

SC-CAMLR-XXIX

**SCIENTIFIC COMMITTEE FOR THE CONSERVATION  
OF ANTARCTIC MARINE LIVING RESOURCES**

**REPORT OF THE TWENTY-NINTH MEETING  
OF THE SCIENTIFIC COMMITTEE**

HOBART, AUSTRALIA  
25–29 OCTOBER 2010

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Chair of the Scientific Committee  
November 2010

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### **Abstract**

This document presents the adopted report of the Twenty-ninth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 25 to 29 October 2010. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Ecosystem Monitoring and Management, Fish Stock Assessment and Statistics, Assessments and Modelling, the Subgroup on Acoustic Survey and Analysis Methods and the ad hoc Technical Group for At-sea Operations, are appended.

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**REPORT OF THE TWENTY-NINTH MEETING  
OF THE SCIENTIFIC COMMITTEE**  
(Hobart, Australia, 25 to 29 October 2010)

## OPENING OF MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met from 25 to 29 October 2010 at the CCAMLR Headquarters in Hobart, Tasmania, Australia. The meeting was chaired by Dr D. Agnew (UK).

1.2 The Chair welcomed to the meeting representatives from Argentina, Australia, Belgium, 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) and Nigeria (non-Contracting Party), along with observers from ACAP, ASOC, CEP, COLTO, IWC, SCAR and SEAFO, and encouraged them to participate in the meeting to the extent possible. SCAR also represented SCOR in relation to their joint activity relevant to CCAMLR's work (SOOS).

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 E. Barrera-Oro (Argentina) and V. Bizikov (Russia), Mr A. Dunn (New Zealand), Prof. B. Fernholm (Sweden), Dr S. Hanchet (New Zealand), Mr C. Heinecken (South Africa), Dr S. Hill (UK), Prof. P. Koubbi (France), Ms I. Lutchman (UK), Drs P. Martinez (Argentina), R. Mitchell (UK), S. Nicol (Australia), G. Parkes (UK), P. Penhale (USA), D. Ramm (Data Manager), K. Reid (Science Officer), V. Siegel (EU), P. Trathan (UK), G. Watters (USA) and D. Welsford (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 (see also SC-CAMLR-XXVIII, paragraph 1.7).

## Adoption of agenda

1.7 The Provisional Agenda had been circulated prior to the meeting (SC-CAMLR-XXIX/1) and was adopted without change (Annex 3).

## Chair's report

1.8 The following meetings took place in 2010:

- (i) SG-ASAM met at the British Antarctic Survey (BAS), Cambridge, UK, from 1 to 4 June 2010. The meeting was convened by Dr J. Watkins (UK) and was attended by 10 participants representing five Member countries.
- (ii) Two meetings took place at the National Research Aquarium, Cape Town, South Africa in July–August 2010:
  - WG-SAM met from 19 to 23 July 2010. It was convened by Dr A. Constable (Australia) and attended by 23 participants representing eight Member countries.
  - WG-EMM met from 25 July to 3 August 2010. It was convened by Dr Watters and attended by 49 participants representing 16 Member countries.
- (iii) WG-FSA was held from 11 to 22 October 2010 in Hobart. It was convened by Dr C. Jones (USA) and attended by 29 participants representing 12 Member countries.
- (iv) Ad hoc TASO was held from 11 to 15 October 2010 in Hobart. It was co-convened by Mr Heinecken and Dr Welsford and attended by 11 participants representing six Member countries.

1.9 In addition, two correspondence groups worked during the intersessional period on matters related to capacity building and the MPA Special Fund.

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

### WG-SAM advice

2.1 Dr Constable (WG-SAM Convener) presented the report of WG-SAM (Annex 4), noting that most of the report was referred to WG-EMM and WG-FSA for consideration. Dr Constable thanked participants of WG-SAM for their contributions to the meeting, noting that the presence of new participants this year had facilitated useful discussions and progress in the development and review of new methods.

2.2 In endorsing the report of WG-SAM, including its advice summarised in Annex 4, paragraphs 8.1 to 8.9, the Scientific Committee thanked Dr Constable for convening WG-SAM, and thanked all participants in the Working Group for assisting in developing a flexible approach to its work.



## Acoustic survey and analysis methods

2.3 The Scientific Committee thanked the Convener and participants in SG-ASAM for their work estimating krill biomass from a reanalysis of acoustic data collected during the CCAMLR-2000 Survey, noting that SG-ASAM had corrected errors in input files and code, developed new procedures to improve the parameterisation of krill shape and estimation of the orientation distribution of krill, and included a corrected computation of weight/length/TS conversion factors.

2.4 The Scientific Committee endorsed the work of SG-ASAM in revising the methodology for estimating krill biomass (Annex 5, paragraphs 2.40 to 2.44), noting that WG-EMM had also endorsed the finding of this report (Annex 6, paragraph 2.62) and agreed that further consideration of the outcomes of SG-ASAM, in particular the subsequent consideration by WG-EMM, would be further considered under Item 3(i)(b).

2.5 The Scientific Committee endorsed the recommendation of SG-ASAM that application of the full version of SDWBA is preferable to the simplified version for future analyses of acoustic surveys of krill biomass. The Scientific Committee encouraged progress on calculating a probability density function to characterise uncertainty in biomass estimates calculated using these methods, but noted that this is likely to be a complicated task.

2.6 Australia, UK and the USA reported to the Scientific Committee their intention to apply the methods agreed at SG-ASAM to the reanalysis of surveys in Area 58 and Subareas 48.3 and 48.1 respectively. The Scientific Committee welcomed this information, noting that it would lead to a revision of advice on krill biomass and sustainable yield.

## HARVESTED SPECIES

### Krill resources

#### 2008/09 fishery

3.1 In 2008/09 five Members fished for krill and a total of 125 826 tonnes were reported to the Secretariat (Table 1). The bulk of the catch was taken from Subarea 48.2, with a smaller amount from Subarea 48.1 and very little taken from Subarea 48.3 (SC-CAMLR-XXIX/BG/1).

#### 2009/10 fishery

3.2 Six Members fished for krill in 2009/10 and about three-quarters of the catches were taken in Subarea 48.1 (Table 2). The reported catch to 24 October was 211 000 tonnes (SC-CAMLR-XXIX/BG/1). The two major fishing nations were Norway (120 429 tonnes) and the Republic of Korea (43 805 tonnes).

3.3 The krill fishery in Subarea 48.1 was closed when the catch reached 99.8% of the trigger level for the subarea (155 000 tonnes). This was the first time that the krill fishery has

been closed because it has reached one of the trigger levels, noting that these were introduced for the first time last year. The catch in Subarea 48.1 was the highest ever recorded in this subarea.

3.4 The Scientific Committee noted that the closure of the krill fishery had occurred efficiently as the catch approached the trigger level, principally because of the voluntary reporting of catches at five-day intervals by the vessels fishing in this area.

3.5 The Scientific Committee noted that the current requirement for vessels to begin reporting catches at 10-day intervals once the catch reaches 80% of the trigger level for Area 48 (CM 23-06) was not consistent with the spatial allocation of the trigger level among subareas.

3.6 The Scientific Committee recommended that CM 23-06 be modified to reflect that the 80% (and 50%) levels referred to in CM 23-06 should apply to the subarea-specific trigger levels, and that once this level had been reached, a five-day reporting interval should be adopted.

#### Krill fishery notifications for 2010/11

3.7 Notifications were received from seven Members to conduct krill fisheries in Subareas 48.1, 48.2, 48.3 and 48.4, as well as Divisions 58.4.1 and 58.4.2 (Table 3). The notified krill fleet consisted of 15 vessels with a projected catch of 410 000 tonnes. Those notified in languages other than in English were translated prior to the meeting of WG-EMM so that they could be appropriately assessed by the Working Group. All notifications for krill fisheries in the 2010/11 fishing season met the requirements in CM 21-03.

3.8 The utility of the notification scheme was reiterated and it was noted that the projected level of catches in the notifications and actual catches were beginning to converge. Further, the recent increase in catch reflected the earlier increase in notifications suggesting that notifications did assist with predicting trends in the fishery.

3.9 The notifications specify a range of methods for estimating the green weight of krill, including use of volumetric, weight and conversion-calculated estimates. The Scientific Committee recommended that standardisation of methods for estimating the green weight of the catch is urgently required to achieve more accurate estimates of actual catches.

#### Fishing patterns

3.10 The Commission's attention was drawn to a recent change in the pattern of krill fishing operations with the catches coming mostly from Subarea 48.2 in 2008/09 and from Subarea 48.1 in 2009/10, but with little catch from Subarea 48.3 despite there being krill present in the South Georgia area in 2009/10. The fishery had concentrated on the Bransfield Strait area in 2009/10 and the catch from this region was an order of magnitude higher than catches reported from this area in the past. Additionally, the krill fishery now appears to be largely a winter operation.

3.11 Reports from Norwegian, Japanese and Korean fishing vessels indicated that, in the 2009/10 fishing season, there was little ice in the Bransfield Strait and favourable winds coupled with very big krill swarms made for good fishing conditions. These conditions were different from previous years.

#### Krill escape mortality

3.12 Escape mortality is calculated as the amount of krill escaping through the trawl mesh multiplied by the proportion of animals that die as a result of this process. A standard approach to collecting and processing data on escape mortality will be required to address this potentially serious issue and, to assist this, an operating manual for use by scientific observers is being developed by Russia and Ukraine (SC-CAMLR-XXVIII, paragraphs 4.14 and 4.15). The Scientific Committee expressed concern that potential methods be trialled before being requested as routine activity by observers. Ukraine agreed to conduct investigations into escape mortality of krill in the 2010/11 season in the case of Ukraine's participation as an observer in a krill cruise and to suggest how such approaches might impact the workload of scientific observers. The Scientific Committee also requested that the resulting manual (once developed) should be reviewed by WG-EMM to determine the results of, and instructions for, implementing a standardised approach.

3.13 The Scientific Committee encouraged pilot studies into escape mortality using techniques such as those outlined in SC-CAMLR-XXVIII/BG/10. Norway reported that it would trial camera systems in 2010/11.

#### Scientific observation

3.14 In 2009, the Commission agreed to a new general measure (CM 51-06) for scientific observation in krill fisheries, and noted that this measure should be reviewed in 2010, taking into account the Scientific Committee's recommendation on the statistical design of systematic observer coverage (CCAMLR-XXVIII, paragraph 10.7).

3.15 The Scientific Committee noted WG-EMM's discussions on scientific observations in the krill fishery (Annex 6, paragraphs 2.45 to 2.52). The Scientific Committee agreed that, although its advice remains that 100% coverage of vessels is the fastest way to develop a scientific understanding of the fishery, data collected during an initial period of 50% systematic observer coverage could characterise underlying variability and assist with the design of an observer program in the long term. A two-year program with sampling effort distributed across potential time–area strata would be useful to start establishing a baseline dataset for such work.

3.16 Three options for distributing observers among time–area strata during the 2010/11 and 2011/12 fishing seasons, in line with the requirements of CM 51-06, were developed by WG-EMM (Annex 6, Table 1). All three options would distribute observers among 50% of the time–area strata and require 20% coverage of hauls in a manner consistent with the requirements of CM 51-06 for the 2010/11 and 2011/12 fishing seasons. All three options can be modified to accommodate changes (increases) in levels of observer coverage:

- (i) Option 1 divided all notified vessels into two groups and each fishing season into two six-month periods. Observers would be deployed in a rotational strategy where 100% of vessels in each group would be observed during a single six-month period that alternates between fishing seasons.
- (ii) Option 2 divided the fishing season into four quarters and specifies 100% vessel coverage or 50% vessel coverage in specific time–area strata. The vessel coverage in each time–area stratum would alternate between fishing seasons.
- (iii) Option 3 required a minimum of 50% vessel coverage in all time–area strata in which each vessel operates.

3.17 The Scientific Committee agreed that, although option 2 provided the best opportunity for distributing observer sampling effort, option 1 was scientifically useful and operationally feasible and accordingly the Scientific Committee advised the Commission that option 1 could be implemented for observer coverage in the 2010/11 and 2011/12 fishing seasons (Annex 6, paragraph 2.49 and Table 1). This option divides vessels into two groups and divides seasons into two periods (Table 4):

100% of vessels in the first vessel group is observed in the first period of 2010/11 and the second period of 2011/12. 100% of vessels in the second group is observed in the second period of 2010/11 and the first period of 2011/12. 20% of hauls are observed on each observed vessel in accordance with the priorities and methodologies as set out in the CCAMLR *Scientific Observers Manual*.

3.18 As notifications for 2011/12 are not currently available, the Scientific Committee agreed that observation in 2011/12 should correspond with option 1, including:

- (i) At least 50% of all vessels (and at least 50% of vessels of each Member participating in the fishery where that Member has two or more vessels participating in the fishery simultaneously) should be observed in each period during which they fish.
- (ii) Any vessel that fished in 2010/11 and did not carry an observer should carry an observer in 2011/12 irrespective of the period in which it fishes.

3.19 The Scientific Committee acknowledged that this implementation scheme, or any scheme with less than 100% vessel coverage, does not provide all the information required to make a full comparison of variability across vessels, spatial and temporal strata. The best scheme for achieving this is therefore 100% coverage.

3.20 The Scientific Committee agreed that the scheme for deployment outlined above may deliver, over a two-year period, the required level of coverage and sufficient scientific data to allow it to do its work. It therefore advised the Commission that CM 51-06 could be extended for the additional year required to complete the deployment scheme.

3.21 The Scientific Committee was pleased to note that China had initiated a scientific observer scheme on its krill fishing vessels in their first season of operation, taking six observers on two vessels (Annex 7, paragraphs 1.19 and 1.20).

3.22 The Scientific Committee acknowledged the increased level of observer data from fishing nations that increased the levels of understanding of krill biology and the operation of the fishery (paragraphs 3.21 and 3.23 to 3.25).

### Surveys for krill

3.23 The Scientific Committee welcomed a Norwegian proposal for a krill fishing vessel to commit five days each year for the next five years to conduct research surveys in Subarea 48.2 (Annex 6, paragraphs 2.4 to 2.7). This is a major development that signals an active role for fishing vessels in providing scientific information which can be used for the management of the krill fishery.

3.24 Norway indicated that they would welcome Members' assistance in collecting predator overlap data and with the analysis of the acoustic data collected during these surveys, and that the results of these surveys would be submitted to CCAMLR.

3.25 The surveys will be standardised and will complement annual surveys conducted by the USA (in Subarea 48.1) and the UK (in Subarea 48.3), and, together, all three efforts could form an integrated monitoring program that potentially links the three areas containing major concentrations of krill and which are the focus of the commercial fishery. Germany indicated that it too was investigating the possibility of undertaking a survey in 2013 to link the US and Norwegian surveys. These surveys also provide the first opportunity to link land-based and marine research at the South Orkney Islands.

3.26 The Scientific Committee welcomed plans by Argentina to monitor krill larvae summer abundance in the Weddell Sea-Scotia Sea Confluence using a research vessel for three years beginning in 2012, and noted that such monitoring has the potential to provide useful data on krill recruitment processes that may be indicative of spawning biomass (Annex 6, paragraphs 2.8 to 2.10).

3.27 The Scientific Committee thanked Norway and Argentina for developing these initiatives and agreed that the development of technical protocols for the calibration, collection, storage and analysis of data from acoustic surveys of krill from fishing vessels should be developed as a matter of priority by its working groups. It was noted that there are international protocols being developed for the collection of acoustic data by fishing vessels (when acoustic scientists are not present) which may assist WG-EMM in its development of specific protocols for the krill fishery; Russia agreed to provide these protocols for consideration by WG-EMM.

### Krill biomass and catch limits

3.28 WG-EMM reviewed the work by SG-ASAM to correct the estimate of  $B_0$  for Subareas 48.1 to 48.4, using data collected during the CCAMLR-2000 Survey (Annex 6, paragraphs 2.53 to 2.67). The Scientific Committee endorsed the recommendation of WG-EMM that, in the future, estimates of  $B_0$  should use the full SDWBA model in preference to the simplified model (Annex 6, paragraph 2.56).

3.29 The Scientific Committee agreed that the recalculated  $B_0$  estimate of 60.3 million tonnes with a sampling CV of 12.8%, derived from the full SDWBA model, represented the best estimate of krill biomass during the CCAMLR-2000 Survey. The value provided in 2007 was incorrect, and several errors were corrected in 2010.

3.30 On the basis of advice from WG-EMM (Annex 6, paragraph 2.69), the Scientific Committee recommended a new precautionary catch limit of 5.61 million tonnes for Subareas 48.1 to 48.4 (based on a harvest rate of 0.093) and agreed that this value would be appropriate for a revision of CM 51-01. It noted that the current trigger level (620 000 tonnes) is not linked to the assessment of  $B_0$  and should not be changed at this time.

3.31 The Scientific Committee recommended that the corrections to implementation of the SDWBA model should be applied to krill biomass estimates for Divisions 58.4.1 and 58.4.2 to generate new estimates of  $B_0$  and precautionary catch limits (Annex 6, paragraph 2.71). Given the notified catch for these regions, the present  $B_0$  values and catch limits should remain until an appropriate reanalysis can be conducted.

3.32 The Scientific Committee endorsed WG-EMM's comments on the importance of investigating the potential impact of climate change on recruitment variability, and agreed that full review of the influence of recruitment variability on the calculation of sustainable yield be undertaken (Annex 6, paragraphs 2.72 to 2.78).

#### Krill meetings

3.33 The Scientific Committee noted the increasing international interest shown in krill, specifically recognising a recent Ukrainian–Russian seminar (CRAK-2010 – ‘Climate, South Ocean Resources, CCAMLR and Antarctic Krill’ on 27 and 28 September 2010, Kyiv, Ukraine (CCAMLR-XXIX/BG/35)). The seminar was organised with the assistance of the State Committee of Fisheries of Ukraine, Kyiv National Taras Shevchenko University and with support from the Antarctic Krill Conservation Project (PEW, ASOC). Key Russian, Ukrainian and Canadian experts, scientists and officials engaged in discussions of the issues of the South Ocean ecosystem, in particular Antarctic krill, and its consumers. Participants expressed concern about the unsatisfactory state of the current understanding of the krill-based ecosystem. Parties expressed their conviction in the rationale of conducting such meetings on a regular basis.

3.34 The EU announced that it is funding a workshop that aims to compile the state of knowledge about the impact of environmental change and increasing human exploitation on Antarctic krill, and to discuss potential implications for CCAMLR's ecosystem-based management approach. The Government of the Netherlands has expressed an increasing interest in CCAMLR-related work and will co-sponsor the workshop, which will be held in the Netherlands from 11 to 15 April 2011. The EU noted with concern that there may be a reduction in time available for discussions of krill biology and management at WG-EMM. The workshop aims to be complementary to CCAMLR and to contribute to WG-EMM.

## Comments from Observers

3.35 ASOC presented its paper (CCAMLR-XXIX/BG/21). Interest in krill fishing continues to grow and catches have already exceeded 200 000 tonnes in 2009/10. Lack of sufficient information about abundance of krill and krill predator populations, their distribution and seasonal variability, predator–prey relationships and the effects of climate change are delaying the establishment of krill catch limits among SSMUs in Area 48. Uncertainties over krill escape mortality and the impact of krill fishing on fish larvae and krill predators are also concerning. These are urgent issues and ASOC called on CCAMLR’s Scientific Committee to make recommendations to address them and for the Commission to act on them at this meeting.

## Fish resources

### Fisheries information

#### Catch, effort, length and age data reported to CCAMLR

3.36 Fishing took place in 15 fisheries targeting icefish (*Champscephalus gunnari*), toothfish (*Dissostichus eleginoides* and/or *D. mawsoni*) and krill (*Euphausia superba*) under conservation measures in force in 2009/10 (CCAMLR-XXIX/BG/10 Rev. 1).

3.37 Three other fisheries were conducted in the Convention Area in 2009/10:

- 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.

3.38 The preliminary total catch of target species by country and region reported from fisheries conducted in the CAMLR Convention Area in 2009/10 is summarised in Table 2. Catches reported in 2008/09 are summarised in Table 1.

3.39 The Scientific Committee noted the estimates of catch and effort from IUU fishing (Annex 8, paragraphs 3.10 to 3.14, Tables 5 and 6).

3.40 The Scientific Committee noted the catches of toothfish from waters outside the Convention Area reported in the CDS (see Annex 8, paragraph 3.15 and Table 7) (see also paragraphs 3.45 to 3.47).

### Research surveys

3.41 The Scientific Committee noted that two Members reported on bottom trawl surveys undertaken in 2009/10 (Annex 8, paragraphs 3.16 and 3.18):

- (i) a survey in Division 58.5.2 was carried out by Australia. The results from the survey were used to update assessments of icefish in this division;

- (ii) a survey in Subarea 48.3 was carried out by the UK. The results from the survey were used to update the assessment of icefish in this subarea.

3.42 The Scientific Committee thanked Australia and the UK for completing research surveys, the data from which will contribute to the long-term series of information on a number of finfish species besides icefish.

### Tagging

3.43 The Scientific Committee noted the discussion by WG-FSA on tagging of toothfish, particularly in exploratory fisheries (Annex 8, paragraphs 3.25 to 3.32). The Scientific Committee noted that there have been significant improvements in matching recaptured tags to releases since the Secretariat started to manage the distribution of tags to vessels, and as interaction between data users, data providers and the Secretariat has improved.

3.44 The Scientific Committee noted the importance of returning photos or physical tags (preferably both) to the Secretariat to aid matching (Annex 8, paragraph 3.26), and suggested that otoliths from tagged fish may also be returned with the tags to the Secretariat for storage (see further discussion of this in paragraphs 3.55 to 3.57).

### Tagging studies for *D. eleginoides* outside the Convention Area

3.45 Dr Barrera-Oro advised that the catch limit in the Argentine EEZ in Area 41 in 2009/10 was 3 250 tonnes, which was higher than the average level of 2 500 tonnes in the four previous seasons. Approximately 73% of the catch had been taken by longline vessels and 27% by bottom trawls. To date, 3 390 *D. eleginoides* have been tagged and released, but only 20 tagged fish have been recaptured and reported. The majority of recaptures occurred in areas close to release areas, illustrating similar limited movements of toothfish to those reported for CCAMLR areas.

3.46 Prof. O. Pin (Uruguay) advised that approximately 551 tonnes of *D. eleginoides* had been caught by Uruguayan vessels fishing inside the Uruguayan EEZ and the Argentine–Uruguayan Common Fishing Zone (ZCPAU) in Area 41 in 2009/10. No tags have been released, nor were any tags originating in other tagging programs recovered in 2009/10.

3.47 The Scientific Committee noted that the results of tagging studies outside the Convention Area provide valuable information on the movement of toothfish which may assist with the understanding of toothfish behaviour inside the Convention Area. The Scientific Committee urged Members managing fisheries for *D. eleginoides* outside the Convention Area to provide information to WG-FSA on these fisheries next year and to attend the meetings of WG-FSA, if possible.



## Management advice

3.48 Noting discussions during WG-FSA (Annex 8, paragraph 3.31), the Scientific Committee endorsed WG-FSA's recommendations for the Secretariat to translate existing signs and information about the tagging program into the languages commonly spoken by crews on board vessels active in exploratory fisheries, in addition to the CCAMLR official languages.

3.49 The Scientific Committee noted the advice of WG-FSA (Annex 8, paragraph 3.32) that various tag-specific parameters (e.g. tag-induced growth retardation, immediate post-tag mortality and tag loss) had originally been determined early in the tagging programs and endorsed recommendations made by WG-FSA to periodically review these parameters.

## Biology, ecology and demography

3.50 The Scientific Committee noted the work of WG-FSA on biology, ecology and demography of target and by-catch species in the fisheries. This work is the foundation of understanding the impacts of fishing on these populations, and the Scientific Committee encouraged Members to continue to contribute such information to WG-FSA.

3.51 Prof. P. Arana (Chile) highlighted a Chilean study in Management Area A of Subarea 48.3 which demonstrated a higher CPUE and a greater frequency of large toothfish from some research hauls in this area. Prof. Arana confirmed that Chile will submit a research proposal in 2011 for studies to continue in this area in 2011/12 to further explore impacts of area closures on fish resources.

