIII, paragraph 4.16). In 2010 there was recognition by the Commission that standardisation of methods for estimating the green weight of krill caught was urgently required to achieve more accurate estimates of actual catches (CCAMLR-XXIX, paragraphs 4.13 to 4.15). Accordingly, the Commission adopted the following amendment to CM 21-03 to require submission of information concerning the estimate of green weight:

> ‘As of 2011/12, the notification shall include a description of the exact detailed method of estimation of the green weight of krill caught and, if conversion factors are applied, the exact detailed method of how each conversion factor was derived. Members are not required to re-submit such a description in the following seasons, unless changes in the method of green weight estimation occurred.’

4. In 2011 the issue was further discussed in WG-EMM (SC-CAMLR-XXX, Annex 4, paragraphs 2.56 to 2.58), including a description of the process of catch estimation on vessels and advice on the type of analyses required to investigate uncertainty in these estimates. The

Scientific Committee noted that all methods for estimating green weight of krill have associated uncertainty and that this uncertainty is not accounted for in the current management; it requested that WG-EMM characterise such variability and uncertainty to investigate their impacts on krill management advice (SC-CAMLR-XXX, paragraphs 3.14 and 3.15). The Commission noted that the uncertainty in the estimation of green weight of krill was not accounted for in the current management process for krill and looked forward to receiving advice from the Scientific Committee on the potential impacts of this on the management of krill (CCAMLR-XXX, paragraph 4.13).

ESTIMATING TOTAL REMOVALS

5. Removals, R, as green weight in a haul can be estimated directly from the measured component of the catch, W, according to the following equation

$$R = mW + \varepsilon \tag{1}$$

where m is a multiplier that converts the measured component to green weight.

6. Examples of the measured component of the catch and the associated multiplier are:

Example of measured components of the catch	Multiplier
Weight of total krill landed on deck	Approx. 1
Flow meter estimates of total catch	Approx. 1
Estimate of volume of haul in fish pond	Volume-to-weight conversion factor
Weight of product from factory	Product-to-green weight conversion factor.

7. The estimation of total removals will be less sensitive to errors in those multipliers that are close to 1.0 (e.g. using a flow meter or frozen whole estimates of krill weight) than to multipliers for other products that have higher (and more variable) product-to-catch ratios.

8. If the error in the multiplier is random with respect to all of the hauls in a season then the estimate of total removals, $\hat{R}$, used in the approaches described above needs to consider only the multiplier and the measured component of the catch of each haul, h, such that

$$\hat{R} = \sum_h m_h W_h \quad . \tag{2}$$

9. Typically, total removals are estimated using a function in place of haul-specific measures of m_h, such that

$$m_h = f\left(W_h, \vec{a}_h, \vec{c}\right) \tag{3}$$

where $\vec{c}$ is a vector of constants that can be used to convert a particular attribute of the haul into an estimate of green weight and $\vec{a}_h$ is a vector of those haul-specific attributes (see

Table 2). The inclusion of W_h in the function (2) reflects those situations where the multiplier has non-linear relationships with catch. This part of the function would be 1 for a linear relationship.

10. Understanding of the details of the different methods that are used in order to determine the actual values (and uncertainties) of the attributes and constants used in the estimation of removals has been identified as a priority for CCAMLR (see 'Background' above). In particular, there has been a focus on understanding the implications of using product weight and product-to-green weight conversion factors in a fishery that produces a range of products that have quite different product-specific conversion factors.

11. At present, few data are available to assess whether the values of multipliers, such as product conversion factors, are well estimated or consistent between hauls. This data was summarised in WG-EMM-08/46, which provided a compilation of available information on the conversion factors reported to the Secretariat. Another source for understanding the uncertainty associated with the different multipliers is the values reported in the notifications; for example, an estimate of the variance in conversion factors for different products from notifications is presented in Table 1.

Table 1: Summary product-to-green weight conversion factors indicated in notifications for the 2012/13 fishing season.

Products	Mean	SD	Factor							
Meal (feed)	8.78	1.64	7.7	10.0	9.0	10.0	10.0	6.0		
Meal (human)	10.00	na	10.0							
Krill paste	na	na								
Oil	na	na								
Hydrolisate	na	na								
Lipid complex	na	na								
Frozen whole	1.00	0.00	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Boiled	1.00	na	1.0							
Peeled	10.25	3.18	12.5	8.0						
Raw (crude)	1.00	na	1.0							

12. Figure 1 indicates how the relative risk that the reported catch might exceed a catch limit may change as a function of reported catch for a particular function. This type of figure might be useful in decision-making. The shape of the curve would depend on the particular set of attributes and constants used in the multiplier. With a more detailed understanding of the uncertainty in the multipliers (in particular in the error distribution) it would be possible to appropriately parameterise this type of risk curve for each method presented in Table 2, with which the Commission could determine management response according to an appropriate level of risk that the removals might exceed the catch limit.

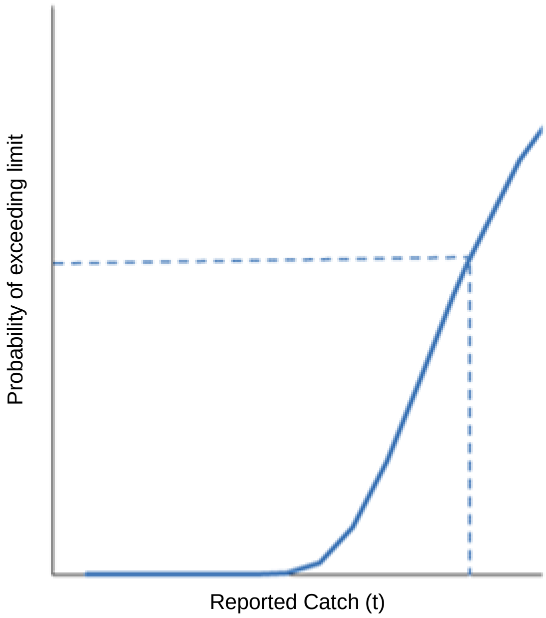

Figure 1: Example relationship between reported catch and the probability of that catch exceeding a specific catch limit. The vertical dashed line indicates the point on the horizontal axis where reported catch equals the catch limit. The horizontal line indicates how the probability that this reported catch is greater than the catch limit can be read off the vertical axis.

DATA REQUIREMENTS

13. The Working Group agreed on the need to acquire more detailed information on the uncertainties associated with each method used by different vessels for estimating green weight. In particular, being able to measure the variability associated with haul-by-haul and vessel-by-vessel estimates of green weight was identified as important. As a way forward, it was proposed to:

(i) review those methods that had been described in notifications

(ii) determine which of those methods included sufficient details to assess uncertainty in the estimate of catch

(iii) provide recommendations on the details that would be required for the Working Group to assess uncertainty in the estimate of catches for each method.

14. The review of notifications revealed a total of five different methods that have been described for the 2011/12 and 2012/13 fishing seasons and of these, most methods used volume as a proxy for krill mass and the multiplier for converting volume-to-weight has not been provided for any method. It was also noticed that although the equation and parameters for estimating the green weight for each haul was known for several methods, the notifications did not provide enough information as for estimating the accuracy for each

parameter and thus, the total uncertainty of the haul-by-haul green weight (Table 2). Accordingly, the Working Group provided recommendations on the details that would be required to assess uncertainty in the estimate of green weight for each method.

15. The recommendations for specific methods are as follows:

Flow meter

This method uses the volume estimates from the flow meters associated to the production line to estimate the green weight (M) of each haul. The formula used is:

$M = V_h \rho$,

where 'V_h' is the volume estimated for each haul; and 'ρ' is the volume-to-mass multiplier.

Specific recommendations for each parameter are as follows:

Volume (V): provide the precision of the flow meters used (i.e. the percentage error associated with the equipment itself and/or undertake experiments to repeatedly pass a known weight of krill through the flow meter and record the resultant meter readings).

Rho (ρ): explain in full the exact method used for estimating the value of the volume-to-weight parameter (i.e. by weighing a 10 litre bucket of krill with a balance accurate to ±0.1 kg).

Flow scale

This method use direct estimates of krill mass as it is transported on the conveyor belt from the holding tank to the factory. Estimates of green weight using this method should measure and report the multiplier accounting for the fraction of krill and water on the belt.

Holding tank volume

This method uses the volume of the catch estimated from the height at which each holding tank is filled with krill for estimating the green weight (M) of each haul. The formula used is:

$M = V_h \rho$, with $V_h = WLH_h$,

where 'W' is the width of the holding tank; 'L' is the length of the holding tank; 'H_h' is the height of the krill catch in the holding tank for haul 'h'.

Specific recommendations for each parameter are as follow:

Describe the formula (depending on tank shape) and total volume of each holding tank and the accuracy of these estimates (i.e. $\pm 0.0001\ m^3$)

H_h: describe the exact method used for estimating the height of krill in the holding tanks each haul and the accuracy of the measurements (i.e. ±5 cm)

Rho (ρ): explain in full the exact method used for estimating the value of the volume-to-mass parameter (i.e. by weighing a 10 litre bucket of krill with a balance accurate to ±0.1 kg).

Condend volume

This method takes advantage of the regular stylidium shape of the codend to estimate the green weight (M) of each haul. The formula used is: $M = \rho\pi WHL/4$,

where 'M' is the mass of the catch; 'W', 'H' and 'L' are the width (major axis), height (minor axis) and length of the filled codend respectively; and 'ρ' is the density of the catch.

It is noticed that W and H remain constant for all hauls. Vessels shall provide the exact method and accuracy (i.e. ±5 cm) for estimating these measures.

Rho (ρ): explain in full the exact method used for estimating the value of the volume-to-mass parameter (i.e. weighing a 10 litre bucket of krill with a balance accurate to ± 0.1 kg).

Length (L): describe precisely the method used for measuring the length of the codend. According to information provided in CCAMLR-XXX/10, the length of the codend is estimated by counting the number of equidistant rope rings designed to strengthen the codend. This method has large inherent error associated with it (that will depend on the number and spacing of the rope rings) and a more precise method for estimating the codend length on each haul is strongly recommended.

Product conversion factors

This method estimates the green weight (M) of hauls by multiplying the total weight of each product produced in each haul by a known conversion factor: $M = A_{hz} * \beta_z$,

where 'A_{hz}' is the weight of product 'z' for haul 'h'; and 'β_z' is the conversion factor for product 'z'.

16. The Working Group noted that conversion factors are not estimated regularly and often remain constant over multiple seasons. Regular measurements of each will assist in determining how variability in these parameters may affect the estimation of total removals. Accordingly, it is strongly recommended that conversion factors shall be estimated frequently during each fishing season, using, for example, the method outline in WG-EMM-11/29.

17. This method should include an estimation of the value of the volume-to-weight parameter used (see below recommendation for estimating Rho). Furthermore, the Working Group recommended that estimations of green weights should be conducted in the most direct possible way.

18. Arising from the analysis of the descriptions of the methods for estimating green weight, the Working Group agreed that a parameter common to all methods, and which is likely to vary throughout the fishing season, but is currently not reported in any of the notifications, is the estimation of the volume-to-mass conversion factor (parameter Rho (ρ)).

19. The Working Group requested that the multipliers used to convert the measured component of the catch to an estimate of green weight should be estimated at least once every reporting period where those reporting periods are specified in CM 23-06.

20. A method suggested for estimating Rho is as follows:

1. Fill a 25 litre container with krill from the point at which the estimation of volume is made.

2. Drain the sample and weigh the krill to a precision greater than ±0.1 kg.

3. Repeat the process 10 times, provide the values to the Secretariat.

21. Although the reporting of catch is a Flag State responsibility, the Working Group recognised that this process could be done by, or with the aid of, the scientific observer. Likewise, scientific observers could aid in providing detailed descriptions of the method(s) used on the vessels to estimate each parameter in the relevant equation in Table 2, including an evaluation of the associated uncertainty. The Working Group also recommended that for those vessels using product-to-green weight conversion factors, these should also be re-estimated at least once every reporting period.

Table 2: Examples of parameters on which uncertainty estimates are needed. V – volume of krill; W – width; L – length; H – height; ρ – volume-to-weight conversion factor; A – product weight; β – product-to-green weight conversion factor; sub-index 'h' indicates haul-by-haul estimation.

Method	Equation	Parameter	Parameter type	Estimation method	Examples of error estimation
Flow meter	$V_h * \rho$	V = volume (litres of krill)	Haul-specific	Difference between flow meter 1 (krill + water) and flow meter 2 (water content extracted before processing)	± 0.01% or ± 0.1 litre every 1 000 litres measured
		ρ = density of the catch	Constant	Not provided	± 0.01 kg/litre
Flow scale	$M_h*(1–F)$	M_h = mass of krill	Haul-specific	Direct estimate	± 0.01% or ± 0.1 kg every 1 tonne measured
		F = fraction of water in the sample	Constant	Not provided	± 0.001
Holding tank volume	$W*L*H_h*\rho$	W = tank width	Constant		± 5 cm
		L = tank length	Constant		± 5 cm
		ρ = density of the catch	Constant	Not provided	± 0.005 kg/litre
		H = tank height	Haul-specific	Not specified	± 5 cm
Codend volume	$W*H*L_h*\rho*\pi/4$	W = codend width	Constant	Measure before fishing starts. Exact method not provided	± 10 cm
		H = codend height	Constant	Measure before fishing starts. Exact method not provided	± 10 cm
		ρ = density of the catch	Constant	Not provided	± 1 kg/m^3
		L = codend length	Haul-specific	Number of equidistant rope-rings designed to strengthen the codend are counted	± 1/4 distance between rope rings
Conversion factors	$A_{hz}*\beta_z$	A_{hz} = weight of product 'z' for haul 'h'	Haul-specific	Weight of product obtained from factory estimate	± 1 kg
		β_z = product 'z'-to-green weight multiplier	Constant	See WG-EMM-11/29	Mean ± SD

Annex 7

Report of the Working Group
on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

CONTENTS

* Appendices F to U are published only in electronic format (www.ccamlr.org/node/75667).

Appendix R*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.2

Appendix S*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3a

Appendix T*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3b

Appendix U*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 8 to 19 October 2012)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 8 to 19 October 2012. The Convener, Dr M. Belchier (UK), opened the meeting and welcomed participants (Appendix A).

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 This year's agenda of WG-FSA focused on data-poor fisheries, depleted and recovering stocks, by-catch, biology and ecology, CCAMLR's Scheme of International Scientific Observation and VMEs (SC-CAMLR-XXX, Table 6). The agenda included a workshop on ageing of otoliths from *Dissostichus eleginoides* and *D. mawsoni* (SC-CAMLR-XXX, paragraph 3.139). The agenda of the meeting was discussed and adopted without change (Appendix B).

2.2 Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all the authors for their valuable contributions to the work presented to the meeting.

2.3 Components of WG-FSA's work were developed during the meeting by the following subgroups:

- Subgroup on Assessments (coordinator: Dr D. Kinzey, USA)
- Subgroup on Research Plans in Data-poor Fisheries (coordinator: Dr B. Sharp, New Zealand)
- Subgroup on VMEs (coordinator: Dr C. Jones, USA, SC-CAMLR Chair)
- Subgroup on the Scientific Observer Program (coordinator: Dr J. Brown, UK)
- Subgroup on Non-target Catch in CCAMLR Fisheries (coordinator: Dr C. Darby, UK)
- Subgroup on Biology, Ecology and Fish-based Ecosystems (coordinator: Dr K.-H. Kock, Germany)
- Workshop on Techniques and Procedures for Ageing of Otoliths from *D. eleginoides* and *D. mawsoni* (coordinator: Dr D. Welsford, Australia).

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 13. In addition, the information used in developing assessments and other aspects of the Working Group's work is provided in the Report on Bottom Fisheries and VMEs (Appendix F) and the Fishery Reports (Appendices G to U). These reports will be published on the CCAMLR website (www.ccamlr.org – go to 'Publications', see 'Fishery Reports').

2.5 The report was prepared by Drs Brown, Darby, J. Ellis (UK), Mr N. Gasco (France), Drs O. Godø (Norway), S. Hanchet (New Zealand), Jones, Kinzey, Kock, S. Mormede (New Zealand), S. Parker (New Zealand), D. Ramm (Data Manager), K. Reid (Science Manager), Mr R. Sarralde (Spain), Mr R. Scott (UK), Dr Sharp, Mr C. Sutton (New Zealand), Drs K. Taki (Japan), Welsford, R. Wiff (Chile) and P. Ziegler (Australia).

REVIEW OF AVAILABLE DATA

3.1 The Working Group reviewed data submitted to the Secretariat from commercial fisheries and fishery-based research in 2011/12, including information relevant to stock assessments. This information is briefly described in this section and the data have been used throughout the report.

Data reporting

3.2 Since WG-FSA-11 the Secretariat has continued to develop procedures, databases and data forms based on the advice from the Scientific Committee and the Commission. This work has included, inter alia:

(i) updating fishery and scientific observer data forms and the tag-overlap statistic calculator prior to the start of the 2011/12 fishing season, and related revisions to the databases

(ii) processing fishery, observer, research and compliance data from all fisheries in the Convention Area in 2011/12 – these data have undergone limited and preliminary validation prior to the meeting, and further validation will be conducted in the forthcoming intersessional period

(iii) facilitating the deployment of research hauls in the exploratory fisheries in Subareas 48.6 and 58.4 (WG-SAM-12/06; Item 5)

(iv) updating fishery and observer information reported in the Fishery Reports (see Items 4 and 5) and the Report on Bottom Fisheries and VMEs (Item 6).

3.3 The Working Group recalled that daily catch and effort reporting in exploratory finfish fisheries was introduced to assist the Secretariat in monitoring fisheries during the seasons (CM 23-07). This reporting system has been operating alongside the five-day catch and effort system (CM 23-01) and there is considerable duplication in the reporting and processing of data (CCAMLR-XXXI/BG/06, Figure 1).

3.4 The Working Group agreed that five-day catch and effort reporting in exploratory finfish fisheries was no longer necessary, and it recommended that the requirement for five-day reporting (CM 23-01) be removed from these fisheries. The Working Group agreed that all data required in the existing five-day, 10-day and monthly catch and effort reporting forms can be incorporated into a single data reporting form (see CCAMLR-XXXI/BG/06).

3.5 The Working Group endorsed WG-SAM's recommendation that fishing vessels undertaking research fishing under CMs 21-02 or 24-01 and carrying observers would use form C1 (trawl) or C2 (longline) throughout these activities to record catch and effort, and the scientific observers on board would use cruise reports and logbooks to record biological and tagging data (Annex 5, paragraph 3.6). Research vessels undertaking research under CM 24-01 would continue to use form C4 to record catch, effort and biological data.

3.6 The Working Group acknowledged the important role of fishing crews, scientific observers and Members in collecting CCAMLR data.

Activities in CCAMLR fisheries

3.7 The 2011/12 fishing season started on 1 December 2011 and will end on 30 November 2012, and fishing was still in progress in some areas at the time of the meeting. Members' fishing vessels operated in the fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*Euphausia superba*), and catches reported to September 2012 are summarised in Table 1. Detailed information is provided in the Fishery Reports (Appendices G to U).

3.8 The Secretariat monitored catch limits in all areas fished and used a forecast model to advise Members and vessels of the closure of areas and fisheries. In 2011/12, 10 fishing areas were closed by the Secretariat (CCAMLR-XXXI/BG/06, Table 2); these closures were triggered by catches of *Dissostichus* spp. approaching agreed catch limits.

3.9 The Working Group noted that catch limits were exceeded on three occasions in 2011/12, and the amount caught in excess of the limit (overrun) was <1 tonne in SSRU 5842E, 1 tonne in SSRU 5841E, and 123 tonnes in SSRUs 881B, C and G; the total catch limit for Subarea 88.1 was not exceeded. The overrun in SSRUs 881B, C and G occurred during a period of strong winds and dense sea-ice which hindered fishing activities and resulted in erratic daily fishing effort and catches. In addition, high catches on the day of the closure, and subsequent catches taken by two vessels which were unable to recover all of their lines (including lost lines) by the time of the closure contributed to the overrun (CCAMLR-XXXI/BG/06) (paragraph 5.18).

3.10 The Working Group noted that four vessels had conducted fishing under CM 41-01 in the exploratory fisheries for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a in 2011/12: *Hong Jin No. 701* (Republic of Korea), *Koryo Maru No. 11* (South Africa), *Saint André* (France) and *Shinsei Maru No. 3* (Japan). These vessels completed 267 research hauls in designated fine-scale rectangles and these activities were reviewed by WG-SAM (Annex 5, paragraphs 3.1 to 3.6). Research fishing was also conducted in the exploratory fishery in Division 58.4.3b under CM 41-07.

3.11 Members also conducted research fishing under CM 24-01 on *Dissostichus* spp. in Division 58.4.4b and Subareas 88.1 (SSRUs J and L), 88.2 (SSRU A) and 88.3 (WG-FSA-12/08).

Estimates of effort from IUU fishing

3.12 The Working Group reviewed estimates of IUU fishing activities in 2011/12 (WG-FSA-12/11 Rev. 1). Three IUU fishing vessels were sighted in Division 58.4.1 and Subarea 58.6: *Huiquan* (previously *Wutaishan Anhui 44*), *Huang He 22* (previously *Sima Qian Baru 22*) and *Baiyangdian*. Information available indicated that one of these vessels used gillnets, and one vessel used longlines. These vessels, and three other IUU-listed vessels, were also sighted in areas outside the Convention Area, and some of these vessels were observed during port visits.

3.13 Information available to the Secretariat indicated that some IUU fishing vessels in the Convention Area go undetected either because of limited surveillance or because the vessels are not sighted and reported by licensed vessels. Seven IUU fishing vessels appear to be consistently engaged in fishing activities (*Huang He 22*, *Huiquan*, *Kuko, Octopus I*, *Perlon, Ray* and *Shaanxi He 33*) and sighting information in 2010, 2011 and 2012 indicated that these vessels have operated in conjunction with at least one support vessel.

3.14 The Working Group noted that estimates of IUU catches are important in informing inputs into stock assessments in assessed fisheries and research requirements and stock status in data-poor exploratory fisheries. These estimates are also important in developing the Working Group's advice to the Scientific Committee and Commission on broader issues of IUU fishing that might impact on achieving the objectives of the Convention.

3.15 WG-FSA-12/11 Rev. 1 summarised the recommendations of the Joint Assessment Group (CCAMLR-XXX, paragraph 9.6; CCAMLR-XXIV, paragraphs 8.3 to 8.6) into data collection, estimation of uncertainty and risk analysis. The Working Group agreed that the information presented in WG-FSA-12/11 Rev. 1 indicated that, although the mechanism for data acquisition existed through CMs 10-02, 10-06 and 10-07, relatively little information is currently being provided.

3.16 In considering the estimation of uncertainty in IUU catch, the Working Group noted that the two components used to calculate catch were the catch rate of IUU fishing vessels and the number of days that IUU fishing vessels had fished at that catch rate. The Working Group agreed that it is important to consider uncertainty in both components and recognised that uncertainty in the number of days fished could only be evaluated with data on surveillance effort (rather than just sighting reports from that surveillance effort). In the absence of such effort data, it is not possible to determine whether a decrease in sighting reports reflects a decrease in IUU fishing effort or a decrease in surveillance effort.

3.17 The Working Group noted that it may be possible to undertake a spatial risk assessment, similar to that used by WG-IMAF for seabird–fishery interactions, using data on the distribution of fishable areas, the periods of the year when these areas are accessible to fishing and some measure of the presence of licensed vessels or surveillance effort. However, some concern was expressed that undertaking such an analysis would require careful evaluation, as the outcomes may be of potential utility to IUU fishers.

3.18 The Working Group also discussed alternative approaches to acquiring data on IUU fishing, such as deriving estimates of IUU catches from market-based information, and the possible use of genetic approaches to determine the provenance of fish.

3.19 The Working Group agreed that the information currently provided to the Secretariat is insufficient to provide sightings-based estimates of IUU catches. Furthermore, given the absence of data on surveillance effort with which to effort-correct the number of sightings and number of days fished, it is not possible to provide an estimate of uncertainty or to evaluate trends in IUU catches. The Working Group sought advice from the Scientific Committee and Commission on how the required data might be provided to the Secretariat.

Catches of *D. eleginoides* in waters adjacent to the Convention Area

3.20 Catches of *D. eleginoides* from fisheries outside the Convention Area and reported in the CDS in the calendar years 2011 and 2012 (to September) are summarised in Table 2; most of this catch came from Areas 41 (southwest Atlantic) and 87 (southeast Pacific).

3.21 The Working Group noted that some vessels fishing for *D. eleginoides* inside and outside the South African EEZ in Area 51, adjacent to the Convention Area, report fine-scale catch and effort data (Resolution 18/XXI) to the Secretariat.

ESTABLISHED FISHERIES

4.1 In addition to specific recommendations for each of the individual assessments, the Working Group made a number of general recommendations that should apply to all stock assessments. These include:

(i) for assessment methods that incorporate a composite likelihood (e.g. CASAL), a plot or table showing the contribution to the total likelihood of each likelihood component, as well as a plot of the likelihood profile for SSB_0, should be displayed

(ii) an evaluation of the spawning biomass estimated by the assessment model to be in a population but not vulnerable to the fisheries should be reported and its influence on management advice considered (e.g. through a sensitivity analysis using alternative selectivity)

(iii) work plans be developed to allow species-specific analyses and management advice for toothfish assessments and catch limits where both species co-occur, such as in Subareas 48.6 and 88.1, as opposed to combined species (*Dissostichus* spp.) catch limits

(iv) development of methods to incorporate the effect of depredation on stock assessments, including the impact on catch rates, and the quantity and size distribution of fish taken by depredation.

4.2 The Working Group reviewed preliminary assessments for *C. gunnari* in Division 58.5.2 and *D. eleginoides* in Division 58.5.1.

C. gunnari South Georgia (Subarea 48.3)

4.3 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Appendix G.

4.4 In 2011/12, the catch limit for *C. gunnari* was 3 072 tonnes. Commercial fishing was conducted by two vessels and the total reported catch up to 24 September was 546 tonnes, although the fishery is still open and a third vessel entered the fishery in September 2012.

4.5 WG-FSA-12/37 reported on a groundfish survey conducted in January 2012 in Subarea 48.3. Twenty hauls were conducted around Shag Rocks, and three hauls northwest of South Georgia. The survey indicated mainly age 2+ and 3+ fish around Shag Rocks. Mainly 2+ fish were found in the northwest of South Georgia compared to 1+ and 2+ fish last year. This survey did not provide adequate spatial coverage to provide an assessment.

Management advice

4.6 The Working Group did not undertake an assessment of *C. gunnari* for Subarea 48.3 in 2012, and recalled its advice from 2011 that the catch limit for *C. gunnari* should be set at 2 933 tonnes in 2012/13 based on the outcome of the short-term projection undertaken in 2011.

C. gunnari Heard Island (Division 58.5.2)

4.7 The Fishery Report for *C. gunnari* at Heard Island (Division 58.5.2) is contained in Appendix H.

4.8 In 2011/12, the fishery was closed to commercial fishing operations and a catch limit of 30 tonnes of *C. gunnari* was set aside for research and by-catch (4.4 tonnes were taken in the survey, Appendix H).

4.9 The results from the annual random stratified trawl survey to estimate the abundance of *D. eleginoides* and *C. gunnari* in Division 58.5.2 for 2012 were described in WG-FSA-12/25. The Working Group noted the change in cohort structure of *C. gunnari*, first noted in 2011 with 4–5 year classes present simultaneously, had persisted in the 2012 survey, however, 2+ fish currently dominate the population.

4.10 The Working Group also noted that investigation of condition factors through time may provide some insight into the cause of the recent changes in cohort structure observed in surveys in Division 58.5.2.

4.11 The Working Group evaluated the preliminary assessment of *C. gunnari* in Division 58.5.2, based on survey results set out in WG-FSA-12/26. The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 987 tonnes from the 2012 survey and using the revised growth parameters described in WG-FSA-10/12.

4.12 The projection of fish of the 1+ to 3+ age classes from 2011/12 gives a projected yield of 679 tonnes in 2012/13 and 573 tonnes in 2013/14.

4.13 The Working Group noted that sensitivity tests included in WG-FSA-12/26 indicated that the approach of using the lower one-sided 95% percentile of the survey biomass is robust to uncertainty in estimates of natural mortality (*M*) and the von Bertalanffy growth parameter (*K*), resulting in lower catch limits when compared to scenarios using the median biomass estimate.

Management advice

4.14 The Working Group recommended that the catch limit for *C. gunnari* in Division 58.5.2 should be 679 tonnes for 2012/13 and 573 tonnes for 2013/14 based on the outcome of the short-term projection.

D. eleginoides South Georgia (Subarea 48.3)

4.15 The Fishery Report for *D. eleginoides* at South Georgia (Subarea 48.3) is contained in Appendix I. The catch limit for *D. eleginoides* in 2011/12 for Subarea 48.3 was 2 600 tonnes. The total reported catch was 1 844 tonnes.

Management advice

4.16 The Working Group did not undertake an assessment of this stock in 2012, and therefore recommended that its advice from 2011 be carried forward in its entirety for 2012/13.

D. eleginoides Heard Island (Division 58.5.2)

4.17 The Fishery Report for *D. eleginoides* at Heard Island (Division 58.5.2) is contained in Appendix J.

4.18 In 2011/12, the catch limit of *D. eleginoides* was 2 730 tonnes. The catch of *D. eleginoides* reported for this division by the end of September 2012 was 1 935 tonnes.