## Management advice

3.52 The Scientific Committee noted that WG-FSA had considered a request from ad hoc TASO on whether it was useful for observers to continue collecting macroscopic gonad staging information (Annex 8, paragraph 8.14). The Scientific Committee recognised TASO's concern with respect to this matter, but requested that WG-FSA examine the issue in more detail in order to develop a more concrete program for implementation.

3.53 The Scientific Committee considered issues discussed by WG-FSA relative to the CCAMLR Otolith Network, including the current holdings of toothfish otoliths amongst Members with limited capacity for otolith preparation or reading (Annex 8, paragraphs 8.18 to 8.24). The Scientific Committee recognised that otoliths provide a valuable input to stock assessments and that finding a solution to the coordination of otolith reading in fisheries where Member capacity was lacking was paramount to developing assessments for these fisheries.

3.54 The Scientific Committee agreed that the coordination of age determination using otoliths from exploratory fisheries would be a suitable project for the General Science Capacity Special Fund, and requested that the practical and procedural issues associated with the proposal be progressed prior to its meeting in 2011.

3.55 Considering the practical issues, the Scientific Committee requested that in advance of the next meeting, the Secretariat be tasked with determining the location and extent of current otolith holdings amongst Members and whether these holdings could be stored at the Secretariat Headquarters until a time at which they could be processed. The Scientific Committee also requested WG-FSA at its next meeting to determine which otoliths and how many would need to be aged for assessment purposes.

3.56 The Scientific Committee agreed that in order to address the procedural aspects, the *ad hoc correspondence group to develop options to build SC-CAMLR capacity in science to support CCAMLR*, working with the Secretariat, should be requested to prepare a proposal to undertake otolith processing through a sub-contractual process using the General Science Capacity Special Fund and present this at SC-CAMLR-XXX, and that this proposal should include the following:

- (i) development of a tender process to select appropriately qualified service providers;
- (ii) development of decision-making process for tenders;
- (iii) development of a timetable for the progress of the proposal.

3.57 The Scientific Committee suggested that the General Science Capacity Special Fund could be applied in the same way for acoustic analysis required by SG-ASAM.

#### Preparation of assessment and assessment timetables

3.58 The Scientific Committee noted that WG-FSA had reviewed and endorsed the relevant sections of the WG-SAM report (Annex 8, paragraphs 4.1 and 4.2).

#### Review of preliminary stock assessment papers

3.59 The Scientific Committee noted that WG-FSA had reviewed preliminary stock assessments developed during the intersessional period for *D. eleginoides* and *D. mawsoni* in Subarea 48.4, and *C. gunnari* in Subarea 48.3 and Division 58.5.2, in preparation for the assessments. The discussions relative to preliminary assessments of these three fisheries are set out in Annex 8, paragraphs 4.4 to 4.13.

#### Assessments carried out and assessment timetable

3.60 The Scientific Committee noted that under the current arrangement for multi-year management, no new assessments were necessary this year for *Dissostichus* spp. fisheries in Subareas 48.3, 88.1 and 88.2 and Division 58.5.2.

3.61 Assessments were carried out for:

- *D. eleginoides* in Subarea 48.4
- *C. gunnari* in Subarea 48.3
- *C. gunnari* in Division 58.5.2.

3.62 All assessment work was undertaken by primary authors of the preliminary assessments, and reviewed independently at the WG-FSA meeting. The outcomes of the assessments were reported in the Fishery Reports (Annex 8, Appendices F to T).

#### Assessments and management advice

##### *Dissostichus eleginoides* South Georgia (Subarea 48.3)

3.63 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Annex 8, Appendix M and paragraphs 5.127 to 5.130.

3.64 The catch limit for *D. eleginoides* in the 2009/10 season was 3 000 tonnes and fishing commenced in this subarea on 26 April 2010 (CM 41-02, paragraph 5). The catch of *D. eleginoides* reported for this subarea in 2010 was 2 522 tonnes, with catches of 903 tonnes and 1 618 tonnes in Management Areas B and C respectively (in addition, <1 tonne was taken during a research survey). Following the advice of the Scientific Committee, the assessment was not updated in 2010.

#### Management advice

3.65 The Working Group did not undertake an assessment of this stock in 2010, and had no additional management advice. It therefore recommended that CM 41-02 be carried forward in its entirety for the 2010/11 fishing season.

3.66 In the 2009/10 fishing season, five vessels fished within the five-day early extension (26–30 April), with an average by-catch of 0.4 birds per vessel. In respect of a further season extension, the Scientific Committee noted that, according to CM 41-02, paragraph 6(i), the 2010/11 fishery could start on 21 April 2011.

##### *Dissostichus* spp. South Sandwich Islands (Subarea 48.4)

3.67 The Fishery Report for *D. eleginoides* in Subarea 48.4 is contained in Annex 8, Appendix N, and the discussion by WG-FSA is in Annex 8, paragraphs 4.4 to 4.6 and 5.131 to 5.137.

3.68 A tagging experiment has been conducted in Subarea 48.4 North over the last five years. This experiment was extended to Subarea 48.4 South in the 2008/09 fishing season. Currently, there is an assessment for Subarea 48.4 North, and 2009/10 was the second year of a three-year tagging experiment in Subarea 48.4 South.

3.69 In 2009/10, one New Zealand-flagged vessel and one UK-flagged vessel conducted research fishing and reported a total catch of 114 tonnes of *Dissostichus* spp. from Subarea 48.4 (Annex 8, Appendix N, Table 1(a)).

#### *Dissostichus* spp. Subarea 48.4 North

3.70 The catch limits for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 North in the 2009/10 season were 41 tonnes and 0 tonnes (except for scientific purposes) respectively, with recorded catches of 40 tonnes and 0 tonnes respectively.

3.71 The Scientific Committee noted that a single CASAL assessment model had been used for *D. eleginoides* in Subarea 48.4 North. Discussions are presented in Annex 8, paragraphs 5.131 to 5.134.

#### *Dissostichus* spp. Subarea 48.4 South

3.72 The catch limit for *Dissostichus* spp. in Subarea 48.4 South in the 2009/10 season was 75 tonnes, with a recorded catch of 74 tonnes.

3.73 A preliminary assessment using the limited number of tag-recaptures to date and CPUE/area comparisons with Subarea 48.4 North suggested a vulnerable population of between 600 and 1 500 tonnes. This is lower than the estimate made in 2009, after the first season of fishing, which was based only on CPUE/area comparison (WG-FSA-09/18).

#### Management advice

3.74 The Scientific Committee recommended that the experiment in Subarea 48.4 South should be continued for another year, but with a reduced catch limit for *Dissostichus* spp. of 30 tonnes. The catch limit in Subarea 48.4 North should be revised to 40 tonnes of *D. eleginoides*. All other aspects of the current conservation measure (41-03) should remain unchanged.

#### *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)

3.75 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Annex 8, Appendix O, and the discussion by WG-FSA is in Annex 8, paragraphs 4.14 to 4.17 and 5.138 to 5.145.

3.76 The catch of *D. eleginoides* reported for this division to October 2010 was 2 977 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2009/10 season was zero in Division 58.5.1 (Annex 8, Appendix O).

3.77 The Scientific Committee noted that WG-FSA had reviewed progress toward the development of a formal stock assessment for *D. eleginoides* in Division 58.5.1 (Kerguelen)

(Annex 8, paragraphs 4.14 to 4.17). The Scientific Committee encouraged the development of an integrated assessment model and recommended that a descriptive summary of the input data, the model stock and structural assumptions, and parameter values be submitted to WG-FSA and encouraged Members to collaborate on the development of a stock assessment for the area. Australia and France undertook to work together throughout the intersessional period in order to improve the stock assessment of the Kerguelen Plateau (Divisions 58.5.1 and 58.5.2).

3.78 The Scientific Committee recognised and appreciated the good progress that had been made in developing stock assessments for fisheries in Subarea 48.4 and Division 58.5.1.

#### Management advice

3.79 The Scientific Committee encouraged the estimation of biological parameters for *D. eleginoides* in Division 58.5.1 and encouraged the development of a stock assessment for this area. The Scientific Committee encouraged France to continue its tagging program in Division 58.5.1.

3.80 The Scientific Committee recommended that avoidance of fishing in zones of specific high rates of abundance in by-catch should also be considered and recommended that WG-FSA provide advice for by-catch mitigation in these areas. The Scientific Committee suggested that similar move-on rules to those used in other fisheries could be developed and encouraged Members to participate in WG-FSA to better facilitate this process.

3.81 No new information was available on the state of fish stocks in Division 58.5.1 outside areas of national jurisdiction. The Scientific Committee therefore recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-13, remain in force.

#### *Dissostichus eleginoides* Heard Island (Division 58.5.2)

3.82 The Fishery Report for *D. eleginoides* in Division 58.5.2 is contained in Annex 8, Appendix P, and the discussion by WG-FSA is in Annex 8, paragraphs 5.146 to 5.148.

3.83 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2009/10 season was 2 550 tonnes (CM 41-08) and catch of *D. eleginoides* reported for this division by October 2010 was 1 881 tonnes. The longline fishery was active from April to September 2010 and took 1 237 tonnes; the trawl fishery was active throughout the whole season and took the remainder of the catch. The estimated IUU catch for the season was 0 tonnes.

#### Management advice

3.84 The Scientific Committee did not undertake an assessment of this stock in 2010, and had no additional management advice. The Scientific Committee therefore recommended that CM 41-08 be carried forward in its entirety for the 2010/11 fishing season.

*Dissostichus eleginoides* Crozet Islands (Subarea 58.6)

3.85 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Annex 8, Appendix Q, and the discussion by WG-FSA is in Annex 8, paragraphs 5.149 to 5.154.

3.86 The catch of *D. eleginoides* reported for this subarea to October 2010 was 512 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2009/10 season was zero inside Subarea 58.6 (Annex 8, Appendix Q).

3.87 The standardised CPUE series for this fishery was not updated by WG-FSA in 2010.

Management advice

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

3.89 The Scientific Committee recommended that avoidance of zones of specific high by-catch abundance should also be considered.

3.90 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) inside the EEZ

3.91 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 inside the South African EEZ is contained in Annex 8, Appendix R, and the discussion by WG-FSA is in Annex 8, paragraphs 5.155 to 5.159.

3.92 The catch reported for Subareas 58.6, 58.7 and FAO Area 51 as of 5 October 2010 was 84 tonnes (21 tonnes within the CCAMLR area and 63 tonnes within the South African EEZ but outside the CCAMLR area), all of which was taken by longlines. There was no evidence of IUU catch in 2009/10.

3.93 The standardised CPUE series was not updated by WG-FSA in 2010.

Management advice

3.94 The Scientific Committee recommended that CCAMLR decision rules also be used in estimating yields for this fishery, but also noted that South Africa is considering the adoption of an operational management procedure approach (SC-CAMLR-XXVII, Annex 7, paragraphs 6.1 to 6.3) which addresses previous concerns over the sensitivity of the ASPM to

weightings used for different data sources and the estimation of recruitment levels for forward projections. The Scientific Committee noted that a catch limit for 2010 has not been set as yet, but it is likely to be in the range of 250–450 tonnes.

3.95 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 and therefore the Scientific Committee recommended that the prohibition of directed fishing for *D. eleginoides*, described in CMs 32-10, 32-11 and 32-12, remain in force.

#### *Champscephalus gunnari* South Georgia (Subarea 48.3)

3.96 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Annex 8, Appendix S, and discussion by WG-FSA is in Annex 8, paragraphs 4.8 to 4.11 and 5.161 to 5.166.

3.97 In the 2009/10 fishing season the catch limit set for *C. gunnari* in Subarea 48.3 was 1 548 tonnes. During the 2009/10 season the fishery caught 12 tonnes by 10 October 2010 (including 11 tonnes caught during the research survey).

3.98 The Scientific Committee noted that WG-FSA had agreed that the short-term assessment for *C. gunnari* in Subarea 48.3 be implemented using the length-based method (WG-FSA-10/37) in order to calculate catch limits in accordance with the CCAMLR decision rules for icefish.

#### Management advice

3.99 The Scientific Committee recommended that the catch limit for *C. gunnari* should be set at 2 305 tonnes in 2010/11 and 1 535 tonnes in 2011/12 based on the outcome of the short-term assessment.

#### *Champscephalus gunnari* Heard Island (Division 58.5.2)

3.100 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Annex 8, Appendix T, and discussion by WG-FSA is in Annex 8, paragraphs 4.12 and 4.13 and 5.167 to 5.173.

3.101 The catch limit of *C. gunnari* in Division 58.5.2 for the 2009/10 season was 1 658 tonnes. The catch reported for this division as at 10 October 2010 was 365 tonnes.

3.102 The Scientific Committee noted that the short-term assessment was implemented by means of the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2010 survey. Revised growth parameters described in WG-FSA-10/12 were also used, all other parameters were the same as in previous years.

## Management advice

3.103 The Scientific Committee recognised the importance of discussions during WG-FSA (Annex 8, paragraph 5.171) highlighting that additional work remains outstanding from the Workshop on Assessment Methods for Icefish (SC-CAMLR-XX, Annex 5, Appendix D) to evaluate whether the short-term projection method could be problematic for stocks at very low or of highly variable abundance because the method will always project a precautionary yield. The Scientific Committee also noted that this work will contribute to addressing the CCAMLR PRP recommendation whether a rebuilding strategy needs to be employed for such stocks when they have low levels of biomass. The Scientific Committee encouraged Members to work on this issue for Division 58.5.2 and Subarea 48.3 as a matter of priority.

3.104 The Scientific Committee recommended that the catch limit for *C. gunnari* in 2010/11 should be set at 78 tonnes.

3.105 The Scientific Committee recommended that other measures in the conservation measure be carried forward.

## Other fisheries

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

3.106 The Scientific Committee noted that there was no new information available for the 2009/10 season for these subareas.

3.107 The Scientific Committee recommended that the existing CMs 32-02 and 32-04 on the prohibition of finfishing in Subareas 48.1 and 48.2 respectively remain in force.

## Crab resources

Crabs (*Paralomis* spp.) (Subarea 48.2)

3.108 An exploratory fishery for crabs in Subarea 48.2 was carried out for the first time in 2009/10. The fishery was undertaken in accordance with the requirements of CM 52-02, and a total of 79 140 pot hours and 17 sets were completed by one vessel. Only three *Paralomis formosa* males were captured.

3.109 Dr Bizikov confirmed that an international observer and a Russian observer had been on board the vessel during fishing operations in Subarea 48.2. Russia has submitted observer reports to the Secretariat and planned to analyse biological data on crabs and submit the full results to WG-FSA in 2011.



### Management advice

3.110 No Member has notified its intention to fish for crabs in Subarea 48.2 in the 2010/11 fishing season. The Scientific Committee endorsed the advice of WG-FSA that the crab fishery in Subarea 48.2 was not likely to be viable (Annex 8, paragraph 5.184) and accordingly recommended that CM 52-02 not be renewed for the 2010/11 fishing season.

### Crabs (*Paralomis* spp.) (Subarea 48.3)

3.111 One vessel (Russia) fished for crabs in the 2009/10 fishing season from August to 15 October 2010. The Scientific Committee noted that vessel and observer (UK) data could not be submitted in time for analysis at WG-FSA-10, but strongly encouraged Russia to provide a full analysis of the data collected for WG-FSA-11.

3.112 Russia confirmed plans to submit a notification to CCAMLR to fish for crabs in this subarea in 2010/11.

### Management advice

3.113 With no new information available on the stock status of crabs or the conduct of the fishery in Subarea 48.3, the Scientific Committee was unable to provide new advice and recommended that CM 52-01 remain in force.

### Crabs (*Paralomis* spp.) (Subarea 48.4)

3.114 The Scientific Committee noted that no vessels fished for crabs in Subarea 48.4 in 2009/10 and therefore no new information was available on stock status in this area.

### Management advice

3.115 No Member has notified its intention to fish for crabs in Subarea 48.4 in the 2010/11 fishing season. The Scientific Committee was unable to provide new advice and recommended that CM 52-03 not be renewed for the 2010/11 fishing season.

## Fish and invertebrate by-catch

### Data reporting for by-catch species

3.116 The Scientific Committee noted that there had been some difficulty in interpretation of reporting requirements for by-catch that is retained when caught south of 60°S, as required under CMs 26-01, 41-04 and 41-11, and subsequently discarded as offal when the vessel is north of 60°S (Annex 8, paragraphs 6.8 and 6.9).

3.117 The Scientific Committee agreed that further guidance on reporting requirements be provided to both vessels and observers by way of additional detail in the instructions on the relevant data reporting forms as follows (Annex 8, paragraph 6.10):

- C2 Retained: Individuals landed and retained on board the vessel. Some retained product may be disposed at sea at a later date in accordance with conservation measures in force for the relevant subarea or division.
- C2 Discarded: Individuals landed on board the vessel and immediately discarded overboard. This excludes individuals released alive. ‘Discards’ are defined as whole fish or other organisms returned to the sea dead or with low expectation of survival. Discards are prohibited south of 60°S (see CM 26-01).

The above changes should also be made to the other relevant C forms (e.g. C1, C3, C5).

- L5 Observed number discarded dead: Observed number caught, landed on board then discarded (including factory discards) during the hauling period. This is equivalent to the C2 Discarded above. This DOES NOT include individuals released alive or lost, or those individuals which are retained for processing and discarded at a later date, in accordance with the conservation measures in force for the relevant subarea/division.

#### Year-of-the-Skate

3.118 The Scientific Committee noted the general success of the initiatives undertaken during the Year-of-the-Skate and noted the need to continue to collect data on tagged skates, and endorsed the advice of WG-FSA, including:

- (i) removing the requirement for tagging of one in five skates in new and exploratory fisheries from paragraph 2(iii) in CM 41-01, Annex C; paragraph 13 of CM 41-04, 41-09 and 41-10; paragraph 11 in CM 41-05; and paragraph 14 in CMs 41-06 and 41-07 (Annex 8, paragraph 6.27);
- (ii) using the tagging protocols developed during the Year-of-the-Skate, including tagging with T-bar tags, where any further tagging is carried out by Members (Annex 8, paragraph 6.21);
- (iii) replacing the existing text in CM 33-03, paragraph 4, with (Annex 8, paragraph 6.26):

On all vessels, all skates must be brought on board or alongside the hauler to be scanned for tags and for their condition to be assessed.

3.119 The Scientific Committee also endorsed the advice (Annex 8, paragraph 6.28) to replace the text in paragraph 2(vi) of CM 41-01, Annex C, with the following:

(vi) recaptured tagged toothfish should be biologically sampled (length(s), weight, sex, gonad stage), an electronic time-stamped photograph should be taken of the removed tag alongside the recovered otoliths, detailing the number and colour of the tag;

(vii) recaptured tagged skates should be biologically sampled (all length(s), weight, sex, gonad stage), two electronic time-stamped photographs should be taken; one of the whole skate with tag attached, and one close-up of the tag detailing the number and colour of the tag.

3.120 The Scientific Committee noted that WG-FSA had requested the Scientific Committee to consider a system of incentives to encourage crew to continue to scan skates for tags (Annex 8, paragraphs 6.29 and 6.30). It was noted that such incentives may also assist with the recovery of tagged toothfish where they are captured by vessels outside the Convention Area, and that incentive systems have been shown to improve the rates of reporting of tags in some fisheries outside the Convention Area.

3.121 The Scientific Committee agreed that the potential for poor reporting of tagged toothfish and skates was an issue that should be brought to the attention of SCIC. It further requested that the Commission consider methods for improving the reporting of tagged skates and tagged toothfish recaptured outside the Convention Area.

#### Focused data collection for macrourids in the Convention Area

3.122 The Scientific Committee noted the discussion by WG-FSA on the need for focused data collection for macrourids. It endorsed the advice of WG-FSA that during 2010/11 observers be asked to focus on correctly identifying macrourids to species. To assist WG-FSA with evaluating the need for a fully focused data collection program on macrourids in 2011/12, it also encouraged Members to analyse available data to determine key gaps not currently being addressed (Annex 8, paragraph 6.35).

#### Review of move-on rules

3.123 The Scientific Committee noted that WG-FSA had reviewed the move-on rules for macrourids and rajids in Subarea 48.4 under CM 41-03, and endorsed its advice that these rules should remain unchanged in 2010/11 (Annex 8, paragraph 6.42).

#### IUU gillnetting

3.124 The Scientific Committee noted that no new information was available to WG-FSA on the levels and types of by-catch resulting from gillnet fishing as conducted by IUU vessels (Annex 8, paragraph 6.44). It encouraged Members to collect any information that may reduce the uncertainty in IUU gillnet by-catch, and provide such data for consideration by WG-FSA.

## New and exploratory finfish fisheries

Review of experience with new and exploratory fisheries:  
development of a research framework for data-poor fisheries

3.125 The Scientific Committee recognised that WG-FSA had engaged in a review of fisheries described as ‘data-poor’ and that this was directly relevant to the Performance Review Rec. 3.1.1.2.

3.126 The term ‘data-poor fisheries’ was considered by WG-FSA as referring to a fishery for which a robust stock assessment that provides advice on catch limits according to CCAMLR decision rules has not been developed due to lack of information. At present, robust assessments of stock status of toothfish are lacking in many areas (e.g. Subareas 48.6 and 58.4). For the purposes of this report, the Scientific Committee has adopted the term ‘data-poor exploratory fisheries’ to include all those fisheries that are closed or exploratory fisheries for which stock assessments are lacking.

3.127 The Scientific Committee noted the following points in clarifying how research in exploratory fisheries could be advanced:

- (i) research requirements that require special allocation of catch by the Commission, including research catch in closed areas, would be considered to be CCAMLR-sponsored research;
- (ii) the term ‘data-poor fisheries’ had been useful in WG-FSA to separate the Ross Sea exploratory fishery for *Dissostichus* spp. from other exploratory fisheries; some of the exploratory fisheries, including those in Divisions 58.4.4 and 58.4.3b, have been closed or had the catch limit set to zero on the basis of advice from the Scientific Committee;
- (iii) a consideration by WG-FSA of research standards to be met by commercial fishing vessels if they are to participate in research for CCAMLR purposes is an important part of the WG-FSA advice on data-poor exploratory fisheries and is the issue for which WG-FSA has least information. Methods for research and assessments of toothfish are well established, whereas the difficulties in the implementation of the research programs seem to be the greatest gap.

3.128 The Scientific Committee agreed that the characteristics of data-poor exploratory fisheries matched the definition of an exploratory fishery given in CM 21-02, paragraph 1(ii). A number of fisheries in the Convention Area may currently be described as data-poor and continue to match the definition of an exploratory fishery (Table 5). Those that currently carry substantial fishing activity are in Subarea 48.6 and Divisions 58.4.1 and 58.4.2 where, despite many years of a structured research and tagging program, data are currently insufficient to undertake a stock assessment. The Scientific Committee agreed that its objective for all fisheries is to develop management advice on catch levels consistent with Article II of the CAMLR Convention.

3.129 It was noted that, of all the exploratory fisheries for toothfish, robust information on abundance and yield, and advice on appropriate harvest levels, was only available for the fisheries in Subarea 88.1 and SSRU 882E. The Scientific Committee noted that for these

fisheries all requirements in paragraph 1 of CM 21-02 have now been met (Table 5). The research and assessment work in these areas has led to an evaluation of the distribution, abundance and demography of *D. mawsoni* leading to an estimate of the potential yield of the fisheries, many reviews of the potential impact of the fisheries on dependent and related species, and allowed the Scientific Committee to formulate and provide advice to the Commission on appropriate harvest levels and other aspects of conservation over the last eight years.

3.130 The Scientific Committee recalled that the characteristics of successful assessments included the use of well-designed experiments to develop an integrated tag-based assessment of *Dissostichus* spp. in Subarea 48.4 (SC-CAMLR-XXVIII, paragraph 4.87), and the use of a multi-national multi-year tag-based assessment for Subareas 88.1 and 88.2. In recalling these successful experiments, the Scientific Committee agreed that concentrating tagging effort spatially was a key factor that led to the success of the tag-based assessment. Further, the Scientific Committee noted that successful assessments in Subarea 48.3 and Division 58.5.2 have also included data collected from trawl surveys.

3.131 The Scientific Committee agreed that the research standards to be met by commercial vessels if they are to participate in research for CCAMLR purposes is an important issue. It further considered that the standard of research applied by vessels fishing in exploratory fisheries as carried out under the research data and collection plan (CM 41-01) should also be of a high level. The Scientific Committee also agreed that trawl surveys of juvenile and young adults could also contribute to successful stock assessments.