Management advice

4.19 The Working Group did not undertake an assessment of this stock in 2012, therefore it recommended that its advice from 2011 be carried forward in its entirety for 2012/13.

D. eleginoides Kerguelen Island (Division 58.5.1)

4.20 The Fishery Report for *D. eleginoides* at Kerguelen Island (Division 58.5.1) is contained in Appendix K.

4.21 In 2011/12, the catch limit of *D. eleginoides* set by France in its EEZ in Division 58.5.1 was 5 100 tonnes (season 1 September to 31 August), allocated to seven longliners. The catch for the current CCAMLR season reported to October 2012 was 2 957 tonnes.

4.22 An integrated assessment using CASAL was presented in WG-FSA-12/09 and the Working Group discussed several issues regarding model fits to catch rate, tagging and length-frequency data in the base-case model. Biomass estimates from the POKER surveys were substantially underestimated (by about half of the observed values), the model-estimated length frequencies for the POKER surveys were bimodal compared to the unimodal observations, the CPUE estimates did not fit well the initial high observations of the time series when high levels of IUU fishing were reported, and tag-recaptures from all release years tended to be overestimated in the first year of liberty.

4.23 A series of sensitivity runs were conducted during the meeting to explore the effects of different data sources and assumptions on model outputs (Table 3). Three scenarios were run with YCS fixed to 1, excluding CPUE data for the model fit, and assuming twice the observed levels of IUU catches in each year. This resulted in estimates of B_0 ranging from 215 835 to 244 460 tonnes compared to 218 078 tonnes in the base case; *SSB* status ranged from 0.62 to 0.67 compared to 0.72 in the base case.

4.24 The Working Group recommended that the following issues be investigated to provide a more robust assessment:

(i) explore simpler models with fewer fisheries based on similarity of data

(ii) use recapture data from tagged fish at liberty for five years or less

(iii) age fish from POKER surveys and fisheries catches and include them in the model as they become available

(iv) explore IUU fishing effects on unfished biomass estimate

(v) compare results from a configuration with YCS fixed at 1, and exclude CPUE data to the base case.

Management advice

4.25 The Working Group agreed that until a more robust stock assessment is undertaken, the model described in WG-FSA-12/09 could be used to provide management advice for the 2012/13 season. The Working Group agreed that the current catch limit of 5 100 tonnes could be used as management advice for 2012/13.

4.26 At the time of adoption, Mr Gasco noted that the assessment subgroup had agreed that the catch limit of 5 100 tonnes satisfies the CCAMLR decision rules as presented in WG-FSA-12/09.

4.27 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 32-13, remain in force.

D. eleginoides Crozet Islands (Subarea 58.6)

4.28 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Appendix L.

4.29 In 2011/12, the catch of *D. eleginoides* reported in Subarea 58.6 to October 2012 was 480 tonnes.

Management advice

4.30 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 32-11, remain in force in 2012/13.

D. eleginoides Prince Edward and Marion Islands (Subareas 58.6 and 58.7)

4.31 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 (South African EEZ) is contained in Appendix M.

Management advice

4.32 No new information was available on the state of fish stocks in the South African EEZ at the Prince Edward Islands and the Working Group was unable to provide management advice for this fishery.

EXPLORATORY AND OTHER FISHERIES

Exploratory fisheries in 2011/12

5.1 Seven exploratory longline fisheries for *Dissostichus* spp. operated in 2011/12 and the season's catches from these fisheries are summarised in Table 4 (see Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b). Detailed information is provided in the Fishery Reports (Appendices G to U). No new fishery was conducted in 2011/12.

5.2 All vessels fishing in these exploratory fisheries are required to tag and release *Dissostichus* spp. in accordance with the tagging protocol and requirements (CM 41-01) and rates specified in CMs 41-04 to 41-07 and 41-09 to 41-11; these requirements also apply to the fishery for *Dissostichus* spp. in Subarea 48.4 (CM 41-03). In 2011/12, all vessels met the required tagging rates (Table 4), and all but one vessel achieved, or exceeded, the required tag-overlap statistic (Table 5). A total of 7 609 *Dissostichus* spp. were tagged and released (Table 6), and 278 tagged fish were recovered (Table 7).

5.3 Vessels engaged in exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a are also required to undertake research hauls (CM 41-01). Research fishing in these fisheries in 2011/12 was reviewed by WG-SAM (paragraph 3.10).

5.4 The Working Group reviewed information on hook loss in longline fisheries (WG-FSA-12/65). All longline fishing vessels are required to report the number of hooks attached to sections of longlines which are lost or abandoned during the course of fishing (refer 'number of hooks lost that were attached to lost sections of the longline' in the C2 data form). These data are required to develop methods to estimate unaccounted fishing mortality arising from lost sections of longlines (SC-CAMLR-XXX, Annex 7, paragraphs 4.35 and 4.36).

5.5 The Working Group noted that approximately 60% of the vessels operating in the exploratory longline fisheries in 2010/11 and 2011/12 had reported hooks lost attached to sections of lines. In some cases vessels did not report these data in the C2 data, although information from scientific observers indicated that hooks attached to sections of longline were lost. Based on available data, an estimated 313 000 to 318 000 hooks were lost attached to sections of lines in each of the last two seasons in these fisheries (WG-FSA-12/65).

5.6 The Working Group reiterated the need for all vessels operating in longline fisheries in the Convention Area to report the number of lost hooks that are attached to sections of lines (SC-CAMLR-XXX, Annex 7, paragraph 4.36). It urged the Scientific Committee and Commission to consider an appropriate mechanism to achieve a greater level of engagement with the requirements to complete the C2 data reporting form.

5.7 The Working Group recalled that an increased spatial overlap in fishing effort between seasons had the potential to increase the success of tag-recapture experiments. A process to constrain fishing effort in a number of fine-scale rectangles to achieve this spatial overlap was implemented in 2011/12 (SC-CAMLR-XXX, Annex 7, paragraph 6.76). The subsequent deployment of research hauls in data-poor exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a was reviewed by WG-SAM (paragraph 3.10). WG-SAM had agreed that it would be useful for WG-FSA to have available maps of these deployments that include depth, catches, mark–recapture information and a distance scale (Annex 5, paragraphs 3.1 to 3.4).

5.8 The Working Group reviewed the Secretariat's development of mapping and visualisation tools to facilitate the review of data from data-poor exploratory fisheries (WG-FSA-12/62). A visualisation and initial analysis of fishing effort and tag-recapture data indicated that the relative rate of tag recaptures was higher in the northern SSRUs of Subarea 48.6 and in Division 58.4.3a compared to the southern SSRUs of Subarea 48.6 and in Divisions 58.4.1 and 58.4.2.

5.9 The Working Group reviewed the fishery characterisation for the exploratory fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2 (WG-FSA-12/42). Most of the catch in Subarea 88.1 in 2011/12 was taken from SSRU 881K (i.e. on the slope). About 70% of the catch in the north was taken from SSRU 881C, and about 85% of the catch on the shelf was taken from SSRU 881J. As in the past, most of the catch in Subarea 88.2 was taken from SSRU 882H in the north. There is no evidence of truncation of the overall length-frequency distribution in any of the SSRUs, but there has been a marked reduction in median fish length in SSRUs 881H and I over the last two to three years. This appears to be at least partly a result of vessels carrying out more fishing in shallower parts of the slope, but could also reflect fishing on different parts of the slope, or a pulse of strong year classes. However, the Working Group recognised the limitations of length-frequency distribution data from commercial fishing and cautioned against over-interpretation.

5.10 The Working Group reviewed an analysis in WG-FSA-12/07, prepared by the Secretariat and the Republic of Korea, of the anomalously high CPUEs reported by two Korean-flagged vessels (*Insung No. 2* and *Insung No. 7*) fishing in the exploratory fisheries (CCAMLR-XXX, paragraph 11.3(i) and Annex 6, paragraph 2.30). The joint analysis provided an overview of the data and a commentary on the fishing operations of the vessels. The distribution of CPUE values from these vessels showed distinct differences to the other vessels that participated in longline fisheries in Subarea 48.6 and Divisions 58.4.1 and 58.4.2. The analysis also indicated that the only other vessel that displayed a similar pattern of CPUE was the *Insung No. 22* when fishing in Subarea 48.6.

5.11 The Working Group agreed that it was not possible to explain the anomalous characteristics of the CPUE data from the three Korean vessels at this time, and that such data collected on these vessels should not be used in scientific analyses for CCAMLR. The Working Group agreed that all data, including tagging data, collected on these vessels in the years with anomalous CPUE data should be flagged as not suitable for analysis. The Working Group recommended that all data collected on the *Insung No. 22* in 2009, *Insung No. 2* in 2010 and *Insung No. 7* in 2011 should be flagged accordingly.

5.12 The Working Group welcomed the undertaking from the Republic of Korea and the Secretariat to provide an analysis of all data collected on these vessels for consideration at the next meeting of WG-SAM, noting that data-quality flags could be reviewed on the basis of this analysis.

5.13 The Working Group reviewed the fishery characterisation for the exploratory fishery for *Dissostichus* spp. in Subarea 48.6 (WG-FSA-12/38). Most of the catch of *D. mawsoni* was taken in SSRUs 486E and G, while *D. eleginoides* was mostly caught in SSRUs 486A and G. The mean length of individuals of both species is larger in females, and individuals of *D. mawsoni* are caught in deeper water and have a larger mean length than *D. eleginoides*. There is no evidence of truncation in the overall length-frequency distribution of both species, although some evidence of a reduction in the mean fish length has been observed in the past three fishing seasons.

5.14 The Working Group recalled the operational difficulties encountered at the start of the tagging program in the exploratory fisheries in Subareas 48.6 and 58.4. It requested that further consideration be given to the inclusion of the early tag-recapture data in these time series.

5.15 The Working Group agreed that the regular updates on the characterisations of the fisheries in Subareas 88.1 and 88.2 (paragraph 5.9) provide essential information for the development and review of assessments and management of these fisheries. The recent development of the characterisation of the fishery in Subarea 48.6 (WG-SAM-12/33; WG-FSA-12/38; paragraph 5.13), led by Dr Wiff (first recipient of a CCAMLR Scholarship), had contributed to a better understanding of the fishery and stock in that subarea. The Working Group also noted that similar characterisations are being developed by Mr J.C. Quiroz (Chile) and his colleagues for the exploratory fisheries in Divisions 58.4.3a and 58.4.3b and the closed fisheries in Divisions 58.4.4a and 58.4.4b. The Working Group encouraged the development of characterisations for other fisheries (e.g. the exploratory fisheries in Divisions 58.4.1 and 58.4.2).

Exploratory fisheries notified for 2012/13

5.16 Ten Members submitted notifications for a total of 26 vessels for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1, 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b in 2012/13 (Table 8, CCAMLR-XXXI/12 Rev. 1 and XXXI/18 to XXXI/27). There were no notifications submitted for new fisheries.

5.17 The Working Group expressed concern at the number of vessels which had been notified in Subarea 88.2 (23 vessels). A total of 16 vessels were permitted to fish in that subarea in 2011/12, and a maximum of 19 vessels were permitted to fish in 2008/09 (Table 5; Appendix N). The Working Group agreed that a large number of vessels fishing in an area with a small catch limit would increase the risk of an overrun.

5.18 The Working Group requested that the Scientific Committee and Commission review fishing capacity in exploratory fisheries with small catch limits relative to the number of vessels that may fish in the coming season.

5.19 The Working Group noted that there have been occasional catch overruns in a number of SSRUs in the Convention Area over several years in both exploratory and assessed fisheries. It recommended that the Scientific Committee consider how catch overruns within SSRUs should be accounted for with respect to the management of these areas within season and in the forthcoming season.

5.20 During the course of the meeting, three Members advised the Secretariat of replacement vessels for the exploratory fisheries in Subareas 88.1 and 88.2 in 2012/13:

(i) *Jung Woo No. 3* (Korean-flagged) has been replaced by *Kostar*
(ii) *Chio Maru No. 3* (Russian-flagged) has been replaced by *Ugulan*
(iii) *Professor Frolov* (Ukrainian-flagged) has been replaced by *Poseydon I*.

5.21 The Working Group requested advice from the Scientific Committee on how the introduction of vessels with limited or no experience in the conduct of potential research fishing in exploratory, data-poor or closed fisheries, either as replacement vessels or newly notified vessels, may compromise the evaluation and implementation of research plans agreed during the meeting.

5.22 The notifications for exploratory fisheries in Divisions 58.4.1, 58.4.2 and 58.4.3a and Subarea 48.6 also required a research plan (CM 21-02, paragraph 6). These plans were submitted to WG-SAM which requested that the plans be revised and submitted to WG-FSA for evaluation (Annex 5, paragraphs 3.1 to 3.28 and Table 6). The revised research plans were reviewed under Item 5.3.

5.23 The Working Group did not undertake an assessment of *Dissostichus* spp. in Subareas 88.1 and 88.2 in 2012 and therefore recommended that its advice from 2011 be carried forward in its entirety for the 2012/13 fishing season.

5.24 All exploratory bottom fisheries notified for 2012/13 required a preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on VMEs (CM 22-06, paragraphs 2, 3 and 7). These preliminary assessments were reviewed under Item 6.2.

Other *Dissostichus* spp. fisheries

Dissostichus spp. South Sandwich Islands (Subarea 48.4)

5.25 The Fishery Report for *Dissostichus* spp. South Sandwich Islands (Subarea 48.4) is contained in Appendix O.

5.26 In 2011/12, the catch limits of the fishery for *Dissostichus* spp. in Subarea 48.4 were 48 tonnes for *D. eleginoides* in the north and 33 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined) in the south. The reported catch of *Dissostichus* spp. in Subarea 48.4 North and 48.4 South was 44 tonnes and 33 tonnes respectively.

5.27 The Working Group reviewed the preliminary assessments of *Dissostichus* spp. in Subarea 48.4 (WG-FSA-12/36). A CASAL age-based assessment is used for *D. eleginoides* in the northern area of Subarea 48.4, and Petersen biomass estimates were conducted separately for *D. eleginoides* and *D. mawsoni* in the southern area.

5.28 For the stock assessment of *D. eleginoides* in the northern area, a comparative length-based assessment yielded very similar estimates of spawning biomass, harvest rate and recruitment to those of the age-based assessment.

5.29 Compared to the assessment last year (SC-CAMLR-XXX, Annex 7), additional size-at-age and catch-at-age information have been included in the assessment in an attempt to reduce the dependency of the model on a relatively small amount of age-based data. The Working Group recommended that further work be conducted to obtain additional age-based information for earlier years of the fishery.

5.30 The assessment continues to identify a single, very large recruitment event in the early 1990s that has a strong influence on the age structure of the population in subsequent years. The Working Group discussed the apparent dependence of the fishery on only one or two cohorts and the problems associated with this in projecting future yields. The merits and disadvantages of parametric and non-parametric bootstrapping procedures were discussed. The Working Group recommended that this issue should be further investigated for the next assessment of this stock.

5.31 The Working Group noted that information on ageing error is not currently available for Subarea 48.4. Sensitivity analyses could be conducted using indicative ageing error estimates available for *D. eleginoides* in Division 58.5.2 to provide a sensitivity estimate of the assessment to possible levels of mis-ageing.

5.32 The Working Group recalled its recommendations of previous years for separate, species-specific assessments to be conducted for the entire management area instead of species-combined assessments for separate areas. The Working Group noted that this should be achievable with the information presently available.

Management advice

5.33 The Working Group recommended the following limits for toothfish and by-catch in Subarea 48.4:

(i) Subarea 48.4 North –

(a) a catch limit of 63 tonnes for *D. eleginoides*

(b) the continued prohibition of the targetting of *D. mawsoni*. Any *D. mawsoni* that are retained must be counted against the catch limit of *Dissostichus* spp. in the southern area

(c) maintenance of catch limits for by-catch species, with a limit for macrourids of 10 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 3 tonnes (5% of the catch limit for *D. eleginoides*).

(ii) Subarea 48.4 South –

(a) a catch limit of 52 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined)

(b) maintenance of a move-on rule for by-catch species, with a minimum macrourid trigger of 150 kg and 16% of the catch of *Dissostichus* spp. per line, and a trigger for rajids set at 5% of the catch of *Dissostichus* spp. per line.

Research to inform current or future assessments

5.34 The Working Group evaluated research and proposals to undertake research intended to lead to stock assessments of *Dissostichus* spp. within regions of the following subareas and divisions:

- Subarea 48.5
- Subarea 48.6
- Division 58.4.1
- Division 58.4.2

- Division 58.4.3a
- Division 58.4.3b
- Division 58.4.4.

5.35 The Working Group evaluated aspects of research fishing designs, assumptions, proposed tagging approaches and catch rates, and likelihood of achieving objectives, taking into consideration previous research endeavours, progress made, or new/refined approaches in these areas. In addition, the Working Group discussed general matters relevant to all research plans.

5.36 The Working Group endorsed the research fishing proposal evaluation process recommended by WG-SAM using the criteria laid out in Annex 5, Table 6 and CM 24-01, Format 2. The Working Group also considered the specific advice provided by WG-SAM on the individual research proposals, as well as vessel suitability, to complete the proposed research. Results of the WG-FSA evaluation using Table 6 of WG-SAM for all research proposals are provided in Tables 9 to 13.

Exploratory fisheries

Subarea 48.6

5.37 Information on this fishery is summarised in Appendix P.

5.38 The Working Group evaluated preliminary species-specific age-structured assessments for *D. mawsoni* and *D. eleginoides* in Subarea 48.6 north of 60°S (SSRUs 486A and G) and for *D. mawsoni* in Subarea 48.6 south of 60°S (SSRUs 486B, C, D and E) (WG-FSA-12/31). The assessment framework was implemented in AD model builder.

5.39 The Working Group noted that the assessment framework was developed in direct response to the recommendation from WG-SAM-12 and is still in an early stage of development. The model framework was not presented to WG-FSA-12 as a formal assessment of *Dissostichus*. It is presented (i) as the basis for a biomass estimate in support of the research plan submitted by South Africa for Subarea 48.6 (WG-FSA-12/30), and (ii) to illustrate the modelling framework that South Africa intends to develop over the next few years for analysis of the data collected during the proposed research in order to provide a robust assessment of the resources in Subarea 48.6.

5.40 Recalling the advice of WG-FSA-07 on evaluating new methods (SC-CAMLR-XXVI, Annex 5, paragraph 4.27), the Working Group suggested that such an evaluation should include, inter alia, the analysis of simulated (theoretical) data for a number of fish stock scenarios and a description on how uncertainty is treated by the model. Furthermore, the Working Group provided the following guidance for further development of the model framework:

(i) the length structure of the tagged fish should be incorporated and the tag-recapture likelihood modified to use size of tagged fish

(ii) calculations of tag availability, scanning probabilities, and double tag loss implemented in this model follow the single-tag approximation. Methods to implement a full double-tag model should be investigated. It is noted that further work on these topics may benefit CASAL assessments as well

(iii) likelihood profiles, cryptic spawning biomass, the contribution of each component to the total likelihood, and similar model evaluation methods should be displayed (paragraph 4.1)

(iv) age data for this subarea are not available. Within the model, von Bertalanffy growth parameters for *D. mawsoni* were estimated in preference to assuming growth parameters from other regions. It would be preferable to obtain age data for this subarea and incorporate those into the likelihood

(v) additional work on estimated species proportions in the IUU fishery should be undertaken.

5.41 The Working Group noted that an assessment implemented in CASAL is also planned for Subarea 48.6 in 2014 and this would provide an opportunity to compare the results from different assessment models for the same fishery to evaluate parameter uncertainty due to model structure.

5.42 The Working Group recommended that an evaluation of the model framework in WG-FSA-12/31 be provided to WG-SAM and that CCAMLR decision rules be used in estimating yields for this fishery.

5.43 Proposals for research fishing in Subarea 48.6 were submitted by South Africa (WG-FSA-12/30) and Japan (WG-FSA-12/60 Rev. 1). Both proposals were revisions of papers submitted to WG-SAM-12 (WG-SAM-12/12 Rev. 1 and 12/09 respectively).

5.44 WG-FSA-12/60 Rev. 1 provided a research proposal that included, inter alia, plots of tag releases by fine-scale rectangle, and proposed that research blocks should focus on those rectangles with the highest numbers of tags available for recapture, extended also to include adjacent rectangles that are extensions of continuous bathymetric features. It was recommended in this proposal to eliminate the 3 n mile limit requirement between research sets. A Petersen estimate of biomass was presented for the northern SSRUs of Subarea 48.6.

5.45 The proposal in WG-FSA-12/30 aimed to divide the SSRUs in the northern part of Subarea 48.6 into seven research areas and the southern SSRUs into four research areas, based on historical fishing activities and tag releases. It proposed that vessels select areas prior to each fishing season, prioritising the areas with the highest number of tag releases, but taking ice conditions into account, and conduct the first 10 sets as research lines 3 n miles apart, targeting fine-scale rectangles with the highest number of tag releases.

5.46 The Working Group noted that WG-FSA-12/30 included no commitment to do ageing for the otoliths collected in this research. The Working Group noted that ageing data was a high priority for input into stock assessments, and encouraged collaboration between Members to age otoliths in different data-poor fisheries.

5.47 WG-FSA-12/30 also proposed modifying the tagging rates within fine-scale rectangles based on the density of tagged fish within the fine-scale rectangle. Although the Working Group felt that adaptively changing the tagging rate had some merit, it recommended retaining a consistent tagging rate of five tags per tonne throughout the subarea.

5.48 The Working Group recommended that research fishing be undertaken in the northern and southern research blocks previously described in WG-FSA-12/60 Rev. 1 and agreed that all sets should be considered as research sets, until time is such that a robust stock assessment has been undertaken.

5.49 The Working Group noted with concern that there has been only a single recapture of a tagged fish in the southern SSRUs in Subarea 48.6, and emphasised that recaptures are critical if a tag-based method of assessment continues to be pursued for these SSRUs. Alternate explanations were proposed that may explain the lack of recaptures in the south, including poor tagging size-overlap statistics in earlier years, poor spatial overlap between fishing years (WG-FSA-12/31, Appendix A, Figure 6), movement of tagged fish out of the fished area, and/or very low exploitation rates resulting in a low probability of recapturing tagged fish (WG-FSA-12/60 Rev. 1, Table 9).

5.50 The Working Group noted that suitable fishing areas of southern Subarea 48.6 SSRUs B, C and F are often covered by sea-ice. It was noted the research blocks identified in SSRUs D and E in WG-FSA-12/60 Rev. 1 are more likely to be ice-free and that more tags have been released in these two SSRUs, and thus there is a higher likelihood of recapturing tagged fish in these blocks.

5.51 The Working Group therefore recommended research fishing in the southern Subarea 48.6 should be restricted to the research blocks in SSRUs D and E identified in WG-FSA-12/60 Rev. 1. Expanding research fishing to other southern SSRUs should only occur after there are sufficient tag returns to inform a robust tag-based index of abundance in SSRUs D and E.

5.52 The Working Group agreed that the research blocks identified in Figure 94 of WG-FSA-12/60 Rev. 1 could be used as a basis for research fishing in both the northern and southern area SSRUs of Subarea 48.6.

5.53 Dr T. Ichii (Japan) indicated that, when the research blocks are covered with sea-ice, the alternative survey in the neighbouring ice-free area is valuable to clarify the life-history of toothfish. The Working Group referred this issue to the Scientific Committee for advice.

5.54 With respect to total allowable catch limits for the northern and southern Subarea 48.6, the Working Group recommended that it would be desirable to set species-specific catch limits (*D. eleginoides* and *D. mawsoni*) given the mixed species composition in parts of the northern region. Should a catch limit of one species be met, additional fish of that species could be tagged and released, or the vessel could move to another area where the likelihood of catching the species is decreased.

5.55 The Working Group noted the results of the preliminary age-structured assessment model described in WG-FSA-12/31 and the preliminary estimate of biomass based on the

Petersen estimate set out in WG-FSA-12/60 Rev. 1. It was noted that the two methods gave very different answers, were based on different assumptions, and more work was needed to better understand the disparity between the two estimates.

5.56 The Working Group agreed that the estimates as set out in Table 9 of WG-FSA-12/60 Rev. 1 could be used as interim advice for catch limits associated with research fishing in Subarea 48.6, and that the catches can be apportioned to the four areas described in Subarea 48.6. The Working Group noted that the proposed overall levels of catch limit in Subarea 48.6 (200 tonnes in the northern SSRUs, and 200 tonnes in the southern SSRUs) were consistent with the preliminary assessment set out in WG-FSA-12/31.

Divisions 58.4.1 and 58.4.2 – East Antarctica

5.57 Information on this fishery is summarised in Appendixes Q and R.

5.58 Proposals for research fishing in Divisions 58.4.1 and 58.4.2 were submitted by Japan (WG-FSA-12/60 Rev. 1), the Republic of Korea (WG-FSA-12/39) and Spain (WG-FSA-12/69). The Working Group evaluated WG-FSA-12/69 independently from the other proposals, as the research was fundamentally different relative to the other proposals.

5.59 The Working Group noted that South Africa had submitted a paper to WG-SAM (WG-SAM-12/21) with the intention of conducting research fishing in Division 58.4.2. However, this paper was not revised on the basis of advice from WG-SAM, and not resubmitted to WG-FSA. The Working Group was not in the position to comment on the merits of this research plan.

5.60 WG-FSA-12/60 Rev. 1 presented a revised research plan (a revision of WG-SAM-12/09) for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Divisions 58.4.1 and 58.4.2. The proposal presented catch, effort and biological information from previous fishing trials in these divisions, and proposed continued research be carried out in five specific areas within three SSRUs in Division 58.4.1 (SSRUs C, E and G) and one SSRU in Division 58.4.2 (SSRU E).

5.61 The Working Group noted the proposal provided estimates of *D. mawsoni* standing stock based on a Petersen estimate (WG-FSA-11/31 Rev. 2) in SSRUs 5841C and G, and an overall estimate of stock biomass across the division. The Working Group noted that there is considerable uncertainty regarding the total number of tags currently available for recapture in these areas and the corresponding estimates of biomass, but that WG-FSA-12/60 Rev. 1 adopted the following conservative assumptions:

(i) weighting the year-specific Petersen biomass estimates inversely proportional to the CV, so that years with higher numbers of recaptures have higher weight in the final biomass estimate

(ii) assuming a higher tagging mortality (0.2) than is commonly applied in assessed fisheries.

5.62 Dr Welsford noted that the local biomass estimates provided in WG-FSA-12/60 Rev. 1 are still likely to be biased upwards as tags from vessels with poor tag-overlap statistics in the past are included.

5.63 In areas with insufficient tag recaptures to inform Petersen estimates, including SSRU E, the proposal uses CPUE × seabed area to derive preliminary estimates of biomass. The Working Group noted that estimates based on CPUE are inherently uncertain, but that the proposal applies the following assumptions:

(i) exploitation rates in WG-FSA-12/60 Rev. 1, Table 9, are based on proposed catches as a proportion of estimated local biomass within the research blocks, not total biomass estimates for the whole SSRU

(ii) exploitation rates for Divisions 58.4.1 and 58.4.2 are sufficiently low that they are likely to remain within appropriate limits even when applying a precautionary discount factor (e.g. 0.3 as in SC-CAMLR-XXX, Annex 5, paragraph 2.40iv) in the estimation of local biomass.

5.64 The Working Group noted the proposed timetable of research and analysis which includes a stock analysis using GLM and GAM to be established in 2012/13, a method of analysis for otolith in 2013/14, a CASAL catch-at-age model applied in 2014/15, and a full stock assessment completed in 2015/16–2016/17. The Working Group noted that the authors of the proposal had produced a preliminary stock assessment in SSRU 5844C using similar methods, and that the proposed timeline was reasonable.

5.65 The Working Group noted that there were several assumptions in the proposal that had not previously been evaluated, such as number of tags available for recapture, tagging mortality/loss rates and associated uncertainties, and that caution should be used when interpreting results and the feasibility of the timetable. Because the assumptions used were generally precautionary, the estimated exploitation rates and corresponding estimates of future tag recaptures per year shown in WG-FSA-12/60 Rev. 1, Table 9, are quite low, indicating that if the biomass estimates are accurate, then proposed catch limits are sufficiently conservative, but may be too low to lead to an assessment in the proposed time frame within these SSRUs.

5.66 Some Members were concerned that Japan had committed itself to a very large number of areas, and whether conducting research to deliver stock assessments across such a large number of areas was feasible. The Working Group recommended that Table 9 in WG-FSA-12/60 Rev. 1 could be used to set catch limits for the coming season. The Working Group recalled that the current catch limits in Division 58.4.1 were based on the analysis presented in Agnew et al. (2009). While it was recognised that it may take some time to get to an assessment based on a tag-recapture method with these catch limits, the Working Group agreed that it would be in a better position to evaluate the estimates of expected number of recaptures set out in WG-FSA-12/60 Rev. 1, Table 9, after the first year of the research fishing has been undertaken.

5.67 WG-FSA-12/39 (Republic of Korea) provided a research plan for *Dissostichus* spp. in SSRUs 5841C, E and G for 2012/13 which was a revision of WG-SAM-12/10 Rev. 1. The Working Group noted that there was some ambiguity with regard to the proposed analytical methods by which the objectives of the research would be achieved; proposed methods included, inter alia, estimating the stock status by assessing/comparing estimates of biomass derived from mark–recapture experiments, VPA analysis based on the length or/and age composition, and local depletions.

5.68 The Working Group noted that VPA analysis is based on an assumption of exact catch-at-age with consequent underestimation of associated uncertainty and that the technique does not generally use tagging data. The Working Group recommended that, of the proposed methods, tag-based integrated assessments had the highest likelihood of estimating sustainable yield that would be consistent with the objectives of Article II.

5.69 The Working Group noted that the proposed research design was constrained to areas where tags had previously been released. The Working Group noted that the estimates of biomass in SSRUs C and G in WG-FSA-12/39 were very different to those set out in WG-FSA-12/60 Rev. 1 for the same SSRUs, and emphasised that this required further attention.

5.70 The Working Group also questioned the level of experience the vessel had working in the CAMLR Convention Area, and that it would be valuable to get more information on both experience in the area and experience with respect to tagging toothfish. Dr I. Yeon (Republic of Korea) indicated that the captain of the vessel has had experience fishing in the Antarctic for toothfish.

5.71 The Working Group noted that the proposals in WG-FSA-12/60 Rev. 1 and 12/39 both included commitments to do toothfish ageing. The Working Group recommended that a commitment to ageing the toothfish in the research fishery should be made for all data-poor areas and be initiated in the short term and following the recommendations in Item 10.

5.72 With respect to catch limits proposed in both WG-FSA-12/39 and 12/60 Rev. 1, the Working Group agreed that the research-block-specific limits set out in WG-FSA-12/60 Rev. 1, Table 9, were appropriate to achieve the objectives of these proposals. It further agreed that this will be revisited next year depending on the level of recaptures in the coming season.

5.73 WG-FSA-12/69 provided a research plan for *Dissostichus* spp. to be undertaken by Spain in Divisions 58.4.1 and 58.4.2. This was an update and revision to the proposal submitted at WG-SAM (WG-SAM-12/13). The objective of the research is to estimate the local abundance of toothfish using depletion experiments and tag-recapture experiments in the same locations, enabling a comparison of the two methods. The Working Group noted that WG-FSA-12/69 addressed the specific requests of WG-SAM.

5.74 The Working Group recalled the depletion model described in Agnew et al. (2009) in this region. It was recognised that this analysis had been conducted using commercial C2 data, with no experimental design implemented. The Working Group agreed that controlled depletion experiments are expected to be of higher value than the opportunistic use of commercial data to look for evidence of local depletion, such that the results described in Agnew et al. (2009) were of little value with respect to evaluating the potential success of the research proposed in WG-FSA-12/69. The Working Group emphasised that depletion-type experiments cannot be expected to achieve their objectives in a multi-vessel Olympic fishery.

5.75 The Working Group agreed that there was great potential value in conducting a simultaneous depletion and tagging experiment, and the combined use of these techniques could provide a very useful understanding of the localised stocks of toothfish. However, some Members felt that there would be advantages in undertaking a trial experiment in another area.

5.76 With respect to the timetable for achieving the objectives of the research, the Working Group agreed that a depletion experiment, if successful, could provide enough information to estimate standing stock biomass for the local area in one season. The tagging component of this research, if treated similarly to other experiments in the Convention Area, would likely take 2–3 years (e.g. Subarea 48.4 North) before results would be useful. However, taken together, the research could be used to address other uncertainties in these divisions, such as localised movements or potential of recapture at different temporal/spatial scales.

5.77 WG-FSA-12/69 indicated that the depletion experiment will commence when the vessel locates an area with a threshold CPUE >0.3 kg/hook, and end when it declines to 0.2 kg/hook. The Working Group agreed that it was important to differentiate a detectable decline in CPUE from variability in CPUE, which can be due to many factors.

5.78 The Working Group recommended that a program, or routine, be prepared to determine when a decline in CPUE is statistically significant and that a clear decision rule be developed to determine a basis to start and stop the depletion experiment.

5.79 The Working Group recognised that, even in the absence of a statistically significant depletion, a large number of tags would be released in the single area. As such, there would remain value in returning to the locations where tags had been released.

5.80 The Working Group recommended that the experiment should not rely on one set to determine when to start, but on clusters of three to five sets. To that end, setting short lines would be worthwhile, with a standardised constrained soak time. The Working Group also recommended that clusters of three lines separated by 10 n miles may be appropriate to search for a concentration of fish appropriate to initiate the experiment.

5.81 In terms of a catch limit for this research, the Working Group recommended that, in the absence of further information, the catch limits should be set at a limit of 50 tonnes in each proposed SSRU. Catch rates and levels taken during the experiment will be reviewed by WG-FSA in 2013 to determine the appropriateness of continuing the research with these limits.

5.82 The Working Group noted that there are currently two registered VMEs in SSRU 5841H, and agreed that there needs to be an appropriate buffer zone around these VMEs. The Working Group recommended that during the searching phase, before the initiation of the depletion experiment, fishing should not occur within 10 n miles from the centre point of the two registered VMEs (Appendix F).

Division 58.4.3a (Elan Bank)

5.83 Information on this fishery is summarised in Appendix S.

5.84 During the meetings, a preliminary stock assessment using CASAL was initiated for Elan Bank (Division 58.4.3a). The data included in the model were catch-weighted length frequencies, catches including estimated IUU catches, tag-release and tag-recaptures. The Working Group agreed that this assessment model was in a preliminary state but could be further developed to provide management advice. The Working Group suggested that proposals for future research fishing on Elan Bank should be based on the estimates of stock size, status and potential yield using further development of this model.

5.85 Proposals for research fishing in Division 58.4.3a (Elan Bank) were submitted by France (WG-FSA-12/29) and Japan (WG-FSA-12/60 Rev. 1).

5.86 The Working Group noted that South Africa had submitted a paper to WG-SAM (WG-SAM-12/21) with the intention of conducting research fishing in Division 58.4.3a. However, this paper was not revised on the basis of advice from WG-SAM, and not resubmitted to WG-FSA. The Working Group was not in the position to comment on the merits of this research.

5.87 WG-FSA-12/29 presented a research fishing plan to be conducted in the forthcoming season using 82 longlines, with 28 research hauls. This proposal was a revision and update of WG-SAM-12/14. The revised plan provides a preliminary estimate of biomass using Division 58.5.1 as a reference area, and incorporates both legal and available IUU catches in the analyses.

5.88 The Working Group considered that the use of small-scale rectangles in this area may not necessarily be required. However, it was agreed that, as with all other research proposals that will rely on tagging, effort should focus in the regions where tags are already in the water.

5.89 The Working Group recommended that the fishing be constrained to the area where the tags were previously released, and that sets and tagging should be more evenly distributed across the entire Division 58.4.3a bank.

5.90 The Working Group agreed that there is currently enough information, due to the recapture of tagged fish, to undertake a preliminary stock assessment of *D. eleginoides* in this division. With respect to a future age-based assessment, the Working Group agreed that the ageing process is important, and noted that there are currently no plans by France to age otoliths collected from Division 58.4.3a. It was recommended that France take steps to ensure that otoliths from this research fishery are aged.

5.91 The Working Group noted that the proposal included a commitment to monitor depredation levels by killer whales, but no commitment to take necessary measures to avoid the impact of depredation on the research. The Working Group recommended that vessels undertaking research in areas where depredation is a risk should propose strategies to avoid or mitigate depredation, e.g. stopping hauling and moving to other locations, and the use of holding tanks to retain tagged fish until predators are no longer present.

5.92 The Working Group questioned the source of the estimate of biomass obtained by the CPUE × seabed area method in WG-FSA-12/29, as it was considerably higher than the corresponding estimates in WG-FSA-12/60 Rev. 1 obtained for the same area using both this method and the Petersen estimator. The Working Group noted that the CPUE and reference biomass estimate in WG-FSA-12/29 used data from Division 58.5.1, which may be inappropriate for application in research proposals of this kind due to the way in which fishing effort locations are assigned in the French EEZ fishery. The Working Group further noted that all estimates based on CPUE × seabed area should be viewed with caution, and that the Petersen estimate in WG-FSA-12/60 Rev. 1 should be considered more reliable if the assumptions regarding available tags are appropriate.

5.93 The Working Group undertook a preliminary stock assessment using CASAL which provided a framework for length-based and tag-based assessments, but was unable to provide additional management advice based on this analysis, other than that the biomass in this region is likely to be <4 000 tonnes. The Working Group suggested that proposals for future research in Division 58.4.3a could base estimates of precautionary catch using further progression of this model.

5.94 Based on last year's catch levels and number of tag returns (nine tags), the Working Group recommend using the research catch as set out in WG-FSA-12/60 Rev. 1, Table 9, which indicated a total catch of 32 tonnes.

Division 58.4.3b (BANZARE Bank)

5.95 Information on this fishery is summarised in Appendix T.

5.96 WG-FSA-12/56 presented a research proposal by Japan for continued research on BANZARE Bank (Division 58.4.3b). This paper was a revision of WG-SAM-12/15 Rev. 1, and focused on the continuation of research surveys undertaken by Japan since 2006/07.

5.97 The Working Group noted that the survey design adopted last year by the Scientific Committee was not followed due to operational difficulties by the vessel. Mr N. Miyagawa (Japan) indicated that operational difficulties included very rough weather, snow and fuel running short. The fishing master felt the vessel may have been in danger and thus the survey was not completed.

5.98 The Working Group recalled SC-CAMLR-XXX, paragraphs 9.34 to 9.36, where it was agreed that further advice on population status and trends, and the potential for a future fishery in the area, could not be provided until such time as available data on the current status of the stock on BANZARE Bank, historical fishing data, the results of past surveys and current research, and estimates of past and ongoing IUU removals have been fully analysed and reviewed. In the absence of such a review, the Working Group was not able to provide additional advice on the research plan or to revise management advice.

Closed fisheries

Subarea 48.5 – Weddell Sea

5.99 WG-FSA-12/12 proposed a plan of research by Russia to conduct fishing research in Subarea 48.5 in 2012/13. This proposal is a revision of WG-SAM-12/04. Subarea 48.5 is currently closed to fishing, and there has been no commercial fishing for *Dissostichus* spp. in this subarea. The Working Group noted that the proposal set out a 3–5 year research plan with three different options with respect to regions of Subarea 48.5 where research fishing is to be undertaken.

5.100 Dr A. Petrov (Russia) informed the Working Group that this research would be undertaken for a minimum of three years, and if conditions are favourable, research could potentially proceed in all three proposed areas in a single season. In particular, he noted that in the eastern region, satellite-based sea-ice distribution charts provided in WG-FSA-12/12 indicated that some areas are consistently ice-free from January to March.

5.101 The Working Group recommended that of the three survey areas proposed, option 2 (WG-FSA-12/12, Figure 6) likely had the highest probability to achieve the objective of the research, given the recent sea-ice charts provided.

5.102 The Working Group recommended a catch limit of 50 tonnes in the eastern research block (option 2), as this was unlikely to be met in the proposed 40 sets, as the estimated catch rate was based on commercial CPUE from SSRU 881H.

5.103 Further, the Working Group recommended that the survey design be modified such that it was based on a more grid-like, or cluster-based, survey design so that adjacent sets in a cluster would span a range of depths, as this would provide considerably more information about relative fish abundance as a function of depth and would increase the likelihood of tag recaptures in the survey area.

5.104 It was recognised that the first component of this research could lead to indicative estimates of CPUE for the surveyed region, and potentially an initial estimate of biomass, but that a rigorous stock assessment involved considerably more information, such as gear selectivity, productivity, information on age and growth etc. The Working Group noted that the research proposal in WG-FSA-12/12 planned to provide a CPUE-based biomass estimate after three years of research fishing.

5.105 Several members of the Working Group were concerned that the heavy sea-ice in the Weddell Sea, and uncertainty in ice conditions (often changing on a daily basis), could impede efforts to return to the same research areas in subsequent seasons in order to recapture tags, thereby seriously compromising the ability to achieve the research objectives.

5.106 Some Members were concerned about vessel safety in the Weddell Sea given heavy sea-ice conditions. Although it was recognised that this was not a science question, the Working Group agreed that this should be taken into consideration by the Scientific Committee and Commission during deliberation of this research proposal.

5.107 Dr Petrov made the following statement to WG-FSA:

> 'While Russia respects the Working Group's opinion, Russia has its own view regarding its planned research in Subarea 48.5. Unfortunately, our view was not heard during the discussion within the Working Group. Russia's scientific research plan fully meets the requirements of CM 21-02, paragraph 6(iii), and the requirements of the Scientific Committee (SC-CAMLR-XXX, Annex 5, paragraph 2.35). Russia will follow the advice of the Working Group to focus its research on option 2 (WG-FSA-12/12, Figure 6) with a catch limit of 50 tonnes. However, Russia would like to

emphasise that during discussion at the Working Group no objections other than ice-condition uncertainty were made regarding two other options (1 and 3) and all three options fully meet the requirements of CM 21-02 and CM 24-01 as reflected in Table 9 of the WG-FSA report. In this regard, Russia wishes to have its proposition better considered that if in the forthcoming 2012/13 season the areas in options 1 and 3 become free of sea ice, its intention in that proposal was to conduct research in these areas, with a catch limit 60.6 tonnes for option 1 (based on 50 longline stations × 6.0 km × 0.202 tonnes), and 111.84 tonnes for option 3 (based on a combined catch limit 'Eastern zone' + 'Western zone'). These catch limits are calculated based on advice contained in SC-CAMLR-XXX, Annex 5, Table 2.'

Divisions 58.4.4a and 58.4.4b (Ob and Lena Banks)

5.108 Information on this fishery is summarised in Appendix U.

5.109 The Working Group considered a preliminary CASAL stock assessment for *D. eleginoides* in SSRU 5844C (WG-FSA-12/59) and noted that IUU catches from the mid-1990s have not been incorporated into the model. The Working Group recommended sensitivity runs of the model using levels of IUU in SSRU C, ranging from zero to assuming that all observed IUU fishing in the division was from SSRU C.

5.110 The Working Group discussed whether model estimates of YCS, which showed an increasing trend between 1998 and 2005, might represent an actual increase in recruitment due to density dependence following release from IUU fishing and recommended sensitivity runs with YCS fixed at 1.

5.111 The Working Group considered that some estimates of age-at-length (Figure 1 of WG-FSA-12/59) were implausible and recommended that methods for age determination need to be better calibrated and validated (paragraph 5.119).

5.112 In the model fits, the combined penalties and priors appear to have a large effect in the likelihood profile for SSB_0. The Working Group recommended an evaluation of the effects of separated penalties and priors and exploration of alternative prior assumptions. In addition, the MPD and MCMC values estimated by the model were dissimilar, indicating either that the MCMCs had not converged or that there was some other structural problem.

5.113 The Working Group agreed that this assessment model was in a preliminary state but could be further developed to provide management advice in the future.

5.114 WG-FSA-12/58 Rev. 1 presented a research plan in Divisions 58.4.4a and 58.4.4b, and was a revision of WG-SAM-12/17. The paper proposed to continue the mark–recapture experiment previously undertaken in 2010/11 and 2011/12. While research in previous years was focused in SSRUs B and C, the updated paper proposed to discontinue the research in SSRU B and focus future research in SSRUs C and D. The rationale for moving the research fishing was based on high and annually increasing levels of depredation by killer whales in SSRU B over the past three seasons.

5.115 The Working Group agreed that it was likely that depredation was having a detrimental effect on the achievement of the research objectives by decreasing the potential for retrieving tags and creating considerable uncertainty in the estimation of total removals. On this basis, the Working Group recommended that research fishing in SSRU B should be discontinued.

5.116 The Working Group also recommended that this and future research plans should implement strategies to avoid or mitigate depredation by killer whales early, before whales become habituated to fishing vessels and depredation increases to high levels.

5.117 The Working Group agreed that estimates of unaccounted mortality arising from killer whale depredation should be taken into consideration in future assessments, noting the method of Moir-Clark and Agnew (2010).

5.118 The Working Group noted that, consistent with recommendations of WG-SAM (Annex 5, paragraph 4.15), in SSRU C a preliminary stock assessment using CASAL had been presented to WG-FSA this year (WG-FSA-12/59) and that the proposed research program can be expected to contribute to an improved assessment in subsequent years.

5.119 The Working Group noted questions about the age–length key utilised in the SSRU C assessment and agreed that checking and supplementing the age data is a priority and that ageing from Ob and Lena Banks would also assist with understanding recruitment variability. Dr Taki informed the Working Group that within these divisions it is planned to expand the ageing program that led to the original age–length data used in the assessment.

5.120 The Working Group recommended that proposed research design and development of the CASAL-based assessment in SSRU C continue.

5.121 The Working Group noted that the research design has been shown to contribute data to the development of a preliminary assessment for SSRU C, and that the vessel and research proponents have a good track record of contributing useful science arising from their research results to WG-FSA, and of utilising these results to progress towards stock assessments in this division.

5.122 Some Members also noted that the potential to recapture tags that have moved between SSRUs would provide additional information about fish movements and stock structure. Some Members felt that, on this basis, the same research design implemented successfully in SSRU C should be extended to SSRU D.

5.123 Dr Welsford also noted that the research proposal for Division 58.4.4 was originally proposed in 2008 with the expectation that after three years a stock assessment would be produced. This expectation was not met. He further noted that it was important to remain focused on refining the assessment for SSRU C following the recommendations above, as this would provide a firm basis for evaluating the likelihood that the research design described in WG-FSA-12/58 Rev. 1 would also be successful in other SSRUs.

5.124 Other Members felt that the research should remain focused only in SSRU C until a full assessment is completed, in addition to noting the failure of the research to progress an assessment in SSRU B due to rapidly increasing killer whale depredation.

5.125 The Working Group noted that SSRU D was the only SSRU in which killer whale depredation has not been recorded during past research in this division.

5.126 The Working Group agreed that, if the research is extended into SSRU D, then the research design proposed in WG-FSA-12/58 Rev. 1 is appropriate, but that the continuation of research in SSRU C is the highest priority. The Working Group recommended that, if research occurs in both SSRUs, then in the coming year all planned research sets in SSRU C should be completed before research in SSRU D is initiated.

5.127 The Working Group noted that a catch limit of 70 tonnes was adopted for this division for 2011/12, but that only 28.3 tonnes were caught during the survey of SSRUs B and C. It further noted that, given the research design and expected catches, the catch limit is unlikely to be reached. The Working Group agreed that the catch limit should be set higher than anticipated catches to reduce the likelihood that the survey design has to be abandoned before completion in the event that catches are higher than anticipated, but that the catch limit should be appropriately precautionary given available information, including the fact that the fishery for this stock was closed in 2002 based on the conclusion that it was depleted.

5.128 It was noted that updated Petersen biomass estimates in WG-FSA-12/58 Rev. 1 estimated a biomass of 1 725 tonnes in SSRUs B and C. Therefore, the 70 tonne catch limit proposed in WG-FSA-12/58 Rev. 1 implies a local exploitation rate of 4.1%.

5.129 The Working Group noted that the application of these estimates to SSRUs C and D, instead of SSRUs B and C, requires assumptions about the relative abundance of fish between these two SSRUs. It noted that CPUEs in SSRU D from past research fishing by the *Shinsei Maru No. 3* were higher than in SSRU B in 2012, implying that the actual exploitation rate within SSRUs C and D may be lower than 4.1%. It further noted that the local biomass estimate is for only two of the four SSRUs, such that the overall exploitation rate of toothfish populations across the division as a whole will be lower than the local estimate.

5.130 Some Members recommended that the existing catch limit of 70 tonnes be retained consistent with advice in 2011/12 (SC-CAMLR-XXX, Annex 7, paragraphs 5.22 and 5.23), which included consideration of precautionary assumptions about historical depletion rates using the method of WG-FSA-10/42.

5.131 Other Members felt that the catch limit should be reduced to 50 tonnes (estimated local exploitation rate 2.9%) on the basis that lower exploitation rates are more appropriate if research was to proceed in SSRU D, given uncertainties in the current biomass and status of the stock in Division 58.4.4. They also noted that 50 tonnes was a closer reflection of the expected catches for the proposed survey design, and therefore was unlikely to restrict the survey in SSRU D if it proceeds in 2012/13.

5.132 The Working Group recommended that the Scientific Committee consider a catch limit in the range of 50 to 70 tonnes for this research in 2012/13, and that the catch limit be revisited in 2013/14 on the basis of new information from this research.

Generic issues applicable across all research proposals

5.133 The Working Group requested guidance from the Scientific Committee regarding maximum acceptable exploitation rates for research in data-poor or closed fisheries in order to guide both the design and evaluation of research proposals. Estimated local exploitation rates in research proposals agreed by the Working Group (WG-FSA-12/60 Rev. 1, Table 9) range from 0.3% to 5.1%. It was further noted that an exploitation rate near 0% could also be an option, whereby all fish caught during the course of a research survey could be tagged and released.

5.134 The Working Group noted the conclusions of WG-FSA-12/18 that poor data arising from low tagging size overlap may be expected to produce biased biomass estimates, especially in the early years of research programs with low numbers of recaptures, i.e. as is expected for all new research proposals. The Working Group recommended that vessels undertaking research should seek to achieve the highest possible tag overlap rather than merely achieving the minimum required overlap of 60%. The Working Group further noted that a tag overlap that over-catches large fish will deviate from 100% the same as a tag overlap that over-catches small fish, and that evaluation of tag-overlap statistics should distinguish between these two situations.

5.135 The Working Group noted that, where spatially constrained research designs proposed by Members under CM 21-01 are approved, the requirements of CM 41-01, Annex B, as applied in 2011/12, under which the Secretariat-designated fishable fine-scale rectangles where fishing may occur, are no longer relevant. Both conservation measures seek to achieve the same outcome by focusing fishing effort in areas where tags are available for recapture, but via a different mechanism. The Working Group noted that the fine-scale rectangle approach under CM 41-01, Annex B, is still useful where particular research designs have not been designated in advance, and requested that the Scientific Committee consider whether either or both approach(es) are preferred in future.

5.136 The Working Group noted that sea-ice may interfere with research designs that require vessels to return to the same area in consecutive years, and recommended that future research proposals include information to enable WG-FSA to evaluate typical or historical ice conditions that may affect research feasibility.

5.137 The Working Group recommended that coordination between multiple vessels undertaking research fishing in the same area should be encouraged, and that there is scientific value in designing this coordination such that multiple vessels undertake research fishing in highly spatially overlapping areas. This will provide a maximum amount of information, allowing for comparisons between gear selectivity, catch rates, catch composition, tag recaptures, and other factors that are indicative of vessel performance and/or that will elucidate how research fishing can be optimised. It was agreed that:

(i) this type of coordinated research could substantially decrease the time necessary to collect information that would lead to a robust stock assessment

(ii) Olympic-style fishing would compromise effective research implementation

(iii) the scientific merit of the research will be substantially improved if there is a balance of catch and effort between the vessels fishing in the same spatially constrained area.

5.138 The Working Group recalled the CCAMLR-2000 Survey, which was a multi-national, multi-vessel, coordinated effort that yielded sufficient information to successfully allow a stock assessment of krill in Area 48. Following a multi-national, multi-vessel, collaborative effort for finfish research could also prove very valuable toward gathering information to conduct a stock assessment in relatively short order.

5.139 The Working Group recalled the advice of the Scientific Committee (SC-CAMLR-XXX, paragraph 3.123) that the failure to achieve stock assessments in data-poor fisheries may be a consequence of research implementation rather than research design and noted that the track record of the individual vessels carrying out the research was relevant in the evaluation of research proposals. Relevant considerations include:

(i) past compliance with CCAMLR conservation measures (vessel dependent)
(ii) past tagging performance (vessel dependent)
(iii) fulfilment of prior commitments to conduct research (Member dependent)
(iv) subsequent delivery of analyses of the resulting data in ways that are likely to produce stock assessments (Member dependent).

5.140 The Working Group noted that only one vessel, the FV *Koryo Maru No. 11* (South Africa), did not meet the target tag-overlap statistic of 60% in 2011/12 in Division 58.4.2 (Table 5). For future research, the Working Group agreed that the value achieved in the tag-overlap statistic in previous years should be taken into consideration. The Working Group referred this matter to SCIC for further consideration.

5.141 The Working Group noted that the methods provided in WG-FSA-12/44, which evaluated the relative tagging performance in terms of tag detection and tag mortality between individual vessels, could also be used to evaluate vessel performance in future years.

5.142 The Working Group agreed that analysis of research implementation and vessel performance is important for a robust evaluation of research proposals to succeed, and that this analysis should include all vessels involved in the research fishery. It agreed that there was neither the time nor appropriate resources to undertake these evaluations during the course of the meeting.

5.143 The Working Group recommended that a framework for analysis of research implementation, vessel performance and associated quantitative metrics be developed, preferentially in collaboration with SCIC (as several aspects of these sorts of evaluations are coupled with compliance). The development of this framework could take place during the intersessional period and potentially be implemented at the next meeting of WG-FSA.

Results of research in exploratory fisheries

5.144 The Working Group considered WG-FSA-12/13 describing the results of two years of research fishing by Russia in Subarea 88.3. The authors presented a summary of the catches and biological data collected during the surveys, noting that ice conditions were much worse in 2012 and fishing was restricted to SSRU C. The authors presented catch estimates for SSRUs 883B, C and D based on the comparative CPUE method recommended by WG-SAM (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii) for research plans and used an exploitation rate of 10% to calculate a yield of 343 tonnes. Dr Petrov recommended the Working Group consider this preliminary assessment of toothfish in Subarea 88.3.

5.145 The Working Group noted that, although this method is approved for use in providing indicative estimates of abundance for proposed research surveys, it is not considered sufficiently reliable for deriving catch limits for an exploratory fishery using the CCAMLR decision rules. The Working Group also noted some methodological problems with the estimates provided, including the absence of a discount factor (SC-CAMLR-XXX, Annex 5, paragraph 2.40iv) and the use of an exploitation rate of 10% to estimate yield.

5.146 The Working Group recalled that the original proposal was for three years of research (SC-CAMLR-XXIX, paragraphs 9.17 to 9.20), which would have allowed for at least two years of tag recaptures. Dr Petrov explained that Russia was unable to complete the third research survey because no vessels with the same fishing gear and experience were available for the 2012/13 season.

5.147 Dr Petrov noted that, based on the result of WG-FSA-12/13, Russia recommended that SSRUs 883B and C be opened as an exploratory fishery with a catch limit of 343 tonnes. He noted that these data represent the best available information for this subarea. He requested that this recommendation be considered by the Scientific Committee.

5.148 Dr Welsford did not consider that it was appropriate to open an exploratory fishery in SSRUs 883B and C, given the lack of a stock assessment for these areas.

5.149 The Working Group considered WG-FSA-12/15, describing the results of two years of research fishing by Russia in SSRU 882A. The authors presented catch estimates for SSRU 882A based on the CPUE method recommended by WG-SAM (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii) for research plans which equalled 286 tonnes. Dr Petrov recommended the Working Group consider this preliminary assessment of toothfish in SSRU 882A.

5.150 The Working Group noted that this method is not considered sufficiently reliable for deriving catch limits for an exploratory fishery in accordance with the CCAMLR decision rules, and that there were again methodological issues with the lack of a discount factor and the exploitation rate used to estimate yield. No tags were recovered from previous releases from this SSRU or the adjacent SSRUs in Subarea 88.1. The Working Group also noted that SSRU 882A is currently assessed as part of the Ross Sea assessment (SC-CAMLR-XXX, Annex 7, Appendix R) and that results of research carried out in SSRU 882A would be most appropriately included within the Ross Sea assessment.

5.151 Dr Petrov noted that, based on the result of WG-FSA-12/15, Russia recommended that SSRU 882A be opened as an exploratory fishery with a catch limit of 286 tonnes. He noted that these data represent the best available information for this SSRU and that the area should be opened for rational use. He also noted that, if this area were opened, then this would relieve some of the pressure in SSRUs 881H, I and K. He requested that this recommendation be considered by the Scientific Committee.

5.152 The Working Group discussed how SSRU 882A could potentially be opened and managed as part of the Ross Sea fishery. In particular, how catch limits from the Ross Sea assessment could be applied to this SSRU, and whether additional research should be undertaken, given the paucity of information from this region. There is also uncertainty as to the stock affiliation and movements between SSRU 882A and the adjacent SSRUs 881K and L. Collection of data on movements could also be valuable for informing movement hypotheses identified by Hanchet et al., 2008 and WG-FSA-12/P02, and to inform the spatial models (WG-FSA-12/44).

5.153 The Working Group reviewed WG-FSA-12/41 presenting the results of the first pre-recruit survey of Antarctic toothfish in the southern Ross Sea by New Zealand. It noted that the authors had included the additional analyses requested by WG-SAM (Annex 5, paragraph 4.23).

5.154 The Working Group noted that the design of the proposed 2012/13 survey had been supported by WG-SAM, including the assignment of 15 sets to the Glomar Challenger trough to the northeast of the three core strata (Annex 5, paragraph 4.22). However, it also recommended that some stations continue to be surveyed in the shallower (400–500 m) strata, in case the depth distribution of fish changed between years. The Working Group agreed that this would be best accomplished by moving five stations from the core strata into the 400–500 m depth strata (stratum D12 in WG-FSA-12/41).