3.132 The Scientific Committee endorsed the generalised work plan developed by WG-FSA for implementing research in data-poor exploratory fisheries as summarised in Annex 8, paragraph 5.11 (see also Item 9).

3.133 The Scientific Committee recommended that some specific elements of the work plan be considered as a high priority focus topic for WG-SAM in the coming intersessional period with the following terms of reference:

WG-SAM focus topic: work plan for implementing research proposals for data-poor exploratory fisheries. To consider:

- (i) methods for evaluating capability of vessels and gear types to contribute to research outcomes and for calibrating vessels and gears, including specific case studies relevant to current exploratory fisheries such as in tag-recapture programs;
- (ii) proposed research designs and data collection protocols for estimating stock status in data-poor exploratory fisheries;
- (iii) methods for assessing stock status in data-poor exploratory fisheries.

#### New and exploratory toothfish fisheries

3.134 Seven exploratory longline fisheries for *Dissostichus* spp. were agreed for the 2009/10 season (CMs 41-04 to 41-07 and 41-09 to 41-11), an exploratory trawl fishery for *E. superba*

in Subarea 48.6 (CM 51-05), and exploratory fisheries for crab in Subareas 48.2 and 48.4 (CMs 52-02 and 52-03). Activities in the exploratory fisheries are outlined below and summarised in Annex 8, Table 1. The planned exploratory fishery for krill in Subarea 48.6 was not carried out.

3.135 Nine Members notified 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 the 2010/11 season (Annex 8, Table 8). Another Member (France) withdrew its notifications for Subareas 88.1 and 88.2 prior to the meeting.

#### Tagging in exploratory toothfish fisheries

3.136 Under CM 41-01, each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. in 2009/10 was required to tag and release *Dissostichus* spp. at a specified rate per tonne (Annex 8, Table 10). All vessels achieved the required tagging rate. Consideration of the cumulative tag-releases prepared by the Secretariat showed that in exploratory fisheries all vessels released tags continuously, at or above the required rates, throughout their fishing trips.

3.137 Each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. in 2009/10 was also required to tag and release *Dissostichus* spp. in proportion to their occurrence by size and species in the catch. The Scientific Committee noted that the analyses of the tag overlap statistic by WG-FSA showed that in most subareas/divisions at least one vessel had achieved a high ( $\geq 60\%$ ) overlap between tag-release length frequency and catch-weighted length frequency (Annex 8, paragraphs 5.18 to 5.21, Table 12). The Scientific Committee agreed that a high overlap statistic was achievable by all vessels fishing in exploratory fisheries.

3.138 The Scientific Committee was encouraged to see that many vessels had improved their performance over the last three years, and that, for example, the *Tronio* in Subarea 88.1 had improved from 20% in 2009 to 62% in 2010. However, it also noted that despite its advice from last year on this issue (SC-CAMLR-XXVIII, paragraphs 4.148 to 4.151), there are still some vessels whose overlap statistic is low ( $< 30\%$ ) – *Insung No. 1* in Subarea 88.1, *Jung Woo No. 2* in Subarea 88.1 and *Jung Woo No. 3* in Subarea 88.2. Furthermore, although *Insung No. 1* achieved a medium score for *D. eleginoides* in Subarea 48.6, it failed to tag any of the 2 404 much larger *D. mawsoni* caught in the same subarea, making it impossible to estimate a statistic.

3.139 The Scientific Committee recalled its advice from last year that tagging large numbers of small fish in these exploratory fisheries would have very limited use for the estimation of abundance (SC-CAMLR-XXVIII, paragraph 4.150). It reiterated its concern that the failure to tag a representative part of the fished population was seriously undermining its ability to carry out robust stock assessments in the exploratory fisheries. The Scientific Committee recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

3.140 The Scientific Committee considered that Members with vessels which had consistently low overlap statistics should advise their vessels to implement CM 41-01, Annex C, by translating the requirement to tag toothfish at a particular rate per tonne into a

corresponding rate per number of fish. The appropriate tagging rate per number of fish will vary in different areas as a function of the average weight of the fish. The indicative tagging rate per number of fish to achieve the conservation measure is given by subarea/division and SSRU in Table 6. This could be implemented on the vessel by systematically selecting every  $N$ th fish for tagging, noting that if that fish is in poor condition, the next fish in good condition should be tagged instead. Thus, for example, in SSRU 486A every 20th fish should be tagged. It also recalled that a paper had been submitted to WG-FSA in 2007 which outlined methods by which large toothfish could be tagged in good condition (WG-FSA-07/36), and advised that vessels consider such methods when tagging larger fish.

3.141 The Scientific Committee requested that the Commission take appropriate action for all vessels to achieve a high ( $\geq 60\%$ ) overlap between tag-release length-frequency and catch length-frequency data and that CM 41-01, Annex C, be altered to reflect this. The equation for calculating the overlap statistic is given below:

$$\theta = \left( 1 - \frac{\sum_{i=1}^n |P_t - P_c|}{2} \right) \times 100$$

where  $P_t$  was the proportion of all fished tagged in length bin  $i$ ,  $P_c$  was the proportion of all fish caught (i.e. the sum of all the fish caught and either landed or tagged and released), for 20 cm length bins.  $\theta$  is therefore one minus half the sum of the absolute differences in the proportions-at-length in 20 cm length bins, over the range of the data, expressed as a percentage.

3.142 To assist Members in meeting this threshold, the Scientific Committee suggested that vessels could use the indicative tagging rate outlined in Table 6, and included in the CCAMLR Tagging Protocol.

3.143 The Scientific Committee recommended that the tag overlap statistic should be the metric by which compliance with CM 41-01 is evaluated and noted that the indicative tag rates in Table 6 are provided for information purposes only.

3.144 The very low recovery of tags from the exploratory fisheries in Subareas 48.6 and 58.4 remains a concern. A number of possible reasons for the low recovery rates had been identified by WG-FSA (Annex 8, paragraphs 5.22 to 5.24), but the continued lack of information coming from these fisheries makes it difficult to provide advice on precautionary catch limits for these fisheries.

3.145 The Scientific Committee agreed that the continuation of fishing, when combined with the continuing absence of information, may increase the uncertainty over whether the stock status is above safe levels.

#### Other issues in exploratory fisheries

3.146 The use and implementation of research hauls was reviewed by WG-SAM (Annex 4, paragraphs 3.5 to 3.9) and by WG-FSA (Annex 8, paragraphs 5.25 to 5.28). They agreed that

the current single allocation of starting positions could be augmented in areas of sea-ice by providing each vessel with up to three random lots of start positions for the required research hauls in a given SSRU. Since 2002/03, a total of 1 654 research hauls had been made in the exploratory fisheries in Subareas 48.6 and 58.4, and the Scientific Committee noted that WG-FSA had considered there was likely to be sufficient data available by 2011 to review these data at its next meeting.

3.147 The Scientific Committee noted that an approach for determining and summarising data collection requirements (including catch and effort data, length, sex, gonad stage sampling, tagging and VME reporting requirements) in Subareas 88.1 and 88.2 had been developed by New Zealand (Annex 8, paragraphs 5.31 to 5.33). The Scientific Committee agreed that the table of data collection requirements outlined in Annex 8, Table 16, provided a useful summary of the data collection requirements in Subareas 88.1 and 88.2, and that such a table would be a useful summary to have for all CCAMLR fisheries.

3.148 The Scientific Committee requested the Secretariat prepare a table of the data collection requirements for each new and exploratory fishery that summarises the data collected, frequency of data collection (i.e. samples per thousand hooks), and the rationale for that frequency, following the format outlined in Annex 8, Table 16. The Scientific Committee recommended these tables be used by WG-FSA in 2011 to review the data collection requirements in each fishery, and should be included within the Fishery Reports as a description of the data collection required.

#### *Dissostichus* spp. Subarea 48.6

3.149 Two Members (Japan and the Republic of Korea) and three vessels fished in Subarea 48.6 SSRUs D and E in 2009/10. The precautionary catch limit for *Dissostichus* spp. was 200 tonnes north of 60°S (SSRUs A and G) and 200 tonnes south of 60°S (SSRUs B–F). Information on this fishery is summarised in Annex 8, Appendix F.

3.150 The combined SSRUs B, C, D, E and F were closed on 21 March 2010 (catch limit for *Dissostichus* spp.: 200 tonnes; final reported catch: 197 tonnes). The combined SSRUs A and G (catch limit for *Dissostichus* spp.: 200 tonnes; reported catch to date: 98 tonnes) are currently open and one vessel was fishing. There was no evidence of IUU fishing in 2009/10.

3.151 The total number of tag-recaptures increased to 12 in Subarea 48.6 in 2009/10. However, there are still very few tag-recaptures from this subarea, and no progress could be made on assessments of *D. eleginoides* in Subarea 48.6. The overlap in size frequency of tagged fish with the overall size frequency of fish caught was medium for two vessels and high for one vessel which fished in 2009/10. One vessel which had fished in SSRUs A and G, where both species of *Dissostichus* occur, had not tagged any *D. mawsoni* (see Annex 8, Appendix F, Figure 3).

3.152 Three Members (Japan, Republic of Korea and South Africa) and a total of six vessels notified their intention to fish for toothfish in Subarea 48.6 in 2010/11.



#### *Dissostichus* spp. Division 58.4.1

3.153 Two vessels from two Members (Japan and the Republic of Korea) fished in the exploratory fishery in Division 58.4.1 in 2009/10. The precautionary catch limit for toothfish was 210 tonnes in three SSRUs (C: 100 tonnes, E: 50 tonnes and G: 60 tonnes), of which 196 tonnes were taken between 1 December 2009 and 20 February 2010. Information on this fishery is summarised in Annex 8, Appendix G.

3.154 High levels of IUU fishing have been reported in 2005/06 and 2006/07 and an estimated IUU catch of 910 tonnes was taken in 2009/10.

3.155 Vessels were required to tag and release *Dissostichus* spp. at a rate of three fish per tonne of green weight caught and both vessels achieved the target rate. A total of 5 012 *D. mawsoni* and 314 *D. eleginoides* have been tagged and released in Division 58.4.1, and 20 *D. mawsoni* and one *D. eleginoides* have been recaptured in that division. In 2009/10, 615 *D. mawsoni* and 12 *D. eleginoides* were tagged with three *D. mawsoni* and one *D. eleginoides* recaptured. The vessels in Division 58.4.1 had a medium level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught.

3.156 Five Members (Japan, Republic of Korea, New Zealand, South Africa and Spain) and a total of 11 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2010/11.

#### *Dissostichus* spp. Division 58.4.2

3.157 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.2 was limited to Japanese, Korean, New Zealand, Spanish and Uruguayan vessels using longlines only. Only one Member (Republic of Korea) fished in the division and reported a catch of 93 tonnes. SSRU E was closed on 17 February 2010 (SSRU E catch limit for *Dissostichus* spp.: 40 tonnes; final reported catch: 40 tonnes), and SSRU A and consequently the fishery was closed on 24 February 2010 (SSRU A catch limit for *Dissostichus* spp.: 30 tonnes; final reported catch: 53 tonnes). The other SSRUs (B, C and D) were closed to fishing. Information on this fishery is summarised in Annex 8, Appendix H.

3.158 The fishery targeted *D. mawsoni* and operated in SSRUs A and E in 2009/10. It was estimated that 432 tonnes of *D. mawsoni* were taken by IUU fishing in 2009/10.

3.159 A total of 291 toothfish were tagged and released in 2009/10 and no tagged toothfish were recaptured. The vessel in Division 58.4.2 achieved the target tagging rate of three tags per tonne of green weight with a high level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught.

3.160 Five Members (Japan, Republic of Korea, New Zealand, South Africa and Spain) and a total of eight vessels notified their intention to fish for toothfish in Division 58.4.2 in 2010/11.

*Dissostichus* spp. Division 58.4.3a

3.161 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.3a was limited to Japanese and Korean vessels using longlines only. The precautionary catch limit for toothfish was 86 tonnes, but no vessel participated in this fishery. Information on this fishery is summarised in Annex 8, Appendix I.

3.162 There was no evidence of IUU fishing in 2009/10.

3.163 No toothfish were tagged and released in 2009/10 and no tagged toothfish were recaptured during that season.

3.164 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2010/11.

*Dissostichus* spp. Division 58.4.3b

3.165 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.3b was limited to research fishing conducted by Japanese, Korean, South African and Uruguayan vessels using longlines only, and no more than one vessel per country was permitted to fish at any one time. In November 2007, the division was divided into two SSRUs: A north of 60°S and B south of 60°S. In November 2008, the area north of 60°S was further subdivided into four SSRUs (A, C, D and E). The precautionary catch limit for *Dissostichus* spp. in the fishery was set to zero tonnes in each SSRU. An additional limit of 72 tonnes was set for research fishing between 1 December 2009 and 31 March 2010 within four designated sampling sectors (CM 41-07, Annex A, Figure 1). Information on this fishery is summarised in Annex 8, Appendix J.

3.166 In 2009/10, one Member (Japan) and one vessel participated in research fishing. The vessel operated in the southeastern sampling sector and reported a total catch of 14 tonnes of *Dissostichus* spp. (*D. eleginoides*: 2 tonnes, *D. mawsoni*: 12 tonnes).

3.167 Information on IUU activities indicated that 171 tonnes of toothfish were taken in 2009/10.

3.168 A total of 60 toothfish were tagged and released in 2009/10, including eight *D. eleginoides* and 52 *D. mawsoni*. One tagged toothfish (*D. eleginoides*) was recaptured during the 2009/10 season. The vessel in Division 58.4.3b had only a medium level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught.

3.169 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3b in 2010/11.

3.170 The Scientific Committee noted that WG-FSA had considered a research fishing proposal tabled by Japan during WG-FSA-10 (Annex 8, paragraphs 5.69 to 5.73). It concurred with the general advice provided by WG-FSA in relation to the 2011 research proposal to conduct research fishing on BANZARE Bank outlined in those paragraphs. It

further noted that the sampling design undertaken for the proposed research in Division 58.4.3b was not submitted for review by any SC-CAMLR working group, and recommended that future research plans be reviewed by WG-FSA.

3.171 Dr K. Taki (Japan) noted that the distribution and abundance of *Dissostichus* spp. were only surveyed in the southeastern sector by the Japanese vessel during the 2009/10 survey, and that no new data were collected from the remaining three sectors. He reiterated the need to obtain new information for all four sectors in any subsequent surveys.

3.172 The Scientific Committee recalled its previous advice (SC-CAMLR-XXVIII, paragraph 4.165) noting the need for research plans to deliver data that would lead to stock assessments. The proposal by Japan acknowledged the need to move toward tag-based assessments, and suggested that the proposed research fishing for 2011 will lead to this objective. However, it also noted that without a minimum estimate of biomass it is very difficult to determine the total number of tags required to be released, or subsequent tagging rates for proposed removals to achieve biomass estimates with target CVs as recommended previously. It agreed that such research proposals could consider the possibility of conducting trawl surveys as an alternative method to using longline methods for establishing initial biomass estimates that could be used to inform the design of longer-term tagging programs.

Management advice on Subarea 48.6 and  
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b

3.173 The Scientific Committee agreed that it could provide no new advice on catch limits for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a.

3.174 Should the Commission agree catch limits for the exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a, the Scientific Committee recommended that all measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls, be retained.

3.175 The Scientific Committee noted that a research plan for data-poor exploratory fisheries was being developed which could provide advice for these subareas and divisions in the future (Annex 8, paragraphs 5.1 to 5.12).

3.176 In progressing a research plan to develop *D. mawsoni* assessments for Division 58.4.1, the Scientific Committee encouraged Members to collaborate in the intersessional period to progress elements of the generalised work plan (Annex 8, paragraphs 5.10 to 5.12), and in particular to provide inputs over the biology and ecology of *D. mawsoni* in this division. Further, the Scientific Committee also noted that a special research area that could be investigated in this process could be the combined SSRUs F and G in Division 58.4.1. Possible canyons and submarine features in this area could be investigated for their importance to *D. mawsoni*. Research in both these SSRUs may provide an opportunity to compare the characteristics of an area with a known history of fishing with an area that has been closed over the same period.

3.177 The Scientific Committee recommended that the catch limits for Division 58.4.3b be retained for 2010/11.

3.178 The Scientific Committee noted that a research plan was being developed which could provide advice for Division 58.4.3b in the future (Annex 8, paragraphs 5.1 to 5.12). The Scientific Committee could not reach consensus on advice for additional catch for research fishing.

*Dissostichus* spp. Subareas 88.1 and 88.2

3.179 Five Members (Argentina, Republic of Korea, New Zealand, Spain and the UK) and 12 vessels fished in the exploratory fishery in Subarea 88.1. The fishery was closed on 9 February 2010 and the total reported catch of *Dissostichus* spp. (excluding research fishing) was 2 870 tonnes (101% of the limit) (Annex 8, Appendix K, Table 3). The following SSRUs were closed during the course of fishing:

- SSRUs 881B, C and G closed on 23 December 2009, triggered by the catch of *Dissostichus* spp. (total catch 370 tonnes; 100% of the catch limit);
- SSRUs 881J and L closed on 29 January 2010, triggered by the catch of *Dissostichus* spp. (total catch 358 tonnes; 96% of the catch limit);
- SSRUs 881H, I and K closed on 9 February 2010, triggered by the catch of *Dissostichus* spp. (total catch 2 142 tonnes; 102% of the catch limit).

The IUU catch for the 2009/10 season was estimated to be 0 tonnes.

3.180 Eight Members (Argentina, Japan, Republic of Korea, New Zealand, Russia, Spain, UK and Uruguay) and a total of 20 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.1 in 2010/11.

3.181 Four Members (Argentina, Republic of Korea, Spain and the UK) and five vessels fished in the exploratory fishery in Subarea 88.2. The fishery closed on 31 August 2010 and the total reported catch of *Dissostichus* spp. was 314 tonnes (55% of the limit) (Annex 8, Appendix K). The IUU catch for the 2009/10 season was estimated to be 0 tonnes.

3.182 Seven Members (Argentina, Republic of Korea, New Zealand, Russia, Spain, UK and Uruguay) and a total of 18 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2010/11.

3.183 The Fishery Report for *Dissostichus* spp. in Subareas 88.1 and 88.2 is in Annex 8, Appendix K. In 2005, the Scientific Committee recommended that Subareas 88.1 and 88.2 be split into two areas for stock assessment purposes: (i) the Ross Sea, and (ii) SSRU 882E.

3.184 Vessels were required to tag and release *Dissostichus* spp. at a rate of one fish per tonne of green weight caught and all vessels achieved the required target rate. However, the tagging overlap statistic varied widely between vessels ranging from 20% to 87%.

3.185 The Scientific Committee noted that WG-FSA had discussed the possibility of developing a time series of relative abundance of recruitment in the southern Ross Sea based on a research longline survey conducted from a commercial longline vessel (Annex 8, paragraphs 5.92 and 5.93). The Scientific Committee agreed that a time series of relative

recruitments from a well-designed survey could be a useful input into the Ross Sea stock assessment model. It also considered this could be important with respect to monitoring future effects of climate change. The Scientific Committee requested Members develop a survey design to meet these objectives and submit it to an intersessional working group for evaluation.

3.186 The Scientific Committee also considered the question of how such a survey might be carried out, without compromising fishing activities, in the austral summer fishing season. It agreed that, if this research was to be conducted from a commercial fishing vessel, the fishers concerned should not be compromised by the fact that it is an Olympic fishery.

3.187 The Scientific Committee agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of one toothfish per tonne, be retained for the exploratory fisheries in Subareas 88.1 and 88.2. It also encouraged the further development of the data collection plan for these fisheries as outlined in Annex 8, paragraphs 5.31 and 5.34.

3.188 In accordance with the advice of the Scientific Committee in 2009, the assessment for Subareas 88.1 and 88.2 was not updated. The Scientific Committee agreed that the management advice on catch limits for Subareas 88.1 and 88.2 could be carried forward from last year.

## INCIDENTAL MORTALITY ARISING FROM FISHING OPERATIONS

### Marine debris

4.1 At SC-CAMLR-XXVIII it was agreed that WG-IMAF would meet every two years, and hence did not meet in 2010.

4.2 Dr Trathan presented SC-CAMLR-XXIX/BG/10, a report on beached debris, marine predator entanglement and hydrocarbon soiling at study sites on South Georgia and at the South Orkney Islands during the 2009/10 fishing season. Reported beached debris remained low, as did reports of entanglement of fur seals. Marine debris associated with albatrosses appears to be above the long-term mean, with debris that could not be directly attributed to fisheries making a significant contribution. In the case of wandering albatross, debris with a fisheries origin remains at a high level.

4.3 Prof. Pin indicated that Uruguay has been monitoring marine debris, and evaluating its potential effect on seal and seabird colonies at Fildes Peninsula, King George Island, from 2001 to date. This information is presented on a regular basis to CCAMLR, and incorporated into the Secretariat's database. During the 2009/10 fishing season, no seals were found entangled in remnants of fishing gear.

4.4 The Scientific Committee welcomed this information and urged Members to report on their monitoring programs and to present their data to the Secretariat.

## Incidental mortality of seabirds and marine mammals associated with fisheries

4.5 Incidental mortality of seabirds and marine mammals in fisheries was discussed by WG-FSA. Tables 2 and 3 of the WG-FSA report (Annex 8) provide information on seabird and marine mammal by-catch, and also indicate that no cases of marine mammal mortalities in CCAMLR fisheries were observed.

4.6 The Scientific Committee asked whether it was pertinent to review information on seabird incidental mortality in the year when no advice from WG-IMAF is available. The Scientific Committee considered that it was important to ask WG-FSA to review this type of information in the years when WG-IMAF does not meet, in order to identify any possible anomalous situations and, if appropriate, take the necessary measures.

4.7 Prof. Duhamel presented a report on the French plan of action to minimise seabird incidental mortality at Crozet and Kerguelen Islands, initiated in 2006 (SC-CAMLR-XXIX/14). It was reported that, through the use of methodologies that included streamer lines, fishery closures and daily monitoring of situations that could lead to seabird incidental mortality, the latter was reduced by 84% from 2006/07 to 2009/10, and during the last two fishing seasons this reduction has continued (50%).

4.8 The Scientific Committee thanked France for this information and for reducing seabird incidental mortality in the French EEZ, and asked WG-IMAF to examine the data and to provide advice with respect to the significance of the reduction.

## SPATIAL MANAGEMENT OF IMPACTS ON THE ANTARCTIC ECOSYSTEM

### Bottom fishing and vulnerable marine ecosystems

5.1 The Scientific Committee reviewed discussion and received advice regarding bottom fishing and VMEs from WG-SAM (Annex 4, paragraphs 4.1 to 4.9), WG-EMM (Annex 6, paragraphs 3.1 to 3.58) and WG-FSA (Annex 8, paragraphs 9.1 to 9.37 and Appendix E). Substantive aspects of work conducted by WG-EMM were extended by WG-FSA and, therefore, discussions summarised below reference paragraphs from both groups.

### Glossary

5.2 Recognising the need for a glossary of terms relevant to the consideration and management of VMEs in the CCAMLR area, the Scientific Committee endorsed definitions for the following terms: fragility, resilience, vulnerability, threat, instantaneous impact, cumulative impact, fishing footprint, ecological consequence and risk. The definitions for these terms are provided in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Annex 8, Appendix E, Attachment A); this report also includes a diagram that provides a useful illustration of the conceptual relationships between terms in the glossary (Annex 8, Figure 3).

5.3 The Scientific Committee also considered alternative ways of defining the term 'Vulnerable Marine Ecosystem'. Two approaches were considered by WG-FSA (Annex 8,

paragraphs 9.9 to 9.11), and discussion is ongoing to reach an agreed definition. The Conveners of WG-EMM and WG-FSA were requested to correspond with Members intersessionally to reach a conclusion on this issue.

5.4 Acknowledging that (i) available estimates of the cumulative impact of bottom fishing on benthic communities are not dependent on defining the term VME, and (ii) that substantial progress has been made to address a suite of topics relevant to bottom fishing, and using the agreed glossary, the Scientific Committee agreed that it could provide advice on precautionary management actions that can be taken to mitigate immediate risks to VMEs without the definition of a VME.

### Impact assessments

5.5 The Scientific Committee noted WG-FSA's review of preliminary impact assessments provided in conjunction with Members' notifications to participate in new and exploratory fisheries (Annex 8, paragraph 9.15 and Appendix E, Table 2). The preliminary impact assessments submitted in 2010 were much more complete compared to those submitted in 2009. Most of these preliminary assessments provided detailed information and diagrams of gear configuration, proposed effort and anticipated impacts, but direct comparisons of these assessments were not considered appropriate (Annex 8, paragraph 9.17). Further review of the information requested in CM 22-06, Annex A, indicated that the pro forma used to facilitate Members' preliminary impact assessments could facilitate comparisons if it was made more succinct and streamlined (Annex 8, paragraph 9.18).

5.6 The Scientific Committee recommended that the revised Annex 22-06/A pro forma developed by WG-FSA (Annex 8, Appendix D) be adopted by the Commission. Submission of information in this pro forma will facilitate the work of WG-FSA to estimate the spatial footprint and potential impact of notified fishing activities in forthcoming fishing seasons.

5.7 The Scientific Committee reviewed results from work by WG-FSA to provide combined, cumulative fine-scale bottom fishing impact assessments for all bottom fishing methods in all subareas and divisions included under CMs 22-06 and 22-07. During the course of this review, the Scientific Committee recognised relevant points made by both WG-FSA and WG-EMM.

- (i) WG-FSA noted that results from the combined impact assessment for longlining, a full description of which is included in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Annex 8, Appendix E), 'demonstrate that within the fished areas of each subarea or division, fishing effort is distributed unevenly, with most fished pixels experiencing impacts less than 0.4%, and with higher impacts concentrated in a few pixels. Applying the mean impact index estimate, 41 of 10 155 fished pixels in all the subareas included within CM 22-06 are estimated to have experienced greater than 3% longline impact for the most fragile VME taxa. The single-highest fine-scale pixel-specific longline impact estimate is 10.07%' (Annex 8, paragraph 9.25).
- (ii) WG-EMM agreed 'that there are currently data available to inform estimates of impact, but that the functional form of the relationship between impact and

ecological consequence is currently unknown, and that various hypothetical forms of the relationship between impact and ecological consequence may be plausible, including linear, non-linear, stepwise or a variety of other forms; any of which may be taxon or assemblage specific' (Annex 6, paragraph 3.6; Annex 8, Figure 3).

5.8 To develop combined cumulative impact assessments for all bottom fishing methods that can be updated annually, the Scientific Committee requested Members to complete method assessments for Spanish longlines, trotlines, pots and trawls comparable to the method assessment that has been done for autolines (see e.g. WG-SAM-10/20).

#### Notifications under CM 22-06 and Risk Areas under CM 22-07

5.9 The Scientific Committee considered advice from WG-EMM regarding two notifications of encounters with potential VMEs during a fishery-independent trawl survey in Subarea 48.2 (Annex 6, paragraphs 3.42 and 3.43). These notifications were submitted on the basis of observing anomalously high densities of two indicator taxa at two survey stations, and it was agreed that these high densities were not likely to be artefacts of the survey sampling design. Thus, the Scientific Committee advised that the two sites should be entered into the VME Register (Annex 8, Appendix E, Attachment B).

5.10 Recognising that a number of approaches could be used to justify notification of a potential VME under CM 22-06, including (but not limited to): (i) anomalously high densities of VME taxa; (ii) observed rare or unique benthic communities; (iii) high diversity of VME taxa; (iv) benthic communities likely to be of particular importance for ecosystem function or species' life cycles; or (v) benthic communities with other characteristics likely to be vulnerable to bottom fisheries activities (Annex 6, paragraph 3.48), the Scientific Committee agreed that notifications of encounters with VMEs during fishery-independent research activities should not be constrained by the format of CM 22-06, Annex B. Members were encouraged to provide additional supplemental information to support notifications under CM 22-06, and it was noted that each notification should be considered on its own merits.

5.11 During further consideration of approaches to justify notification of potential VMEs, it was noted that compact autonomous camera systems can allow rapid, efficient and inexpensive collection of data about benthic habitats. Members were encouraged to use such camera systems to map the distribution of vulnerable habitats and establish links between catch rates of bottom fisheries and organism density on the seafloor (Annex 6, paragraph 3.41).

5.12 Recognising that a process to review Risk Areas is required by CM 22-07, the Scientific Committee endorsed advice from WG-EMM that such a process should reference all available information on the nature, abundance and ecological importance of VME taxa and benthic organisms in each Risk Area under review. A listing of such information is provided in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Annex 8, Appendix E, paragraph 15).



## Progress on the Scientific Committee's work plan on bottom fisheries

5.13 The Scientific Committee agreed that Members, WG-EMM and WG-FSA had made substantial progress on a variety of elements in its work plan related to bottom fisheries. Progress on the work plan is summarised in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Annex 8, Appendix E, paragraph 62).

### Marine Protected Areas

5.14 The Scientific Committee endorsed the advice of WG-EMM regarding terminology relevant to bioregionalisation and systematic conservation planning (Annex 6, paragraphs 3.105 and 3.106). The Scientific Committee recalled its advice in 2005 (SC-CAMLR-XXIV, paragraph 3.54) that: (i) the whole Convention Area is equivalent to an IUCN Category IV MPA, but there are areas within the Convention Area that require further special consideration in a representative system; and (ii) the ideas, concepts and terminology used by CCAMLR were to fulfil the objectives specified in Article II of the Convention and may not be related to terminology used elsewhere.

5.15 The Scientific Committee also endorsed the advice of WG-EMM which referred to ecological terminology in systematic conservation planning (Annex 6, paragraph 3.108). The Scientific Committee recognised that it was currently not feasible to develop a single set of terms that would adequately and accurately describe the classification of ecosystem components, processes and properties across all scales for all MPAs. However, the Scientific Committee agreed that it would help increase understanding amongst the CCAMLR community if practitioners of such planning could, to the extent possible, explain how they have implemented the systematic conservation planning principles. It was agreed that different analytical methods may be used to develop proposals for MPAs, based on systematic conservation planning.

5.16 The Scientific Committee reviewed approaches to bioregionalisation and agreed that Members planning to undertake bioregionalisation and systematic conservation planning in the Convention Area should (Annex 6, paragraph 3.110):

- (i) where biological data are lacking, use bathymetric, oceanographic or climatological data indicative of biogeographic boundaries to define large-scale biogeographic provinces within which spatial planning will occur separately;
- (ii) where biological and other spatial data are available, use appropriate datasets to locate areas containing ecosystem processes that may constitute conservation objectives in their own right and represent these areas as separate spatial overlays;
- (iii) generate separate pelagic and benthic bioregionalisations;
- (iv) for pelagic bioregionalisations, consider the selection of the following large-scale environmental drivers: (a) depth, (b) water mass characteristics, and (c) dynamic ice behaviour.

## Rational use

5.17 The Scientific Committee agreed that it was important for both the Scientific Committee and Commission to provide guidance on how to address the topic of rational use in the development of a Representative System of Marine Protected Areas (RSMPAs) (Annex 6, paragraph 3.117). In response to a recommendation by WG-EMM (Annex 6, paragraph 3.118), Dr Constable had coordinated an informal intersessional discussion which resulted in a paper focusing on how scientific issues related to rational use may be considered in the development of MPA proposals (SC-CAMLR-XXIX/BG/9); he noted that this paper represented a point in time at which comments in an ongoing discussion were compiled. There was no attempt to weigh the merits of various points of view nor to consolidate a single view. The discussion included a number of topics, such as data needs, data availability and how to further progress on MPAs in the absence of comprehensive ecological data.

5.18 Members acknowledged that a discussion of how rational use can best be incorporated into MPA planning has relevance to the Scientific Committee, but that discussions of what types of activities constitute rational use and how to measure success in balancing rational use and conservation was primarily a Commission issue.

5.19 The Scientific Committee observed that a discussion on the balance between conservation and rational use would benefit from scientific understanding of the marine ecosystem. It was noted that the selection of methodologies to assess the goals of rational use and conservation goals was a complex matter, which would benefit from further discussion by the Scientific Committee.

5.20 The Scientific Committee recalled that it had agreed that it should, as a priority, continue the process of consolidating scientific views to maintain a common basis for the development of MPAs (SC-CAMLR-XXVII, paragraph 3.55(iv)). The Scientific Committee noted that it was important to create a transparent process by which multiple objectives for spatial protection could be considered in balance with rational use. It agreed that the discussions would best proceed with a focus on individual MPA proposals, rather than at a broad overarching scale. This is due to the expectation that different MPAs could have a different combination of objectives as agreed by CCAMLR-XXIV, paragraph 4.14, i.e. protection of ecosystem processes, habitats and biodiversity, and protection of species, including population and life-history stages. In the development of MPA proposals there is a need to clearly identify how achievement of the objectives will be assessed, while taking account of uncertainty.

## MPA Workshop

5.21 The Convener of WG-EMM noted that there was agreement on a set of milestones to progress the development of MPAs (SC-CAMLR-XXVIII, paragraph 3.28). To achieve the second milestone, the Scientific Committee agreed to convene a workshop in 2011 to review progress, share experience on different approaches to the selection of candidate sites for protection, to review draft proposals for MPAs in the CAMLR Convention Area, and to determine a work program for the identification of MPAs in as many of the priority regions as possible (and other regions as appropriate).

5.22 The Scientific Committee endorsed the following terms of reference, based on advice provided by the MPA Special Fund Correspondence Group (Annex 6, paragraph 3.126):

- (i) To review progress on the development of a Representative System of Marine Protected Areas (RSMMPAs) in the Convention Area, including consideration of:
  - (a) recently designated MPAs and other spatial protection/management measures;
  - (b) proposals for new MPAs and other spatial protection/management measures.
- (ii) To share experience on different approaches to the selection of candidate marine sites for protection, including consideration of:
  - (a) types of scientific information that could be used for the identification of areas of conservation importance;
  - (b) use of bioregionalisation and other data compilations, e.g. characterisations of priority regions in terms of biodiversity patterns and ecosystem processes, physical environmental features and human activities, and representation of particular biological distributions and ecosystem processes as separate overlays;
  - (c) identification of conservation objectives appropriate to different regions; with reference to particular data layers and metrics against which achievement of objectives might be assessed;
  - (d) identification of the value of particular areas for rational use;
  - (e) methods for identifying and prioritising candidate sites for protection, including the means by which conservation and rational use objectives might be addressed;
  - (f) use of decision-support tools or approaches.
- (iii) To review draft proposals for MPAs or an RSMMPA in the CAMLR Convention Area, submitted for this purpose, such that Members developing proposals can incorporate feedback from the workshop and revise their proposals accordingly in advance of SC-CAMLR in 2011.
- (iv) To develop a work program for further developing an RSMMPA in each statistical area, including consideration of:
  - (a) regions in which further work to identify MPAs is now required, based on current progress and considering the 11 priority regions and other regions as appropriate;
  - (b) collaboration with the Committee on Environmental Protection towards a harmonised approach to the development of RSMMPAs south of 60°S.

5.23 The Scientific Committee also recommended a list of workshop outputs (Annex 6, paragraph 3.127):

- (i) Summary of progress on developing an RSMMPA, which could include:
  - (a) the current status of existing and proposed MPAs in the Convention Area;
  - (b) updated consideration of priority regions in which further work to identify MPAs could be focused;
  - (c) recommendations on draft MPA proposals.
- (ii) Work program for finalising recommendations on an RSMMPA for the Commission meeting in 2012.

5.24 The Scientific Committee noted that practical aspects of the 2011 workshop included the selection of a time and venue for the workshop, as well as planning to ensure that technical experts (e.g. representatives from SCAR, CEP and IUCN) were invited, subject to the Scientific Committee's Rules of Procedure.

5.25 France's offer to host the 2011 MPA Workshop was welcomed by the Scientific Committee.

### Proposals

5.26 The Scientific Committee endorsed the revised management plan for ASPA No. 149, Cape Shirreff and San Telmo Islands (WG-EMM-10/21) (Annex 6, paragraph 3.134), and forwarded the plan to the Commission for consideration. Members were reminded that, in an effort to harmonise protection of the site within the ATS and avoid duplication of effort, CCAMLR's protection of Cape Shirreff was rescinded with the lapse of CM 91-02.

5.27 Dr Constable presented SC-CAMLR-XXIX/11 which described a process to elaborate RSMMPAs in data-poor regions, using the bioregionalisation process, available ecological and biodiversity data and outcomes in a systematic conservation planning framework for a region in East Antarctica.

5.28 The Scientific Committee agreed that this process could be applied to other data-poor areas, while different approaches may be more appropriate in regions where sufficient datasets exist, such as the Ross Sea and the South Orkney Islands.

5.29 In an example from East Antarctica, Australia applied the Comprehensiveness, Adequacy and Representativeness (CAR) principles (Annex 6, paragraph 3.123), resulting in a proposal for seven separate MPAs in the East Antarctica RSMMPA. It was noted that these areas were designed to be sufficiently large to protect conservation values during a period in which further data will be collected. Such data could be used in a review process at a later date to refine and reduce the size of the areas if warranted.

5.30 Members acknowledged the challenges involved in designating MPAs in data-poor areas, with some Members noting the advantages of the transparent approach used in the

development of this proposal. Some Members noted that it was important to have clear objectives for individual areas and in some cases, no-harvesting protected areas might need to be established as reference areas while other areas could potentially have some harvesting that would not impact their objectives.

5.31 The Scientific Committee recalled that in 2005 it endorsed the advice of the Workshop on Marine Protected Areas (SC-CAMLR-XXIV, paragraph 3.54) which stated that the Convention Area as a whole would qualify as Category IV in the IUCN System of Protected Areas. Prof. Koubbi suggested that it could be useful to examine criteria and standards for protected areas according to Ecologically and Biologically Significant Areas (EBSAs) of the Convention on Biodiversity (CBD) and to the international Global Ocean Biodiversity Initiative (GOBI).

5.32 The large size and the number of MPAs in the East Antarctic RSMMPA was a subject of concern to some Members, particularly given the lack of ecological data in the region. Dr Constable noted that there were different objectives for the various areas, with some being designated for benthic values, others for conservation of pelagic biodiversity or as reference areas for studies of the impacts of climate change or harvesting. He indicated that they had been developed together as a system in order to identify the important areas for representing different biogeographic provinces, combined with some areas that would be useful as reference areas for monitoring climate change impacts without interference from fishing. As above in paragraph 5.29, he noted that further knowledge would be needed to refine the areas needed to achieve the objectives.

5.33 Some Members supported application of the above approach for East Antarctica due to the paucity of ecological data in the region, but noted that in other areas where there is more ecological data, analysis could go further than bioregionalisation for purposes of demonstrating representativeness, in the process of identifying a system of MPAs. It was recommended that the identification of MPAs could also be based on consideration of biological or ecological data to achieve other possible objectives for MPAs identified by the Scientific Committee, i.e. protection of ecosystem processes, habitats and biodiversity, and protection of species (including population and life-history stages) (CCAMLR-XXIV, paragraph 4.14).

5.34 It was noted that spatially explicit representations of the distribution of harvestable resources (e.g. modelled species distributions or catch effort histories) could be used in the design of a system of MPAs, to evaluate potential costs to rational use. Members noted that the systematic conservation planning approach is designed to address multiple spatial protection objectives, and to achieve a balance between protection and rational use, and has been endorsed by the Scientific Committee as an appropriate method for designing a system of MPAs in the CCAMLR area (SC-CAMLR-XXVII, paragraph 3.55(iii)).

5.35 The Scientific Committee expressed concern about the process and timetable for a review of MPAs. Some Members suggested that the Scientific Committee develop guidelines for the process. Some Members noted that establishment of RSMMPAs should be grounded on the best available scientific data.

5.36 The Scientific Committee agreed that the process for establishing each MPA should include the development of a research and monitoring program to be conducted within a

specified timetable (e.g. 3 to 5 years). The results of these research and monitoring programs should be submitted to the Scientific Committee for review and a possible recommendation for revision of the status and boundaries of particular MPAs.

5.37 Some Members noted that the processes for the designation of MPAs and the development of a monitoring and review plan may best proceed in a step-wise fashion. Other Members suggested that both processes may occur simultaneously.

5.38 Some Members stressed the importance of data derived from harvesting activities and noted that this could be the main source of information about marine ecosystems. These Members felt that limiting fishing within a system of MPAs could result in insufficient data for monitoring purposes. Other Members noted that national and international collaborative research programs could be a valuable source of monitoring and process study data on marine ecosystems.

5.39 Prof. Koubbi presented France's strategy for designating MPAs in the Crozet and Kerguelen Archipelago and East Antarctica (SC-CAMLR-XXIX/13). The scientific framework to be applied by France is in accordance with research conducted in East Antarctica regarding regionalisation and to the studies in the Ross Sea for the ecological approaches. A multiple-category approach according to different IUCN categories will be used by France and should be encouraged when vast areas or RSMPAs are considered. Some Members strongly supported the French strategy, noting in particular the use of biological distributions and ecological data to locate pelagic and benthic habitats at smaller spatial scales, or areas of particular importance to fish life cycles and top predators.

#### Statements by Observers

5.40 IUCN, noting CM 91-03 which afforded protection of the southern shelf of the South Orkney Islands, encouraged progress to develop and implement RSMPAs in the Southern Ocean by 2012. The Ross Sea shelf and slope ecosystem was identified as an important region for further work. Of particular concern are climate change and ocean acidification. They are expected to have pronounced effects in the coming decades on marine life.

5.41 ASOC encouraged further work to identify candidate areas and develop proposals for those areas where work is not under way in order to meet the 2012 goal to establish an RSMPA in the Convention Area (CCAMLR-XXIX/BG/23). The Ross Sea shelf and slope ecosystem was identified as a priority area for work as it fulfils many criteria for designation as an MPA because of its biodiversity, value as a refuge, unique benthos, full complement of top predators and status as the largest marine system untouched on earth (CCAMLR-XXIX/BG/26).

#### IUU FISHING IN THE CONVENTION AREA

6.1 The Scientific Committee noted the advice of WG-FSA (Annex 8, paragraphs 3.10 to 3.14 and 7.1 to 7.5 and Tables 4 to 7) on IUU fishing trends in the 2009/10 fishing season. It also noted that the estimated IUU catches had increased from 938 tonnes in 2008/09 to 1 615 tonnes in 2009/10 and approached the level of the 2007/08 season (1 712 tonnes) (Annex 8, Tables 4 and 5).

6.2 The Secretariat received information from reports submitted by Members that seven vessels were engaged in IUU fishing in the Convention Area in 2009/10, and all were believed to be gillnet vessels (Annex 8, paragraph 7.1).

6.3 The estimated catch history of *Dissostichus* spp. taken by IUU longlining and gillnetting activities in the Convention Area was updated using new information on estimated catch rates for gillnets (Annex 8, Tables 5 and 6).

6.4 The Scientific Committee noted the shift in IUU fishing activities, from high levels in Divisions 58.5.1 and 58.5.2 and Subareas 58.6 and 58.7 in the late 1990s and early 2000s, to lower levels in the more southern areas of Divisions 58.4.1, 58.4.2 and 58.4.3b in recent seasons. IUU fishing activities appear to have been concentrated in Divisions 58.4.1 and 58.4.2 in 2009/10 (Annex 8, Table 5).

6.5 The Scientific Committee agreed that the methodology used by the Secretariat for estimating IUU effort was appropriate, but that catch estimates made using this information were highly uncertain because the catch rates in toothfish gillnet fisheries are unknown. The Scientific Committee requested that, in future, tracking of progress of CCAMLR in eliminating IUU fishing was best done by monitoring trends in IUU effort rather than estimates of IUU catch. It agreed that WG-FSA should use these effort estimates along with knowledge of catch rates, when available, when estimating total removals needed for assessments.

6.6 The Scientific Committee reiterated its previous advice that gillnets are less selective than longlines, the by-catch of fish and seabirds and impact on benthos are unknown, and nets continue to fish if abandoned or lost. The Scientific Committee agreed that gillnets are a destructive fishing method. Every effort should be made to end gillnet IUU activity in the Convention Area. Additional information and approaches are urgently required to better document the extent of IUU fishing and its impact on toothfish stocks and the environment.

6.7 The Scientific Committee asked SCIC to confirm that the estimates of zero catch are based on actual intelligence, rather than simply resulting from a lack of information.

6.8 Dr L. Pshenichnov (Ukraine) noted there is an inverse correlation between distribution of IUU and legal vessels fishing for toothfish. He suggested that the principal reason for the absence of IUU fishing estimates in the areas closed to fishing was that there has been an absence of licensed vessels in those areas. As a result, the real number of IUU vessels, especially in closed areas, could be grossly underestimated.

6.9 Dr Pshenichnov also believed that most companies that manage IUU vessels are familiar with CCAMLR conservation measures (for example, through the CCAMLR website), which provide explicit details of areas of the Southern Ocean in which it would be possible to encounter licensed ships in the upcoming year, and in which areas it would be unlikely to encounter them. To avoid this problem, he suggested the removal from the CCAMLR website of the Fishery Reports, Commission reports and conservation measures. Non-Member countries could get access to these documents in accordance with the Rules for Access and Use of CCAMLR Data, following a formal request.

6.10 Other Members agreed that the information now available on the CCAMLR website could be used improperly by operators engaged in IUU fishing. However, they emphasised

the value of transparency, publicity and openness of CCAMLR activities that should not be put at risk. The Scientific Committee agreed that the existing level of transparency of CCAMLR fisheries should be retained.

## CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

7.1 Information collected by scientific observers for finfish on board longline, trawl and pot vessels and krill trawl cruises was summarised by the Secretariat in SC-CAMLR-XXIX/BG/2. In accordance with the text of the CCAMLR Scheme of International Scientific Observation, paragraph A(f), the Secretariat provided copies of all scientific observer reports to the Receiving Members.

7.2 The Scientific Committee noted that reports were not received from two Korean vessels, and was advised by the Republic of Korea that the deployed government-appointed observers on these vessels were still at sea and that they would submit the reports when they returned.

7.3 The Scientific Committee noted the discussions on the observer program by WG-FSA (Annex 8, paragraphs 10.1 to 10.7), WG-EMM (Annex 6, paragraphs 2.45 to 2.52) and discussed the report of ad hoc TASO (Annex 7).

### WG-FSA

7.4 The Scientific Committee endorsed the recommendations of WG-FSA (Annex 8, paragraph 10.4) for improving the quality of observer data through:

- enhanced 'within-trip' error checks and feedback to observers from technical coordinators;
- the option for a database entry of data by observers to allow enhanced data entry checking;
- reviewing data performance metrics that include, inter alia, species identification, measurements, sex and maturity stage determination, and tagging, and provide this feedback to observers to improve their performance.

7.5 The Secretariat agreed to implement these changes in the observer system during 2011.

7.6 The Scientific Committee noted the concerns of WG-FSA in Annex 8, paragraph 10.5, that a lack of clarity in the instructions for observers in new and exploratory fisheries exists because of contradictory instructions on sampling requirements in the *Scientific Observers Manual*, observer logbook and CM 41-01, Annex B. The Secretariat noted that the *Scientific Observers Manual* was in the process of being revised and that sampling instructions would be addressed in the updated version. This would be first done for finfish and then for krill.



## WG-EMM

7.7 The Scientific Committee noted advice from WG-EMM (Annex 6, paragraphs 2.45 to 2.52) on observer coverage in the krill fishery (see also paragraphs 3.14 to 3.22).

7.8 The Scientific Committee thanked all observers for their hard work in collecting scientific data during the 2009/10 season.

## Ad hoc TASO

7.9 The Co-conveners of ad hoc TASO, Mr Heineken and Dr Welsford, presented the report from the third meeting held in Hobart, Australia, from 11 to 15 October 2010 (Annex 7).

7.10 The Scientific Committee noted that the agenda of the third meeting of ad hoc TASO covered primarily the development of standards for an accreditation scheme for all participants in the CCAMLR Scheme of International Scientific Observation in accordance with its recommendations from last year (SC-CAMLR-XXVIII, paragraph 6.8).

7.11 The UK welcomed this first step in a process to standardise the scientific observer program but noted that clarity was required in the mechanisms to deal with the review process, noting in particular that the persons with the experience to review programs were often those already managing programs and that this could lead to a conflict of interest.

7.12 The Scientific Committee agreed that TASO could constitute an appropriate review panel and sought advice from the Commission and SCIC on a dispute-resolution procedure should there be a dispute over the assessment of criteria provided by a Member (Annex 7, paragraph 2.6). The Scientific Committee agreed that the panel should consult with the Secretariat and SCIC over the next year to establish the precise mechanism for undertaking the accreditation assessment.