5.155 The Working Group noted that it was intended to try including the results of the 2012 and proposed 2013 surveys as input to the 2013 stock assessment (using CASAL) for the Ross Sea fishery. The results of the work will provide additional proportion-at-age data of toothfish not fully recruited to the fishery and a time series of abundance index for these age classes. With two surveys, there should be sufficient data to try estimating YCS in the stock assessment model as a sensitivity analysis. The Working Group also noted that, independent of its contribution to the model, the pre-recruit survey may enable detection of a change in recruitment earlier than would be reliably detected using data from the commercial fishery alone.

5.156 The Working Group reviewed WG-FSA-12/56, describing the results of research by Japan in Division 58.4.3b. It noted that, due to operational difficulties and poor weather, only 22 of the planned 48 research hauls were completed in 2012 and no tagged fish were recaptured. The Working Group agreed that the survey had provided useful new information on the comparison of CPUE between the trotline and Spanish systems and on the suitability of fish for tagging between the two methods.

5.157 The Working Group reviewed WG-FSA-12/57, describing the results of research by Japan in Division 58.4.4. It noted that the authors had included details of the measures used to avoid killer whale depredation as requested by WG-SAM (Annex 5, paragraph 4.12). Despite these measures, killer whale depredation in SSRU 5844B may still have compromised the success of research in this area. The Working Group agreed that there has been a low incidence of killer whales in SSRU 5844C, and that research carried out in this area has been more successful.

5.158 The Working Group noted that in Division 58.4.4 killer whales were generally more frequently seen and were in higher numbers in SSRUs A and B than in SSRUs C and D. The Working Group noted that a standardised CPUE analysis showed that catch rates were 40% lower when killer whales were present when the lines were being hauled, and recommended that future analyses should include gear type (e.g. trotline or Spanish line) in the analysis. Tag recaptures from this research had provided the data necessary to develop a preliminary stock assessment for *D. eleginoides* in SSRU 5844C (WG-FSA-12/59).

Research methods

5.159 WG-FSA-12/18 presented a simulation study to examine the influence of a low tag-overlap statistic (matching the length distribution of tagged fish with the length distribution of captured fish), the numbers of tagged fish, depletion history, the scan rate (catch), and the number of years of tag releases and recoveries, on the accuracy and precision of estimates of SSB_0 and $SSB_{current}$ from an integrated assessment model using CASAL. Variable tag size overlap levels resulted in a changing pattern of expected tag recoveries through time, as tagged fish grew and were selected more or less frequently by the fishery.

5.160 Low tag overlap was the most influential factor, acting to generate conflict in the fits to different data sources and generating an overestimation bias in this example. This effect degraded with longer data time series, and was not greatly influenced by the number of tags deployed or the scan rate. Because the mechanism of influence within a model is complex and depends on the actual assumptions and model configuration, the Working Group recommended that it would be important to examine the potential for further bias in each situation. For example, bias of the Ob and Lena assessment (WG-FSA-12/58 Rev. 1) was simulated, and was underestimating biomass by 16%.

5.161 The Working Group agreed that a tag-overlap statistic of at least 60% was supported by the study (WG-FSA-12/18), and encouraged vessels to maximise their overlap statistic, especially in the context of new fisheries or research proposals where initial models are likely to rely on low numbers of recaptures.

5.162 The Working Group suggested that, because consistent trends in recruitment estimates emerged in the simulations, it would be useful to examine the influence of fixing recruitment for this analysis. Further work is needed to understand the mechanism of why the degree of tag overlap influences assessment model performance. The conclusions of this paper will be incorporated into the research design recommendations for research plans in exploratory fisheries.

5.163 WG-FSA-12/44 and 12/45 described the further development of SPM in the Ross Sea region. The SPM presented in WG-FSA-12/44 is illustrative only, but is already generating realistic spatial distribution patterns and fits with observed fishery data. The Working Group noted that the primary purpose of developing SPM is to test the potential bias of single-area population models under assumptions implicit with various ontogenetic migration patterns. Estimating this potential bias was investigated in WG-FSA-12/45. Initial results suggested a small negative bias in the single-area model relative to the spatial model. The Working Group encouraged further development.

5.164 WG-FSA-12/47 Rev. 1 used a case-control study which controls for the confounding effect of factors such as time and location for tagging and size of fish tagged to develop relative indices of tagging mortality and the detection rate of recaptured fish for individual vessels.

5.165 The Working Group noted that this was a powerful and useful analytical approach and recommended it be used to develop a data-quality selection algorithm to select trips for use in the Ross Sea assessments. The actual selection criteria remain to be developed for discussion at WG-SAM-13.

5.166 One of the components of a successful tagging program is to be sure that the fishing method provides adequate numbers of fish suitable for tagging across the entire size range of fish captured. New data collection forms introduced in 2012 were designed to allow an evaluation of the suitability of fish captured for tagging. WG-FSA-12/49 summarised the data collected to date and recommended some changes to the data collected. The paper also used paired trotline–Spanish line experimental gear to estimate relative differences in length selectivity between the two gear configurations used. Those results suggested that the trotline catch rates were higher for medium-sized *D. eleginoides*, but about the same for very small and very large fish.

Tagging training

5.167 As indicated in WG-FSA-12/47 Rev. 1, the Working Group recognised that the significant differences in relative tagging mortality and relative recapture rates between vessels suggest that improvement of performance in both tagging deployment and tagging recovery is needed on some vessels.

5.168 Following advice from WG-SAM (Annex 5, paragraphs 2.1 to 2.31) an intersessional ad hoc tagging group further developed a toothfish and skate tagging protocol checklist. This checklist is intended to be a reference for fish tagging and a tagging training module for all involved (observers and crew) in tagging and recapturing toothfish or skates, as presented in WG-SAM-12/31.

5.169 A nine-step tagging checklist was developed, covering fish handling to tagged fish release (Appendix D). Currently, the checklist is in text form, but the Working Group recommended that the checklist should be transformed into a diagrammatic version that contains minimal text and uses graphics (drawn or photographic) to convey the essential information.

5.170 The Working Group noted that using new technologies to minimise recording errors should be investigated. Developing data recording methods and error trapping at data entry could improve recovered tag linking and potentially reduce the time fish are out of the water during the tagging procedure.

5.171 The Working Group agreed with the recommendations of WG-SAM (Annex 5, paragraph 2.26) that weighing fish to be tagged was not necessary.

5.172 The Working Group noted that the condition of tissue surrounding the tag attachment site is typically documented with photographs for recaptured fish. However, collecting these data places demands on observer time and the benefits of collecting these data have not been evaluated. The Working Group recommended that data derived from tag site photographs be evaluated intersessionally with a view to providing recommendations on the value of continuing to collect these data routinely.

5.173 The Working Group recommended that the ‘fish condition and hooking injury form’ for use in exploratory fisheries be modified to assess fish using the tagging suitability categories, detailed in Appendix D. These higher-resolution categories would be much more useful in the analysis of gear configuration and fishing operational effects on the suitability of fish for tagging.

5.174 The Working Group recommended that the L11 tag deployment form only record the fate of the tagged fish if the tag deployment was observed to fail. In that case, the reason for the failure should be noted (e.g. fish attacked by predator, and the type of predator identified) from a dropdown list in the form.

5.175 The Working Group recommended that the text-based tagging checklist be implemented in the upcoming season, and that a diagram-based version be developed and implemented intersessionally. The Working Group also recommended further development of the tagging training module to incorporate video and photographs for review by WG-FSA-13.

5.176 The Working Group noted the use of holding tanks on some vessels during the tagging procedure and encouraged Members to provide details of these, including, when used, effectiveness, size and materials of tank.

5.177 The Working Group noted concerns about potential increased loss of T-bar style tags from skates in comparison to dart tags. Pole tagging using dart tags while fish were in the water has been trialled, but tag-shedding and post-tagging mortality rates were likely to be high. Tagging fish brought on board with dart tags has also been carried out by some Members with more success. Noting that using two different tag types and applicators would incur extra cost and some potential for confusion, the Working Group encouraged comparative work from existing skate recaptures to examine tag-shedding rates of T-bar tags if possible.

5.178 Notwithstanding the advice of WG-SAM that implementation of an incentive system may be difficult (Annex 5, paragraph 2.22), the Working Group noted that some incentive program designs may be feasible and serve to improve the performance of tag deployment and tag recoveries. The Working Group considered that a program that included the key principles below could be successful:

- The incentive scheme should be a lottery to permit a substantive prize.

- The lottery should be comprised of verified tags returned to CCAMLR any time after the fishing season the tag was deployed.

- The lottery winner should be the vessel that recovered the tag (as opposed to an individual), with a corresponding prize to the vessel releasing the tagged fish. This recognises the entire vessel crew as a team (as all do not handle fish), and creates an incentive for vessel operators to encourage good tagging and tag-recovery performance.

- The prize should be funded by fishing Members only, for example, a levy on purchased tags or on the notification application fee for fishing in exploratory fisheries. A single prize could be awarded annually.

5.179 The Working Group requested that the Secretariat produce a tagging poster for display on vessels to encourage checking for tag recaptures, including details of the tag lottery.

5.180 The Working Group recommended that a tag recovery lottery system with the characteristics noted above be considered for development intersessionally if adopted.

5.181 The Working Group noted that the tagging training module developed by the intersessional correspondence group is currently configured as an MS PowerPoint, describing the purpose and importance of the tagging program, plus the details of tag-deployment and tag-recapture protocols. Several Members have provided photographs and videos that could be used as training materials for those tagging toothfish and skates. The Working Group noted a list of desired photographs and videos of particular tagging operations to better describe the proper tagging process and to be used in the training module, including examples of:

(i) fish landing and handling techniques for each gear type
(ii) evaluation of suitability to tag
(iii) configuration and use of holding tanks
(iv) tagging station layout
(v) tag application
(vi) fish release
(vii) data recording
(viii) tagging of toothfish and skates
(ix) tag-recovery operations
(x) toothfish and skate biological sampling (otoliths, gonad weights, tag site photos, tag documentation).

5.182 The Working Group noted it is important that examples are received from a variety of vessels and vessel configurations so that the training module is directly applicable to all operations. It requested that photos and videos could be submitted intersessionally through the CCAMLR tagging program coordinator by 1 July 2013 to be incorporated into the tagging training module and presented to WG-FSA-13. Photo and video credits will be listed in the training module.

5.183 The Working Group recommended that, to improve the performance of the tagging program, all persons tagging toothfish and skates in CCAMLR longline fisheries should be trained to do so. Training resources will be enhanced through the use of the tagging training module, and once implemented, could be used by vessel crews and observer programs.

5.184 To be able to target the appropriate audience for training, the Working Group recommended that the person or people tagging or recovering tagged fish are identified as crew (C), observer (O) or mix of observer and crew (M) in the L11 tag deployment and L12 tag recovery forms.

Assessment and management advice for depleted and recovering stocks

Subarea 48.1 – *C. gunnari* and *N. rossii*

5.185 WG-FSA-12/10 summarised the results of a random stratified trawl survey undertaken on the shelf of the South Shetland Islands (Subarea 48.1). The Working Group recalled that *C. gunnari* and *Notothenia rossii* were heavily exploited in this subarea in the late 1970s and 1980s, and the fishery was closed in 1990/91 due to a collapse of these stocks. Thus, the recovery of these species from depletion is of considerable interest to CCAMLR.

5.186 It was noted that *C. gunnari* were regularly encountered across much of the western and northern shelves of Elephant Island (WG-FSA-12/10, Figure 2F). The estimate of total standing stock biomass for *C. gunnari* (WG-FSA-12/10, Table 3A) for the total surveyed area was 25 038 tonnes, primarily composed of age 3+ fish. The Working Group noted that the survey indicated the first substantial signal of recovery for this stock, and the highest level of biomass observed since the fishery was closed and the stock monitored on a semi-annual basis by the USA and Germany (1996 to 2012).

5.187 The Working Group recommended that this fishery remain closed until such time that another survey(s) be undertaken to confirm the recovery of these populations and an assessment be undertaken.

C. gunnari Kerguelen Islands (Division 58.5.1)

5.188 There is currently no Fishery Report for this species in Division 58.5.1.

5.189 The Working Group reviewed a preliminary stock assessment of *C. gunnari* in the vicinity of the Kerguelen Islands (Division 58.5.1) based on the 2010 POKER biomass survey (WG-FSA-12/16 Rev. 1). The assessment used the same procedure to that used for this species in Division 58.5.2.

5.190 The Working Group agreed that it may be possible to compare dynamics between icefish populations in Divisions 58.5.1 and 58.5.2 based on recent survey results (e.g. correlations in trawl surveys). Recruitment between two areas may indicate that the different populations are responding to environmental changes at the scale of the Kerguelen Plateau (e.g. Sokolov and Rintoul, 2009).

Management advice

5.191 The Working Group agreed that the approach outlined in WG-FSA-12/16 Rev. 1 was a valid methodology to use for assessing icefish in this division and encouraged progress toward a new assessment based on the 2013 POKER survey.

BOTTOM FISHING ACTIVITIES AND VULNERABLE MARINE ECOSYSTEMS

6.1 WG-FSA-12/27 compared the rates at which VME by-catch is observed on autoline sets versus Spanish gear longline sets in the Ross Sea region fishery, and models the relative probability of detecting VME taxa using these gear types as a function of depth. While the authors noted that biased reporting between vessels would change the outcome of the calculations, they concluded that autolines have a higher impact on VME taxa relative to Spanish longlines.

6.2 The Working Group noted that the analysis compares VME taxa by-catch at the surface between different gear types, and that this may not be related to the level of impact occurring to VME taxa on the bottom. Some Members noted that model calculations are likely to be sensitive to the way in which the model treats observations of zero by-catch, and that alternate methods may be more appropriate. On this basis, the Working Group did not support the conclusions regarding relative levels of impact between gear types.

6.3 The Working Group agreed that further work to evaluate VME impacts by longlines would likely require direct observations of gear behaviour in contact with the seafloor, for example, using cameras (WG-FSA-08/58 and WG-EMM-10/33), as differences among fishing gears, especially with depth, can influence the ability to map VME taxa distributions with longline gears. Dr Brown informed the Working Group that camera work of this kind on different gear types was currently in progress in Subarea 48.3. The Working Group encouraged Members to continue with this work and to submit the results for further consideration within CCAMLR. The Working Group encouraged progressing this work, including incorporating additional factors (e.g. hauling time, hauling speed, or weather conditions) and considering a case-control approach described in WG-FSA-12/47 Rev. 1 to control for spatial heterogeneity.

6.4 WG-FSA-12/69 proposed research fishing using a depletion experiment design in SSRU 5841H (paragraph 5.73), in which two VMEs were registered under CM 22-06 based on information from direct observation using underwater video (WG-EMM-08/38). The Working Group discussed the particular research design of the fishing experiment in WG-FSA-12/69 and recommended that during the 'searching' phase prior to initiation of the depletion experiment, fishing should not occur within 10 n miles of the registered VME locations. This requirement will ensure that in the course of the depletion experiment fishing will not occur within 5 n miles of the registered VMEs.

6.5 The Working Group noted that under the requirements of CM 21-02, fishing in data-poor areas will occur in the context of approved research designs, but that, where existing conservation measures, such as CMs 22-06 and 22-07, have the potential to impact that research (for example research using tethered cameras to investigate longline impacts on known VMEs), it is unclear whether there exists a mechanism to exempt fishing under CM 21-02 from these requirements, as currently exists for research under CM 24-01. The Working Group agreed that resolution of these questions would require guidance from the Scientific Committee and/or Commission.

Review of VMEs notified in 2011/12

6.6 The Working Group noted that in 2011/12, 38 VME risk areas were triggered under CM 22-07 (CCAMLR-XXXI/BG/06) and six new VMEs were recommended by WG-EMM for inclusion in the VME registry under CM 22-06 (Annex 6, paragraphs 3.82 to 3.93).

Review of preliminary assessments of the impact of bottom fishing

6.7 The Working Group recalled the advice of WG-FSA-11 (SC-CAMLR-XXX, Annex 7, paragraphs 7.11 to 7.13) and agreed that in future the Secretariat should review preliminary VME impact assessments included in Members' notifications to participate in new and exploratory fisheries, in consultation with Members where required, to update Tables 1 and 2 in the Report on Bottom Fisheries and VMEs (SC-CAMLR-XXX, Annex 7, Appendix D) and report the results for consideration by WG-FSA.

6.8 The Working Group noted that all notifying Members provided the required information to inform VME impact estimates in their research notifications this year, but that not all of this information was easily located and in a format that facilitated easy integration into Appendix F.

6.9 The Working Group conducted a review of the preliminary assessments of bottom fishing activities provided by Members notifying to fish in exploratory fisheries. The review consisted of summarising the information required for Table 2 of Appendix F, and producing spatial summaries of historical fishing effort using the cumulative impact assessment framework incorporated into the plotImpact software (WG-FSA-12/55).

6.10 The Working Group noted that the historical spatial summaries of footprint and percentage impact provide the best summary of estimated impacts to date, and that the proposed fishing effort in each subarea or area/subarea/division (ASD) is dependent on catch limits in each area, accessibility due to sea-ice, and decisions made during fishing operations throughout the season. Therefore, accurate predictions of the spatial distribution of proposed fishing effort cannot be made within each subarea or ASD, or even among ASDs. Furthermore, the Working Group noted that the rate at which the cumulative impact is growing in each ASD is small relative to the estimated cumulative impact and can be evaluated by examining the historical fishing footprint and impact estimates provided in Appendix F.

6.11 The Working Group recommended that the potential for bottom fisheries to cause significant adverse impacts to VMEs could be evaluated with available fishing data, and does not require information on proposed effort for the upcoming season. The Working Group recommended that, if this approach to assessing the potential for bottom fishing to have significant adverse impacts on VMEs as required in CM 22-06 is adopted, then the preliminary assessments submitted via CM 22-06, Annex A, would no longer be required and Annex A could be removed.

6.12 As new information becomes available to inform gear-specific footprint and impact estimates for trotlines, Spanish lines, pots and trawls, e.g. using tethered cameras as in paragraph 6.3, then the gear-specific input parameters used in the impact assessment framework and associated spatial impact summary software (paragraph 6.13) can be updated.

Report on Bottom Fisheries and VMEs

6.13 WG-FSA-12/55 described an update of the plotImpact software adopted by the Scientific Committee in 2011 to produce combined cumulative VME impact assessments and impact maps using Secretariat databases (SC-CAMLR-XXX, paragraph 5.4). The updated software has been developed into an R library with improved functionality. The Working Group welcomed these developments.

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

7.1 In accordance with CCAMLR's Scheme of International Scientific Observation, scientific observers were deployed on all vessels in all finfish fisheries in the Convention Area in 2011/12. Information collected by scientific observers was summarised in WG-FSA-12/66 Rev. 2 and 12/70 Rev. 2.

7.2 The Working Group noted that training resources, such as guides for maturity staging and species identification, were used by various Members' technical coordinators to train observers and urged those Members to provide these to the Secretariat to be available on the CCAMLR website for general use.

7.3 Recognising that data collected by observers is an important source of information used by the Scientific Committee to assess the status of resources in the CCAMLR region, the Working Group thanked the observers and technical coordinators for the sterling work that they continue to undertake and for the body of data that they have provided over the years.

7.4 The Working Group recommended that an external review is undertaken of the CCAMLR Scheme of International Scientific Observation to promote the ongoing improvement of the program and the quality of its data collection.

7.5 This external review of the CCAMLR Scheme of International Scientific Observation would involve consultation with the CCAMLR Secretariat, Member State technical coordinators, observers, the fishing industry and data clients such as scientists participating in CCAMLR working groups. The outcomes and recommendations resulting from this review would be available for consideration by the Scientific Committee (or a subgroup designated by the Scientific Committee). The proposed aims for the external review are:

1. Describe the current situation

   Provide an overview of the existing observer scheme, including its objectives, organisational structure, observer training requirements, observer deployment, data collection processes and management and quality assurance processes.

2. Identify present challenges

   Evaluate performance of the Scheme of International Scientific Observation relative to defined goals and objectives. These will include the original objectives as well as current science priorities of CCAMLR. Has the scheme met these objectives in an effective manner?

3. Describe potential solutions and improvements

   Can positive changes be made to existing procedures to better meet stated objectives of the scheme? This evaluation should identify instances where objectives are currently not being met and circumstances where changes could improve delivery of objectives.

7.6 The Working Group proposed that the review panel would be composed of the following persons:

(i) an internationally recognised person with experience in the coordination of an international observer program such as NAFO or NMFS. It also recommended that this external expert shall be internationally recognised in their field, but shall have no previous involvement or direct experience with CCAMLR

(ii) an expert from a CCAMLR Member State with experience of operating within the Scheme of International Scientific Observation

(iii) the Chair of the Scientific Committee

(iv) a proficient CCAMLR observer with wide experience in the different CCAMLR target fisheries.

7.7 The Working Group proposed that the review panel would be appointed by the Executive Secretary in consultation with the Chair of the Scientific Committee. The panel members shall be independent and participate in their personal capacity, not as a Member representative.

7.8 The Secretariat calculated the approximate cost of the review as A$25 000 to cover the meeting of the review panel at the Secretariat and the costs of the invited external expert and possibly the other panel members.

FISH BY-CATCH

Submitted papers

8.1 Nine papers on fish by-catch were presented to WG-FSA covering identification, associations and abundance within the krill fishery in Area 48, and the directed toothfish and icefish fisheries in Areas 48, 58 and 88.

8.2 WG-EMM-12/28 presented the results of a method used to explore variables influencing finfish by-catch in the krill fishery of Area 48. The majority of fish caught were either small juveniles or larvae, dominated by Myctophidae (lanternfish) and Channichthyidae (icefish) with lower levels of Nototheniidae present. Time of day, krill catch, sea-surface temperature, bottom depth, fishing depth and season were all significantly associated with the presence of finfish by-catch in krill catches by the observed vessel. The Working Group noted that another likely covariate that will determine the catch rate of finfish juveniles is distance from the shore.

8.3 WG-EMM-12/29 presented a methodology that could be used to estimate the total finfish by-catch of the Area 48 krill fishery and quantify the impact of by-catch on the finfish stocks. Estimates of total unrealised spawning biomass of the by-catch (i.e. the spawning biomass that the small fish caught in the krill fishery would have contributed to the population) suggested that finfish by-catch by the vessel was unlikely to have impacted the finfish stock biomass in Area 48. The Working Group noted that uncertainties regarding mortality rates of early life-history stages would influence the levels of impact estimated in this study.

8.4 The Working Group noted that the two studies provide a useful methodology to the monitoring of the potential impact of krill fishing removals of by-catch species on the finfish stocks and that in order to conduct an extended analysis that can be applied to the total fishery, similar data on catch rates and explanatory variables would be required for other krill fishing techniques. Consequently, the training of observers on krill vessels should be extended to include identification of juvenile finfish, at least to the family level. The CCAMLR Secretariat was requested to develop an identification guide with the help of scientists from Member States that can be added to the CCAMLR website in order to facilitate the extension to the data collected by CCAMLR observers (Annex 6).

8.5 WG-FSA-12/24 reviewed the by-catch of *Channichthys rhinoceratus* and *Lepidonotothen squamifrons* in fisheries at Heard Island and McDonald Islands (Division 58.5.2); both species are widespread over the plateau in waters of <1 000 m. *Channichthys rhinoceratus* and *L. squamifrons* are among the most common by-catch species caught in the toothfish and mackerel icefish trawl fisheries at Heard Island and McDonald Islands (Division 58.5.2). These species are rarely taken in the longline fishery. The annual take of these species is well below the precautionary by-catch limits set by CCAMLR, move-on rules apply, and a substantial part of their distribution occurs within the HIMI Marine Reserve, and therefore current by-catch levels are likely to be low risk. The Working Group noted that potentially the catch rates could be compared to swept-area biomass estimates from the survey in order to provide estimates of the exploitation rate for use in the provision of future management advice. The Working Group noted that a mark–recapture experiment for *L. squamifrons* could be useful for comparing biomass estimates with other methods.

8.6 WG-FSA-12/35 presented a study comparing molecular and morphological identification of *Macrourus* species caught as by-catch in the toothfish longline fisheries in CCAMLR Subareas 48.3 and 48.4. The Working Group noted that changes in species identification which result in splitting of species will require modifications to the CCAMLR database and introduce complexity, in that historic data will comprise more than one species, where splitting of catches was not possible (paragraph 9.23).

8.7 WG-FSA-12/42 presented a characterisation of the by-catch in Subareas 88.1 and 88.2 from 1997/98 to 2011/12. For each by-catch group, the main species were identified and the location and depth distribution of catches and catch rates illustrated.

8.8 WG-FSA-12/50 characterised the by-catch of *Muraenolepis* spp., which are caught in low numbers with bottom longline and trawl gears throughout the CAMLR Convention Area. The paper was discussed under Item 9.

8.9 WG-FSA-12/51 examined demersal fish population densities in the Ross Sea region using comparisons between video and trawl survey methods. *Macrourus* spp. were approximately eight times less abundant by number in the demersal trawl than the video data, but because of different selectivities, derived biomass estimates were similar. The Working Group agreed that video and trawl methods could provide complementary information that could be used together to provide data for assessments of demersal fish populations.

8.10 WG-FSA-12/P11 explored whether acoustic methods can be used to monitor grenadier (Macrouridae) abundance in the Ross Sea region. Grenadiers are the main by-catch species in exploratory longline fisheries for toothfish. Ongoing monitoring tools are needed to assess the stock status of grenadiers and to ensure ecological relationships are maintained. Acoustic data collected during New Zealand's International Polar Year Census of Marine Life survey of the Ross Sea in 2008 provided evidence that single acoustic targets close to the bottom over the Ross Sea slope are grenadiers. There was a positive correlation between acoustic backscatter and trawl and longline catches of grenadiers. Key uncertainties of the acoustic method were mark identification away from the bottom, and technical issues with low signal-to-noise ratio at depths greater than 1 000 m and the acoustic dead zone close to the bottom.

Skate tagging

8.11 The Working Group noted that the skate tag returns from the Year-of-the-Skate (2009/10 and 2010/11) had currently not been examined in detail. Table 14 presents the number of skate recorded each year by CCAMLR division, Table 15 the number of skate tagged, Table 16 the percentage tagging rate and Table 17 the number of recaptures in each year.

8.12 Tagging has occurred almost exclusively in Subareas 48.3, 48.4 and 88.1 and Division 58.5.2, despite regular catches of substantial numbers of skate in Subareas 58.4 and 58.6. The Year-of-the-Skate increased the numbers of areas in which tagging had regularly occurred but the overall numbers released in the new areas remained low.

8.13 Tag returns from the additional areas not covered by the Year-of-the-Skate program have subsequently been low. For example, only a single tag has been returned from Subarea 58.6. Returns from Subareas 48.3, 48.4 and 88.1, which had approximately double the number of tags released during 2009 and 2010, have not yet shown an increase that might be expected from the increased tagging effort. However, the Working Group noted that an evaluation of scanning rates would be required to confirm whether the recapture rates had changed. Australia provided data on returns from Division 58.5.2 which showed that they have increased, however, it is yet to be determined if these increased returns result from activities during the Year-of-the-Skate.

8.14 A significant factor in the release and subsequent recapture of tags is the strategy used by vessels to avoid areas with higher concentrations of skates in order to comply with the by-catch mitigation measures as set out in CM 33-03, to minimise lost fishing time in releasing and/or tagging skates, and in order to increase the potential for catching toothfish – a hook occupied by a skate is not available to a toothfish.

8.15 The Working Group recalled that WG-FSA-08/55 discussed analysis of the skate tagging at Heard Island and McDonald Islands (Division 58.5.2). The recapture rate was <1% in eight years (46 recaptures) and the longest time at liberty was six years. The average distance between release and recapture points was 4.8 n miles, the furthest distance was 40 n miles and the shortest 0.2 n miles, with only 3 recaptures >10 n miles from their release point.

8.16 The Working Group considered that evaluations of the potential for assessment in areas with a history of tag releases would be useful, but recognised that such an assessment would not only be problematic in terms of the spatial overlap of the fishery with previously tagged fish, and also in terms of the species composition of the skate complex and their distributions and size compositions.

8.17 Despite the potential problems with development of stock assessments, the Working Group considered that the tagging data will provide useful data on growth rates, distribution and movement rates as the time series of recaptures develops.

8.18 As a start to the process, the Working Group requested that the CCAMLR Secretariat prepare a review of the skate and ray by-catch and tagging program, including:

(i) Catch data –

  (a) table of skate retained, discarded, released, tagged, total hauled by subarea/division and year from C2 data

  (b) table of skate retained, discarded, released, tagged, total hauled by subarea/division and year from observer data (need % observed and then pro-rated by observation tally period)

  (c) plot of location of catches/catch rates by subarea/division and year from C2 data.

(ii) Tag data –

  (a) table of skate releases and recaptures by year (including number of single/double-tagged fish) and number of tags linked

  (b) movement of tagged skate within Subareas 48.3, 48.4 and 88.1

  (c) changes in growth of tagged skate as a function of length with time at liberty within Subareas 48.3 and 88.1

  (d) plots showing location of tag releases and tag recaptures for Subareas 48.3 and 88.1 and subsequent fishing effort.

(iii) Biological data –

  (a) table of biological data collected by subarea/division

  (b) scaled length-frequency distributions of skates by subarea/division and year (for areas where there are sufficient data for individual species)

  (c) table of fate of released skate by condition by subarea/division and year.

Skate by-catch in Division 58.4.3a

8.19 WG-FSA-12/29 outlined a research plan for *Dissostichus* spp. in 2012/13 in Division 58.4.3a fishing twice a year from 2013 to 2015 (paragraph 5.87).

8.20 The Working Group noted that there was an unusually high by-catch of skate in Division 58.4.3a in 2011/12 (WG-FSA-12/29); a total catch of 33 tonnes of skate was reported, just below that of the target species toothfish (34 tonnes). The fishing was conducted by the vessel fishing in the same area as that proposed in the proposed research plan covering the period from 2013 to 2015.

8.21 Data submitted by the vessel indicated that all of the skate were considered dead and consequently processed rather than being released when alive, as would have been required by CM 33-03, paragraph 4.

8.22 The Working Group examined catch rates by other vessels that have fished within Division 58.4.3a. The majority of vessels fishing in the area have substantially lower catch rates of skate, only one of which had similar catch rates to those detailed in WG-FSA-12/29 in 2005 prior to the requirement to release skates in CM 33-03, paragraph 4, which was introduced in 2007.

8.23 Given that the average soak time was 29 hours and that the vessel returned toothfish that were considered in sufficiently good condition to meet the vessel's tagging objectives, the Working Group could find no reason for the abnormally high rate of skate mortality.

8.24 The high skate by-catch mortality rate resulting from fishing by this vessel within Division 58.4.3a introduces a complication in determining its suitability to conduct research fishing twice a year in the subarea without further consideration of substantial by-catch of skate and potential impact on the skate stock in the subarea.

8.25 The Working Group noted that, if the research proposal outlined in WG-FSA-12/29 is to proceed, then the restrictions outlined in CM 33-03 are unlikely to be sufficient to prevent a substantial by-catch of skate by the *Saint André* during 2013 to 2015. The Working Group recommended that the Scientific Committee consider a specific skate by-catch mitigation measure (e.g. a revised skate catch limit or move-on rule) that would be appropriate to this vessel during the research fishing in Division 58.4.3a.

8.26 The Working Group recommended that the high skate by-catch and mortality rates from the *Saint André* fishing in Division 58.4.3a be drawn to the attention of SCIC.

Seabirds and marine mammals

8.27 The Working Group recalled the outcomes of discussions at WG-IMAF last year (SC-CAMLR-XXX, Annex 8, paragraphs 10.1 to 10.8) that, while the number of seabirds being killed in CCAMLR fisheries had reduced, there remained a need for a routine review of incidental mortality and of the implementation of conservation measures associated with mitigation. Accordingly, the Secretariat presented WG-FSA-12/66 Rev. 2 and 12/70 Rev. 2 that provided this review.

8.28 During 2011/12 (WG-FSA-12/66 Rev. 2) there were two seabird mortalities in Subarea 48.3 (one black-browed albatross and one southern giant petrel). In the French EEZs, 16 seabird mortalities were observed (all white-chinned petrels) in Subarea 58.6 and 38 (34 white-chinned and four grey petrels) in Division 58.5.1. In addition, a single Cape petrel was recorded dead in the krill fishery in Subarea 48.1. There were two marine mammal mortalities recorded in longline fisheries in 2012, one sperm whale entangled in the main line in Subarea 48.3 and one southern elephant seal hooked/entangled and drowned in Division 58.5.2. There were no recorded mortalities of birds or mammals in finfish trawl fisheries.

8.29 WG-FSA-12/28 Rev. 1 provided an update on the French plan of action to reduce seabird by-catch in the French EEZs in Subarea 58.6 and Division 58.5.1. The Working Group welcomed the update and noted that, while from 2008 to 2012 there had been an 80% decrease in total seabird mortality, the rate of decrease over the past three years was 27%. Compared to last year, there had been a continued reduction in seabird mortality in Division 58.5.1 but an increase in Subarea 58.6.

8.30 The Working Group noted that the level of seabird by-catch had stabilised (WG-FSA-12/28 Rev. 1, Figures 2 and 3) in recent years and that the seabird by-catch should be zero. It recommended that France continue to take additional steps to mitigate seabird by-catch.

8.31 Mr Gasco informed the Working Group that French authorities had identified two vessels responsible for the majority of the by-catch in Subarea 58.6 and restrictions would be placed on the operation of these vessels in order to further reduce seabird by-catch. The Working Group welcomed the proposal for targeted action to further reduce seabird by-catch in the French EEZs.

8.32 The analysis in WG-FSA-12/28 Rev. 1 showed the difference between the annual extrapolated estimate of seabird mortality when presented in CCAMLR seasons (1 December to 30 November) and French seasons (1 September to 31 August). The Working Group suggested that, if the rate of by-catch was estimated on a monthly basis for extrapolation, this would resolve the discrepancies between reporting periods that cover different parts of the year, and that presenting these data at monthly intervals would assist in interpreting time series of seabird catches.

Marine debris

8.33 WG-FSA-12/64 provided a review of marine debris surveys in the Convention Area which have been reported to the Secretariat as part of the CCAMLR marine debris monitoring program. As in previous years, monitoring sites were located in Subareas 48.1, 48.2, 48.3 and 58.7. Results indicate that there has been no trend (either up or down) in the amount of debris in beach surveys, in nests of seabirds and in the incidence of marine mammal entanglements in the last decade.

8.34 The Working Group encouraged those Members currently engaged in the collection of marine debris data to review any potential covariates, including both fishing and non-fishing shipping traffic, that might provide insights into the pattern of occurrence of marine debris, with research programs in areas where there was currently no marine debris monitoring, but where there was an active fishery (e.g. the Ross Sea), to undertake such monitoring.

BIOLOGY, ECOLOGY AND INTERACTIONS IN FISH-BASED ECOSYSTEMS

9.1 Thirty-six papers on biology and ecology were provided and discussed by the subgroup. The papers covered:

(i) biological parameters for target and by-catch species, including those data that can be used in stock assessment

(ii) ecological and ecosystem studies

(iii) taxonomic studies that have implications for observer programs and/or biodiversity studies.

9.2 Given the number of papers submitted and the time available for discussion, it was not possible to consider all papers in plenary. All papers are summarised in Appendix E. The discussion in the Working Group relating to selected papers are provided below (by region where applicable).

9.3 The characterisation of population structure and distribution patterns of both target and by-catch species is an important component of fisheries management. With the advent of spatial population and ecosystem models, the factors influencing population distribution are increasingly important. Biological investigations utilising various methods such as larval dispersal simulations, catch distributions, adult movement simulations, genetics, tagging, age composition, parasite species composition, and otolith microchemistry have all been recently applied to a number of target and by-catch species throughout the Convention Area. In most cases, these studies are indicative and provide hypotheses for further testing, but have not provided definitive answers to this complex problem. For most species, detailed knowledge of the biology, distribution and habitat preferences of different life-history stages is needed to develop more realistic models, for example parameterising the spatial population models presented in WG-FSA-12/44. The Working Group welcomed these studies and encouraged Members to continue conducting studies to inform the characterisation of population structure. It was noted that such studies could benefit from collaborative initiatives.

9.4 The collection of data from target and by-catch species from CCAMLR fisheries have provided a unique dataset with which to examine the biology and ecology of these species. The Working Group encouraged Members to consider not only the broader scientific interest, but also to consider the implications of these studies for CCAMLR’s ecosystem-based approach to fisheries management.

9.5 Members were encouraged to outline their plans for upcoming research to facilitate collaborative studies and to allow the Biology and Ecology Subgroup to develop more targeted discussions on work of relevance to future meetings of WG-FSA.

Pan-Antarctic studies

9.6 Detailed information on various aspects of the biology and ecology of *D. mawsoni* from Russian literature was provided in WG-FSA-12/14 and the Working Group considered that this information would complement the *D. mawsoni* species profile (WG-FSA-10/24) and encouraged relevant material from the extensive Russian literature on *D. mawsoni* be added to the species profile.

9.7 The Working Group noted that the genetic population study of *D. mawsoni* given in WG-FSA-12/21 indicated a homogeneous circumpolar population that contradicts previous genetic findings. However, the small sample size and methods applied meant that the findings were not comparable to previous genetic studies. The Working Group encouraged the authors to submit this paper for peer review in order that the methods used can be fully evaluated. Homogeneity of the *D. mawsoni* population was also suggested by its parasite fauna (WG-FSA-12/P09) but more detailed information on the abundance and prevalence of parasites, and the location and timing of sampling, was needed. The Working Group noted that although genetic and parasite data may be useful tools to give information on stock structure, other methods (e.g. spatial patterns in life-history parameters, microsatellite data, movements from tagging data) should also be examined to give a coherent view of stock structure.

9.8 The Working Group recognised that some interesting information regarding *Pleuragramma antarcticum* was indicated in WG-FSA-12/23 but it was not possible to comment further, as only an abstract and some figures were presented at this time, and it looked forward to receiving a concise account of the full results in the future.

9.9 WG-FSA-12/50 provided an overview of the biology of Muraenolepidae from by-catch in the longline fishery. The Working Group agreed that the taxonomy of this genus is complicated and requires further study. Members are encouraged to collaborate with ongoing initiatives by collecting samples and biological information of *Muraenolepis* spp. from various locations in the Southern Ocean and making these available to the Working Group.

9.10 The Working Group discussed the suggestion of *Muraenolepis* spp. having a semelparous reproductive strategy and noted that most fish with such a strategy are from freshwater and from very different taxa (e.g. Osmeridae and Salmonidae). Further work was encouraged to confirm this reproductive strategy, as it is possible that germinal cells (oogonia) are localised within the ovary in this taxon.

Ross Sea

Biological parameters for commercial and by-catch species

9.11 Age-at-sexual maturity of *D. mawsoni* receives regular updated data. Several papers described maturity stages from macroscopic changes analysis in gonadosomatic index and histological assessments of gonads of females and males. Reproductive studies of other species (e.g. *Macrourus* spp., *Muraenolepis* spp. and two liparid species) were also conducted recently.

9.12 A multi-disciplinary approach, incorporating otolith chemistry, age data and numerical Lagrangian particle simulations, indicated a single self-recruiting population of *D. mawsoni* in the southeast Pacific basin and the Ross Sea, with a life history structured by the large-scale circulation (WG-FSA-12/P02). It was one of the first papers viewing the population structure of *D. mawsoni* on a circumpolar scale. The Working Group encouraged the authors to continue their work.

9.13 The Working Group agreed that the most robust estimate of the spawning ogives for *D. mawsoni* in the Ross Sea were the $L_{50\%}/A_{50\%}$ values of females 135 cm/16.9 years, and males 109 cm/12 years, presented in WG-FSA-12/40, and that these should be evaluated for use in the upcoming assessment for Subareas 88.1 and 88.2. The Working Group also encouraged collection of reproductive data from the winter spawning period to distinguish fish which may abort maturation and fish that may develop later in the spawning season.

9.14 The Working Group noted that many biological studies of toothfish were conducted using fishery-collected samples, with various conclusions about the size and age of spawning in the Ross Sea and elsewhere. These studies are often limited by sample size, spatial and/or temporal distribution of samples, or assumptions of reproductive development. The Working Group encouraged an overall review and synthesis of these studies to provide robust and consistent inputs for use in stock assessment.

Ecological and ecosystem studies

9.15 WG-FSA-12/P04 provided an updated analysis of a McMurdo Sound vertical longline survey for *D. mawsoni*, which started in 1972, for which recent changes in the CPUE were attributed to the effects of the longline fishery in the Ross Sea. The Working Group recalled an earlier paper which had been submitted by the authors on this subject (WG-EMM-08/21) and the consideration of the paper at the time (SC-CAMLR-XXVII, Annex 4, paragraphs 6.21 to 6.26). The Working Group agreed that many of the inconsistencies of the earlier paper had been addressed, and thanked the authors for submitting the associated data to the CCAMLR Secretariat. However, it noted that the dataset was still lacking some basic details, such as the depth of the fishing sites each year. Depth appears to have varied across the time series and would be an important part of a CPUE standardisation, as it has been shown to be strongly related to toothfish abundance (WG-FSA-10/24 and 12/41).

9.16 The Working Group agreed that the apparent decline in toothfish CPUE at McMurdo Sound since 2001 was not consistent with analyses based on the data collected by the fishery elsewhere in the Ross Sea region. Unstandardised CPUE from the fishery, in terms of catch per hook or catch per set, have been relatively stable since the start of the fishery (WG-FSA-12/42), whilst the 2011 stock assessment indicated that spawning stock biomass had declined to 80% B_0. Furthermore, the standardised catch rates from a research longline survey of pre-recruit toothfish (70–110 cm TL) in the southern Ross Sea in 2012 were similar to those made by the same vessel fishing in the area earlier in the fishery, between 1999 and 2003 (WG-FSA-12/41; Figure 1). Fish condition in the southern Ross Sea was similar to that observed in McMurdo Sound (Figure 2).

9.17 The Working Group agreed that, given the relative spatial scale of the Ross Sea fishery and the location of McMurdo Sound (Figure 3), the changes reported in WG-FSA-12/P04 may reflect local ecosystem changes arising from the extreme hydrological conditions caused by the breaking-off and grounding of two large icebergs between 2000 and 2005 (Robinson and Williams, 2012). These icebergs had a profound effect on the hydrology and primary productivity in the McMurdo Sound region during this period and caused a 50–70% reduction in phytoplankton in 2000/01 and 90% in 2002/03. Extensive ice build-up also occurred in the inner Sound from 1998 onwards with an increasing thickness of a band of multi-year fast-ice extending around the edge of the Sound until 2010. The resulting lower abundance of food in the area could have led to the reduced abundance of toothfish and poor condition, as noted in WG-FSA-12/P04. The Working Group also considered that the potential changes in the mean number of killer whales per pod during the past decade (presented in WG-FSA-12/P03) were consistent with these local-scale changes.

9.18 The Working Group agreed that the time series in McMurdo Sound could be a useful tool to monitor local toothfish abundance and ecology within McMurdo Sound and recommended it be continued. However, it also emphasised the importance of the standardisation of the survey with respect to hook and bait type, time of sampling, fishing depth and fishing location, among other factors. The Working Group also noted that, given the spatial scale of the Ross Sea and the location of McMurdo Sound (Figure 3), a local sampling effort would not be expected to provide an index of the status of the stock centred well over 500 km away.

9.19 Recent data on the diet of *D. mawsoni* in the Ross Sea were provided (WG-FSA-12/06 and 12/52). Trophic level was related to fatty acids and stable isotopes (WG-FSA-12/61). The Working Group noted that quantified dietary data are needed to better understand trophic interactions and for use in trophic and ecosystem models.

9.20 A balanced ecosystem model (WG-EMM-12/53) for the Ross Sea, using 35 trophic groups, indicated that eight groups (phytoplankton, mesozooplankton, *P. antarcticum*, small demersal fish, *E. superba*, cephalopods, crystal krill (*E. crystallorophias*) and pelagic fish) would be informative for examining ecosystem changes.

Taxonomic studies

9.21 As by-catch species collections and investigations grow, questions arising from observed variations in biological characteristics suggest the presence of cryptic (morphologically similar but genetically distinct) species within several families of Antarctic fish, especially the families Rajidae, Macrouridae, Muraenolepididae, Liparidae and Zoarcidae (see WG-FSA-12/53).

9.22 Recent molecular studies have confirmed the presence of a fourth species of *Macrourus* in the Southern Ocean (WG-FSA-12/54 Rev. 1). The new species, *M. caml* has now been formally described by McMillan et al. (2012). These documents list the characteristics that can be used for correct identification of the species (see Appendix E). The Working Group recommended that updated identification guides be provided to observers throughout the Convention Area to aid in documenting catch of this new species.

9.23 The Working Group noted that historical *M. whitsoni* catch data would have included the newly described species (*M. caml*). The Working Group agreed that a new species code should be developed for *M. caml* and another species code should be used for historical data for *M. whitsoni* catches for use in regions where there is spatial overlap in the range of the two species.

9.24 The Working Group noted that there are currently several ongoing studies aimed at revising the taxonomy of the genus *Muraenolepis* and encouraged cooperation among Members to collect specimens from various subareas to inform future studies.

Scotia Sea

Biological parameters for commercial and by-catch species

9.25 Several documents provided biological information for a range of species in the Scotia Sea, including toothfish (*D. mawsoni* and *D. eleginoides*) (WG-FSA-12/37 and 12/38); *L. squamifrons* (WG-FSA-12/34); South Georgia icefish (*Pseudochaenichthys georgianus*) (WG-FSA-12/68 Rev. 1), with site-specific data also provided for a range of species in WG-FSA-12/10 and 12/P06.

Ecological and ecosystem studies

9.26 WG-FSA-12/P01 provided information on trends in relative catch rates for two previously overexploited demersal notothenid species sampled by trammel net over a 28-year period. The Working Group noted that the low sampling effort and site-specific nature of the survey means that it may not necessarily be informative for understanding the stock status of the species considered over the geographic range of the stock.

9.27 Changes in abundance of the marbled *N. rossii* sampled by trawl surveys since 1998 in Subarea 48.1 were presented in WG-FSA-12/19. An increase in catches of *N. rossii* around Elephant Island over this period was observed, although the aggregating nature of this species means that trawl surveys have a high number of hauls with zero/low catches, and a few sites with high catch rates (>5 tonnes per 30 mins). This variability can result in uncertain biomass estimates. Indeed, this survey was not originally designed to monitor this species. The Working Group noted that further analyses could be undertaken on catch rates, and that modification to existing survey design would compromise the time series, and a species-specific survey may be required. The Working Group recommended a further survey to be undertaken using an improved survey design.

9.28 Current catch rates for *Gobionotothen gibberifrons* (WG-FSA-12/20) during surveys are substantially lower than at the start of the time series (1998). This time series indicated low recruitment since 2000, even though fisheries on this species ceased in the early 1980s and were prohibited after 1989/90. The Working Group considered that the current status of this species remains unclear and our knowledge of what environmental factors influence recruitment for Antarctic demersal fishes remains poor.

9.29 Article II.3(c) of the Convention aims to prevent changes that are not potentially reversible over two or three decades. Given that targeted fisheries for *N. rossii* and *C. gunnari* were prohibited over two decades ago, studies on these populations may now inform on the appropriateness of this time frame for their recoveries. The Working Group noted that improved studies on the age composition of these populations would be valuable in assessing population age structure as an indicator of stock recovery.

9.30 The relationships between fish populations and their occurrence in the diet of Antarctic shags at the South Shetland Islands was presented in WG-FSA-12/05. The Working Group considered that, while such data may provide useful insights into changes in local fish populations, the relationships with wider stock/population trends remain unclear.

9.31 The Working Group agreed that analyses of long-term data on fish populations should also include analyses of other relevant species and environmental indices to better understand changes in populations, especially rates of recovery in the context of broader ecosystem dynamics.

9.32 WG-FSA-12/33 summarised data from ichthyoplankton surveys in Cumberland Bay, South Georgia (2002–2008), which informs on the spawning periods of various species, and highlights the important role of bays for these early life-history stages. The Working Group encouraged further studies on ichthyoplankton and post-larval stages in the region (WG-FSA-12/04 and 12/33), as these can provide valuable ecological information for ecosystem management and ecosystem models.

9.33 WG-FSA-12/P10 presented results of modelled simulations of egg/larval dispersal to examine the potential influence of oceanographic and life-history variability on the dispersal and retention of *C. gunnari* (a demersal egg-layer) and *N. rossii* (a pelagic spawner). The Working Group considered that such models can give a broad regional-scale approach to understanding issues of potential connectivity. However, the spatial resolution of models may not fully address some coastal oceanographic features, and a poor understanding of larval behaviour means such models may be less accurate on finer spatial scales.

Taxonomic studies

9.34 The taxonomic issues relating to *Macrourus* spp. were discussed in WG-FSA-12/35, showing similar spatial distributions in relation to oceanography as noted in the Ross Sea (WG-FSA-12/54 Rev. 1). This study also reported that the sub-Antarctic species *M. holotrachys* was indistinguishable genetically from the North Atlantic *M. berglax*. The Working Group considered that further taxonomic revision of this genus is required.

AGEING WORKSHOP FOR *D. ELEGINOIDES* AND *D. MAWSONI*

10.1 Recalling the Workshop on Estimating Age in Patagonian Toothfish held in 2001 (SC-CAMLR-XX, Annex 5, Appendix H), it was agreed to focus primarily on *D. mawsoni*, and that the objectives of the 2012 Workshop would be to provide advice on the following topics:

(i) otolith collection protocols
(ii) otolith preparation protocols
(iii) definition of otolith structures

(iv) quality assurance and quality control
(v) validation
(vi) data management.

Otolith collection protocols

10.2 It was noted that two methods of collecting otoliths for ageing are currently used in CCAMLR fisheries:

(i) random sampling: all otoliths are collected from a random selection of toothfish during sampling of the catch by observers

(ii) length-stratified random sampling: otoliths are collected from a random selection of fish during sampling of the catch by observers, with observers ceasing collection for length bins once 5 to 10 otoliths per length bin have been collected.

10.3 It was noted that length-stratified sampling was likely to be more efficient at collecting otoliths from the extremes of the length distribution of the catch, while avoiding collecting large amounts of otoliths from more common size classes. It was agreed that both methods were likely to provide sufficient otoliths that were representative of the age classes of fish in the catch to generate age–length keys and estimate catch-at-age. It was further agreed that a description of the sampling and subsampling that is used to select otoliths for processing and ageing should be presented with any ageing dataset.

Otolith preparation protocols

10.4 Mr Sutton presented WG-FSA-12/43 Rev. 1. It was noted that since 2010 the National Institute of Water and Atmospheric Research Ltd (NIWA) laboratory has developed a reference collection of 240 *D. mawsoni* otoliths, prepared using the 'bake-and-embed' method. Mr Sutton noted that 60 of the sister otoliths of the reference collection had also been thin-sectioned and similar results had been obtained for both methods. Mr Sutton noted that the inner zones of *D. mawsoni* otoliths are the most difficult to interpret, and so measurements based on the annuli widths for juvenile *D. mawsoni* collected in the South Shetland Islands are used to infer the position of the first three annuli. The 4th to 8th annuli can also be unclear, but in older fish annuli narrow, and opaque and translucent zones become easier to distinguish.

10.5 The Working Group noted that a Russian ageing program currently uses the 'break-and-burn' method, as presented in WG-SAM-12/18. Dr Petrov noted that over 6 000 *D. mawsoni* otoliths had been processed and aged from Subarea 88.1 and Divisions 58.4.1 and 58.4.2 and that this had been part of the input data into stock assessments using the TISVPA model presented in WG-FSA-06/50 and 09/14.

10.6 The Working Group noted that the sections shown in WG-SAM-12/18 were similar in appearance to those produced by the bake-and-embed method used by New Zealand. However, it noted that a comparison between the two ageing methods has not been performed and, therefore, it was unable to provide advice on whether the two methods are likely to produce similar results when used for mass ageing. To facilitate this comparison, Dr Petrov provided a sample of otoliths prepared using the break-and-burn method. Mr Sutton undertook to perform a ‘blind’ read of the sample to determine if he could replicate the results of the Russian study during the workshop, and also prepare the sister otoliths provided by Dr Petrov using the bake-and-embed method and report the results to WG-FSA at its next meeting.

10.7 The Working Group recalled the advice from the Workshop on Estimating Age in Patagonian Toothfish, which had concluded that, when followed consistently, both thin-sections and bake-and-embed protocols were likely to enable similar levels of structural detail to be observed in *D. mawsoni* otoliths. It therefore agreed that, for CCAMLR Members wishing to commence ageing programs, the choice of which method to use could be determined by available laboratory equipment and expertise, and the ability to produce consistent results. It also agreed that the ageing manual presented in WG-FSA-12/43, and the ageing manual describing preparation of thin sections of *D. eleginoides* at the Australian Antarctic Division (Nowara et al., 2009) be hosted on the CCAMLR website to assist with Members seeking to develop their own ageing programs.

Definition of otolith structures

10.8 The Working Group noted that the Workshop on Estimating Age in Patagonian Toothfish (SC-CAMLR-XX, Annex 5, Appendix H) had provided detailed advice on the definition of otolith structures. It agreed that the internal and external structures of *D. mawsoni* otoliths were similar to those of *D. eleginoides* otoliths, and therefore the definitions developed at the 2001 Workshop could also be used for *D. mawsoni*.

Quality assurance and quality control

10.9 It was noted that data on readability of individual sections was routinely collected in some ageing programs. It was agreed that, while the assessment of readability may be subjective, it provided a useful ancillary dataset which could be used to assess ageing error rates (e.g. Candy et al., 2012) and for evaluating different processing methods, and therefore should be routinely collected by mass ageing programs.

10.10 It was noted that in mass ageing of fish from Subarea 88.1 and Division 58.5.2, reference collections are used for training and are regularly re-read by experienced readers, and age bias plots (Campana, 2001) are used to ensure consistency across readers and batches. For example, at NIWA, a batch of new otoliths is not read until a reader achieves a CV of 10% when compared to previous readings of the reference collection by an experienced reader.

10.11 It was agreed that development of a reference collection was of critical importance in producing consistent ages for mass ageing used in stock assessment. It was therefore agreed that any laboratory conducting ageing should develop a reference collection that contains otoliths covering:

(i) the full range of sizes encountered across the sampled area
(ii) males and females
(iii) a range of readabilities.

10.12 It was agreed that, to cover the range of age classes likely to be encountered in *Dissostichus* spp., the reference collections should contain more than 100 otoliths. It was noted that there is also a benefit for ageing laboratories to develop a smaller training collection, including otoliths of high readability and images with annuli marked, to assist with familiarising novice readers with the structural features of otoliths, prior to reading the reference collection. It was agreed that electronic images of reference collections for *D. mawsoni* in Subarea 88.1 and for *D. eleginoides* in Division 58.5.2 be made available on the CCAMLR website. The Working Group also encouraged Members to develop reference and training collections for other toothfish populations in the Convention Area.

10.13 It was further agreed that during mass ageing, readers should regularly read and re-read a reference collection. Within- and between-reader ages should then be compared using age-bias plots to ensure that ages are consistent and that there is no significant drift between batches, and this information should be routinely reported alongside ageing datasets used in assessments. The Working Group also encouraged exchange of digital images of reference collections between research groups to enable intercalibration of ageing protocols.

10.14 Dr L. Pshenichnov (Ukraine) noted that Ukrainian scientists had commenced ageing *Dissostichus* otoliths collected from the Indian Ocean sector. More than 200 otoliths had been aged, and it was noted that Ukraine had access to otoliths collected by the Soviet fleet from the Kerguelen Plateau, Ob and Lena Banks and around South Georgia back to the 1980s. The Working Group welcomed the information provided by Dr Pshenichnov and encouraged the Ukrainian research to be reported to WG-FSA, including a description of the protocols used to prepare the otoliths, how annuli were interpreted and age bias plots for repeat readings of a subset of the otoliths prepared to date.

Validation

10.15 It was recalled that a validated ageing protocol has three requirements:

(i) clear incremental structures are visible in the otolith throughout the lifespan of the fish

(ii) ability to identify the first annulus marking the end of the first year of life

(iii) confirmation that annuli are formed on a yearly basis after the first annulus.

10.16 The Working Group agreed that several studies in different populations of *D. eleginoides*, and for *D. mawsoni* in the Ross Sea, have confirmed that all three requirements are likely to be met for these species. It was noted that work conducted on small juvenile *D. mawsoni* had proposed alternative interpretations of the inner structure around the primordium which may lead to an underestimate of age of one year using the ageing protocol currently used by NIWA (Horn et al., 2003; La Mesa, 2007). It was also noted that ageing error was likely to be of a similar magnitude to the difference between the alternative interpretations. It was requested that Members prioritise the collection and analysis of otoliths from small juvenile *D. mawsoni* to assist with verifying the location and appearance of the first annulus in this species.

10.17 The further development of validation studies for *D. mawsoni*, such as the use of fluorescent calcium markers, was encouraged by the Working Group. It was recalled that similar age validation studies had been conducted in Subarea 48.3 (WG-FSA-03/80) and Division 58.5.2 (WG-FSA-05/60) for *D. eleginoides*.

Data handling

10.18 It was agreed that the analysis and application of ageing datasets would be enhanced by developing a database in the Secretariat. It was agreed that to be included in such a database, a dataset should include:

- (i) species
- (ii) unique identifier for each individual animal that can be linked to capture location and time and biological information (length and sex)
- (iii) structure aged (e.g. otoliths in fish, thorns in skates)
- (iv) reader name
- (v) preparation method
- (vi) is the data derived from a reference collection or production batch?
- (vii) unique identifier for each reading instance
- (viii) readability
- (ix) the age estimate/annulus count
- (x) any other comments regarding how the age estimate was derived.

10.19 It was requested that the Secretariat develop a database structure that could store the recommended data fields, and that once developed, Members submit ageing datasets to the Secretariat.

FUTURE WORK

11.1 The Working Group agreed that its meeting in 2013 would focus on stock assessments and the review and development of research plans. Further detailed consideration of biology and ecology and bottom fishing activities and VMEs would be given in 2014.

11.2 The Working Group agreed to the following future work:

(i) Research plans –

(a) development of measures of vessel performance and capacity to undertake specified research activities (paragraph 5.143).

(ii) Assessments –

(a) development and revision of annual and biennial assessments in 2013

(b) evaluation of the consequence of reopening SSRU 882A to fishing and implications for stock assessment and the allocation of catch limits in the Ross Sea (paragraph 5.152)

(c) development of background documentation on the data and approaches used in assessments (paragraph 12.4).