7.13 The components and assessment criteria matrix for baseline standards for CCAMLR international scientific observer programs (Annex 7, Table 1) were endorsed by the Scientific Committee.

7.14 The Scientific Committee noted that in VME discussions in WG-FSA, Members using Spanish and trotline systems could be encouraged to deploy benthic impact camera systems (BICS) and noted that they were already used in national observer programs to gather data on the impacts of these fishing gears on the benthos. The Scientific Committee agreed that initiatives towards utilising electronic monitoring methods by all vessels in the Convention Area could improve data gathering capabilities that would benefit the work of the Scientific Committee.

7.15 The Scientific Committee noted that observers need to be able to do their work in optimum conditions and in a safe environment, and requested the Commission to consider how to set these standards amongst Members.

7.16 It was noted that in CM 10-02, paragraph (2)(vi), Members are required to ensure that their vessels comply with the International Management Code for the Safe Operation of Ships

and for Pollution Prevention (International Safety Management Code) from 1 December 2009, and requested that SCIC consider registration for an IMO number mandatory to ensure that the safety standards on board all vessels operating in the Convention Area where observers are deployed are met.

## CLIMATE CHANGE

8.1 The Scientific Committee thanked the SCAR Observer for his presentation on the Antarctic Climate Change and the Environment (ACCE) report. The Scientific Committee recognised that this was an authoritative report that has clear implications for the work of the Scientific Committee and its working groups, as well as for wider global climate negotiations, e.g. for the United Nations Framework Convention on Climate Change (UNFCCC). The Scientific Committee noted that the findings of the report were far-reaching, with some of particular relevance to CCAMLR, including:

- The ozone hole has delayed the impact of greenhouse gas increases on the climate of the continent. An important exception is the Antarctic Peninsula, which has seen rapid summer warming. This warming is caused by stronger westerly winds bringing warm wet air into the region from the ocean.
- The Antarctic Circumpolar Current has warmed faster than the global ocean as a whole.
- Regional sea-ice has decreased west of the Antarctic Peninsula due to changes in local atmospheric circulation. This is thought to have caused changes in food webs on the northern Antarctic Peninsula that have cascaded to upper trophic level predators, e.g. to Adélie penguins.
- Over this century the ozone hole is expected to heal, allowing the full effects of greenhouse gas increases to be felt across the Antarctic.
- Climate variability in the polar regions is larger than in other parts of the world, yet these remote regions are sparsely monitored. These areas need to be monitored in much greater detail in order to detect change, to improve understanding of the processes at work, and to distinguish between natural climate variability and variability caused by human influences.

8.2 The Scientific Committee requested that the Commission take note of the ACCE report and its findings.

8.3 SC-CAMLR-XXIX/BG/8 provided a report from the CCAMLR Science Officer following his attendance at the Antarctic Treaty Meeting of Experts on the impacts of climate change for management and governance of the Antarctic region (ATME). The meeting was hosted by Norway (Svolvær, 7 to 9 April 2010) and jointly chaired with the UK.

8.4 The primary focus of the ATME was to seek ways to understand the effects of climate change in Antarctica and to discuss ways to mitigate such effects where necessary. The meeting reached agreement on 30 recommendations of which the following are of particular relevance to the Scientific Committee:

- Recommendation 19, ‘that the CEP consider developing a climate change response work program’;
- Recommendation 26, that the CEP ‘coordinate with SC-CAMLR, that the CEP consider, and advise the ATCM accordingly, as to means by which automatic interim protection might be afforded to newly exposed areas, such as marine areas exposed through ice-shelf collapse’;
- Recommendation 27, that the ‘CEP and SC-CAMLR be encouraged to ensure that sufficiently frequent biodiversity surveys and adequate monitoring programs are established to provide an understanding of climate-change induced responses in species distribution and abundance’;
- Recommendation 28, that ‘CEP and SC-CAMLR continue to develop means for collecting and sharing data and information on the status and trends of species of interest to both bodies (seals, penguins and seabirds), including the need to cooperate with other expert bodies such as SCAR and ACAP’.

8.5 SC-CAMLR-XXIX/12 presented a working paper previously submitted to ATME and to CEP XIII/ATCM XXXIII which were hosted by Uruguay (Punta del Este, 3 to 14 May 2010). The paper considered the implications of climate change for the Antarctic Protected Areas System.

8.6 The Scientific Committee noted the recommendations made by the authors of the paper, and endorsed by the CEP, in particular:

- Recommendation 1, the need ‘to ensure a more strategic approach to ASPA selection and designation’;
- Recommendation 2, the need to develop ‘a methodology for classifying existing ASPAs continent-wide according to their potential vulnerability to regional climate change’.

8.7 The Scientific Committee also noted other recommendations endorsed by the CEP:

- Recommendation 4, the need to give ‘newly-exposed marine habitats protection following the collapse of ice shelves to allow scientific research to establish baseline information and monitor further change’;
- Recommendation 5, that ‘spatial protection for species that are particularly vulnerable to climate change (e.g. Adélie and emperor penguins) is appropriate to minimise other impacts that might limit their survival in marginal locations’;
- Recommendation 6, the necessity of reviewing ‘the need for further or continued site-protection of species whose abundance or range has increased substantially under climate warming’.

8.8 The Scientific Committee advised the Commission that in the eventuality of such occurrences as described by Recommendations 4 to 6 taking place, advice from the Scientific Committee would be necessary.

8.9 The Scientific Committee noted that the recommendations detailed in SC-CAMLR-XXIX/12 have implications for the development and implementation of an RSMMPA within the Convention Area and that the consequences of climate change may increase the vulnerability of different ecosystem components necessitating a more precautionary approach in the establishment of an RSMMPA.

8.10 The Scientific Committee agreed that the consequences of climate change have the potential to impact on the work of the Commission and, therefore, there may be utility in developing 'A State of the Environment Report'. The Scientific Committee recognised that this would require coordination and necessitate considerable effort. The Scientific Committee agreed that WG-EMM should consider how such a report might be framed.

8.11 The ASOC Observer introduced CCAMLR-XXIX/BG/19 which highlighted the importance of climate change in the Southern Ocean and encouraged CCAMLR to: (i) coordinate with the CEP to address issues relating to climate change, including monitoring efforts, data collection and area protection; (ii) extend the use of MPA networks; (iii) extend the application of the precautionary approach to include the uncertainties raised by climate change; (iv) strengthen CEMP; and (v) provide leadership in reducing the emissions of greenhouse gases during the course of fishing activities.

8.12 The IUCN Observer expressed concern about the emerging impacts on the Antarctic marine ecosystem of global climate change and ocean acidification. These impacts are exacerbating existing stressors and will become more severe in coming decades.

8.13 IUCN welcomed the efforts of CCAMLR to collaborate with other elements of the ATS, to address the effects of climate change on the Antarctic marine environment and the call to revise existing management tools to assess their continuing suitability in a climate change context (Recommendation 10 of ATME).

8.14 IUCN encouraged the ongoing revision of conservation measures utilising current knowledge about climate change. It also encouraged the use of the precautionary approach in the face of climate change uncertainties.

8.15 IUCN also encouraged CCAMLR to develop a more comprehensive monitoring program collecting data currently not part of CEMP. Monitoring efforts should consider the need to differentiate the effects of fishing from the effects of other human activities and from natural variability, including the designation and use of closed areas for the purposes of scientific study.

## SCIENTIFIC RESEARCH EXEMPTION

9.1 The Scientific Committee considered information from WG-FSA and WG-EMM regarding research undertaken during the 2009/10 season and research notified for the 2010/11 season. Notifications of future scientific research activities received by the Secretariat are listed in Annex 8, paragraphs 11.8 and 11.10.

9.2 Five notifications were received in accordance with CM 24-01; two under paragraph 2 from Germany for krill research and multidisciplinary research, and three under paragraph 3 from Japan, Republic of Korea and Russia, all for toothfish.

## Research fishing using commercial vessels

### Ob and Lena Banks Division 58.4.4

9.3 Research fishing by a Japanese-flagged longliner on Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b) in 2007/08 and 2009/10 was reported in Annex 8, paragraphs 5.112 and 5.113. Other relevant information from this fishery is contained in Annex 8, Appendix L (the Fishery Report for Ob and Lena Banks).

9.4 A proposal to continue this research in a revised format was reviewed by WG-SAM (Annex 4, paragraphs 3.23 to 3.25) and the proposal was further revised and reviewed by WG-FSA (Annex 8, paragraph 5.114).

9.5 The Scientific Committee noted the desirable attributes of a survey series such as this to collect data needed for an assessment listed in Annex 8, paragraph 5.115.

9.6 An alternative method of estimating a precautionary research survey catch was used by WG-FSA (Annex 8, paragraph 5.116). The estimated  $B_0$  value and the current stock biomass were calculated using this method for two stock status scenarios and alternate biological and selectivity parameters arising from WG-FSA-10/48.

- (i) Scenario 1 used the estimated total catch history (legal and IUU) and assumed the biomass in 2010 to be 20% of  $B_0$ . An estimate  $B_0$  was then calculated at 7 900 tonnes. Using the relationship in Figure 3 of WG-FSA-10/42, representing a precautionary research catch, 0.62% of  $B_0$  is 49 tonnes.
- (ii) Scenario 2 used the same catch history and assumed the status at the end of the bulk of IUU fishing (in 2002) was 20% of  $B_0$ .  $B_0$  was then back-calculated to be 9 200 tonnes. This scenario then assumes some recovery through a forward projection, estimating the biomass in 2010 to be 33% of  $B_0$ . A precautionary catch limit (as for scenario 1) is then 1.05% of  $B_0$ , or 97 tonnes.

The Scientific Committee agreed that these two scenarios provided a basis for setting a limit on the catch that could be taken during the survey.

9.7 The Scientific Committee noted several important assumptions that were made when developing these scenarios, and also several other recommendations to improve the design and maximise the value of the information resulting from the survey (Annex 8, paragraphs 5.117 and 5.118).

9.8 The Scientific Committee noted the importance of developing a better understanding of differences in the mortality of tagged fish between those caught on longlines and those caught on trotlines. Japan has previously undertaken fishing trials to investigate this issue and further trials are planned during the coming year.

9.9 The Scientific Committee requested that data from all fishing trials designed to investigate this issue be compiled by the Secretariat and provided to WG-SAM for analysis, consistent with the guidelines for data-poor exploratory fisheries (Annex 8, paragraphs 5.1 to 5.12).

## Management advice

9.10 The Scientific Committee agreed that the results of the analysis performed by WG-FSA (paragraph 9.6 above) provided a basis for setting a limit on the catch that could be taken during the research fishing to be carried out in 2010/11 by the Japanese-flagged vessel in Division 58.4.4. No advice was provided in relation to which catch limit would be most appropriate. It requested that any results and analyses from this research be presented to WG-FSA for further consideration of appropriate research following the 2010/11 season, taking into account any recommendations by WG-SAM (Annex 4, paragraphs 3.23 to 3.25).

### Subareas 88.2 and 88.3

9.11 The Scientific Committee noted the deliberations of WG-FSA with respect to research proposals by the Republic of Korea and Russia to undertake research fishing in closed areas in Subarea 88.3, as well as SSRUs 882A and 883A–C (Annex 8, paragraphs 5.119 to 5.126).

9.12 In the notification from the Republic of Korea, two Korean-flagged vessels were proposed to conduct research in the closed SSRUs 883A–C, undertaking 190 hauls catching up to a total of 190 tonnes and collecting data on the size, catch rates and diet of toothfish, fish by-catch and VMEs, as well as tagging toothfish at a rate of five per tonne (Annex 8, paragraph 5.119).

9.13 Russia proposed to conduct research fishing in closed SSRUs 882A and 883A–C, using a single longline vessel. It proposed to conduct 10 hauls and take up to 10 tonnes of toothfish in SSRU 882A, and to conduct 20 hauls and take up to 65 tonnes of toothfish in Subarea 88.3. The proposed research would collect data on size, age, diet, reproduction and genetics of toothfish, as well as on fish and benthic invertebrate by-catch, tag toothfish at a rate of three per tonne, and tag skates (Annex 8, paragraph 5.119),

9.14 The Scientific Committee recalled its previous advice for evaluating CCAMLR-sponsored research (SC-CAMLR-XXVII, paragraphs 8.9 to 8.11), previous research efforts that have been conducted in Subarea 88.3, and issues relating to similar research fishing activities that have been conducted in other parts of the Convention Area, in terms of their ability to provide information that can be used for a stock assessment.

9.15 The Scientific Committee noted several points from the report of WG-FSA in relation to the Working Group's review of these proposals for research on commercial fishing vessels:

- (i) previous surveys by Chilean and New Zealand vessels have indicated that the toothfish population in this area was dominated by juvenile fish <100 cm in length (Annex 8, paragraph 5.121);
- (ii) during the Chilean survey, catch rates were very low, with 302 kg of toothfish caught from over 50 000 hooks set, indicating the density of toothfish across the area is very low, across a depth range of 600–2 550 m (Annex 8, paragraph 5.121);
- (iii) the best way to develop an assessment in data-poor areas is to carry out a tagging program (SC-CAMLR-XXVIII, Annex 6, paragraph 2.34);

- (iv) Subarea 88.3 is very large; any tagging program would be most successful if the tagging was initially concentrated in a small area; fishing in a smaller area would require a smaller catch allocation (Annex 8, paragraph 5.122);
- (v) toothfish caught on trotlines may have lower survivorship when tagged and released compared to those caught on longlines if they receive multiple hook wounds (Annex 8, paragraph 5.124);
- (vi) experiments to determine post-capture mortality rates from trotlines could be pursued in open areas where such vessels already operate (Annex 8, paragraph 5.124).

9.16 The Scientific Committee noted the conclusion of WG-FSA that the research proposed was unlikely to lead to an assessment for these areas (Annex 8, paragraph 5.126) and that additional data of a biological nature would arise from such research fishing. The Scientific Committee agreed that future proposals for research to develop assessments in the closed areas of SSRU 882A and Subarea 88.3 would benefit from consideration of the generalised approach to conducting research for data-poor exploratory fisheries (Annex 8, paragraphs 5.1 to 5.12).

9.17 Dr Bizikov agreed that research fishing from a single commercial vessel could not lead to an assessment within one year, but would certainly contribute data for a future assessment within the framework of a research program lasting several years. The notification for research fishing in SSRUs 882A and 883A–C submitted by Russia represents a first step in its three-year research program. He pointed out that exploratory fishing for toothfish in Divisions 58.4.1 and 58.4.2 has been carried out for 10 years and still has not resulted in such an assessment (paragraph 3.128). However, that has not resulted in those exploratory fisheries being disapproved. Referring to Annex 8, paragraph 5.121, he remarked that dominance by juvenile toothfish <100 cm in SSRUs 883A–C indicates that this area represents a part of some larger distribution of a single toothfish population, and as such represents a particular interest for investigation of this stock. The proposal from Russia specified a research catch of no more than 10 tonnes from 10 lines in SSRU 882A and no more than 65 tonnes from 20 lines in SSRUs 883A–C, which will result in the collection of data on the size, age, diet, reproduction and genetics of toothfish.

9.18 Dr Bizikov pointed out that Russia submitted its notification to conduct research in SSRUs 882A and 883A–C in full accordance with CM 24-01, and that WG-FSA had not reached a negative conclusion regarding Russia's proposal. He noted that Russia is open to further consultations with the Scientific Committee and its working groups on how to modify its national research program and incorporate the recommendation and advice from the Scientific Committee. However, the necessity for such consultations does not constitute grounds for rejecting or postponing Russia's proposal. In this context, he urged the Scientific Committee to endorse Russia's proposal, noting that failure to do so would set a bad precedent for the conduct of national research programs within CCAMLR.

9.19 Dr K. Seok (Republic of Korea) recommended that despite the low catch rates from previous surveys, the area should be surveyed again to collect up-to-date information on the current status of the toothfish stock in Subarea 88.3 because the previous New Zealand survey was conducted under unfavourable conditions. The Republic of Korea wished to make a scientific contribution to CCAMLR through the conduct of this research fishing plan.

9.20 Dr Pshenichnov noted that in many cases commercial vessels conducting research fishing were the only source of scientific data for assessing fish stocks in areas covered by exploratory fisheries and that such activity should be encouraged.

9.21 The Scientific Committee recalled the procedures followed in respect of the development of successful proposals for research fishing carried out by commercial vessels, citing the examples of the research fishing on Ob and Lena Banks (Division 58.4.4) and the South Sandwich Islands (Subarea 48.4). The proposal to continue research fishing on Ob and Lena Banks had been submitted by Japan to this year's meeting of WG-SAM, revised to address comments received and reviewed again by WG-FSA (paragraphs 9.3 to 9.10).

9.22 The Scientific Committee encouraged the Republic of Korea and Russia to continue to develop their proposed research programs, taking into account the generalised approach to conducting research for data-poor exploratory fisheries (Annex 8, paragraphs 5.1 to 5.12).

#### Management advice

9.23 The Scientific Committee recommended that clearer advice be developed with respect to the submission of proposals for research fishing from commercial fishing vessels in closed areas and areas with zero catch limit. Submission of such proposals only in accordance with CM 24-01 does not provide sufficient opportunity for review. Ideally, these proposals should be submitted in time for review by WG-SAM to enable their revision as necessary, taking account of the general principles and requirements for CCAMLR-sponsored research (SC-CAMLR-XXVII, paragraphs 8.9 to 8.11), in time for further review by WG-FSA and the Scientific Committee. This would enable research to be advanced as quickly as possible within a single year (Annex 8, paragraphs 5.1 to 5.12).

#### Research surveys

9.24 The Scientific Committee also noted that the UK and Australia will be conducting research surveys in 2011 in Subarea 48.3 and Division 58.5.2 respectively. Notifications for these surveys would be submitted in accordance with CM 24-01 in due course.

#### Reporting of small catches taken during scientific research

9.25 Currently CM 24-01 requires small catches taken during research surveys (e.g. small catches of krill in zooplankton nets) to be reported using the CCAMLR within-season five-day reporting system (CM 24-01, paragraphs 2(b) and 4(a)) (Annex 6, paragraph 6.13). The Scientific Committee agreed that reporting of such small catches under the within-season reporting provisions was not the intention of this measure.



## Management advice

9.26 The Scientific Committee recommended that CM 24-01 be modified so as to exempt small catches taken during scientific research from the within-season reporting requirements. This could be achieved through the following change to CM 24-01:

2. Application to Members taking **greater than 1 tonne and** less than 50 tonnes of finfish in a season, including no more than the amounts specified for finfish taxa in Annex 24-01/B and less than 0.1% of a given catch limit for non-fish taxa indicated in Annex 24-01/B.

## Use of gillnets for sampling in scientific research in waters deeper than 100 m

9.27 Drs Barrera-Oro and M. Vacchi (Italy) noted that small gillnets are used routinely from coastal research vessels based at Antarctic research stations for fish sampling for scientific research purposes in waters deeper than 100 m. While the use of gillnets for scientific research purposes is permitted under CM 22-04 (paragraph 1), when they are to be used in waters deeper than 100 m, paragraph 3 of that measure requires research proposals to be notified in advance to the Scientific Committee and be approved by the Commission before the research can commence. This represents a practical impediment for those research programs that regularly operate this gear in waters deeper than 100 m for sampling small amounts of fish.

## Management advice

9.28 The Scientific Committee recommended that the routine use of small gillnets in multi-year scientific research programs should not require annual approval by the Commission, irrespective of the depth of deployment. This could be achieved by modifying CM 22-04 so as to distinguish between the small nets used for scientific purposes and the large commercial nets used in the IUU fishery. The Scientific Committee recommended the following changes to CM 22-04:

2. The use of gillnets for scientific research ~~in waters shallower than 100 metres~~ shall be permitted subject to the requirements of Conservation Measure 24-01.
3. ~~Proposals for the use of gillnets for scientific research in waters deeper than 100 metres shall be notified in advance to the Scientific Committee and be approved by the Commission before such research can commence.~~
43. Any vessel seeking to transit the Convention Area carrying gillnets **with a total cumulative area measuring greater than 100 m<sup>2</sup>** must give advance notice of its intent, including the expected dates of its passage through the Convention Area, to the Secretariat. Any vessel in possession of gillnets **with a total cumulative area measuring greater than 100 m<sup>2</sup>** within the Convention Area which has not given such advance notice shall be in breach of this conservation measure.

## COOPERATION WITH OTHER ORGANISATIONS

### CEP

10.1 The CEP Observer to SC-CAMLR (Dr Penhale) presented SC-CAMLR-XXIX/BG/7 on the ongoing collaboration between CEP and SC-CAMLR, as discussed at CEP XIII held in Uruguay in May 2010, on the following five areas of common interest:

(i) Climate change –

The CEP reviewed the 30 recommendations contained in the report of the ATME on impacts of climate change for management and governance of the Antarctic (see paragraphs 8.1 to 8.15) and agreed to place climate change as a high priority on its five-year work plan and to allocate items to relevant agenda items (see also SC-CAMLR-XXIX/BG/8).

(ii) Biodiversity and non-native species –

The CEP undertook to keep SC-CAMLR informed of any developments of relevance under this issue.

(iii) Species requiring special protection –

There was no discussion at CEP XIII on species requiring special protection.

(iv) Spatial management and area protection –

The CEP recognised SC-CAMLR's timetable for action towards developing a network of MPAs by the 2012 deadline, and mirrored the timetable in the CEP's five-year work program, noting that it would nominate observers to CCAMLR meetings and workshops as appropriate.

The CEP welcomed the evolving cooperation with SC-CAMLR and, noting that the issue of spatial marine management will be discussed in detail, accepted SC-CAMLR's invitation to send an observer to SC-CAMLR's WG-EMM meeting in July 2010. The Committee nominated Dr Watters as its observer to WG-EMM.

The CEP recalled that the Joint SC-CAMLR–CEP Workshop had recognised that the issue of marine spatial protection and management is best led by SC-CAMLR, and that the CEP had previously stressed the need to constructively engage in, and support, SC-CAMLR's work in this area.

(v) Ecosystem and environmental monitoring –

The CEP noted the need for biodiversity surveys to support environmental management for Antarctica and agreed to return to this issue at its next meeting.

10.2 Dr Penhale noted that there are two ASMAs (1 and 7) and two ASPAs (152 and 153) that contain marine components with the potential for harvesting. While these ASPA and ASMA designations have previously been reviewed by CCAMLR, there is no mention of them in CCAMLR conservation measures.

10.3 The Scientific Committee agreed that in the spirit of continued cooperation with the CEP and to encourage advance discussion and coordination of activities, including harvesting, in those ASPAs and ASMAs, the details of these sites and other relevant instruments should be made available to CCAMLR Members on the CCAMLR website. Furthermore, the Scientific Committee agreed to place the details of sites where CEMP data have been collected, highlighting those sites where CEMP research is currently undertaken, on the CCAMLR website.

10.4 The Scientific Committee thanked Dr Penhale for her report and agreed that the presentation of reciprocal reports between the CEP and SC-CAMLR should follow the procedure used this year.

## SCAR

10.5 The SCAR Observer to CCAMLR (Prof. M. Hindell) presented the SCAR annual report to SC-CAMLR (CCAMLR-XXIX/BG/17) and reported on the new activities conducted by SCAR that are of potential interest to CCAMLR, these included:

- SCAR's ACCE report was published in October 2009 and will be updated annually by SCAR's Expert Group on Antarctic Climate Change and the Environment (see Item 8);
- the development of SOOS, the planning document for which will be finalised by the end of the 2010 and will be supported by a Secretariat hosted in Australia;
- two new potential scientific research programs of relevance to CCAMLR activities are under development – Antarctic Ecosystems: Adaptations, Thresholds and Resilience (AntETR) and State of the Antarctic Ecosystem (AntEco);
- SCAR's Action Group on Ocean Acidification;
- SCAR-coordinated CPR surveys continue to grow with an increasing number of countries contributing;
- the SCAR-MarBIN data portal continues to gather information on marine biodiversity in the Antarctic;
- a proposal for a joint CCAMLR–SCAR action group to improve the strategic partnership between the two organisations with the aims of:
  - determining what SCAR's and CCAMLR's expectations of each other are or should be, based on what is of benefit to Members of each organisation, and on a more strategic understanding of what each organisation can provide to make the partnership viable, sustainable and valuable;
  - offering advice on ways and mechanisms that SCAR and CCAMLR might implement to work together more effectively and in a more strategic manner;

- offering guidance on ways in which SCAR and CCAMLR might work together more effectively in the future to provide advice to the ATS;
- identifying a series of topics/issues that are of common interest to SCAR and CCAMLR that could form an agenda for the way forward.

10.6 The Scientific Committee thanked Prof. Hindell for his report and endorsed the proposed terms of reference for the joint action group. In order to make progress on the action group, the Scientific Committee agreed that the Chair of the Scientific Committee should contact the SCAR Executive to suggest a meeting in association with the CEP meeting to be held in Buenos Aires, Argentina, in June 2011.

10.7 Dr E. Marschoff (CCAMLR Observer to SCAR-XXXI) provided the Scientific Committee with a report of the SCAR Delegates' Meeting held in Buenos Aires, Argentina, in July 2010 (SC-CAMLR-XXIX/BG/12). In particular he noted:

- (i) the great commitment of SCAR to promote early careers in Antarctic science;
- (ii) the finding by SCAR's Evolution and Biodiversity in the Antarctic (EBA) of more than 200 alien species;
- (iii) the proposal for SCAR to host a workshop in South Africa in May/June 2011 entitled 'Antarctic Conservation in the XXI Century'. It is expected that the outcomes of the meeting will be useful for the ATS.

10.8 Dr Barrera-Oro, who had attended the SCAR Open Science Conference, also held in Buenos Aires, informed the Scientific Committee that more than 850 papers had been presented and noted that there were a great number of young scientists presenting work at this meeting. The attendance of many of these scientists had been facilitated through the SCAR Science Capacity Fund.

#### Reports of observers from other international organisations

##### ASOC

10.9 Dr R. Werner (ASOC Observer) drew attention to the papers tabled by ASOC.

10.10 With respect to CCAMLR-XXIX/BG/24, ASOC noted that ocean acidification poses severe potential threats to marine ecosystems, particularly the Southern Ocean. Ocean acidification has the potential to cause serious problems for a number of calcifying organisms, and rising CO<sub>2</sub> levels are already reducing the average shell weights of a species of Southern Ocean foraminifera. The relative under-saturation of CaCO<sub>3</sub> in the Southern Ocean suggests that initial impacts of acidification in this ocean will be obvious if greenhouse gas emissions continue on their projected trajectory. Therefore, ASOC requested the Scientific Committee to urgently develop research programs to fill in the gaps of current research on Southern Ocean impacts as soon as possible, including longer-term studies of acidification for the entire life cycle of important species. Information arising from these studies will be very important when assessing the impacts of bottom fishing on VMEs given the effect on calcifying organisms, including cold water corals.

10.11 Also of relevance to the work of the Scientific Committee, WWF on behalf of ASOC, represented by WWF-New Zealand, attended the Fifth Advisory Committee Meeting of ACAP, held earlier this year in Mar del Plata, Argentina. ASOC indicated its support for the progress made on the development of an official MOU between ACAP and CCAMLR. ASOC encouraged all CCAMLR Members and observers to fully implement the Agreement, and encouraged non-signatories to the Agreement to immediately accede. ASOC further noted that it is vital that CCAMLR Parties fully engage to encourage greater cooperation in the Agreement in order to address the high seabird mortality outside the Convention Area, particularly associated with tuna fisheries.

10.12 ASOC member group WWF submitted two papers to WG-EMM.

10.13 ASOC member 'The Antarctic Krill Conservation Project', an initiative of the Pew Charitable Trusts, attended the 7th International Penguin Conference held in August 2010 in Boston, MA, USA, and presented the paper 'Are penguins in Antarctica in danger from krill fishing?' This presentation provided penguin researchers with up-to-date information on the current work of CCAMLR in the management of the krill fishery, especially highlighting the conservation challenges regarding krill fishing and penguin species in Area 48.

## IWC

10.14 Prof. Fernholm (CCAMLR Observer to IWC) presented his report (SC-CAMLR-XXIX/BG/14 Rev. 1) from the 62nd Meeting of the SC-IWC which was held in Agadir, Morocco, from 30 May to 11 June 2010.

10.15 Antarctic whale stocks were discussed by the SC-IWC. For the Antarctic minke whales, two different methods for estimating abundance gave different results, but indicated a possible decline. Work is ongoing to derive an agreed estimate for abundance and trends. For southern hemisphere blue whales, an annual rate of increase of 8% is indicated. For the Australian south coast population of the southern hemisphere right whale, the annual rate of increase is 7.5%.

## Reports of representatives at meetings of other international organisations

### ACAP

10.16 Mr I. Hay (Australia) attended the 5th Meeting of the Advisory Committee (AC5) for ACAP as the CCAMLR Observer. Mr Hay was unable to attend the Scientific Committee meeting, however, he provided SC-CAMLR with a report on the ACAP meeting which was held in Mar del Plata, Argentina, from 13 to 17 April 2010. The meeting was preceded by meetings of three Working Groups (WGs) of the Advisory Committee – Breeding Sites WG, Seabird Bycatch WG and Status and Trends WG – in Mar del Plata, from 8 to 10 April 2010.

10.17 The Scientific Committee noted key ACAP agenda items and results of particular interest to CCAMLR which included:

- revision of ACAP's best-practice advice on mitigation measures for demersal and pelagic trawl and longline fisheries (AC5 report, Annexes 6 to 11);

- the joint revision and publication with Birdlife International, of comprehensive Mitigation Fact Sheets describing, in a range of languages, and illustrating seabird by-catch mitigation measures for the most common fishing methods. The fact sheets are available from the ACAP website ([www.acap.aq](http://www.acap.aq));
- improvements to ACAP Parties national reporting to establish seabird by-catch reporting;
- agreement on some performance indicators to measure the conservation status of ACAP-listed species and the effectiveness of the agreement;
- further substantial progress on the development of a decision-making framework for prioritising which species, populations, breeding sites and threats are the most important for improved conservation;
- engagement with RFMOs and other international organisations, such as CCAMLR, that have fisheries management responsibilities;
- allocation of funds to the ACAP work program and ACAP grants process;
- development of data sharing arrangements.

#### Future cooperation

10.18 The list of meetings of potential relevance to the Scientific Committee was divided into those meetings of other bodies with which CCAMLR has common interests and science conferences/symposia where the subject material is likely to be of relevance to CCAMLR (SC-CAMLR-XXIX/BG/11 Rev. 2).

10.19 In 2009, the Scientific Committee requested that, where Members are aware of, or attending, meetings of potential relevance to the work of CCAMLR (including those listed in SC-CAMLR-XXVIII, paragraph 9.42), that they notify the Secretariat in order that arrangements can be made to ensure that the Scientific Committee and its working groups are kept informed of current scientific developments relevant to their work (SC-CAMLR-XXVIII, paragraph 9.41). The Secretariat received no such notifications during 2010.

10.20 In CCAMLR-XXIX/33 Rev. 1 the Secretariat had invited Members of the Scientific Committee to:

- (i) review the continued need for the Secretariat to produce an annual paper on ‘Calendar of meetings of relevance’, and to annually seek nominations from Members to be the CCAMLR-nominated observer to the meetings of other organisations;
- (ii) consider alternative mechanisms to ensure that CCAMLR is adequately informed of developments in other organisations of relevance to the work of CCAMLR.

10.21 The Scientific Committee noted that the reports of the meetings of other organisations in which CCAMLR has an interest are normally publically available on that organisation's website. However, the Scientific Committee asked that the Secretariat continue to make a 'Calendar of meetings of relevance' of the organisations listed in CCAMLR-XXIX/33 Rev. 1 available to the Scientific Committee in future and make the Scientific Committee aware of project reports – such as from ICED – which are also of relevance to the work of the Scientific Committee.

## PERFORMANCE REVIEW

11.1 The Scientific Committee considered the Performance Review paper prepared by the Secretariat (CCAMLR-XXIX/10) and noted its previous discussions on this issue which resulted in (i) a priority list of work (SC-CAMLR-XXVII, paragraphs 10.10 and 10.11) and (ii) specific tasks for its working groups (SC-CAMLR-XXVIII, paragraphs 10.8 to 10.10).

11.2 The Scientific Committee has made considerable progress with considering the items of work identified in the Performance Review. It developed a status report (CCAMLR-XXIX/BG/43 Rev. 1) which demonstrated that out of the 38 recommendations relevant to the work of the Scientific Committee, six had been completed, 30 were in progress, and two were still to be addressed. This report is intended to be updated at future meetings to track progress against the recommendations.

11.3 The Scientific Committee noted with satisfaction that WG-FSA had started work on Task 3 listed in SC-CAMLR-XXVIII, paragraph 10.8 (identification of a list of depleted species, identification of factors contributing to their current status and the development of risk assessments and recovery plans) (Annex 8, paragraphs 5.186 to 5.193). WG-EMM had not been able to include consideration of the Performance Review in its agenda this year. The working groups plan to address other tasks relevant to the Performance Review in their forward plans (Table 7).

11.4 The Scientific Committee encouraged Members to submit information next year on progress against the recommendations (CCAMLR-XXIX/BG/43 Rev. 1) and any advice or proposals for further work on them.

## BUDGET FOR 2011 AND FORECAST BUDGET FOR 2012

12.1 The budget of the Scientific Committee for 2011 and the forecast budget for 2012, as agreed by SCAF, are summarised in Table 8. The apparent reduction in spending in 2010 reflects a change in the accounting process whereby the cost of meeting support is now calculated on the basis of indicative costing of supporting intersessional meetings (per day, per staff member, and costs of report production based on an estimated preparation and translation cost).

12.2 The Scientific Committee noted that, as in previous years (SC-CAMLR-XXVIII, paragraph 11.2), in order for the working groups to fully consider the information provided in association with notifications under CMs 21-02, 21-03 and 22-06 would require translation of those notifications not submitted in English.

12.3 The Scientific Committee agreed that the publication of papers arising from the Joint CCAMLR-IWC Workshop should be funded from the monies transferred to the Special Science Fund last year (SC-CAMLR-XXVIII, paragraph 11.5).

12.4 Further consideration of budgetary matters related to the General Science Capacity Special Fund are considered under Item 15.

## ADVICE TO SCIC AND SCAF

13.1 The Chair presented the Scientific Committee's advice to SCIC and SCAF during the meeting. The advice to SCAF is summarised in section 12.

13.2 The advice to SCIC was derived from the Scientific Committee's consideration of information provided by WG-EMM, WG-FSA and ad hoc TASO and is contained in sections 3, 4, 5, 6 and 7 (see also SC-CAMLR-XXVIII, paragraph 12.4). The Chair reported that SCIC had noted this advice.

## SECRETARIAT SUPPORTED ACTIVITIES

### Data Management

14.1 The Data Manager reported on recent work in support of the Secretariat's Data Management Function, and measures taken to maintain the integrity of the CCAMLR database (SC-CAMLR-XXIX/BG/3), and outlined a proposal for an independent review of the Secretariat's data management system (CCAMLR-XXIX/13). The goal of the proposed review is to provide assurance that CCAMLR's information assets are appropriately managed and protected, and that identified risks, including those which may arise from the Commission's growing needs, are managed and mitigated using an appropriate international standard as the benchmark. The proposed review forms part of the Secretariat's broad consideration of an information security policy.

14.2 This proposal was considered by WG-SAM and WG-FSA, and the Scientific Committee noted that such a review was expected to assist in the further development of the Secretariat's data services, including the dissemination of web-based metadata and related information (see also Annex 4, paragraphs 6.1 and 6.2; Annex 8, paragraph 12.2). The proposed review was supported and referred to the Commission for further consideration.

### Publications

14.3 The following documents were published in 2010 in support of the Scientific Committee's work:

- (i) Report of the Twenty-eighth Meeting of the Scientific Committee
- (ii) *CCAMLR Science*, Volume 17
- (iii) *Statistical Bulletin*, Volume 22.



14.4 The Scientific Committee also noted the progress made in finalising the reviews arising from the Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Ecosystem Models (SC-CAMLR-XXVII, Annex 12). The reviews were expected to be published in 2011.

#### *CCAMLR Science*

14.5 The Scientific Committee noted the *CCAMLR Science* Editor's report (SC-CAMLR-XXIX/8). In 2010, *CCAMLR Science* had an impact factor of 1.286 and was ranked 16th out of the 42 journals in the Fisheries subject category in Thomson Reuters *Journal Citation Reports*, Science Edition (SC-CAMLR-XXVIII, paragraph 13.12).

14.6 The Scientific Committee thanked the authors and reviewers for their outstanding contributions to the journal, and the Secretariat's editorial team for maintaining the high publication standards.

14.7 The Scientific Committee reviewed the translation requirements of the journal (abstracts and table and figure legends are provided in French, Russian and Spanish) in the context of the review of translation requirements currently being undertaken by the Commission (CCAMLR-XXIX/8). It was noted that without the need for translation, papers could be published online within a few weeks of the final manuscript being received.

14.8 The Scientific Committee agreed to cease the translation of abstracts and table and figure legends, and agreed to publish future volumes of the journal in English only.

14.9 The Scientific Committee also reviewed the current practice of obtaining permission from authors (as stipulated in the disclaimer in the cover page footnote) prior to citing working group papers in manuscripts for *CCAMLR Science* (and all other journals). Authors of *CCAMLR Science* papers have found it increasingly difficult to determine who to contact to receive such permission as the authors may no longer be involved in CCAMLR or may not be contactable with the details provided in the working group paper.

14.10 The Scientific Committee recommended that the permissions to cite working group papers should be delegated to the Scientific Committee representative of the Member responsible for the original submission.

14.11 The Scientific Committee considered approaches to increasing the visibility of science conducted by the working groups by providing public access to working group papers. The Secretariat undertook to continue discussions with Members during the intersessional period to progress this issue.

## SCIENTIFIC COMMITTEE ACTIVITIES

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

15.1 The Scientific Committee identified the three priority areas for its work over the next two to three years as feedback management of the krill fishery, assessment of toothfish

fisheries (especially in exploratory fisheries) and MPAs. A schedule to address issues related to these priority items (including those identified in the PRP report), and the allocation of tasks to particular working groups, were agreed (Table 7).

15.2 The Scientific Committee agreed that, as the role of ad hoc TASO developed into the review panel for the accreditation process, there would no longer be a requirement for this group to meet on a regular basis. However, the Scientific Committee noted that there was still work to be completed on developing the terms of reference of this review panel and a need to develop guidance on the application of the accreditation process, and noted that this would involve consultation with the Chairs of the Scientific Committee and SCIC. It also noted that it would keep the work of TASO under review and may ask TASO to meet when required.

15.3 In considering Table 7, the Scientific Committee provided the following clarifications:

- (i) there may be a need for a meeting of SG-ASAM in 2012 to provide advice on the processing of acoustic data from surveys conducted on commercial krill fishing vessels;
- (ii) catch monitoring in the krill fishery would need to include consideration of escape mortality and estimation of green weight.

15.4 The Scientific Committee noted that the additional work on VMEs identified in Annex 8, paragraph 9.37, would be addressed in 2012.

#### Capacity building and burden sharing

15.5 The Chair of the Scientific Committee provided an update of the work of the *ad hoc correspondence group to develop options to build SC-CAMLR capacity in science to support CCAMLR* (SC-CAMLR-XXIX/BG/5) and thanked all of the Members that had participated in the work of the group through correspondence, teleconference and meetings.

15.6 The Scientific Committee agreed that substantial progress had been made in the consideration of capacity building (see paragraphs 15.9 to 15.12) and that the ad hoc group should continue to focus during 2011 on its second term of reference (SC-CAMLR-XXVIII, paragraph 10.23) resourcing and delivering scientific activities, including field programs, needed for providing advice to the Commission. To facilitate these discussions, the Secretariat was requested to produce a discussion paper on the process for collection, selection and ageing of toothfish otoliths from exploratory fisheries. The Scientific Committee also requested WG-EMM to consider the likely requirements to allow routine processing and analysis of acoustic data from krill fishing vessel surveys, noting that the advice and experience from Norway would be an important part of this discussion.

15.7 Dr Barrera-Oro recalled previous consideration by the Scientific Committee of long-term monitoring of fish populations in Subarea 48.1 that had recently indicated signs of recovery of *Notothenia rossii*, which had been severely overfished in the region in the late 1970s (SC-CAMLR-XXVIII, paragraphs 4.134 and 4.135). In light of these results and in recognition of the local scale of the current research program, Argentina proposed the development of a regional monitoring program to monitor trends in inshore fish populations in Subarea 48.1. Such a program could involve a number of Members with research programs

in this region as the research required relatively simple sampling equipment (inshore gill/trammel nets). Furthermore, such research has been shown to complement the results of offshore fish sampling along the South Shetland Islands because of the inshore/offshore life-cycle phases of the commercially exploited species involved.

15.8 The Scientific Committee welcomed Argentina's offer to coordinate the production of standard sampling and reporting protocols for inshore trammel net surveys in Subarea 48.1. Members with the potential to contribute to this program were encouraged to contact Dr Barrera-Oro.

15.9 The Chair of the Scientific Committee noted the excellent progress in burden sharing, including:

- (i) krill surveys and escape mortality experiments undertaken by Norway (paragraph 3.23);
- (ii) German and Argentine support for krill surveys in Subareas 48.1 and 48.2 (paragraphs 3.25 and 3.26);
- (iii) Argentine gill/trammel net survey in Subarea 48.1 (paragraph 15.7);
- (iv) New Zealand's offer of training courses in the use of CASAL (SC-CAMLR-XXVIII, paragraph 10.20(i)).

#### CCAMLR Scientific Scholarship Scheme

15.10 The Chair of Scientific Committee introduced SC-CAMLR-XXIX/9 which outlined the result of the intersessional discussion of the *ad hoc correspondence group to develop options to build SC-CAMLR capacity in science to support CCAMLR* in respect of the development of the CCAMLR Scientific Scholarship Scheme.

15.11 The Scientific Committee endorsed the terms of the Scholarship Scheme in Annex 9, noting that the objective of the scheme is to contribute to capacity building within the CCAMLR scientific community and to contribute to consistent and high attendance and participation by scientists from all Members and consistent and high-quality scientific advice being provided by the Scientific Committee.

15.12 The Scientific Committee agreed that a review after five years would be appropriate to assess the performance of the scheme and, that while the scheme should be funded from the General Science Capacity Special Fund, the long-term nature of the scheme was dependent on additional funding from the Commission and Members.

15.13 The Scientific Committee expressed its gratitude to the Chair of the Scientific Committee for his leadership in the ad hoc group and the clear presentation of a clear document describing the scheme.

## Intersessional activities during 2010/11

15.14 The Scientific Committee agreed to the following meetings in the 2010/11 intersessional period:

- WG-SAM (Busan, Republic of Korea, 11 to 15 July 2011) (Co-conveners Drs Constable and Jones);
- WG-EMM (Busan, Republic of Korea, 11 to 22 July 2011) (Convener, Dr Watters);
- Workshop on Marine Protected Areas (Brest, France, 29 August to 2 September 2011) (Co-conveners, Dr Penhale and Prof. Koubbi);
- WG-IMAF at CCAMLR Headquarters, Hobart, Australia, from 10 to 14 October 2011 (Convener, Ms K. Rivera (USA));
- WG-FSA at CCAMLR Headquarters, Hobart, Australia, from 10 to 21 October 2011 (Convener, Dr Jones).

15.15 The Scientific Committee endorsed the schedule outlined in paragraph 15.14 and expressed its thanks to both the Republic of Korea and France for their offers to host intersessional meetings.

## Invitation of observers to the next meeting

15.16 The Scientific Committee agreed that all observers invited to the 2010 meeting would be invited to participate in SC-CAMLR-XXX.

15.17 In response to a request from the Secretariat, the Scientific Committee agreed to amend Rule 21 of its Rules of Procedure in order to clarify the period of time Members have to respond to a recommendation from the Chair of the Scientific Committee regarding the participation of an observer not considered at the last meeting of the Scientific Committee under Rule 21(a). The amendments are indicated in bold:

### RULE 21

- (a) The Chairman may, when preparing with the Executive Secretary the preliminary agenda for the meeting of the Scientific Committee, draw to the attention of Members of the Scientific Committee his view that the work of the Scientific Committee would be facilitated by the attendance at its next meeting of an observer referred to in Rule 19, an invitation to which was not considered at the previous meeting. The Executive Secretary shall so inform Members of the Scientific Committee when transmitting to them the Preliminary Agenda under Rule 5;
- (b) Unless a Member of the Committee objects to the participation of an observer no later than 65 days before the beginning of the next meeting, the Executive Secretary shall issue to that observer an invitation to the next meeting of the Scientific Committee. **The Executive Secretary will so inform Members of**

**the Scientific Committee when transmitting to them the Provisional Agenda under Rule 7.** An objection by a Member of the Committee in accordance with this rule shall be considered at an early point during the next meeting of the Committee.

Invitation of observers to working group meetings

15.18 Following a proposal from the USA, the Scientific Committee considered the potential for inviting observers to participate in meetings of its subsidiary working groups. The Scientific Committee agreed that, while this could provide access to additional expertise to the working groups, there would need to be a clear mechanism developed to allow such participation of observers.

15.19 The Convener of WG-EMM offered to lead an intersessional discussion on a potential mechanism to facilitate observer involvement in the working groups and undertook to bring a proposal for evaluation by the Scientific Committee in 2011. The Scientific Committee noted that the issues to be considered would need to include, inter alia:

- the provision for observers not attending some parts of the meeting
- data confidentiality
- the development of management advice to the Scientific Committee.

Invitation of experts to the meetings of working groups

15.20 The Scientific Committee agreed that, where appropriate experts were identified, that these could be invited to participate in working groups and subgroups through consultation with the conveners of those meetings and the Secretariat in respect of budgetary matters.

## ELECTION OF VICE-CHAIR OF THE SCIENTIFIC COMMITTEE

16.1 Dr Bizikov's term as Vice-Chair ended with this meeting and the Scientific Committee sought nominations for a new Vice-Chair. Dr Jones nominated Prof. Koubbi, and this nomination was seconded by Drs B. Sharp (New Zealand) and Parkes. The Scientific Committee unanimously elected Prof. Koubbi to the position for a term of two regular meetings (2011 and 2012) and extended a warm welcome to the incoming Vice-Chair.

16.2 The Scientific Committee thanked Dr Bizikov for his term as Vice-Chair.

## OTHER BUSINESS

17.1 Dr T. Samaai (South Africa) reported that South Africa has continued to research possibilities for a multi-national proposal to the Global Environment Facility (GEF), under its International Waters portfolio (SC-CAMLR-XXIX/BG/4, see also WG-EMM-10/32). The proposal will support science and research in the Southern Ocean, particularly in relation to

capacity building and engagement in CCAMLR initiatives, for Members that are eligible for GEF funding. In the next 12 months, South Africa will continue to engage with other GEF-eligible Members who have expressed an interest to develop a full proposal for submission to the GEF (Argentina, Brazil, Chile, India, Namibia and Uruguay). The full proposal would be submitted to the Scientific Committee, and if possible WG-EMM, for comments and advice in 2011.

17.2 The Scientific Committee endorsed WG-EMM's advice on this proposal (Annex 6, paragraph 6.3), and noted that such a project would build capacity in Antarctic and Southern Ocean science and contribute to research on climate change, large marine ecosystems, conservation planning, oceanographic processes and the management of the krill fisheries in areas beyond national jurisdiction. The Scientific Committee supported this proposal and looked forward to reviewing the full proposal in 2011.

## ADOPTION OF THE REPORT

18.1 The report of the Twenty-ninth meeting of the Scientific Committee was adopted.

## CLOSE OF THE MEETING

19.1 In closing the meeting, Dr Agnew thanked the Conveners of WG-SAM, WG-EMM, WG-FSA, SG-ASAM and ad hoc TASO, all participants for their outstanding work during the meeting and intersessional period, all Secretariat staff for their support, and the interpreters for facilitating the plenary discussions. These contributions had resulted in a very successful meeting.

19.2 Dr Constable and Mr S. Iversen (Norway), on behalf of the Scientific Committee, thanked Dr Agnew for his expertise in leading the Committee's deliberations, including discussions on capacity building and the science scholarship.

19.3 The Scientific Committee also acknowledged Dr Nicol's long-standing contribution to its work in krill research and ecosystem monitoring and management, and wished him every success in his future endeavours.