(iii) Biology and ecology –

(a) Secretariat review of skate biology and dynamics based on data collected during the Year-of-the-Skate and other years (paragraph 8.18)

(b) development of focus topics for the meeting in 2014 (see also paragraph 11.6).

(iv) Tagging training –

(a) development of the tagging training module (paragraph 5.181).

(v) WG-SAM –

(a) development of research plans in data-poor fisheries and closed areas

(b) development of methods to determine appropriate rates of exploitation for research fishing in data-poor and closed fisheries (paragraph 5.133)

(c) development of spatially explicit population models (paragraph 5.163)

(d) review of methods and preliminary results from assessments in 2013

(e) preparation of a scoping paper (led by Dr Candy) on the implementation of the CCAMLR decision rules in stock assessments and related consequences for management advice.

(vi) Review of the Scheme of International Scientific Observation (paragraph 7.4).

(vii) Development of a CCAMLR database for ageing data (paragraph 10.18).

11.3 The Working Group recommended that the Scientific Committee give further consideration to the development of generic, Member-independent research plans based on best science and survey design, and which facilitate long-term, multi-nation, multi-vessel participation. A workshop on this topic in 2013 may assist develop this work.

11.4 The Working Group noted that the successful conduct of multi-year research fishing in exploratory fisheries may require further consideration of the way such fisheries are categorised and notified annually under CM 21-02.

11.5 The Working Group agreed that it had been difficult during this meeting to give full consideration to all papers submitted under Item 9 (Biology, ecology and interactions in fish-based ecosystems). This was due to the broad range of topics covered by these papers, the large number of papers submitted and the limited time available during the meeting.

11.6 The Working Group also noted that the focus topic at this meeting (Item 10) had been successful in bringing together detailed and specific knowledge on the ageing of otoliths. The Working Group encouraged further development of focus topics and thematic sessions.

11.7 The Working Group encouraged participants to prepare future contributions to working groups in close consultation with representatives of the Scientific Committee. These representatives are well placed to provide background on CCAMLR matters and guidance on the development of papers and reporting of findings to the working groups.

OTHER BUSINESS

12.1 The Working Group noted that some analyses reported at its meeting had used data-grooming techniques to remove data which contained errors or were of poor quality. The Working Group encouraged participants to provide detailed accounts in their papers of any data-grooming technique used and a description of CCAMLR data which may have been excluded from the analyses. This would allow the Working Group and others to replicate such analyses.

12.2 The Working Group also encouraged participants to report any CCAMLR data-error or data-quality issue to the Secretariat so that the Secretariat may take appropriate steps to address these errors or associated issues. The Working Group agreed that a reporting form should be distributed with each data extract to assist data users in reporting such matters.

12.3 The Working Group discussed the use of routine procedures for data backup and snapshots, and noted that such procedures are implemented in the Secretariat. The Secretariat also maintains a comprehensive audit trail for amendments made to CCAMLR data.

12.4 The Working Group also discussed the development and maintenance of background documentation on data extractions, grooming and preliminary steps leading to stock assessments. Such information would supplement the information in the Fishery Reports.

12.5 The Working Group reminded participants that CASAL files (estimation.csl, output.csl, population.csl, and MCMC output if available) should accompany the assessment papers submitted to the meetings. The Convener was encouraged to issue a reminder at the time of circulating the agenda for the 2013 meeting.

ADVICE TO THE SCIENTIFIC COMMITTEE AND ITS WORKING GROUPS

13.1 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.

13.2 The Working Group provided advice to the Scientific Committee and other working groups on the following topics:

(i) Data reporting –

(a) daily and five-day catch and effort reporting (paragraph 3.4)
(b) data reporting during research fishing (paragraph 3.5)
(c) reporting of number of hooks lost attached to sections of longlines (paragraph 5.6).

(ii) Estimates of IUU fishing –

(a) submission of data on surveillance effort and other information necessary to develop estimates of IUU fishing (paragraph 3.19).

(iii) Established fisheries –

(a) *C. gunnari* in Subarea 48.3 (paragraph 4.6)
(b) *C. gunnari* in Division 58.5.2 (paragraph 4.14)
(c) *D. eleginoides* in Subarea 48.3 (paragraph 4.16)
(d) *D. eleginoides* in Division 58.5.1 (paragraphs 4.25 and 4.27)
(e) *D. eleginoides* in Division 58.5.2 (paragraph 4.19)
(f) *D. eleginoides* at Crozet Islands (paragraph 4.30)
(g) *D. eleginoides* at Prince Edward and Marion Islands (paragraph 4.32).

(iv) Exploratory and other fisheries –

(a) exclusion of vessel-specific data from future analyses (paragraph 5.11)
(b) fishing capacity in fisheries with small catch limits (paragraphs 5.18 and 5.19)
(c) notification of vessels with limited experience in research fishing (paragraph 5.21)
(d) review by WG-SAM of modelling approaches (paragraph 5.42)
(e) tagging training (paragraphs 5.171, 5.173, 5.174 and 5.180)
(f) review by SCIC of tagging performance (paragraph 5.140)
(g) generic issues related to research proposals (paragraphs 5.133, 5.135, 5.137 and 5.143)
(h) *C. gunnari* and *N. rossii* in Subarea 48.1 (paragraph 5.187)
(i) *C. gunnari* in Division 58.5.1 (paragraph 5.191)
(j) *Dissostichus* spp. in Subarea 48.4 (paragraph 5.33)
(k) *Dissostichus* spp. in Subarea 48.6 (paragraphs 5.48, 5.51 to 5.53 and 5.56)
(l) *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 (paragraph 5.72)
(m) *Dissostichus* spp. in Divisions 58.4.3a and 58.4.3b (paragraphs 5.94 and 5.98)
(n) *Dissostichus* spp. in Subareas 88.1 and 88.2 (paragraph 5.23)

(o) research fishing in Subarea 48.5 (paragraphs 5.101 to 5.103)
(p) research fishing in Divisions 58.4.4a and 58.4.4b (paragraphs 5.113, 5.115, 5.117, 5.120, 5.126 and 5.132).

(v) Bottom fishing activities and VMEs –

(a) preliminary assessments under CM 22-06 (paragraph 6.11).

(vi) Scheme of International Scientific Observation –

(a) external review (paragraphs 7.4 to 7.6).

(vii) Non-target catch –

(a) review of rajid by-catch and tagging program (paragraph 8.18)
(b) rajid by-catch in Division 58.4.3a (paragraphs 8.25 and 8.26).

(viii) Other matters –

(a) future work (paragraphs 11.1, 11.3, 11.4 and 11.7).

ADOPTION OF THE REPORT

14.1 The report of the meeting was adopted.

CLOSE OF MEETING

15.1 In closing the meeting, Dr Belchier thanked all participants, including subgroup coordinators, rapporteurs and the Secretariat for their contributions and collaborations in the work of WG-FSA.

15.2 Dr Belchier, on behalf of the Working Group, also thanked Dr Kock for his life-time scientific contribution and great dedication to the work of WG-FSA and the Scientific Committee. Dr Kock has been involved with CCAMLR since its beginning and has convened WG-FSA and chaired the Scientific Committee. Dr Kock's contribution has been inspirational and the Working Group wished him well in his retirement.

15.3 Dr Sharp, on behalf of the Working Group, thanked Dr Belchier for leading the Working Group during his first year as convener, and during a period of major scientific developments.

REFERENCES

Agnew, D.J., C. Edwards, R. Hillary, R. Mitchell and L.J. López Abellán. 2009. Status of the coastal stocks of *Dissostichus* spp. in East Antarctica (Divisions 58.4.1 and 58.4.2). *CCAMLR Science,* 16: 71–100.

Campana, S.E. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *J. Fish Biol.*, 59: 197–242.

Candy, S.G., G.B. Nowara, D.C. Welsford and J.P. McKinlay. 2012. Estimating an ageing error matrix for Patagonian toothfish (*Dissostichus eleginoides*) otoliths using between-reader integer errors, readability scores, and continuation ratio models. *Fish. Res.*, 115–116: 14–23.

Hanchet, S.M., G.J. Rickard, J.M. Fenaughty, A. Dunn and M.J. Williams. 2008. A hypothetical life cycle for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region. *CCAMLR Science*, 15: 35–53.

Horn, P.L., C.P. Sutton and A.L. DeVries. 2003. Evidence to support the annual formation of growth zones in otoliths of Antarctic toothfish (*Dissostichus mawsoni*). *CCAMLR Science*, 10: 125–138.

La Mesa, M. 2007. The utility of otolith microstructure in determining the timing and position of the first annulus in juvenile Antarctic toothfish (*Dissostichus mawsoni*) from the South Shetland Islands. *Polar Biol.*, 30: 1219–1226.

McMillan, P., T. Iwamoto, A. Stewart and P.J. Smith. 2012. A new species of grenadier, genus *Macrourus* (Teleostei, Gadiformes, Macrouridae) from the southern hemisphere and a revision of the genus. *Zootaxa*, 3165: 1–24.

Moir Clark, J. and D.J. Agnew. 2010. Estimating the impact of depredation by killer whales and sperm whales on longline fishing for toothfish (*Dissostichus eleginoides*) around South Georgia. *CCAMLR Science*, 17: 163–178.

Nowara, G., J. Verdouw and J. Hutchins. 2009. Otolith preparation and ageing of Patagonian toothfish, *Dissostichus eleginoides*, at the Australian Antarctic Division. In: Welsford, D.C., G.B. Nowara, S.G. Candy, J.P. McKinlay, J. Verdouw and J. Hutchins (Eds). *Evaluating Gear and Season Specific Age-length Keys to Improve the Precision of Stock Assessments for Patagonian Toothfish at Heard Island and McDonald Islands*. Final Report, FRDC project 2008/046.

Robinson, N.J. and M.J.M. Williams. 2012. Iceberg-induced changes to polynya operation and regional oceanography in the southern Ross Sea, Antarctica, from in situ observations. *Ant. Sci*., 24 (5): 514–526.

Sokolov, S. and S.R. Rintoul. 2009. The circumpolar structure and distribution of the Antarctic Circumpolar Current fronts. Part 2: Variability and relationship to sea surface height. *J. Geophys. Res. – Oceans*, 114: C11, doi: 10.1029/2008JC005248.

Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in 2011/12. CM: conservation measure; research and by-catch limits in bracket. (Source: catch and effort reports to 24 September 2012 unless otherwise indicated.)

Target species	Region	CM	Catch (tonnes) of target species		Reported catch (%limit)
			Limit	Reported	
Champsocephalus gunnari	48.3	42-01	3 072	546	18
	58.5.2	42-02	0 (30)	4	-
Total				550	
Dissostichus eleginoides	48.3	41-02	2 600	1 844	71
	48.4 North	41-03	48	43	90
	58.5.1 French EEZ[a]	ns	ns	2 810	-
	58.5.2	41-08	2 730	1 935	71
	58.6 French EEZ[a]	ns	ns	450	-
	58 South African EEZ[b]	ns	ns	60	-
Dissostichus spp.	48.4 South	41-03	33	33	100
	48.6	41-04	400	381	95
	58.4.1	41-11	210	157	75
	58.4.2	41-05	70	53	76
	58.4.3a	41-06	86	34	40
	58.4.3b	41-07	0 (40)	9	-
	58.4.4a, 58.4.4b	24-01	0 (70)	28	-
	88.1	41-09	3 282	3 175	97
	88.2	41-10	530	414	78
	88.3	24-01	-	4	-
Total				11 430	
Euphausia superba	48.1, 48.2, 48.3, 48.4	51-01	620 000	157 119	25
	58.4.1	51-02	440 000	No fishing	-
	58.4.2	51-03	452 000	No fishing	-
Total				157 119	

[a] Reported in fine-scale data to August 2012

[b] Inside the Convention Area

ns Not specified by CCAMLR

Table 2: Estimated catch (tonnes) of *Dissostichus eleginoides* reported in the CDS for fisheries operating outside the Convention Area in the calendar years 2010, 2011 and 2012 (to 17 September 2012).

Ocean sector	Region	Catch (tonnes)		
		2010	2011	2012
Southwest Atlantic	41.2.3	448	408	108
	41.3	299	172	29
	41.3.1	1 819	2 538	1 355
	41.3.2	3 967	4 820	3 194
	41.3.3	-	79	-
Southeast Atlantic	47	27	-	-
	47.4	51	196	66
Western Indian	51	238	670	217
Southwest Pacific	81	276	412	85
Southeast Pacific	87	5 316	4 265	3 757
Total			13 560	8 811

Table 3: Values of B_0 (tonnes), *SSB* (tonnes), *SSB* status (ratio), and ratio of model estimates of POKER survey biomass to the observed biomass for four scenarios of the Kerguelen model for Division 58.5.1, including the base case (Scenario 1). In Scenario 2, year-class strength (YCS) was fixed to 1, Scenario 3 excluded CPUE data and Scenario 4 assumed twice the observed levels of IUU catches in each year.

Scenario	1. Base case	2. YCS fixed to 1	3. Without CPUE	4. IUU catches × 2
B_0	218 078	215 835	244 460	223 179
SSB	156 916	132 750	158 582	150 441
SSB status	0.72	0.62	0.65	0.67
POKER 1	0.55	0.57	0.57	0.55
POKER 2	0.51	0.84	0.87	0.51

Table 4: Number of individuals of *Dissostichus* spp. tagged and released and the tagging rate (fish per tonne of green weight caught) reported by vessels operating in 2011/12 in fisheries for *Dissostichus* spp. which have tagging requirements outlined in the conservation measures. The required tagging rate (required rate) for *Dissostichus* spp. is listed for each subarea and division, and does not include any additional requirements when conducting research fishing in closed SSRUs. The number of *D. eleginoides* tagged is indicated in parentheses. (Source: observer data and catch and effort reports.)

Subarea/division (required rate)	Flag State	Vessel name	TOT tagged and released		
			Number of fish		Tagging rate
48.4 (5)	New Zealand	*San Aspiring*	246	(218)	6.5
	UK	*Argos Georgia*	204	(85)	5.2
48.6 (5)	Japan	*Shinsei Maru No. 3*	1239	(14)	5.1
	South Africa	*Koryo Maru No. 11*	708	(57)	5.2
58.4.1 (5)	Korea	*Hong Jin No. 701*	812	(0)	5.2
58.4.2 (5)	Korea	*Hong Jin No. 701*	203	(0)	5.0
	South Africa	*Koryo Maru No. 11*	66	(3)	5.2
58.4.3a (5)	France	*Saint André*	235	(235)	6.9
58.4.3b (5)	Japan	*Shinsei Maru No. 3*	51	(30)	5.7
88.1 (1)	Korea	*Hong Jin No. 701*	109	(3)	1.3
		Hong Jin No. 707	462	(0)	1.0
		Jung Woo No. 2	186	(0)	1.2
		Jung Woo No. 3	236	(0)	1.2
	New Zealand	*Antarctic Chieftain*	128	(1)	1.2
		Janas	168	(0)	1.3
		San Aotea II	304	(15)	3.8**
		San Aspiring	528	(1)	1.1
	Norway	*Seljevaer*	178	(0)	1.0
	Russia	*Chio Maru No. 3*	203	(2)	1.0
		Sparta	2	(2)	1.6
		Yantar 31	362	(0)	1.2
	Spain	*Tronio*	546	(0)	1.0
	UK	*Argos Froyanes*	38	(0)	1.3
		Argos Georgia	301	(1)	1.1
88.2 (1)	Korea	*Hong Jin No. 707*	38	(0)	1.5
	New Zealand	*Antarctic Chieftain*	59	(0)	1.0
		Janas	99	(0)	1.0
	Russia	*Chio Maru No. 3*	101	(0)	10.3*
		Sparta	36	(0)	1.1
	UK	*Argos Froyanes*	210	(0)	1.0

* Tagging rate includes research fishing in SSRU A.
** Tagging rate includes research fishing in SSRUs J and L.

Table 5: Time series of the tag-overlap statistic (CM 41-01) for (a) *Dissostichus mawsoni* and (b) *D. eleginoides* tagged by vessels actively fishing in the exploratory fisheries in 2011/12. The statistic was implemented in 2010/11, and comparative values were calculated for previous seasons. Values were not calculated for total catches of less than 2 tonnes (*) and length data were aggregated by 10 cm length intervals.

(a) *Dissostichus mawsoni*

Flag State	Vessel name	Subarea/ division	2007	2008	2009	2010	2011	2012
Japan	*Shinsei Maru No. 3*	48.6	33	31	65	68	95	85
		58.4.1				57		
		58.4.2			36			
		58.4.3a			*			
		58.4.3b	29	49	36	55	85	86
		58.4.4b		*				
Korea	*Hong Jin No. 701*	48.6					84	
		58.4.1					70	89
		58.4.2						78
		88.1						72
	Hong Jin No. 707	88.1		18	25	50	64	71
		88.2			36		73	62
	Jung Woo No. 2	48.6	12					
		58.4.2	29					
		88.1	29	25	19	26	93	91
	Jung Woo No. 3	88.1			21	42	88	86
		88.2				15	84	
New Zealand	*Antarctic Chieftain*	88.1			57	61	96	89
		88.2			61		92	96
	Janas	88.1	69	80	43	79	85	81
		88.2			73		81	83
	San Aotea II	88.1	52	69	77	79	88	88
	San Aspiring	88.1	76	74	81	88	90	92
		88.2					77	
Norway	*Seljevaer*	88.1						79
Russia	*Chio Maru No. 3*	88.1					78	75
		88.2					55	69
	Sparta	88.1					63	*
		88.1					79	62
	Yantar 31	88.1						90
South Africa	*Koryo Maru No. 11*	48.6					50	70
		58.4.2						48
Spain	*Tronio*	58.4.1	31	21			52	
		58.4.3b	65					
		88.1		22	19	69	69	69
		88.2			17	49		
UK	*Argos Froyanes*	88.1		46	43	53	75	61
		88.2		31	55	54	75	65
	Argos Georgia	88.1	55	65		47	69	89
		88.2			56	100	50	

(continued)

Table 5 (continued)

(b) *Dissostichus eleginoides*

Flag State	Vessel name	Subarea/ division	2007	2008	2009	2010	2011	2012
France	*Saint André*	58.4.3a						79
Japan	*Shinsei Maru No. 3*	48.6	34	44	26	42	*	*
		58.4.1				43		
		58.4.2			*			
		58.4.3a	100		45		86	
		58.4.3b	36	36	21	*	81	69
		58.4.4a		51		100		
		58.4.4b		59		100	95	82
Korea	*Hong Jin No. 701*	48.6					76	
		58.4.1						*
	Hong Jin No. 707	88.1			21		*	
	Jung Woo No. 2	48.6	43					
		58.4.2	*					
		88.1	56	43				*
	Jung Woo No. 3	88.1						*
New Zealand	*Antarctic Chieftain*	88.1					*	*
		88.2						*
	Janas	88.1	*	*	*		*	*
	San Aotea II	88.1	*	*	*	*	*	71
	San Aspiring	88.1	*	*	*	*	*	*
Russia	*Chio Maru No. 3*	88.1					*	*
	Sparta	88.1						*
South Africa	*Koryo Maru No. 11*	48.6					80	70
		58.4.2						*
Spain	*Tronio*	58.4.1	*	*			*	
		58.4.3a	*					
		88.1		75	*		*	
UK	*Argos Froyanes*	88.1			*			
	Argos Georgia	88.1	*	*				*

Table 6: Number of *Dissostichus* spp. tagged and released in exploratory longline fisheries. (Source: scientific observer data.)

Subarea/ division	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
48.6				4	62	171	129		941	1 213	1 308	1 948	5 776
58.4.1					462	469	1 507	1 134	1 127	627	747	812	6 885
58.4.2					342	136	248	673	277	291	408	269	2 644
58.4.3a					199	104	9	41	113		14	235	715
58.4.3b					231	175	289	417	356	60	62	51	1 641
88.1	326	960	1 068	2 250	3 209	2 972	3 608	2 574	2 943	3 066	3 073	3 751	29 800
88.2		12	94	433	355	444	278	389	603	325	667	543	4 143
Total	326	972	1 162	2 687	4 860	4 471	6 068	5 228	6 360	5 582	6 279	7 609	51 604

Table 7: Number of tagged *Dissostichus* spp. recaptured in exploratory longline fisheries. (Source: scientific observer data.)

Subarea/ division	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
48.6						3	2		2	10	2	34	53
58.4.1							4	6	8	4	5		27
58.4.2									1	1			2
58.4.3a						6		2	2			9	19
58.4.3b					1	6	1	1	1	1			11
88.1	1	4	13	32	59	71	206	216	103	250	218	147	1 320
88.2				18	17	28	33	36	56	44	60	88	380
Total	1	4	13	50	77	114	246	261	173	310	285	278	1 812

Table 8: Summary of Members' notifications for exploratory fisheries for *Dissostichus* spp. in 2012/13.

Member and vessel	Subarea/division where fishing has been notified						
	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2
France							
Saint André				✓			
Japan							
Shinsei Maru No. 3	✓	✓	✓	✓	✓	✓	
Korea							
Hong Jin No. 701						✓	✓
Hong Jin No. 707						✓	✓
Insung No. 3		✓				✓	✓
Insung No. 5						✓	✓
Kostar						✓	✓
Sunstar						✓	✓
New Zealand							
Antarctic Chieftain						✓	✓
Janas						✓	✓
San Aotea II						✓	✓
San Aspiring						✓	✓
Norway							
Seljevaer						✓	✓
Russia							
Ugulan						✓	✓
Palmer						✓	✓
Sarbay						✓	✓
Sparta						✓	✓
Yantar-31						✓	✓
Yantar-35						✓	✓
South Africa							
Koryo Maru No. 11	✓		✓	✓			
Spain							
Tronio		✓	✓			✓	✓
Ukraine							
Koreiz						✓	✓
Poseydon I						✓	✓
Simeiz						✓	✓
UK							
Argos Froyanes						✓	✓
Argos Georgia						✓	✓
Total Members	2	3	3	3	1	8	7
Total vessels	2	3	3	3	1	24	23

Table 9: Subarea 48.5 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Subarea 48.5			
CM 24-01 Format 2 Evaluation Criteria		WG-FSA-12/12 – Russia 'Eastern area' (option 2)	WG-FSA-12/12 – Russia option 1 and 'Eastern' plus 'Western area' (option 3)
1.	Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	Y
2.	Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y
3.	Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	Y	Y
	(i) index of abundance	Y	Y
	(ii) stock hypothesis/life history	Y	Y
	(iii) biological parameters	Y	Y
4.	Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)		
	(i) tag overlap	Y	Y
	(ii) spatial overlap	Y	[see note 1]
	(iii) temporal overlap	Y	Y
	(iv) fish viability	Y	Y
	(v) post-release depredation	n/a	n/a
5.	Is the initial design for data-poor area complete? (paragraph 2.40)		
	(i) appropriate spatially restricted area	Y	[see note 1]
	(ii) preliminary plausible estimate of *B*	n/a	n/a
	(iii) total catch and tag rates to achieve a target CV	n/a	n/a
	(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	Y
6.	Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	Y
7.	Is there future planned research leading to an assessment along with a corresponding time frame?	Y	Y

Note 1: Some Members felt that tag-based research in these areas was unlikely to be operationally feasible, due to the likelihood that ice conditions would prevent the research vessel from consistently accessing the same location. Other Members agreed that option 2 should be highest priority but that research should also proceed in the other identified areas subject to favourable ice conditions (paragraph 5.107).

Table 10: Subarea 48.6 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Subarea 48.6			
CM 24-01 Format 2 Evaluation Criteria		WG-FSA-12/60 Rev. 1 – Japan	WG-FSA-12/30 – South Africa
1.	Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	Y [note 4]
2.	Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y
3.	Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	Y	Y
	(i) index of abundance	Y	Y [note 4]
	(ii) stock hypothesis/life history	Y	Y
	(iii) biological parameters	Y* [note 1]	N [note 1]
4.	Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)		
	(i) tag overlap	Y	[note 2]
	(ii) spatial overlap	Y	[note 3]
	(iii) temporal overlap	Y	Y
	(iv) fish viability	Y	Y
	(v) post-release depredation	n/a	n/a
5.	Is the initial design for data-poor area complete? (paragraph 2.40)		
	(i) appropriate spatially restricted area	Y	[note 3]
	(ii) preliminary plausible estimate of *B*	Y	Y [note 4]
	(iii) total catch and tag rates to achieve a target CV	Y	N
	(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 4]
6.	Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	Y [note 4]
7.	Is there future planned research leading to an assessment along with a corresponding time frame?	Y	Y [note 4]

Note 1: WG-FSA-12/60 Rev. 1 included a commitment to undertake otolith ageing, and requests assistance from other Members. WG-FSA-12/30 does not commit to undertake ageing. The Working Group encouraged both proponents to collaborate with other Members to develop appropriate otolith ageing methods and to age toothfish otoliths collected in this area.

Note 2: In the 2011 fishing season the *Koryo Maru No. 11* had a tag-overlap statistic of 48%, lower than the required 60%, in Division 58.4.2, but achieved a 70% overlap in Subarea 48.6. The overall tag-overlap statistic for the whole season was 70%.

Note 3: WG-FSA-12/30 identified spatial research blocks, but the Working Group felt that they were insufficiently constrained, and instead recommended the research blocks identified in WG-FSA-12/60 Rev. 1.

Note 4: WG-FSA-12/30 referenced the preliminary stock assessment framework presented in WG-FSA-12/31 to illustrate the model development that has been initiated in order to analyse the data that will be collected during the research. The Working Group noted that the assessment framework must be submitted to WG-SAM.

Table 11: Divisions 58.4.1 and 58.4.2 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Divisions 58.4.1 and 58.4.2			
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/60 Rev. 1 – Japan	WG-FSA-12/39 – Korea	WG-FSA-12/69 – Spain
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	[note 1]	[note 4]
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y	N
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)			
(i) index of abundance	Y	[note 1]	Y
(ii) stock hypothesis/life history	Y	Y	N
(iii) biological parameters	Y	Y	Y
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)			
(i) tag overlap	Y	Y	Y
(ii) spatial overlap	Y	Y [note 2]	Y
(iii) temporal overlap	Y	Y	Y
(iv) fish viability	Y	Y	
(v) post-release depredation	n/a	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)			
(i) appropriate spatially restricted area	Y	Y [note 2]	Y
(ii) preliminary plausible estimate of *B*	Y	[note 3]	N/A
(iii) total catch and tag rates to achieve a target CV	Y	Y	N/A
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 3]	Y
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	[note 1]	[note 4]
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y	[note 1]	[note 4]

Note 1: WG-FSA-12/39 lists a variety of research and analytical activities and a reporting schedule within which results will be reviewed by CCAMLR, but is unclear with respect to what actual methods will be employed to generate indices of abundance and how the research will be used to produce a stock assessment (paragraph 5.67).

Note 2: WG-FSA-12/39 proposed set locations at which fishing would take place in the vicinity of previously released tags, but the Working Group instead recommended the research blocks identified in WG-FSA-12/60 Rev. 1.

Note 3: WG-FSA-12/39 estimated biomass in SSRUs C and G by simple Petersen estimator, but did not discount the number of tags available for recapture based on assumed tag mortality or natural mortality; the resulting estimates of *B* were judged by the Working Group to be implausibly high. The Working Group instead recommended the biomass estimation method and catch limits proposed in WG-FSA-12/60 Rev. 1.

Note 4: The Working Group noted that the depletion experiment proposed in WG-FSA-12/69 is substantially different from the tag-based methods in other proposals, and that some of the assessment criteria in this table do not apply to this method. However, the Working Group noted that, to inform a comparison with tag-based methods where experimental locations are revisited in subsequent years, and to develop areal biomass estimates from local point-based estimates, further elaboration of proposed methods would be useful.

Table 12: Division 58.4.3a – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Division 58.4.3a		
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/60 Rev. 1– Japan	WG-FSA-12/29 – France
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	N
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y [note 1]
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)		
(i) index of abundance	Y	Y
(ii) stock hypothesis/life history	Y	
(iii) biological parameters	Y	[note 1]
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)		
(i) tag overlap	Y	Y
(ii) spatial overlap	Y	Y [note 2]
(iii) temporal overlap	Y [note 3]	Y
(iv) fish viability	Y	Y
(v) post-release depredation	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)		
(i) appropriate spatially restricted area	Y	[note 2]
(ii) preliminary plausible estimate of *B*	Y	Y [note 4]
(iii) total catch and tag rates to achieve a target CV	Y	N [note 5]
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 4]
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	Y
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y	Y

Note 1: WG-FSA-12/29 did not include a commitment to undertake otolith ageing. The Working Group encouraged proponents to collaborate with other Members to develop appropriate otolith ageing methods and to age toothfish otoliths collected in this area.

Note 2: WG-FSA-12/29 proposed a constrained spatial design but the Working Group recommended the research block identified in paper WG-FSA-12/60 Rev. 1.

Note 3: WG-FSA-12/60 Rev. 1 did not identify a season in which the research would take place but committed to undertake the research in a consistent season each year, to be determined subject to subsequent decisions about research to be undertaken in other areas.

Note 4: WG-FSA-12/29 provided a preliminary biomass estimate based on CPUE and seabed area, but the Working Group recommended use of the Petersen-based estimate in WG-FSA-12/60 Rev. 1.