19.4 The meeting was closed.



Table 2: Preliminary total catch (tonnes) of target species reported in 2009/10 (source: catch and effort reports unless indicated otherwise). Note: the season started on 1 December 2009 and closes on 30 November 2010; catches are those reported to the Secretariat to 24 September 2010, unless indicated otherwise.

| Species                         | Country                     | Subarea/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  |        |         |
| <b>Icefish</b>                  | Australia                   |                  |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       | 365    | 365     |
| <i>Champsocephalus gunnari</i>  | Chile                       |                  |        | 1     |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 1       |
|                                 | EU – Poland                 |                  | <1*    |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | <1      |
|                                 | Norway                      |                  | 1*     |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 1       |
|                                 | UK                          |                  |        | 11    |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 11      |
| Total (icefish)                 |                             | 0                | 0      | 12    | 0    | 0    | 0      | 0      | 0       | 0       | 0       | 0       | 0      | 0      | 365  | 0      | 0    | 0     | 0      | 378     |
| <b>Toothfish</b>                | Australia                   |                  |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       | 1 873  | 1 873   |
| <i>Dissostichus eleginoides</i> | Chile                       |                  |        | 351   |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 351     |
|                                 | EU – France**               |                  |        |       |      |      |        |        |         |         |         |         | 2 977  |        | 512  |        |      |       |        | 3 489   |
|                                 | EU – Spain                  |                  |        | 648   |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 648     |
|                                 | Japan                       |                  |        |       |      |      | 2      |        |         | 2       | 8       | 51      |        |        |      |        |      |       |        | 63      |
|                                 | Korea, Republic of          |                  |        |       |      | 43   |        |        |         |         |         |         |        |        |      |        |      |       |        | 43      |
|                                 | New Zealand                 |                  |        | 336   | 27   |      |        |        |         |         |         |         |        |        |      |        |      | <1    |        | 363     |
|                                 | Russian Federation          |                  |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        |         |
|                                 | South Africa                |                  |        | 179   |      |      |        |        |         |         |         |         |        |        | 6    | 15     |      |       |        | 199     |
|                                 | UK                          |                  |        | 863   | 31   |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 894     |
|                                 | Uruguay                     |                  |        | 145   |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 145     |
| <i>Dissostichus mawsoni</i>     | China, People's Republic of | <1*              |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 0       |
|                                 | Argentina                   |                  |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      | 30    | 8      | 38      |
|                                 | EU – Spain                  |                  |        |       |      |      |        |        |         |         |         |         |        |        |      |        |      | 309   | 42     | 352     |
|                                 | Japan                       |                  |        |       |      | 97   | 86     |        |         | 12      |         |         |        |        |      |        |      |       |        | 196     |
|                                 | Korea, Republic of          |                  |        |       |      | 155  | 108    | 93     |         |         |         |         |        |        |      |        |      | 1 020 | 5      | 1 381   |
|                                 | New Zealand                 |                  |        |       | 31   |      |        |        |         |         |         |         |        |        |      |        |      | 1 310 |        | 1 341   |
|                                 | Russian Federation          |                  | <1*    |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 0       |
|                                 | UK                          |                  |        |       | 26   |      |        |        |         |         |         |         |        |        |      |        |      | 200   | 259    | 484     |
| Total (toothfish)               |                             | <1               | <1     | 2 522 | 114  | 295  | 196    | 93     | 0       | 14      | 8       | 51      | 2 977  | 1 873  | 518  | 15 287 | 0    | 314   | 11 860 |         |
| <b>Krill</b>                    | China, People's Republic of | 77               | 1 879  |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 1 956   |
| <i>Euphausia superba***</i>     | EU – Poland                 | 6 611            | 395    |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 7 007   |
|                                 | Japan                       | 28 924           | 995    |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 29 919  |
|                                 | Korea, Republic of          | 42 140           | 1 665  |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 43 805  |
|                                 | Norway                      | 76 861           | 34 734 | 8 834 |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 120 429 |
|                                 | Russian Federation          |                  | 8 065  |       |      |      |        |        |         |         |         |         |        |        |      |        |      |       |        | 8 065   |
| Total (krill)                   |                             | 154 613          | 47 733 | 8 834 | 0    | 0    | 0      | 0      | 0       | 0       | 0       | 0       | 0      | 0      | 0    | 0      | 0    | 0     | 0      | 211 180 |

(continued)



Table 2 (continued)

| Species               | Country            | Subarea/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 |
| <b>Crab</b>           | Chile              |                  |      | <1*  |      |      |        |        |         |         |         |         |        |        |      |      |      |       | <1   |
| <i>Paralomis</i> spp. | EU – Spain         |                  |      | <1*  |      |      |        |        |         |         |         |         |        |        |      |      |      |       | <1   |
|                       | New Zealand        |                  |      | <1*  |      |      |        |        |         |         |         |         |        |        |      |      |      |       | <1   |
|                       | Russian Federation |                  | <1   | 22   |      |      |        |        |         |         |         |         |        |        |      |      |      |       | 22   |
|                       | UK                 |                  |      | <1*  |      |      |        |        |         |         |         |         |        |        |      |      |      |       | <1   |
|                       | Uruguay            |                  |      | <1*  |      |      |        |        |         |         |         |         |        |        |      |      |      |       | <1   |
| Total (crab)          |                    | 0                | <1   | 22   | 0    | 0    | 0      | 0      | 0       | 0       | 0       | 0       | 0      | 0      | 0    | 0    | 0    | 0     | 22   |

\* Taken as by-catch

\*\* Catch reported in fine-scale data

\*\*\* Catch reported to 24 October

Table 3: Information provided in the notifications for krill fisheries in 2010/11.

| Member | Vessel                  | Expected level of krill catch (tonnes) | Months during which fishing has been notified |      |     |     |     |     |     |     |     |     |     |     | Subareas and/or divisions where fishing has been notified |      |      |      |          |        |
|--------|-------------------------|--|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|------|------|------|----------|--------|
|        |                         |  | 2010  | 2011 |     |     |     |     |     |     |     |     |     |     | 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  | <i>Betanzos</i>         | 16 000                                 | X   | x    | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x    | x    | x    |          |        |
| China  | <i>An Xing Hai</i>      | 5 000                                  | X   | x    | x   | x   | x   | x   |     |     |     |     |     |     | x   | x    | x    |      |          |        |
|        | <i>Kai Li</i>           | 5 000                                  | X   | x    | x   | x   | x   | x   |     |     |     |     |     |     | x   | x    | x    |      |          |        |
|        | <i>Kai Shun</i>         | 5 000                                  | X   | x    | x   | x   | x   | x   |     |     |     |     |     |     | x   | x    | x    |      |          |        |
|        | <i>Kai Xin</i>          | 10 000                                 | X   | x    | x   | x   | x   | x   |     |     |     |     |     |     | x   | x    | x    |      |          |        |
|        | <i>Lian Xing Hai</i>    | 10 000                                 | X   | x    | x   | x   | x   | x   |     |     |     |     |     |     | x   | x    | x    |      |          |        |
| Japan  | <i>Fukuei Maru</i>      | 30 000                                 |   | x    | x   | x   | x   | x   | x   | x   | x   |     |     |     | x   | x    | x    |      |          |        |
| Korea  | <i>Dongsan Ho</i>       | 35 000                                 |   |      | x   | x   | x   | x   | x   | x   | x   | x   | x   |     | x   | x    | x    |      |          |        |
|        | <i>Insung Ho</i>        | 12 000                                 |   |      | x   | x   | x   | x   | x   | x   | x   |     |     |     | x   | x    | x    |      |          |        |
|        | <i>Kwang Ja Ho</i>      | 18 000                                 |   |      | x   | x   | x   | x   | x   | x   | x   |     |     |     | x   | x    | x    |      |          |        |
| Norway | <i>Juvel</i>            | 50 000                                 | X   | x    | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x    | x    |      |          |        |
|        | <i>Saga Sea</i>         | 65 000                                 |   | x    | x   | x   | x   | x   | x   | x   | x   |     |     |     | x   | x    | x    | x    |          |        |
|        | <i>Thorshøvdi</i>       | 60 000                                 | X   | x    | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x    | x    | x    | x        | x      |
| Poland | <i>Dalmor II</i>        | 9 000                                  |   |      | x   | x   | x   | x   | x   | x   | x   |     |     |     | x   | x    | x    |      |          |        |
| Russia | <i>Maksim Starostin</i> | 80 000                                 | X   | x    | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x   | x    | x    |      |          |        |
| Total  | 15 vessels              | 410 000                                | 9   | 11   | 15  | 15  | 15  | 15  | 10  | 10  | 10  | 5   | 5   | 5   | 15  | 15   | 15   | 4    | 1        | 1      |

Table 4: Scientific observations on krill fishing vessels in 2010/11 and 2011/12. X – vessel should carry observers for 100% of the days at sea (20% of hauls observed); \* – vessel name to be advised.

| Season  | Period  | Member: | China             |                   |                  |                 |        | Japan         |                    |
|---------|---------|---------|-------------------|-------------------|------------------|-----------------|--------|---------------|--------------------|
|         |         |         | Vessel:           | C1*               | C2*              | C3*             | C4*    | C5*           | <i>Fukuei Maru</i> |
| 2010/11 | Dec–May |         | X                 | X                 | X                |                 |        |               |                    |
| 2010/11 | Jun–Nov |         |                   | No winter fishing |                  |                 |        | X             |                    |
| 2011/12 | Dec–May |         |                   | See text          |                  |                 |        | X             |                    |
| 2011/12 | Jun–Nov |         |                   | See text          |                  |                 |        |               |                    |
| Season  | Period  | Member: | Republic of Korea |                   |                  | Chile           | Norway | Poland        | Russia             |
|         |         |         | Vessel:           | <i>Dongsan Ho</i> | <i>Insung Ho</i> | <i>Kwang Ja</i> |        | All vessels   |                    |
| 2010/11 | Dec–May |         | X                 | X                 |                  |                 |        | 100% coverage |                    |
| 2010/11 | Jun–Nov |         |                   |                   | X                |                 |        | 100% coverage |                    |
| 2011/12 | Dec–May |         |                   |                   | X                |                 |        | 100% coverage |                    |
| 2011/12 | Jun–Nov |         | X                 | X                 |                  |                 |        | 100% coverage |                    |

Table 5: Summary of information status for the exploratory and closed toothfish fisheries in relation to the information requirements of an exploratory fishery (CM 21-02, paragraph 1). Y – reviewed by WG-FSA/Scientific Committee; X – no review.

| Information requirements                           | Subarea/division |             |             |             |                                |        |                        |             |               |        |
|--|------------------|-------------|-------------|-------------|--------------------------------|--------|------------------------|-------------|---------------|--------|
|  | 48.6             | 58.4.1      | 58.4.2      | 58.4.3a     | 58.4.3b                        | 58.4.4 | Ross Sea (88.1, 882AB) | 88.2 (882E) | 88.2 (882CDG) | 88.3   |
| Toothfish fishery classification                   | Exploratory      | Exploratory | Exploratory | Exploratory | Exploratory (zero catch limit) | Closed | Exploratory            | Exploratory | Exploratory   | Closed |
| Distribution and demography                        | Some             | Some        | Some        | Y           | Y                              | Some   | Y                      | Y           | Some          | Some   |
| Abundance and potential yield                      | X                | Some        | Some        | Some        | X                              | X      | Y                      | Y           | X             | X      |
| Potential impacts on dependent and related species | X                | X           | X           | X           | X                              | X      | Y                      | X           | X             | X      |
| Allow advice on appropriate harvest levels         | X                | Some        | Some        | Some        | X                              | X      | Y                      | Y           | X             | X      |

Table 6: Indicative tagging rate (rounded down to the nearest 5) of *Dissostichus* spp. to be tagged (based on an SSRU-specific mean mass of fish) that may assist vessels in achieving the required tagging rates in exploratory fisheries for *Dissostichus* spp. This could be implemented on the vessel by systematically selecting every *N*th for tagging, noting that if that fish is in poor condition, the next fish in good condition should be tagged instead. Thus, for example, in SSRU 486A every 20th fish should be tagged. Source: C2 data from 2007/08 to 2009/10.

| SSRU   | Mean mass of fish (kg) | Mean number fish per tonne | Required tagging rate (fish tagged per tonne*) | Indicative tagging rate per number of fish ( <i>N</i> ) brought to roller |
|--------|------------------------|----------------------------|--|---|
| 486A   | 16                     | 61                         | 3  | 1 in 20   |
| 486B   | no data                |                            | 3  | -   |
| 486C   | no data                |                            | 3  | -   |
| 486D   | 44                     | 23                         | 3  | 1 in 5  |
| 486E   | 46                     | 22                         | 3  | 1 in 5  |
| 486F   | no data                |                            | 3  | -   |
| 486G   | 25                     | 40                         | 3  | 1 in 10   |
| 5841C  | 33                     | 30                         | 3  | 1 in 10   |
| 5841E  | 33                     | 30                         | 3  | 1 in 10   |
| 5841G  | 37                     | 27                         | 3  | 1 in 5  |
| 5842A  | 44                     | 23                         | 3  | 1 in 5  |
| 5842E  | 26                     | 39                         | 3  | 1 in 10   |
| 5843aA | 9                      | 108                        | 3  | 1 in 35   |
| 5843bA | 24                     | 42                         | 4  | 1 in 10   |
| 5843bC | 35                     | 28                         | 4  | 1 in 5  |
| 5843bD | 34                     | 30                         | 4  | 1 in 5  |
| 5843bE | 32                     | 31                         | 4  | 1 in 5  |
| 881B   | 28                     | 35                         | 1  | 1 in 35   |
| 881C   | 31                     | 32                         | 1  | 1 in 30   |
| 881G   | no data                |                            | 1  | -   |
| 881H   | 24                     | 42                         | 1  | 1 in 40   |
| 881I   | 29                     | 34                         | 1  | 1 in 35   |
| 881J   | 14                     | 71                         | 1  | 1 in 70   |
| 881K   | 23                     | 44                         | 1  | 1 in 40   |
| 881L   | 13                     | 80                         | 1  | 1 in 80   |
| 882C   | no data                |                            | 1  | -   |
| 882D   | 29                     | 35                         | 1  | 1 in 35   |
| 882E   | 35                     | 29                         | 1  | 1 in 25   |
| 882F   | 27                     | 37                         | 1  | 1 in 35   |
| 882G   | 9                      | 112                        | 1  | 1 in 110  |

\* Tonne of green weight caught

Table 7: Indicative program of work for the Scientific Committee for the next three years. Where items of work will contribute towards completion of the Performance Review recommendations, this is indicated. The year in which issues will be addressed is indicated by an 'x' and the group which will be responsible for undertaking the work is indicated in the final column.

|   | PRP report                                      | 2011 | 2012 | 2013 | Work by                                      |
|---|---|------|------|------|--|
| <b>Krill</b>                                      |   |      |      |      |  |
| Feedback management                               | 3.1.2.2, 3.1, 3.2.6                             | x    | x    | x    | EMM/SAM                                      |
| Recruitment variation, $B_0$                      |   | x    | x    | x    | EMM  |
| Fishing vessel survey methods                     |   | x    | x    | x    | EMM  |
| Catch monitoring, escape mortality, green weight  | 3.3.4.2, 3.3.4.3                                | x    | x    | x    | EMM  |
| Spatial distribution                              |   | x    |      |      | EMM  |
| CEMP review and STAPP                             | 3.1.2.2, 3.1.2.3, 3.1.3.2.6, 3.1.3.2.7, 3.2.1.4 | x    | x    |      | EMM  |
| <b>Fish</b>                                       |   |      |      |      |  |
| Biennial assessments                              |   | x    |      | x    | FSA/SAM                                      |
| Other assessments 48.4, 58.5.1                    |   | x    | x    | x    | FSA  |
| By-catch  | 3.1.3.2.1, 3.1.3.2.2                            |      | x    | x    | FSA  |
| Data-poor fisheries                               | 3.1.1.2, 3.1.1.3                                | x    | x    | x    | FSA/SAM                                      |
| Depleted/recovering stocks                        | 3.1.1.1   |      | x    | x    | FSA  |
| Biology and ecology                               |   |      | x    |      | FSA  |
| Ecosystem interactions                            |   |      | x    | x    | FSA/EMM                                      |
| <b>MPA</b>  | 2.4.3.1, 2.4.3.2                                |      |      |      |  |
| MPA workshop                                      |   | x    |      |      | MPA  |
| MPA proposals                                     |   |      | x    |      | EMM  |
| Recommendations                                   |   |      | x    |      | EMM  |
| <b>Incidental mortality</b>                       |   | x    |      | x    |  |
| <b>Observers</b>                                  |   |      |      |      |  |
| Accreditation                                     | 3.3.4.1   | x    | x    | x    | Review panel correspondence (paragraph 7.12) |
| General advice on sampling                        | 3.3.4.2   |      |      |      |  |
| <b>VME</b>  |   |      |      |      |  |
| Outstanding future work (Annex 8, paragraph 9.37) |   |      | x    |      | FSA  |
| Modelling   |   |      |      | x    | SAM  |
| CM 22-06  |   | x    | x    | x    | EMM  |
| Review and update of impact assessments           |   | x    | x    | x    | FSA  |
| Method assessment for all bottom methods          |   |      | x    |      | FSA  |
| Climate change                                    | 3.5.2.2   |      |      | x    | EMM  |

2011  
 SAM coincident with EMM  
 EMM 2 weeks  
 FSA 2 weeks  
 IMAF 1 week  
 MPA 1 week

Table 8: Scientific Committee budget for 2011 and forecast budget for 2012.

| 2010 Budget<br>A\$ |               | Item  | 2011 Budget<br>A\$ | 2012 Forecast<br>A\$ |
|--------------------|---------------|---|--------------------|----------------------|
| Draft              | Revised       | <b>WG-SAM</b>   |                    |                      |
| 6 400              | 20 000        | Secretariat support and participation costs                 | 27 000             | 27 800               |
| 21 700             | 22 000        | Report completion and translation                           | 22 700             | 23 400               |
| <u>28 100</u>      | <u>42 000</u> |   | 49 700             | 51 200               |
|                    |               | <b>WG-EMM</b> <i>Costs dependent on location of meeting</i> |                    |                      |
| 88 600             | 28 000        | Secretariat support and participation costs                 | 32 000             | 33 300               |
| 43 300             | 35 000        | Report completion and translation                           | 36 200             | 37 300               |
| <u>131 900</u>     | <u>63 000</u> |   | 68 200             | 70 600               |
|                    |               | <b>WG-FSA</b>   |                    |                      |
| 6 000              | 0             | Computing facilities  | 0                  | 0                    |
| 21 000             | 0             | Secretariat support   | 0                  | 0                    |
| 62 200             | 62 200        | Report completion and translation                           | 64 100             | 66 000               |
| <u>89 200</u>      | <u>62 200</u> |   | 64 100             | 66 000               |
|                    |               | <b>WG-IMAF</b> <i>held in conjunction with WG-FSA</i>       |                    |                      |
| 0                  | 0             | Secretariat support   | 0                  | 0                    |
| <u>0</u>           | <u>0</u>      | Report completion and translation                           | 15 500             | 0                    |
|                    |               |   | 15 500             | 0                    |
|                    |               | <b>SG-ASAM</b>  |                    |                      |
| 6 200              | 21 500        | Secretariat support and participation costs                 | 0                  | 22 700               |
| 8 600              | 15 000        | Report completion and translation                           | 0                  | 16 000               |
| <u>14 800</u>      | <u>36 500</u> |   | 0                  | 38 700               |
|                    |               | <b>Ad hoc TASO</b>  |                    |                      |
| 12 500             |               | Secretariat support and participation costs                 |                    |                      |
| 27 500             | 15 000        | Report completion and translation                           |                    |                      |
| <u>40 000</u>      | <u>15 000</u> |   |                    |                      |
|                    |               | <b>Other expenses for Scientific Committee program</b>      |                    |                      |
| 32 500             | 0             | External experts invited to meetings                        | 34 000             | 35 000               |
| 6 000              | 6 000         | Education and outreach materials                            | 6 000              | 6 200                |
| 0                  | 0             | International Fisheries Observer Conference                 | 10 000             | 0                    |
| <u>5 000</u>       | <u>0</u>      | <b>Contingency</b>  | 5 000              | 5 000                |
| 347 500            | 224 700       |   | 252 500            | 272 700              |

Special Funds

| 2010 Budget<br>A\$ |  | Item  | 2011 Budget<br>A\$ | 2012 Forecast<br>A\$ |
|--------------------|--|---|--------------------|----------------------|
|                    |  | <b>Workshop on MPAs*</b>                    |                    |                      |
|                    |  | Secretariat support and participation costs | 22 500             |                      |
|                    |  | Report completion and translation #         | 15 500             |                      |
|                    |  | Invited experts                             | 25 000             |                      |
|                    |  |   | <u>63 000</u>      |                      |

\* These are indicative based on a meeting in France supported by two Secretariat staff.

# The timing of the meeting means that outsourcing of translation may be required.





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Ms Lucy Barúa  
Ms Rosemary Blundo-Grimison  
Ms Sabine Bouladon  
Ms Vera Christopher  
Ms Joëlle Coussaert  
Mr Vadim Doubine  
Dr Sandra Hale  
Mr Alexey Ivacheff  
Ms Isabel Lira  
Mr Marc Orlando  
Mr Peter Peterson  
Dr Ludmila Stern  
Mr Philippe Tanguy  
Ms Irene Ulman  
Ms Roslyn Wallace  
Dr Emy Watt



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| SC-CAMLR-XXIX/3  | Report of the Working Group on Ecosystem Monitoring and Management<br>(Cape Town, South Africa, 26 July to 3 August 2010)  |
| SC-CAMLR-XXIX/4  | Report of the Working Group on Fish Stock Assessment<br>(Hobart, Australia, 11 to 22 October 2010)   |
| SC-CAMLR-XXIX/5  | Report of the Working Group on Statistics, Assessments and Modelling<br>(Cape Town, South Africa, 19 to 23 July 2010)  |
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| CCAMLR-XXIX/BG/20 | CCAMLR's role in combating IUU fishing in the Southern Ocean and globally<br>Submitted by ASOC   |
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| CCAMLR-XXIX/BG/44           | New and revised conservation measures recommended by<br>SCIC for adoption by the Commission  |
| CCAMLR-XXIX/BG/45<br>Rev. 1 | Proposals for new and revised conservation measures<br>forwarded by SCIC to the Commission for further<br>consideration  |
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WG-FSA-10/7

Development of the VME registry  
Secretariat

WG-FSA-10/P1

At-sea distribution and diet of an endangered top predator:  
links of white-chinned petrels with commercial longline  
fisheries  
K. Delord, C. Cotté, C. Péron, C. Marteau, P. Pruvost,  
N. Gasco, G. Duhamel, Y. Cherel and H. Weimerskirch  
(France)

**AGENDA FOR THE TWENTY-NINTH MEETING  
OF THE SCIENTIFIC COMMITTEE**



## **AGENDA FOR THE TWENTY-NINTH MEETING OF THE SCIENTIFIC COMMITTEE**

1. Opening of meeting
  - (i) Adoption of agenda
  - (ii) Chair's Report
  
2. Advances in statistics, assessments, modelling, acoustics and survey methods
  - (i) Statistics, assessments and modelling
  - (ii) Acoustic survey and analysis methods
  - (iii) Advice to Commission
  
3. Harvested species
  - (i) Krill resources
    - (a) Status and trends
    - (b) Ecosystem effects of krill fishing
    - (c) Advice to Commission
  
  - (ii) Fish resources
    - (a) Status and trends
    - (b) Advice from WG-FSA
    - (c) Advice to Commission
  
  - (iii) Crab resources
    - (a) Status and trends
    - (b) WG-FSA advice
    - (c) Advice to Commission
  
  - (iv) Fish and invertebrate by-catch
    - (a) Status and trends
    - (b) WG-FSA advice
  
  - (v) New and exploratory finfish fisheries
    - (a) New and exploratory fisheries in 2009/10 season
    - (b) Notifications for new and exploratory fisheries in 2010/11 season
    - (c) Advice to Commission
  
4. Incidental mortality arising from fishing operations
  - (i) Marine debris
  - (ii) Incidental mortality of seabirds and marine mammals associated with fisheries
  - (iii) Advice to Commission
  
5. Spatial management of impacts on the Antarctic ecosystem
  - (i) Bottom fishing and vulnerable marine ecosystems
    - (a) Status and trends
    - (b) Advice to Commission

- (ii) Marine Protected Areas
    - (a) Scientific analysis of proposals for MPAs
    - (b) Advice to Commission
- 6. IUU fishing in the Convention Area
- 7. CCAMLR Scheme of International Scientific Observation
  - (i) Scientific observations
  - (ii) Advice to Commission
- 8. Climate change
- 9. Scientific research exemption
- 10. Cooperation with other organisations
  - (i) Cooperation with Antarctic Treaty System
    - (a) Committee for Environmental Protection
    - (b) Scientific Committee for Antarctic Research
  - (ii) Reports of observers from other international organisations
  - (iii) Reports of representatives at meetings of other international organisations
  - (iv) Future cooperation
- 11. Performance Review
- 12. Budget for 2011 and forecast budget for 2012
- 13. Advice to SCIC and SCAF
- 14. Secretariat supported activities
- 15. Scientific Committee activities
  - (i) Priorities for work of Scientific Committee and its working groups
  - (ii) Intersessional activities
  - (iii) Invitation of observers to next meeting
  - (iv) Invitation of experts to meetings of working groups
  - (v) Next meeting
- 16. Election of Vice-Chair
- 17. Other business
- 18. Adoption of report of Twenty-ninth Meeting
- 19. Close of meeting.