Note 5: WG-FSA-12/29 reproduced CV estimation figures from WG-SAM-11 but did not apply the formula to generate figures with reference to the particular estimation in Division 58.4.3a.

Table 13: Divisions 58.4.4a and 58.4.4b – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Divisions 58.4.4a and 58.4.4b	
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/58 Rev. 1 – Japan
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	
(i) index of abundance	Y
(ii) stock hypothesis/life history	Y
(iii) biological parameters	Y [note 1]
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)	
(i) tag overlap	Y
(ii) spatial overlap	Y
(iii) temporal overlap	Y
(iv) fish viability	Y
(v) post-release depredation	Y [note 2]
5. Is the initial design for data-poor area complete? (paragraph 2.40)	
(i) appropriate spatially restricted area	Y [note 3]
(ii) preliminary plausible estimate of *B*	Y
(iii) total catch and tag rates to achieve a target CV	Y
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y [note 4]
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y

Note 1: Otolith ageing has been undertaken in this area, but the Working Group recommended that the ageing results be checked and updated in collaboration with other Members where appropriate.
Note 2: Changes to the research design were agreed to avoid depredation in SSRU B.
Note 3: The spatial design of the research for both SSRUs was agreed by the Working Group, but there was no consensus about whether the research should proceed in SSRU D.
Note 4: Biomass estimates and catch limits were calculated in WG-FSA-12/58 using approved methods, but the Working Group did not agree on a recommended catch limit for this research.

Table 14: Total number of rajids hauled in longline fisheries.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004	4 696		0		7		31			8 351	15 204	0	8 137	133	
2005	1 145	0	5	10	537	7 133	1 752			16 781	22 755		15 381	5	
2006	21 991	4 363	0	6	17	2 347	858			6 556	27 382	0	15 444	947	
2007	9 784	6 800	3	13	61	8	2 107			8 723	23 685	0	12 087	16	
2008	21 155	9 000	0	11	74	332	518	1	5	8 028	24 005	0	7 621	0	
2009	26 686	10 075	1	1	0	643	506			10 028	36 444	20	7 998	279	
2010	16 724	6 620	0	0	7		48	1	144	8 801	25 084	9	7 788	0	
2011	13 437	4 785	0	0	0	13	11		88	6 679	14 720	62	5 853	185	
2012	13 731	5 704	2	0	0	9 320	12		8	6 668	18 674	149	2 363	28	8

Table 15: Total number of observed tagged rajidae.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										276					
2005										179			615		
2006	388									843			457		
2007	442	100								1 132			691		
2008	885	112								1 115			1 301		
2009	1 596	254	6			34	5			1 480			1 972	102	
2010	1 594	238			7		8		19	1 402	48	11	2 273		
2011	761	219								1 202			10	1	
2012	856	199								293					2

Table 16: Percentage of rajids tagged.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										3					
2005										1			4		
2006	2									13			3		
2007	5	1								13			6		
2008	4	1								14			17		
2009	6	3	*			5	1			15			25	37	
2010	10	4			*		17		13	16	0.2	*	29		
2011	6	5								18			0	1	
2012	6	3								4					25

* Reported number tagged > total number reported in C2 data.

Table 17: Percentage of rajids recaptured.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										8			6		
2005										2			10		
2006	1									4					
2007	8									16			21		
2008	29									9			36		
2009	31									9			23		
2010	43	3								19	1		30		
2011	43									18			31		
2012	44	1								2			5		

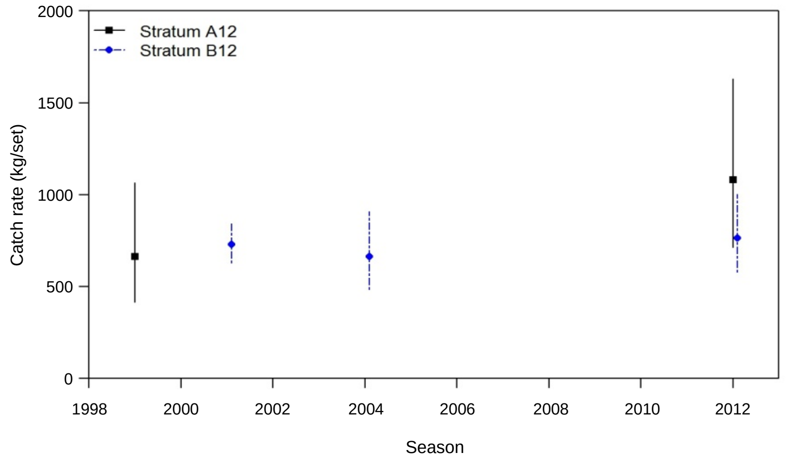

Figure 1: Standardised CPUE indices for New Zealand vessels in strata A12 (southern part of SSRU 881J) and B12 (southern part of SSRU 881L) (WG-FSA-12/41) (see Figure 3) in 1999, 2001, 2004 and 2012. The standardised catch rate refers to 5 662 hooks per set.

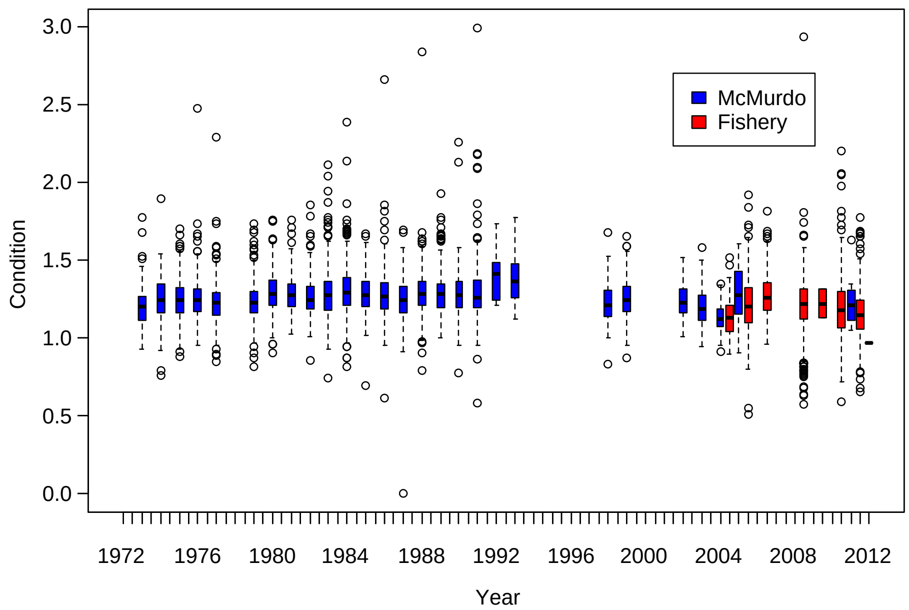

Figure 2: Fish condition for fish sampled in McMurdo Sound (blue) and the commercial toothfish fishery in SSRUs 881J and L, south of 75°S (red). The boxes are centred on the median and show the interquartile range, error bars 1.5 times the interquartile range, and circles indicate values outside that range.

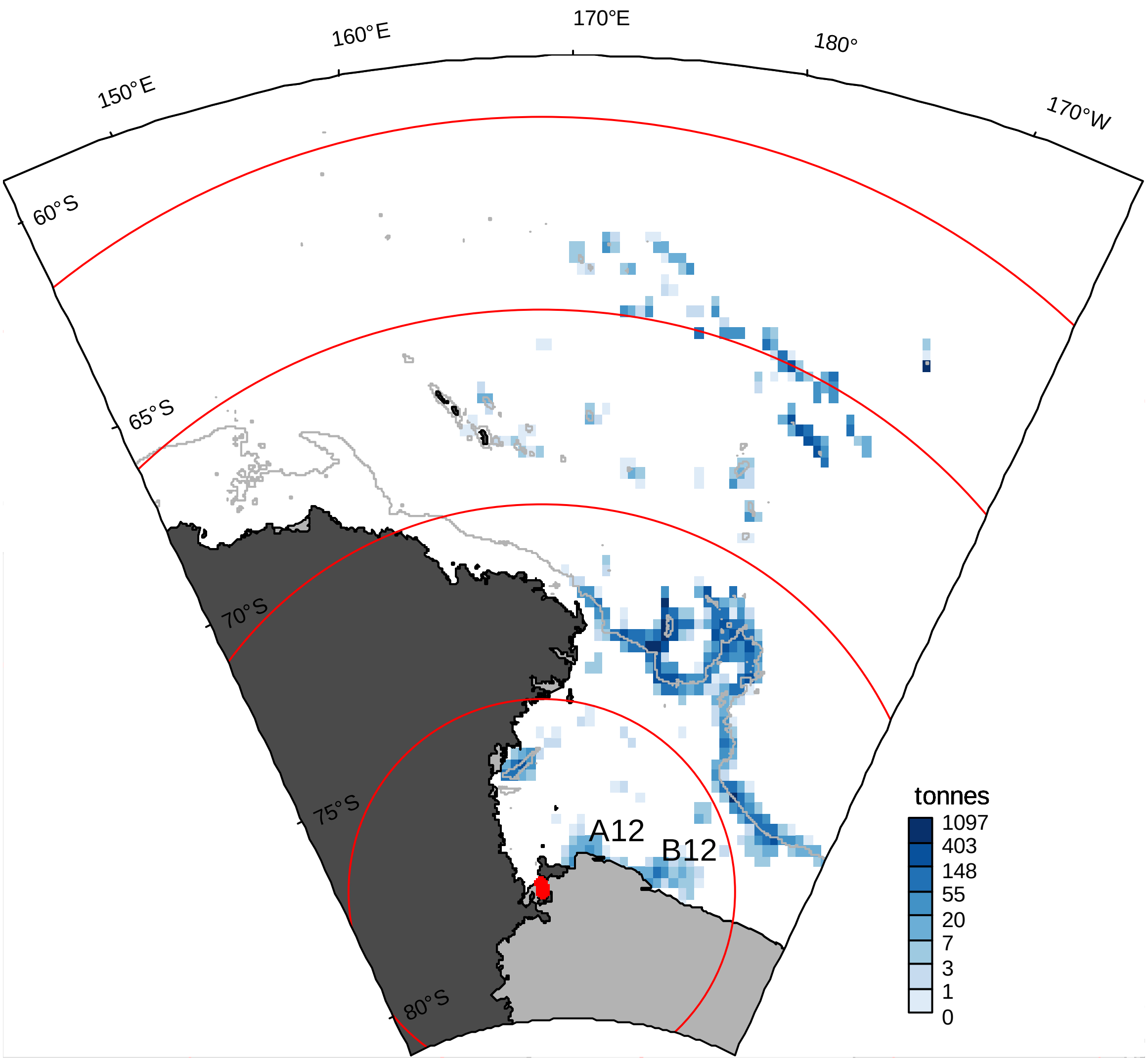

Figure 3: Distribution of total cumulative catch of Antarctic toothfish in the Ross Sea from 1997 to 2012 in relation to the sampling sites in McMurdo Sound (red dots). Red lines indicate 500 km concentric circles from McMurdo Sound. Grey line indicates the 1 000 m depth contour. Strata A12 and B12 (as in Figure 1) are indicated.

Appendix A

LIST OF PARTICIPANTS

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(Hobart, Australia, 8 to 19 October 2012)

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Appendix B

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

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

3. Review of available data

4. Established fisheries

    4.1 Review of preliminary assessments
    4.2 Assessments and management advice
    4.3 Update Fishery Reports for established fisheries

5. Exploratory and other fisheries

    5.1 Exploratory fisheries in 2011/12

    5.2 Exploratory fisheries notified for 2012/13

    5.3 Research to inform current or future assessments
        5.3.1 Research plans
        5.3.2 Results of research in exploratory fisheries
        5.3.3 Research methods (including tagging)

    5.4 Update Fishery Reports for exploratory fisheries

    5.5 Assessment and management advice for depleted and recovering stocks

6. Bottom fishing activities and vulnerable marine ecosystems (VMEs)

    6.1 Review of VMEs notified in 2011/12
    6.2 Review of preliminary assessments of the impact of bottom fishing
    6.3 Report on Bottom Fisheries and VMEs

7. Scheme of International Scientific Observation

8. Non-target catch in CCAMLR fisheries

    8.1 Fish by-catch
    8.2 Marine mammal and seabird by-catch

9. Biology, ecology and interactions in fish-based ecosystems

    9.1 Ross Sea region
    9.2 Scotia Sea region
    9.3 Other regions

10. Ageing workshop for *D. eleginoides* and *D. mawsoni*

11. Future work

12. Other business

13. Advice to the Scientific Committee

14. Adoption of the report

15. Close of the meeting.

Appendix C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

WG-FSA-12/01	Provisional Agenda and Provisional Annotated Agenda for the 2012 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-12/02	List of participants
WG-FSA-12/03	List of documents
WG-FSA-12/04	Microincrement analysis in otoliths of *Notothenia rossii* fingerlings from the South Shetland Islands to estimate early life history timings and to validate annulus formation E. Barrera-Oro (Argentina) and M. La Mesa (Italy)
WG-FSA-12/05	Linking fish and shags population trends R. Casaux and E. Barrera-Oro (Argentina)
WG-FSA-12/06	The Antarctic toothfish *Dissostichus mawsoni* (Nototeniidae) nutrition in the Ross Sea during the fishing season 2011/12 Yu.V. Korzun and N.A. Misar (Ukraine)
WG-FSA-12/07	Analysis of anomalous CPUE data from data-poor exploratory fisheries Secretariat and Delegation of the Republic of Korea
WG-FSA-12/08	Scientific research notifications (Conservation Measure 24-01) Secretariat
WG-FSA-12/09	A updated population status model for the Patagonian toothfish, *Dissostichus eleginoides*, at Kerguelen Islands (Division 58.5.1) using CASAL A. Rélot-Stirnemann (France)
WG-FSA-12/10	The composition, abundance and reproductive characteristics of the demersal fish fauna in the Elephant Island–South Shetland Islands region and at the tip of the Antarctic Peninsula (CCAMLR Subarea 48.1) in March–early April 2012 K.-H. Kock (Germany) and C.D. Jones (USA)

WG-FSA-12/11 Rev. 1	IUU Fishing in 2011/12 and development of methods to estimate IUU catches Secretariat
WG-FSA-12/12	Plan of research program of the Russian Federation in Subarea 48.5 (Weddell Sea) in season 2012/13 A.F. Petrov, V.A. Tatarnikov and I.I. Gordeev (Russia)
WG-FSA-12/13	Results of Phase I and II of the research program for toothfish fishery in Subarea 88.3 during the 2010/11–2011/12 seasons A.F. Petrov, V.A. Tatarnikov, K.V. Shust and I.I. Gordeev (Russia) (this is a revision of WG-SAM-12/05)
WG-FSA-12/14	*Dissostichus mawsoni* distribution and biology A.F. Petrov (Russia)
WG-FSA-12/15	Report of the 1st and the 2nd stage of research fishing conducted by Russian Federation in SSRU 882A in 2010–2012 E.F. Kulish and I.I. Gordeev (Russia) (this is a revision of WG-SAM-12/08)
WG-FSA-12/16 Rev. 1	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2010 POKER Biomass survey R. Sinegre and G. Duhamel (France)
WG-FSA-12/17	Some aspects of size composition dynamics of Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea (Statistical Subarea 88.1) A.K. Zaytsev (Ukraine)
WG-FSA-12/18	Influence of the quality and quantity of data from a multi-year tagging program on bias and precision of biomass estimates from an integrated stock assessment – update P.E. Ziegler (Australia)
WG-FSA-12/19	Has *Notothenia rossii* around Elephant Island and the lower South Shetland Islands (Subarea 48.1) recovered from exploitation some 30 years ago? K.-H. Kock (Germany) and C.D. Jones (USA)
WG-FSA-12/20	The recent decline in recruitment of *Gobionotothen gibberifrons* in the South Shetland Islands (CCAMLR Subarea 48.1) K.-H. Kock (Germany) and C.D. Jones (USA)

WG-FSA-12/21	Characteristics of population-genetic structure of Antarctic toothfish (*Dissostichus mawsoni*) from near-continental seas of Pacific, Indian and Atlantic sectors of the Antarctica N.S. Mugue, A.F. Petrov, D.A. Zelenina, I.I. Gordeev and A.A. Sergeev (Russia)
WG-FSA-12/22	Design of the used on Russian vessels *Sparta* and *Chio Maru No. 3* bottom trot-line for toothfish fishing I.G. Istomin, V.V. Akishin, V.A. Tatarnikov and I.I. Gordeev (Russia)
WG-FSA-12/23	Population structure and connectivity of an important pelagic forage fish in the antarctic ecosystem, *Pleuragramma antarcticum*, in relation to large scale circulation J.W. Ferguson (USA)
WG-FSA-12/24	Analysis of the by-catch of *Channichthys rhinoceratus* and *Lepidonotothen squamifrons* from the fisheries at Heard Island and the McDonald Islands (Division 58.5.2) G.B. Nowara, D.C. Welsford, S.G. Candy and T.D. Lamb (Australia)
WG-FSA-12/25	The annual random stratified trawl survey to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* in the Heard Island region (Division 58.5.2) for 2012 G.B. Nowara and T. Lamb (Australia)
WG-FSA-12/26	A preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on recent survey results D.C. Welsford (Australia)
WG-FSA-12/27	The relative impacts of autolines and Spanish longlines on vulnerable marine ecosystems T. Gerrodette and G. Watters (USA)
WG-FSA-12/28 Rev. 1	Assessment of the Action Plan aimed at reducing incidental catch of seabirds in the French EEZ included in the CCAMLR Division 58.5.1 and Subarea 58.6 C. Marteau and J. Ringelstein (France)
WG-FSA-12/29	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Division 58.4.3a A. Rélot-Stirnemann (France) (this is a revision of WG-SAM-12/14)

WG-FSA-12/30	Finfish research proposals for Subarea 48.6 by *Koryo Maru 11* for 2012/13 C. Heiniken and R. Ball (South Africa) (this is a revision of WG-SAM-12/12)
WG-FSA-12/31	Preliminary analysis of toothfish catch, CPUE, size structure and mark-recapture data from SSRUs 486A and 486G, with comments on the sustainability of different harvest levels E. Thomson and M. Bergh (South Africa)
WG-FSA-12/32	Comparative analysis of the results of determination of reproductive ability of Antarctic toothfish in the Subarea 88.3 S.V. Piyanova, A.F. Petrov and A.V. Presnyakov (Russia)
WG-FSA-12/33	An analysis of temporal variability in abundance, diversity and growth rates in the coastal ichthyoplankton assemblage of South Georgia (sub-Antarctic) M. Belchier and J. Lawson (United Kingdom)
WG-FSA-12/34	Distribution and biology of grey notothen (*Lepidonotothen squamifrons*) around South Georgia and Shag Rocks (Southern Ocean) CCAMLR Subarea 48.3. S. Gregory, J. Brown and M. Belchier (United Kingdom)
WG-FSA-12/35	Molecular and morphological identification of *Macrourus* species caught as by-catch in the toothfish longline fisheries in CCAMLR Subareas 48.3 and 48.4. E. Fitzcharles, K. Brigden, S. Gregory, M. Belchier and J. Brown (United Kingdom)
WG-FSA-12/36	Population assessment of Patagonian toothfish in Subarea 48.4 R. Scott (United Kingdom)
WG-FSA-12/37	Results from the reduced groundfish survey conducted in CCAMLR Subarea 48.3 in January 2012 J. Brown, S. Gregory, A. Stanworth, V. Carretero, G. Baker and M. Belchier (United Kingdom)
WG-FSA-12/38	A characterisation of the toothfish fishery in Subarea 48.6 from 2003/04 to 2011/12 R. Wiff (Chile), M. Belchier (United Kingdom), J.C. Quiroz and J. Arata (Chile)
WG-FSA-12/39	Research plan for the exploratory longline fishery for *Dissostichus* spp. in SSRUs C, E and G in Division 58.4.1 in 2012/13 Delegation of the Republic of Korea (this is a revision of WG-SAM-12/10 Rev. 1)

WG-FSA-12/40	Indexing maturation of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region S. Parker and P. Marriott (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/41	Results of a CCAMLR-sponsored research survey to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea, February 2012 S.M. Hanchet, S. Mormede, S. Parker, A. Dunn (New Zealand) and H.-S. Jo (Republic of Korea) (*CCAMLR Science*, submitted)
WG-FSA-12/42	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2011/12 M.L. Stevenson, S.M. Hanchet, S. Mormede and A. Dunn (New Zealand)
WG-FSA-12/43	Manual for age determination of Antarctic toothfish, *Dissostichus mawsoni* V2 C.P. Sutton, P.L. Horn and S.J. Parker (New Zealand)
WG-FSA-12/44	Further development of coarse- and medium-scale spatially explicit population dynamics operating models for Antarctic toothfish in the Ross Sea region S. Mormede, A. Dunn, S. Parker and S. Hanchet (New Zealand)
WG-FSA-12/45	Using outputs from spatial population models of Antarctic toothfish in the Ross Sea region to investigate potential biases in the single population model S. Mormede and A. Dunn (New Zealand)
WG-FSA-12/46	Spatial Population Model User Manual, SPM v1.1-2012-09-06 (rev. 4806) A. Dunn, S. Rasmussen and S. Mormede (New Zealand)
WG-FSA-12/47 Rev. 1	Quantifying vessel performance in the CCAMLR tagging program: spatially and temporally controlled measures of relative mortality and tag-detection rates S. Mormede and A. Dunn (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/48	Models of larvae dispersion of Antarctic toothfish (*Dissostichus mawsoni*) A. Dunn, G.J. Rickard, S.M. Hanchet and S.J. Parker (New Zealand)

WG-FSA-12/49	Summary of toothfish tagging suitability data from paired Spanish line – trotline sets S. Parker and D. Fu (New Zealand)
WG-FSA-12/50	Characterisation of Muraenolepis species by-catch in the CCAMLR Convention Area S. Parker, P. McMillan and P. Marriott (New Zealand)
WG-FSA-12/51	Demersal fish communities in the Ross Sea region of Antarctica: comparisons between video and trawl survey methods D.A. Bowden, S.M. Hanchet and P.M. Marriott (New Zealand)
WG-FSA-12/52	Diet of Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea region, Antarctica D.W. Stevens, M.R. Dunn, M.H. Pinkerton and J.S. Forman (New Zealand)
WG-FSA-12/53	Testing for genetic differentiation between two size classes of the starry skate (*Amblyraja georgiana*) P. Ritchie and A. Fleming (New Zealand)
WG-FSA-12/54 Rev. 1	Distribution, morphology, growth, reproduction, diet and trophic position of two species of grenadier (*Macrourus whitsoni* and *M. caml*) in the Ross Sea region of the Southern Ocean (CCAMLR Subareas 88.1 and 88.2) M.H. Pinkerton, P. McMillan, J. Forman, P. Marriott, P. Horn, S. Bury and J. Brown (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/55	plotImpact v2.0-2012 D.N. Webber (New Zealand)
WG-FSA-12/56	Survey results on abundance and biology of toothfish in Division 58.4.3b by *Shinsei Maru No. 3* during 2006/07–2011/12 and proposal of the consecutive survey in 2012/13 K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-FSA-12/57	Revised reports on abundance and biological information on toothfish in Divisions 58.4.4 a and 58.4.4b by *Shinsei Maru No. 3* in 2011/12 K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-FSA-12/58 Rev. 1	Revised research plan for toothfish in Divisions 58.4.4 a and 58.4.4b by *Shinsei Maru No. 3* in 2012/13 Delegation of Japan

WG-FSA-12/59	Towards the development of a stock assessment for Patagonian toothfish in Division 58.4.4, SSRU C on Ob and Lena Banks K. Taki (Japan)
WG-FSA-12/60 Rev. 1	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a Delegation of Japan (this is a revision of WG-SAM-12/09)
WG-FSA-12/61	Fatty acid analysis to infer diet of Antarctic toothfish caught in February 2012 in the southern Ross Sea I. Yeon, H.-S. Jo, C. Lim (Republic of Korea), S.M. Hanchet (New Zealand), D.-W. Lee and C.-K. Kang (Republic of Korea) (*CCAMLR Science*, submitted)
WG-FSA-12/62	An analysis of fishing location and tag recaptures in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a in 2012 Secretariat
WG-FSA-12/63	The CCAMLR Scheme of International Scientific Observation – a scoping paper on the operations and sampling requirements of the scheme Secretariat
WG-FSA-12/64	Review of activities in monitoring marine debris in the CAMLR Convention Area Secretariat
WG-FSA-12/65	Hook loss in CCAMLR exploratory fisheries Secretariat
WG-FSA-12/66 Rev. 2	Summary of scientific observations in the CAMLR Convention Area for 2011/12 Secretariat
WG-FSA-12/67	Foraging zones of the two sibling species of giant petrels in the Indian Ocean throughout the annual cycle: implication for their conservation L. Thiers, K. Delord, C. Barbraud (France), R.A. Phillips (United Kingdom) and H. Weimerskirch (France)
WG-FSA-12/68 Rev. 1	Migrations of Antarctic fish *Pseudochaenichthys georgianus* Norman, 1939 in the Scotia Sea R. Traczyk (Poland)

WG-FSA-12/69	Revised research plan for the Spanish exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2: Fundamentals and procedures R. Sarralde, L.J. López Abellán and S. Barreiro (Spain) (this is a revision of WG-SAM-12/13)
WG-FSA-12/70 Rev. 2	Summary of scientific observations related to Conservation Measures 24-02 (2008), 25-02 (2009) and 26-01 (2009) Secretariat

Other documents

WG-FSA-12/P01	Slow recovery of previously depleted demersal fish at the South Shetland Islands, 1983–2010 E.R. Marschoff, E.R. Barrera-Oro, N.S. Alescio and D.G. Ainley (*Fish. Res.*, 125–126 (2012): 206–213)
WG-FSA-12/P02	Does large-scale ocean circulation structure life history connectivity in Antarctic toothfish (*Dissostichus mawsoni*)? J. Ashford, M. Dinniman, C. Brooks, A. Andrews, E. Hofmann, G. Cailliet, C. Jones and N. Ramanna (*Can. J. Fish. Aquat. Sci*., in press)
WG-FSA-12/P03	Trophic interactions and population trends of killer whales (*Orcinus orca*) in the southern Ross Sea D.G. Ainley and G. Ballard (*Aquatic Mammals*, 38 (2) (2012): 153–160, doi: 10.1578/AM.38.2.2012.153)
WG-FSA-12/P04	Decadal trends in abundance, size and condition of Antarctic toothfish in McMurdo Sound, Antarctica, 1972–2011 D.G Ainley, N. Nur, J.T Eastman, G. Ballard, C.L Parkinson, C.W Evans and A.L. DeVries (*Fish and Fisheries* (2012), doi: 10.1111/j.1467-2979.2012.00474.x)
WG-FSA-12/P05	Unnatural selection of Antarctic toothfish in the Ross Sea, Antarctica D.G. Ainley, C.M. Brooks, J.T. Eastman and M. Massaro In: Huettmann, F. (Ed.). 2012. *Protection of the Three Poles*, Chapter 3. Springer Verlag, doi: 10.1007/978-4-431-54006-9_3)

WG-FSA-12/P06	The fish fauna of the Argentine Islands region (Antarctica; 12 UAE 2007–2008) and morphometrical changeability of *Notothenia coriiceps* (Richardson, 1844) V.N. Trokhymets, V.A. Tymofyeyev and J.S. Perechrest (*Ukraininan Antarctic Journal*, 9 (2010))
WG-FSA-12/P07	Robust characterisation of the age structure, growth and recruitment of toothfish in the Macquarie Island and Heard Island and McDonald Islands fisheries D.C. Welsford, S.G. Candy, J.J. Verdouw and J.J. Hutchins (*AFMA Project 2009/839*, Final Report (2012))
WG-FSA-12/P08	The spawning dynamics of Patagonian toothfish in the Australian EEZ at Heard Island and the McDonald Islands and their importance to spawning activity across the Kerguelen Plateau D.C. Welsford, J. McIvor, S.G. Candy and G.B. Nowara (*FRDC Tactical Research Fund Project 2010/064*, Final report (2012))
WG-FSA-12/P09	Modern data on parasitofauna of *Dissostichus mawsoni* and by-catch species from logline fishing in Antarctica I.I. Gordeev and S.G. Sokolov (*Proceedings of the 5th Russian conference with international participation on theoretical and marine parasitology, 23–27 April 2012, Kaliningrad* (2012): 63–64)
WG-FSA-12/P10	Physical and behavioural influences on larval fish retention: contrasting patterns in two Antarctic fishes E.F. Young, J. Rock, M.P. Meredith, M. Belchier, E.J. Murphy and G.R. Carvalho (*Mar. Ecol. Progr. Ser.*, in press. doi: 10.3354/meps09908. The abstract is available on www.int-res.com/prepress/m09908.html)
WG-FSA-12/P11	Can acoustic methods be used to monitor grenadier (Macrouridae) abundance in the Ross Sea region? R.L. O'Driscoll, S.M. Hanchet and B.S. Miller (*J. Ichthyol.*, 52 (10) (2012): 1–9)

TAGGING PROTOCOL CHECKLIST

TAG DEPLOYMENT

1. Use proper handling procedures, minimise time out of water.
2. Ideally use at least two people, more for large fish, transport fish using a carrier.
3. Carefully and quickly remove the hook.
4. Assess suitability categories. Do not tag if any condition or injury listed below is present.

Assessment category	Do not tag
Hook injuries	Hook injury outside the mouth area (outside the lips, jaw, or cheek), or in the back of the mouth
Gills	Gills pink or white
Bleeding	Any visible bleeding from gills, or excessive bleeding elsewhere
Body	Visible damage to fish body with open wounds
Organs	Visible damage to eye or penetration of body cavity, including by crustaceans (amphipods/lice)
Scales	Abrasions or single area of recent scale loss equal to, or exceeding, the area equivalent to the fish tail

5. Double-tag fish using sequential tag numbers if possible.
6. Confirm tag is anchored with a gentle tug.
7. Record set, date and time, species, total length (cm) for toothfish, pelvic length (cm) for skates, and both tag numbers (all leading characters, tag colour and type), and tagger identifier.
8. Double-check both tag numbers.
9. Release fish headfirst into water, unless predators present.

TAG RECOVERY

1. Record set number, tag numbers (all leading characters, tag colour and type), date and time, sex, total length (cm) for toothfish, pelvic length (cm) for skates, total weight (kg), gonad stage, and gonad weight for toothfish (grams) and tag finder identifier code.
2. Photograph attached tag with readable tag numbers using template, multiple photos if needed.
3. Record tag numbers, set number, fish serial number and length on otolith envelope.
4. Collect tags, both otoliths (for toothfish) and place all in otolith envelope.

Appendix E

SUMMARY OF BIOLOGICAL STUDIES

PAN-ANTARCTIC STUDIES

1. A detailed description of *Dissostichus mawsoni* biology is given in WG-FSA-12/14, including information on life cycle, distribution, age and growth, reproduction and diet.

2. WG-FSA-12/21 examined results of genetic data collected from *D. mawsoni* in Subareas 48.6, 88.1 and 88.3 and Divisions 58.4.1 and 58.4.2 for determining population structure. Frequencies of SNP alleles in the study areas were similar, indicating no genetic isolation but a homogeneous population of *D. mawsoni* circumpolar around the Antarctic continental seas. This contradicts the findings of Kuhn and Gaffney, 2008, who identified population differentiation in the Ross Sea.

3. WG-FSA-12/23 used microchemistry of otoliths to show four separate populations (Ross Sea, the southern Antarctic Peninsula in Marguerite Bay and off Charcot Island, off Joinville Island, and around the South Orkney Islands) of Antarctic silverfish (*Pleuragramma antarcticum*) (which is a main prey item of many marine predators). These results suggested that silverfish are not transported by the Antarctic Circumpolar Current, shelf processes on the West Antarctic Peninsula, or along the Weddell Front.

4. WG-FSA-12/32 discussed the reproductive biology of *D. mawsoni* in Subarea 88.3 in the Bellingshausen Sea. There were very few mature fish and no pre-spawning fish found (n = 361). Absolute fecundity was 0.11–0.47 million eggs (n = 3).

5. Data on distribution (spatial and depth), reproduction and growth of *Muraenolepis* spp., a by-catch species in the longline fishery (although caught in low numbers) were presented in WG-FSA-12/50. A lack of understanding of this genus remains and further taxonomic work is required to identify all species. *Muraenolepis* spp. has a circumpolar distribution and is mainly found at depths of 800 to 1 000 m and catches are dominated by females, although there is no sexual dimorphism in length–weight data. In the Ross Sea it is probable that *Muraenolepis* spp. spawn in early winter and are a semelparous species with $L_{50\%}$ 40 cm (7.8 cm) for females. Further research is needed on this species, especially on smaller individuals.

6. WG-FSA-12/P09 described the parasite fauna of *D. mawsoni* and by-catch species *Macrourus whitsoni*, *Chionobathyscus dewitti*, *M. microps* and *Bathyraja meridionalis* in Subareas 48.6, 58.4 and 88.1. *Dissostichus mawsoni* had a similar parasitofauna in other near-shore continental seas of Antarctica, which could be a sign of homogeneity.

ROSS SEA

Biological parameters for commercial and by-catch species

7. Several papers concerning reproduction of *D. mawsoni* and other by-catch species in the Ross Sea were submitted in 2011 and 2012. WG-FSA-11/04 summarised macroscopic maturity stage and gonadosomatic index (GSI) data of Antarctic toothfish from SSRUs of the northern, slope and shelf areas, and noted that some females showed gonad development at less than 85 cm, and resulted in $L_{50\%}$ maturity estimates of 99–102 cm for females and 102–105 cm for males. The paper also suggested a protracted spawning season because some individuals show gonad development as early as December.

8. WG-FSA-11/27 presented a histologically based review of female and male *D. mawsoni* in the Ross Sea using samples from Russian vessels. Their analyses indicated that two vitellogenic size classes of oocytes are found in maturing females. Absolute fecundity estimates therefore should separate the two cell stages to estimate the numbers of eggs to be released in the upcoming spawning season. Oocyte development indicates that spawning occurs after March–April. In a related study, WG-FSA-12/32 described the reproductive status of toothfish sampled in the Bellingshausen Sea (Subarea 88.3). The fish sampled in late summer showed similar reproductive development to those sampled in the Amundsen and Ross Sea slope areas, with large fish of both sexes showing gonad development.

9. WG-FSA-12/40 provided updated Ross Sea slope spawning ogives for *D. mawsoni* males and females based on histological assessment, estimating $L_{50\%}/A_{50\%}$ values of females 135 cm/16.9 years, and males 109 cm/12 years. Analysis of GSI of histologically assessed fish suggested that a summer month GSI value greater than 1% can be used to index development for spawning in the upcoming season. Histological analysis also suggested that almost all fish in the northern area of the Ross Sea had spawned in the previous season and were preparing to spawn in the upcoming season. On the slope, of the samples of fish that had spawned in the previous season, 80% were preparing to spawn in the upcoming season. This suggests either spawning occurs on the slope or migration from the north to the slope occurs during early spring. Collections from closer to, or during, the winter spawning season would be instructive to determine the proportion of fish which may skip spawning, and to identify the timing of movements from the Ross Sea slope area to the north using changes in condition.

10. WG-FSA-11/18 presented oocyte size distributions from several species of Antarctic fishes caught as fishery by-catch. It noted the presence of multiple distinct modes of developing oocytes in summer spawners. A similar feature of the presence of a large size range of oocytes in the maturing class was present for winter spawners. The authors interpreted these developmental characteristics as indicators that spawning likely occurs in several batches as an adaptation to unpredictable environmental conditions in high latitudes.

Ecological and ecosystem studies

11. Three papers described temporal changes, or the potential for temporal changes, in upper trophic level ecosystem dynamics in McMurdo Sound in the southwestern Ross Sea.

12. WG-FSA-12/P03 reported that the mean number of animals per sighting of fish-eating type C killer whales (distinguished from mammal-eating Type B killer whales by pod size and animal size) has decreased off Cape Crozier, Ross Island, during the past decade. The authors speculate that the change in sightings of the type C killer whales is a decrease in residence time in response to the decline in toothfish observed in McMurdo Sound, observed over a similar period.

13. WG-FSA-12/P04 described the toothfish longline fishing data series, spanning 1972–2011 and catch per unit effort declines beginning in 1997–2001. Analysis of fish length and condition suggests changes in sea-ice conditions were associated with a trend of increasing fish length with the index of September–October ice extent, and a trend of decreasing fish condition with minimum ice area. During the time series, fish condition increased until 1992, and has since decreased to a level similar to the start of the series. The change in CPUE was not associated with any of the factors analysed.

14. WG-FSA-12/P05 presented a review of the trophic ecology of the Ross Sea region and of fishery management experiences in other regions to express concern over the potential for longevity overfishing, in which a fishery selecting the largest fish can cause size and age truncation in the population. The authors suggested that, if age and size truncation is significant, the ecological role of toothfish as predator and prey, as well as their reproductive capacity, could be altered.

15. Two papers discussed the ontogenetic distribution of *D. mawsoni* in the Ross Sea in relation to large-scale oceanography. WG-FSA-12/48 presented an updated Lagrangian particle tracking simulation to characterise the potential passive dispersal pathways of Antarctic toothfish larvae originating from specific locations within the Ross Sea. Results show that larvae from some potential spawning sites are retained within the Ross Sea gyre, while larvae from other sites may be dispersed outside the Ross Sea region. Circumpolar simulations using likely spawning locations throughout the Southern Ocean show the dispersal paths for passive drogues. Further simulations require information on vertical distribution and any directed swimming of larvae or juveniles.

16. WG-FSA-12/P02 described a multidisciplinary approach to understanding adult Antarctic toothfish movement patterns within the Ross Sea. Otolith microchemistry, age composition, tag-recapture data, and passive particle movement simulations of sub-adults on the Ross Sea shelf all support the life history and stock structure hypotheses of Hanchet et al. (2008), which entailed a general alignment of ontogenetic movement with the Ross Sea gyre. Juvenile fish recruit from the eastern Ross Sea and SSRUs 882A and B shelf regions then grow and migrate to northern area hills and seamounts for spawning. The paper also supported different stock origin of toothfish in the Ross Sea compared with toothfish from the Antarctic Peninsula using otolith microchemistry.

17. Korzun and Misar (WG-FSA-12/06) reported on the stomach contents of specimens (n = 2 623) caught during 2011/12 (SSRUs 881B, C, H, J, K). A total of 29 prey taxa were recorded, with the main prey species including grenadiers (e.g. *Macrourus* spp.), channichthyids (mainly *C. dewitti*), nototheniids and squids (e.g. glacial squid (*Psychroteuthis glacialis*)). Although primarily piscivorous, crustaceans (e.g. *Notocrangon antarcticus*) were observed occasionally. No instances of cannibalism were reported. Information on sizes of prey was also provided.

18. Stevens et al. (WG-FSA-12/52) examined 1 022 toothfish caught in Subarea 88.1 during 2003, 2005 and 2010. The diets of sub-adults and adults were broadly similar, with a variety of demersal fish, cephalopods and benthic invertebrates consumed, although sub-adult toothfish predated on a greater variety of smaller prey (e.g. *Trematomus* spp., *Bathydraco* spp. and crustaceans such as *Nematocarcinus*). Overall, *Macrourus* spp. was the most important prey taxa, with icefish (e.g. *C. dewitti*), eel cods (probably *M. evseenkoi*) and *P. glacialis* also consumed. On oceanic seamounts, toothfish fed substantially on *Macrourus* spp., the morid cod *Antimora rostrata* and occasional meso- and epipelagic fish.

19. Yeon et al. (WG-FSA-12/61) analysed the fatty acids (FA) and stable isotopes ($\delta^{15}N$) of *D. mawsoni* and a range of other species (mostly fish, but samples of octopus and shrimps were also analysed) to better understand the trophic structure of the Ross Sea. There were similarities in the FA compositions in the muscle tissue of *D. mawsoni* and *P. antarcticum*, *Pogonophryne barsukovi*, *Dacodraco hunteri* and *T. loennbergii*, suggesting a trophic link between toothfish and these fish species. The mean $\delta^{15}N$ values of *D. mawsoni* were higher than those of *P. antarcticum*, *P. barsukovi* and *T. loennbergii*, confirming the higher trophic position of toothfish.

20. Pinkerton and Bradford-Grieve (WG-EMM-12/53) used a balanced ecosystem model to explore biomass and flow of organic matter by trophic level, mixed trophic impacts and to evaluate ecosystem-level characteristics of the Ross Sea shelf and slope. The model used 35 trophic groups, averaged over a typical year. The system was characterised by a high biomass of mesozooplankton and benthic invertebrates. The biomass of top predators (trophic levels >4.5) was only 0.5% of the total living biomass in the Ross Sea (excluding bacteria). The six groups with the highest 'indices of ecological importance' in the food web were phytoplankton, mesozooplankton, *P. antarcticum*, small demersal fishes, Antarctic krill (*Euphausia superba*) and cephalopods. Crystal krill (*E. crystallorophias*) and pelagic fishes were also likely to be important in the food web. It was suggested that these eight groups could be priorities for further monitoring of ecosystem change in the region. Antarctic toothfish was found to have a moderate index of ecological importance for the wider ecosystem, although it would have a greater impact on 'medium-sized' demersal fish.

Taxonomic studies

21. Ritchie and Fleming (WG-FSA-12/53) undertook a genetic study of samples of *Amblyraja georgiana* collected across the Ross Sea, as an earlier study had reported different size classes, which could have been due to the presence of cryptic species. However, the results of this study indicated that samples were not reproductively isolated. In contrast, some subtle differences in the DNA sequences of *B. eatonii* samples were observed.

22. Recent studies have indicated that a fourth species of *Macrourus* occurred in the southern Ocean. Pinkerton et al. (WG-FSA-12/54 Rev. 1) provided recent species-specific information on the distribution, morphology, growth, reproduction, diet and trophic position for the newly described *M. caml* and the sympatric *M. whitsoni* (these species were previously confounded in biological studies). The geographic distributions of the two species were similar, although *M. caml* may be proportionally more common in waters less than ca. 1 000 m deep. Biological differences are summarised in Table 1.

Table 1: Reported differences in various aspects of the biology of *Macrourus caml* and *M. whitsoni* in the Ross Sea. Adapted from Pinkerton et al. (WG-FSA-12/54 Rev. 1).

Species:	*M. caml*	*M. whitsoni*
Sample size	636 (74%)	227 (26%)
No. of rays in left pelvic fin	Usually (ca. 95%) with 8 fin rays (range 7–9)	Usually (ca. 97%) with 9 fin rays (range 8–10)
Teeth in lower jaw	Usually (98%) with 2 rows of teeth (range 1–3). Teeth small and close	Usually (99%) with 1 row of teeth (range 1–2). Teeth large and spaced
Teeth in upper jaw	Outer row not enlarged	Outer row enlarged
Body colour	Medium/dark brown or blackish	Pale to medium brown
Length of intestine	Intestines relatively long, wide and flaccid	Intestines relatively short, narrow and robust
Total length (L_T) range observed	34.5–84 cm (observed to 89 cm in a previous study)	34.5–65.1 cm (observed to 66 cm in a previous study)
Median length (L_T)	52 cm (male); 55 cm (female)	45.5 cm (male); 51.8 cm (female)
Relationship between pre-anal length (L_{PA}) and total length (L_T)	$L_{PA} = 0.534 + 0.333\ L_T$ $L_T = 4.51 + 2.67\ L_{PA}$ (Combined, $r^2 = 0.89$, N = 632)	$L_{PA} = –0.536 + 0.355\ L_T$ $L_T = 7.37 + 2.48\ L_{PA}$ (Combined, $r^2 = 0.88$, N = 226)
	$L_{PA} = 1.78 + 0.302\ L_T$ $L_T = 1.91 + 2.87\ L_{PA}$ (Males, $r^2 = 0.87$, N = 252)	
	$L_{PA} = 0.653 + 0.336\ L_T$ $L_T = 3.11 + 2.71\ L_{PA}$ (Females, $r^2 = 0.91$, N = 380)	
Length–weight relationship	$W = 0.002203\ L_T$ ^3.218 (Combined; $r^2 = 0.91$, N = 634)	$W = 0.001754\ L_T$ ^3.232 (Combined; $r^2 = 0.93$, N = 234)
	$W = 0.08779\ L_{PA}$ ^3.136 (Combined; $r^2 = 0.91$, N = 634)	$W = 0.09334\ L_{PA}$ ^3.047 (Combined; $r^2 = 0.92$, N = 234)
Observed age range	13–38 years	6–27 years
Estimated von Bertalanffy growth parameters (due to a lack of small fish in samples, t_0 assumed to be –0.1.)	L_{inf} = 59.9 (male), 62.9 (female) K = 0.091 (male), 0.101 (female)	L_{inf} = 50.1 (male), 57.2 (female) K = 0.175 (male), 0.146 (female)
Estimated length at 50% sexual maturity (females only)	46 cm L_T; 16 cm L_{PA}; 13.2 yrs	52 cm L_T; 18 cm L_{PA}; 16 yrs
Estimated tropic level	4.4	4.1–4.2

SCOTIA SEA REGION

Biological parameters for commercial and by-catch species

23. Additional information on the biology of some fish species were also provided in accounts summarising current data for toothfish (*D. mawsoni* and *D. eleginoides*) in Subarea 48.6 (WG-FSA-12/38) and from a reduced groundfish survey around South Georgia and Shag Rocks (Subarea 48.3) (WG-FSA-12/37).

24. Gregory et al. (WG-FSA-12/34) summarised available groundfish survey data (1986–2012) on the distribution and biology of grey rockcod (*Lepidonotothen squamifrons*) around South Georgia and Shag Rocks. The distribution was patchy, with large aggregations

in specific 'hotspots' east of Shag Rocks and southwest of South Georgia. This patchy distribution resulted in uncertain biomass estimates. Greatest catch rates were in waters 250–350 m deep. Length-frequency data showed a progression of recognisable cohorts and increasing size over time, possibly indicating some recovery of the stock or progression of a strong cohort over the time period. Mean length at 50% maturity for males and females (37–38 cm) was similar to that described for the population in the Indian Ocean basin. Analyses of stomach contents indicated a diet dominated by salps/tunicates, euphausiids and amphipods, with ontogenetic and bathymetric differences in the diet.

25. Traczyk (WG-FSA-12/68 Rev. 1) examined the geographic and bathymetric distribution of South Georgia icefish (*Pseudochaenichthys georgianus*) in the area of Scotia Arc islands and on the shelf of South Georgia Island. Results from biological investigations for the species (including age and growth, length at maturity etc.) were summarised.

Ecological and ecosystem studies

26. Kock and Jones (WG-FSA-12/19) discussed the current status of marbled rockcod *Notothenia rossii*. A feature of *N. rossii* catches in surveys is that large numbers may be caught in certain areas, with low catch rates elsewhere. This has implications for survey design and data analysis. The factors that influence where large aggregations of *N. rossii* occur are poorly understood, but may include topographic features, hydrographic conditions and/or the locations of dense concentrations of krill. Although recent surveys have reported occasional large catches of *N. rossii*, following a period of historic low catch rates, the aggregating nature of the species hampers accurate estimates of biomass. Further studies to examine the potential benefits of adapting survey design (e.g. by stratifying trawl surveys in areas of consistent high density; examining the merits of acoustic sampling in areas of high abundance) to better evaluate current biomass are required. Additionally, alternative methods of data analysis for skewed survey data could be explored, such as the delta-lognormal GLM approach described by Lo et al. (1992) and Stefansson (1996).

27. Kock and Jones (WG-FSA-12/20) discussed the status of humped rockcod (*Gobionotothen gibberifrons*) around Elephant Island and the South Shetland Islands. Although commercial fisheries in the area ceased in 1990, analyses of survey data (1998 to 2012) indicated a decline in estimated biomass between 1998 and the most recent surveys (2007 and 2012). The length distributions indicated a reduction in the numbers of juvenile fish (20–30 cm length), with the proportion of juveniles <10% in 2012. Reasons for this apparent decline in recruitment are unclear, but it could be related to changing environmental conditions and subsequent changes in the structure of planktonic assemblages.

28. Belchier and Lawson (WG-FSA-12/33) summarised data from ichthyoplankton surveys in Cumberland Bay, South Georgia (2002–2008). Data were collected for 22 species from nine families. Maximum larval densities were observed in late August and September. Larval identification using morphological features agreed closely with genetic identification for most taxa, although the use of morphological features resulted in some misidentifications between the nototheniids *L. nudifrons* and *T. hansoni* (data for these taxa were subsequently pooled for data analyses). The two other dominant taxa were *Krefftichthys anderssoni* (Myctophidae) and *C. gunnari* (Channichthyidae). Multiple larval cohorts were evident for *C. gunnari*, suggesting a protracted spawning season. Larval growth estimates were provided

for five species, and the timings of peak abundance given for the main species. Multivariate analyses revealed significant seasonal and interannual differences in the larval fish assemblage.

29. Barrera-Oro and La Mesa (WG-FSA-12/04) used otolith microstructure analyses to provide information on the fingerlings of *N. rossii*. Samples of pelagic 'blue' phase (*n* = 7) and demersal 'brown' phase (*n* = 26) fingerlings were collected from Potter Cove (South Shetland Islands). Counting the daily rings back from the date of capture indicated that there were two main periods of larval hatching, one in late summer (February/March) and another in winter (July/August). Larval settlement was estimated to occur about 8 months from hatching. Age/length frequency distributions of fish sampled in spring 2010 showed the presence of two cohorts (biological ages 0+ and 1+) that hatched in summer and winter. Growth rates were estimated at 0.26–0.31 mm/day. This study provided new information on the hatching periods of the species and helped validate annulus formation. Further research on the spawning stages of fish sampled offshore in early summer and on fingerling stages sampled inshore in the winter is needed to confirm the findings and to clarify other uncertainties relative to early life history of the species.

30. Young et al. (WG-FSA-12/P10) contrasted patterns of larval fish dispersal for mackerel icefish (*C. gunnari*) (a demersal egg-layer) and marbled rockcod (*N. rossii*) (a pelagic spawner). Such issues play an important role in the maintenance of adult stocks and connectivity of populations etc. Simulations (using a particle tracking model with biological relevant behaviours in conjunction with an ocean circulation model) was used to examine the potential influence of oceanographic and life-history variability on the dispersal and retention of the two species. Mean retention of *N. rossii* larvae was predicted to be 5.3%, considerably lower than that of *C. gunnari* (31.3%), due to the longer planktonic phase of the former. Dispersal/retention of *C. gunnari* was strongly influenced by location of the spawning site, with the greatest contribution to overall retention from spawning sites on the southwest South Georgia shelf. A consistent feature in *C. gunnari* was the lack of larval exchange between South Georgia and Shag Rocks (despite being separated by only 240 km).

31. Kock and Jones (WG-FSA-12/10) provided a detailed account of a recent demersal trawl survey (70 hauls) in the region of Elephant Island–South Shetland Islands and the tip of the Antarctic Peninsula. Fifty-four fish species were caught, with the dominant species including various nototheniids (*G. gibberifrons*, *L. larseni*, *N. coriiceps* and *N. rossii*), and *C. gunnari*, *C. aceratus* and *Chionodraco rastrospinosus* (Channichthyidae). A range of data (e.g. catch weights, length frequency, length–weight relationships and reproductive biology) were provided.

32. Trokhymets et al. (WG-FSA-12/P06) provided recent information on the ichthyofauna of the Argentine Islands region (2007–2008), including information on the meristic and morphometric characters of black rockcod (*N. coriiceps*) from two areas (Meek–Penola Channel and west coast of Grotto Island).

33. Casaux and Barrera-Oro (WG-FSA-12/05) examined the numbers of breeding pairs of Antarctic shag (*Phalacrocorax bransfieldensis*) at Harmony Point and Duthoit Point (Nelson Island, South Shetland Islands), which declined during the 1990s. The potential effects of historical fishing on two prey species (*N. rossii* and *G. gibberifrons*) on shag populations were discussed.

34. Marschoff et al. (WG-FSA-12/P01) summarised the current status of some fish species. Industrial fishing off the South Shetland Islands in the late 1970s and early 1980s had depleted several fish stocks. Changes in size and abundance of *N. rossii* and *G. gibberifrons* (exploited species) and *N. coriiceps* (unexploited) were examined over the period 1983–2010. Catch rates of *N. coriiceps* increased at the start of the time series, and although indicating a decline over the time series, have been relatively stable in recent years. The abundance of *N. rossii* (relative to *N. coriiceps*) declined from 1983 to 1991, and has subsequently increased. Changes in mean length are suggestive of recruitment pulses. Relative abundance of *G. gibberifrons* also declined at the start of the time series, but has remained low. The increase in mean length over the time series suggests that there has been little recruitment. Factors involved, which may include fishing impacts (e.g. by-catch in krill fisheries), ecosystem interactions, depensation and environmental influences, were discussed.

Taxonomic studies

35. Fitzcharles et al. (WG-FSA-12/35) discussed taxonomic issues regarding *Macrourus* spp. (Macrouridae) from South Georgia and the South Sandwich Islands. The identification by scientific observers and fisheries biologists was compared with subsequent genetic identification, and results generally confirmed the correct identification based on morphological characters. There were, however, some noteworthy findings. Firstly, there was some confusion between the juveniles of *M. carinatus* and *M. holotrachys*. Secondly, four species of *Macrourus* were identified genetically in the Southern Ocean, thus corroborating an earlier study that reported another species (*Macrourus* sp. nov.) occurring in the CAMLR Convention Area, with latitudinal gradients in their distributions observed at the South Sandwich Islands. Thirdly, the sub-Antarctic species *M. holotrachys* was indistinguishable genetically from the north Atlantic *M. berglax*. This new macrourid has recently been formally described as *M. caml* (McMillan et al., 2012).

REFERENCES

Hanchet, S.M., G.J. Rickard, J.M. Fenaughty, A. Dunn and M.J. Williams. 2008. A hypothetical life cycle for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region. *CCAMLR Science*, 15: 35–53.

Kuhn, K.L. and P.M. Gaffney. 2008. Population subdivision in the Antarctic toothfish (*Dissostichus mawsoni*) revealed by mitochondrial and nuclear single nucleotide polymorphisms (SNPs). *Ant. Sci.*, 20 (4): 327–338.

Lo, N.C., L.D. Jacobson and J.L. Squire. 1992. Indices of relative abundance for fish spotter data based on delta-lognormal models. *Can. J. Fish. Aquat. Sci.*, 49: 2515–2526.

McMillan, P., T. Iwamoto, A. Stewart and P.J. Smith. 2012. A new species of grenadier, genus *Macrourus* (Teleostei, Gadiformes, Macrouridae) from the southern hemisphere and a revision of the genus. *Zootaxa*, 3165: 1–24.

Stefansson, G. 1996. Analysis of groundfish survey abundance data: combining the GLM and delta approaches. *ICES J. Mar. Sci.*, 53: 577–588.

Appendices F to U are only available electronically at:
www.ccamlr.org/node/75667

Annex 8

The use of the CEMP Special Fund

THE USE OF THE CEMP SPECIAL FUND

1. The overall objective of the CEMP Special Fund ('the Fund') is to support research consistent with the purpose and scope of the CCAMLR Ecosystem Monitoring Program (CEMP), where CEMP aims to:

   (i) detect and record significant changes in critical components of the ecosystem

   (ii) distinguish between changes due to the harvesting of marine resources and changes due to environmental variability.

2. The priorities for research to support CEMP are those determined by the Scientific Committee, which may include, inter alia:

   (i) monitoring key life-history parameters of selected dependent species to detect changes in the abundance of harvested species. 'Dependent species' are marine predators which depend on species targeted by commercial fisheries for a major component of their diet. 'Krill-dependent species' used in CEMP include land-based species such as seals and penguins

   (ii) research supported by the Fund that will also inform CCAMLR's feedback management system for the krill fishery.

CEMP Special Fund Management Group

3. A CEMP Special Fund Management Group (hereafter The Management Group) will be comprised of a three-person team – a Convener, a Senior and a Junior Member. Each year, the Senior Member will advance to be the Convener and the Junior Member will become the Senior Member and the Scientific Committee will elect a Junior Member for a term of three years' service on the group.

Priorities and strategic plan

4. The Management Group will facilitate the development and maintenance of the priorities and strategic plan of the Fund by facilitating discussions in relevant working groups and in the Scientific Committee. Recommendations regarding the priorities and the strategic plan of the Fund will be submitted to the Scientific Committee for consideration.

5. The Management Group will coordinate input and update of the strategic plan against which the project proposals will be assessed. The Scientific Committee will approve the strategic plan each year, following input by the working groups when such consultation is needed.

Operation of the Fund

6. The Fund will be operated according to the following provisions:

(i) Proposals for projects to be supported by the Fund may be made by Members, by the Commission or the Scientific Committee and their subsidiary bodies, or by the Secretariat. In their submission, details will be given as to how they address the priorities and strategic plan of the Fund.

(ii) Proposals shall be submitted to the CCAMLR Secretariat by 1 June in any year.

(iii) The Management Group will review the proposals, requesting input from relevant Working Groups as needed, in light of the priorities and strategic plan for CEMP.

(iv) The Management Group will submit their recommendations for use of the fund to the Scientific Committee for consideration at the annual meeting following submission(s).

(v) The Scientific Committee will be responsible for final decisions in relation to proposals supported by the Fund.

Administrative arrangements and reporting

7. The Financial Regulations of the Commission shall apply to the Fund, except in so far as these provisions provide or the Commission decides otherwise.

8. The Secretariat shall report to the annual meeting of the Scientific Committee regarding the financial status and activities of the Fund, including its income and expenditure. Progress reports from each project will be submitted by the project manager and be included as part of this reporting. Progress reports must include details of the expenditures. The Secretariat report will be circulated to Members in advance of the annual meeting of the Scientific Committee.

9. The Scientific Committee shall review all ongoing projects at its annual meeting as a standing agenda item and reserves the right, after notice, to cancel a project at any time. Such a decision would be exceptional, but would be based upon lack of progress made to date, and the likelihood of lack of progress in the future.

10. The Commission may modify these administrative provisions at any time.

Annex 9

Glossary of acronyms and abbreviations used in SC-CAMLR reports

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN SC-CAMLR REPORTS

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
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)
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
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
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
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
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
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
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
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)
SC-IWC	Scientific Committee for IWC

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
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
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
UNEP	UN Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNCLOS	UN Convention on the Law of the Sea
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
WWW	World Wide Web
XBT	Expendable Bathythermograph
XML	Extensible Mark-up Language
Y2K	Year 2000
YCS	Year-class Strength(s)