**REPORT OF THE WORKING GROUP ON  
STATISTICS, ASSESSMENTS AND MODELLING**  
(Cape Town, South Africa, 19 to 23 July 2010)



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**REPORT OF THE WORKING GROUP ON  
STATISTICS, ASSESSMENTS AND MODELLING**  
(Cape Town, South Africa, 19 to 23 July 2010)

## INTRODUCTION

### Opening of the meeting

1.1 The fourth meeting of WG-SAM was held at the National Research Aquarium, Cape Town, South Africa, from 19 to 23 July 2010. The meeting was convened by Dr A. Constable (Australia) and local arrangements were coordinated by Mr J. Khanyile, Department of Environmental Affairs (DEA), South Africa. The meeting was opened by Dr M. Mayekiso, Deputy-Director General, DEA.

1.2 Dr Constable thanked Dr Mayekiso for his warm welcome, and the South African Government for hosting the meeting. Dr Constable also welcomed the participants (Appendix A), and, given the increasing number of young scientists, thanked Members for their support of the meeting and of the Scientific Committee's capacity building effort.

### Adoption of the agenda and organisation of the meeting

1.3 The agenda, as amended, was adopted (Appendix B).

1.4 Documents submitted to the meeting are listed in Appendix C; WG-EMM-10/33 was included at the start of the meeting for consideration during the discussion on VMEs. 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 8.

1.6 The report was prepared by Drs S. Candy (Australia) and Constable, Mr A. Dunn (New Zealand), Drs C. Edwards (UK), C. Jones (USA), S. Kasatkina (Russia), S. Kawaguchi (Australia), M. Kiyota (Japan), S. Parker (New Zealand), D. Ramm (Data Manager), K. Reid (Science Officer), B. Sharp (New Zealand), D. Sologub (Russia), G. Watters (USA) and D. Welsford (Australia).

## KRILL

### Integrated assessment of krill

2.1 The Working Group agreed that the development of an integrated assessment for krill was highly desirable. The current approach using the GYM does not incorporate information

from all the data that are currently available; e.g. it does not address ongoing trends in the fishery, changes in the demography of krill (potentially associated with climate change) and does not include data from annual krill monitoring.

2.2 Dr Watters informed the Working Group that the US AMLR Program has committed resources to developing an integrated assessment of krill based initially on the data collected as part of the US AMLR Program in Subarea 48.1, but aiming to be sufficiently general so that data collected by other Members working in other subareas could be used to expand the scope of the work. These data include acoustic surveys, net tow samples, krill predator diet samples and indices of predator performance. In addition, at-sea distributions of predators may also be useful in indicating spatial differences in predation mortality.

2.3 The Working Group recommended that an integrated assessment for krill be developed with consideration given to the following issues:

- (i) it should proceed in a stepwise fashion with increasing levels of complexity added over time;
- (ii) it should be based on clearly defined stock hypotheses;
- (iii) the utility of CPUE data from the fishery in assisting the calibration of the population model should be investigated, particularly in areas of Area 48 which have limited research survey data;
- (iv) the assessment will need to include methods for accounting for different selectivity patterns associated with survey efforts, the fishery and krill predators;
- (v) the information content or utility of different datasets and their exclusion or inclusion needs to be considered in an iterative cycle of data preparation, model fitting and model evaluation.

## Krill observer program

### Background and papers

2.4 WG-EMM requested that WG-SAM provide advice on:

- (i) an appropriate estimation structure of an integrated krill assessment that might utilise observer-derived data on krill length, which could be used to evaluate the efficacy of the observer program;
- (ii) how the accuracy and precision of quantities estimated in the observer program influence assessment outputs, and hence the extent to which different levels of observer coverage will improve assessments;
- (iii) a provisional observer program that could be used in the interim and to help design the observer program in the longer term;

so that a well-designed program for systematic observer coverage in the krill fishery can be adopted at SC-CAMLR-XXIX in 2010 (SC-CAMLR-XXVIII, Annex 4, paragraph 3.60).

2.5 WG-SAM-10/10 presented some important factors related to the collection of krill size-frequency data that need to be considered in designing an observer program for the krill fishery. WG-SAM-10/17 reported on an analysis of krill mean length and fish by-catch for the Japanese krill fishery and examined the impact of observer coverage levels across different factors such as vessels, subareas and years on CVs. Agnew et al. (2010) presented another analysis of observer data and proposed appropriate levels of observer coverage based on data from Subarea 48.3.

## Discussion

2.6 The Working Group recommended that WG-EMM should consider the following discussion in its deliberations on the krill observer program.

2.7 The Working Group noted that sampling the size structure of krill in the catch by the fishery (a primary task for scientific observers) helps to estimate size-specific fishing mortality rates, while inferences about the demographic structure from which that catch was taken would be developed from an integrated assessment model.

2.8 In discussion of Agnew et al. (2010) the Working Group agreed that, based on currently available data, observer coverage of 50% of vessels each year and 20% of hauls, with all vessels being observed at least once every two years, was sufficient to estimate mean krill length and total number of fish larvae by-catch in Subarea 48.3 with an acceptable level of precision.

2.9 The Working Group further agreed that while the levels of coverage described in paragraph 2.8 were appropriate for the current fishery in Subarea 48.3, which is a winter fishery, different levels of coverage in space and time are likely to be necessary for accurate estimation of parameters for other areas and at different times of year.

2.10 Since variation of krill population parameters may differ between areas and time of year, required observer coverage to achieve the precision of parameters of interest may also differ across area and time. Those areas with high variability may need higher coverage than other areas with low variability.

2.11 Considering the requirement for systematic observer coverage of 50% in 2010/11 for Area 48 (Conservation Measure 51-06), and noting that increased coverage is required in time–area strata where variability in the quantities being observed (e.g. krill length) is greatest, the Working Group recommended that WG-EMM develop a table indicating time–area strata where variability is highest and, thus, higher observer coverage is required. This table is expected to provide useful guidance for how a systematic program of observer coverage can be optimised to yield data that would be most useful in an assessment.

2.12 The Working Group further noted that the current instructions in the CCAMLR *Scientific Observers Manual* were not designed to account for vessel and haul coverage trade-offs. The Working Group advised that WG-EMM should consider whether the current level of haul sampling should be revised given different levels of vessel coverage.

2.13 In the analysis of observer coverage from the Japanese krill fishery, increased coverage across vessels caused the largest reductions in CV (increases in precision) for both krill mean length and fish by-catch (WG-SAM-10/17). The Working Group noted that the outcome of the analysis presented in WG-SAM-10/17 could have been influenced by the hierarchical structure of the model, suggested the use of linear mixed models to address this issue and encouraged reanalysis in which year, subarea and vessel effects are crossed while haul effects are nested within vessels.

2.14 The Working Group noted that while the analyses of Agnew et al. (2010) and WG-SAM-10/17 considered mean lengths of krill as the statistic of interest, it is likely that the overall population structure of krill in the catch would be of interest in an integrated assessment, and that this may require increased levels of sampling.

2.15 The Working Group recalled that the current requirement (in the *Scientific Observers Manual*) for sampling krill length frequencies by observers was determined through analysis of the overall length-frequency distribution (not the mean), using observer data collected in Subarea 48.3 (WG-EMM-08/45).

2.16 The Working Group agreed that estimating the total mortality of each length class of krill arising from fishing would require information on the landed catch, conversion factors, escape mortality and the mass-at-length of krill sampled during the period of fishing.

2.17 The Working Group also recalled its earlier agreement that an integrated assessment for krill would require a time series of data from the krill fishery (SC-CAMLR-XXVI, Annex 7, paragraph 3.13) and noted that any delay in acquiring data, such as length frequencies from systematic coverage of the krill fishery, would delay the implementation of an integrated assessment and the provision of updated management advice.

2.18 The Working Group also recalled that the best scientific advice remained that, in areas where appropriate levels of observer coverage has not yet been determined, 100% observer coverage in the short term was the best way to achieve systematic observer coverage (SC-CAMLR-XXVI, paragraph 3.10). An analysis of the data from Subarea 48.3 (Agnew et al., 2010) had also demonstrated that after about four years of coverage at higher levels, it was possible to decide on appropriate levels of observation over the longer term.

2.19 The Working Group agreed that it would not be in a position to provide more advice on designing the krill observer program until such time as new data are available and further statistical work to design the program has been undertaken.

## Krill escape mortality

### Background and papers

2.20 The Working Group recalled that the level of escape mortality in the krill fishery is a matter of concern for assessments and catch allocation schemes. At present, there are few available estimates of krill escape mortality, and these estimates are based on very little data. The Working Group noted that the Scientific Committee had recommended that there should be a concerted effort to estimate escape mortality in the krill fishery (SC-CAMLR-XXVIII, Annex 4, paragraphs 3.5 and 3.6). WG-SAM-10/6 was presented to address this task.



## Discussion

2.21 The Working Group welcomed WG-SAM-10/6 in which the recommendations to the field study of the krill escape mortality, including data collection and processing, are shown. This document would be useful to facilitate the development of an operating manual that could be used to collect relevant data by scientific observers. Elaborating a standard approach to collecting data on escape mortality will ultimately improve estimation of this quantity.

2.22 The Working Group recommended that the issues of escape mortality assessment described in WG-SAM-10/6 should be further discussed by WG-EMM.

2.23 The Working Group also recommended continuing development of a manual for collecting standardised data on escape mortality assessment, noting that such a manual and its implications for the workload of scientific observers should ultimately be considered by ad hoc TASO.

## Fishable biomass

### Background and paper

2.24 It is important to understand how a potential subdivision of the precautionary catch limit for krill among SSMUs or other areas will affect fishery performance. One metric of risk to fishery performance would describe how the spatial distribution of fishable biomass (biomass that is of interest to the fleet) relates to overall biomass that might, for example, be estimated from the results of a research survey. WG-SAM-10/7 Rev. 1 presented the method for assessment of fishable krill biomass at different density thresholds by processing acoustic survey data.

## Discussion

2.25 The Working Group noted that analyses presented in WG-SAM-10/7 Rev. 1 suggest that krill biomass available to the fishery is concentrated in small areas and constitutes only part of the total biomass concentrated within coastal SSMUs (SGW, SGE) in Subarea 48.3. The ratio between fishable biomass and total krill biomass may vary considerably by years and SSMUs, reflecting interannual fluctuations in the structure of the krill-density field, and estimation of fishable biomass should be considered relative to threshold krill densities that determine the efficiency of the fishery.

2.26 The Working Group recommended continuing investigation of the distribution of fishable biomass at the different threshold krill densities relative to fishery performance.

## Use of acoustics data collected from exploratory krill fisheries as relative indices of abundance

2.27 Although WG-EMM had asked the Working Group to advise on how acoustics data collected from exploratory krill fisheries (under the terms of Conservation Measure 51-04) could be used as relative indices of abundance, WG-SAM was not provided any information that could be used to form the basis of such advice. It was noted that WG-EMM had requested such advice under the expectation that during 2009/10, an exploratory krill fishery would occur in Subarea 48.6 and data would be available for analysis and consideration by WG-SAM. Exploratory fishing for krill in Subarea 48.6 has not occurred, and, therefore, the Working Group advised that it would reconsider this issue at a later date, after acoustics data from krill fishing vessels had been submitted for analysis.

## FINFISH

### Strategies for assessing data-poor fisheries

3.1 Robust assessments of toothfish stocks in Subareas 48.6 and 58.4 have been hindered by a lack of data that can be used to characterise the distribution, abundance and productivity of these stocks. Divisions in Subarea 58.4 have also been subject to significant IUU fishing (SC-CAMLR-XXVIII, Annex 5, Table 3). The Working Group noted that the Scientific Committee has expressed concern that the current approach to collecting data in exploratory fisheries outside the Ross Sea was unlikely to result in assessments in the near future, making it urgent to develop approaches that will deliver assessments within the next 3–4 years (SC-CAMLR-XXVIII, paragraphs 4.164 and 4.165).

3.2 The Working Group considered two items under this agenda item:

- (i) reviewing the use of research hauls in exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4, completed as part of the Research and Data Collection Plan;
- (ii) data collection and assessment strategies for data-poor fisheries.

### Use of research hauls in exploratory fisheries for *Dissostichus* spp.

#### Background and papers

3.3 The Working Group noted that standardised CPUE data may assist with assessing distribution and abundance in data-poor fisheries in Subareas 48.6 and 58.4. Since 2008/09, vessels have been required to complete five research hauls in each of two strata (fished and unfished or lightly fished) to assist with developing a comprehensive picture of relative abundance within an SSRU.

3.4 The Working Group considered WG-SAM-10/4, which summarised the implementation of research hauls in the exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 in the 2009/10 season. The Working Group noted that in most

instances, vessels had successfully completed research hauls within the allocated locations across fished and unfished/lightly fished strata. The Working Group further noted that some hauls could not be completed in some allocated locations due to sea-ice, and subsequently lines could only be set in ice-free areas, some of which were set in depths >2 500 m.

## Discussion

3.5 The Working Group recalled its discussion on the allocation of the location of research hauls at its last meeting (SC-CAMLR-XXVIII, Annex 6, paragraphs 2.56 to 2.61). It reiterated its advice that this method continue to be used (ibid., paragraph 2.58), to maximise the utility and comparability of the data being collected.

3.6 The Working Group also considered ways to alleviate fishing vessels' difficulties in reaching allocated research haul locations in ice-bound areas. It agreed that the current single allocation of starting positions could be augmented in areas of sea-ice by providing each vessel with up to three random lots of start positions for the required research hauls in a given SSRU. These options would be provided by the Secretariat, on request from the Flag State or its vessel, immediately prior to the vessel's arrival at the SSRU. The vessel could then choose the option which best suited the local sea-ice conditions, and subsequent research hauls would be conducted using the current agreed procedure.

3.7 The Working Group also recalled its advice on the need to be able to standardise CPUE across gear types in order to allow robust comparison of CPUE within and between areas (SC-CAMLR-XXVIII, Annex 6, paragraphs 2.43 to 2.46).

3.8 The Working Group noted that, in calculating catch rates, it is important to consider the number of hooks retrieved as the measure of effort, rather than the number of hooks set, where large numbers of hooks or sections of line are lost. The Working Group noted that a field to record the number of lost hooks on lost line segments had been included on C1 forms in 2007/08 (SC-CAMLR-XXVI, Annex 5, paragraph 7.5).

3.9 The Working Group requested WG-FSA to review the data collected from research hauls to date to determine:

- (i) Is there sufficient spatial and temporal overlap in research hauls such that a CPUE standardisation (accounting for, inter alia, the effect of vessel, gear type and line orientation to bathymetry) will be possible in the near future?
- (ii) Is there further stratification of research hauls (e.g. to account for areas where sea-ice may be a problem) required to ensure data collected during research hauls can be used to estimate abundance, distribution and population dynamics of toothfish in Subareas 48.6 and 58.4 in the near future?

## Data collection and assessment strategies for data-poor fisheries

### Background and papers

3.10 The southern SSRU of BANZARE Bank (SSRU B, Division 58.4.3b) was closed in 2007 due to concerns about the status of these stocks and their ability to sustain fishing (CCAMLR-XXVI, paragraph 12.8). The Scientific Committee was unable to provide consensus advice of the status of toothfish in the open SSRUs of this division in 2009 (SC-CAMLR-XXVIII, paragraph 4.203).

3.11 Conservation Measure 41-07 required nominated Members to fish across four quadrants of a gridded survey area in Division 58.4.3b in 2009/10. Japan completed the southeast quadrant of the survey area. However, despite initially indicating their intention to do so, the other nominated Members were not able to participate in the survey.

3.12 WG-SAM-10/13 summarised data on *Dissostichus* spp. collected by the *Shinsei Maru No. 3* in a grid survey on BANZARE Bank (Division 58.4.3b) in 2009/10. WG-SAM-10/16 summarised data on *Dissostichus* spp. collected by the *Shinsei Maru No. 3* in the exploratory fishery on BANZARE Bank (Division 58.4.3b).

3.13 Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b) were closed in 2002/03 due to the Scientific Committee's concerns regarding the low levels of the toothfish stock and the high level of IUU fishing (CCAMLR-XXI, paragraph 11.36).

3.14 Japan carried out a research survey on Ob and Lena Banks in 2007/08. It also conducted a modified survey across Ob and Lena Banks in 2009/10.

3.15 WG-SAM-10/14 summarised data collected by the *Shinsei Maru No. 3* in a grid survey of Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b) in 2009/10. WG-SAM-10/15 summarised a proposal to continue survey work by the *Shinsei Maru No. 3* on Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b) in 2010/11.

3.16 The Working Group recommended that WG-SAM-10/13 to 10/16 be considered in full by WG-FSA at its next meeting. The Working Group confined its discussions to the methodological elements of WG-SAM-10/13 and 10/15.

### Discussion

3.17 The Working Group noted the distinction between the current management arrangements for the exploratory fishery on BANZARE Bank (Division 58.4.3b) and the closed fishery on Ob and Lena Banks (Divisions 58.4.4a and 58.4.4b). However, it considered that there were general points of discussion that would be relevant to research conducted in any data-poor fishery.

3.18 The Working Group noted that the survey design implemented in Conservation Measure 41-07 in 2009/10 had not been reviewed by any of the working groups. A lack of clarity on the objectives of the survey, and the lack of participation by Members in completing the sampling grid made it difficult to identify how the data resulting from this

survey would contribute to developing an assessment in this division. For example, some overlap between the areas of the survey grid allocated to vessels would have assisted with standardising the catch rate across the vessels participating.

3.19 The Working Group recalled its advice that the best way to estimate stock size in data-poor areas was to carry out a tagging program (SC-CAMLR-XXVIII, Annex 6, paragraph 2.34). It also recalled that stock assessments had successfully been developed where focused tagging programs had been pursued, such as in Subareas 48.4 and 88.1 where tagging rates of up to 5 fish per tonne green weight caught had been achieved.

3.20 The Working Group recalled its previous advice regarding the characteristics of a well-designed research program (SC-CAMLR-XXVIII, Annex 6, paragraphs 2.34 to 2.40), and requested that WG-FSA also consider the following points in assessing any research survey design:

- (i) research fishing operations should attempt to minimise the injury or mortality of all size classes of fish to provide the maximum number of fish suitable for tagging and release;
- (ii) lines set should be of an appropriate length to ensure that lines do not overlap strata or extend across large bathymetric ranges.

3.21 The Working Group further recalled its advice that where the area being studied is large and the probability of recapture is low, research should concentrate effort on a subset of the management area. In such a case it would be important to recognise that estimates of abundance resulting from the work would be representative of the smaller area. The tagging effort might be extended more widely in future years, subject to review (SC-CAMLR-XXVIII, Annex 6, paragraph 2.35(i)).

3.22 The Working Group noted that there was currently no data to determine if tagged fish are more likely to survive the capture, tagging and release process from particular gear types (e.g. autoline, Spanish line or trotline). The Working Group requested that ad hoc TASO consider the feasibility of collecting such data.

3.23 The Working Group recalled its advice that other data would be required to perform a stock assessment, including reconstructing the legal and IUU catch history, analysing otoliths to determine catch-at-age and growth rates, and the collection of other biological data important to an assessment such as size-at-maturity (SC-CAMLR-XXVIII, Annex 6, paragraph 2.39).

3.24 The Working Group noted that WG-SAM-10/15 included a calculation of biomass on Ob and Lena Banks based on a comparison between relative catch rates and fishable seabed areas, and the biomass estimated in the assessment of Subarea 48.4 (SC-CAMLR-XXVIII, Annex 5, Appendix M). The Working Group noted that several implicit assumptions of this calculation (including similar catchability of autolines deployed at Subarea 48.4 and Spanish longlines deployed at Divisions 58.4.4a and 58.4.4b, similar size distributions in both areas and similar proportions of the total biomass that are mature in both areas) should be evaluated by WG-FSA in deciding if this method is appropriate for determining preliminary biomass estimates. The Working Group encouraged Members to consider simulation work to determine the effect that violating these assumptions may have on the biomass calculated.

3.25 The Working Group noted that in the absence of a robust method for estimating biomass in an area from longline catch rate alone, it is very difficult to estimate a precautionary level of research catch. Furthermore, without a minimum estimate of biomass, it is very difficult to determine a total number of tags to release, or a tagging rate, to achieve a biomass estimate with a target CV, following the method recommended by the Working Group in the past (SC-CAMLR-XXVIII, Annex 6, paragraph 2.35(i)), and implemented in WG-SAM-10/15.

3.26 The Working Group recalled that established methods exist for calculating abundance from trawl surveys, such as used for icefish in Subarea 48.3 and icefish and toothfish in Division 58.5.2 (SC-CAMLR-XXVI, Annex 5, Appendices O, R and S). When evaluating proposals for tag-recapture programs or longline surveys, such as in WG-SAM-10/15, the Working Group requested that WG-FSA consider the possibility of using a trawl survey to establish a preliminary biomass estimate that could then inform the design of a longer-term tagging program.

3.27 The Working Group agreed that its discussions in recent meetings had provided general advice on the methodologies that could be applied to collect data and develop robust assessments for data-poor fisheries in Subareas 48.6 and 58.4. The Working Group encouraged Members to continue to submit papers developing and evaluating methods of assessing data-poor fisheries; however, it considered that there was no need for a standing item on this topic on the Working Group's agenda.

#### Natural mortality of toothfish

3.28 WG-SAM-10/11 Rev. 1 described two models for estimation of  $M$  using catch-at-age and aged release-recapture data, the BODE (Baranov ordinary differential equation) and CCODE (constant within-year catch ordinary differential equation) models. The paper described the results of the application of the models using a realistic simulation framework involving multiple years of releases and all relevant cohorts. The paper concluded that the CCODE model performed better in general than the BODE model. In scenarios where non-domed selectivities were assumed, the CCODE model gave close to unbiased and reasonably precise estimates of  $M$ .

3.29 The Working Group noted that the CCODE model did not account for the fact that catch-at-age is not known exactly, but when applied in practise will be based on catch weight combined with the usual annual length frequency and otolith sampling. However, the Working Group also noted measurement and estimation error relating to weight-to-length conversion and ageing error adds uncertainty. The BODE model assumed the estimation errors are purely 'process' errors (i.e. model lack-of-fit) and hence does not decompose the total variance into the appropriate contributions from the different sources of error. Even though the catch weights in total represent a census which can be assumed to be known exactly, both BODE and CCODE models are approximations given the actual uncertainties in the catch-at-age data.

3.30 The Working Group noted that IUU catch is not accounted for by either model and it is not clear how this catch can be validly accounted for in these models.

3.31 The Working Group noted that the BODE model can give poor estimates of the total catch, and suggested that this might be addressed by modelling the catch-at-age as proportions, with the total catch used as a constraint.

3.32 The Working Group recalled that the estimates of  $M$  used for the *Dissostichus eleginoides* assessments in Division 58.5.2 and Subarea 48.3 are assumed to be  $0.13 \text{ y}^{-1}$ . The value was based on consideration of Beverton-Holt invariants presented in WG-FSA-05/18. The estimate of  $M$  used for *D. mawsoni* is also  $0.13 \text{ y}^{-1}$ , but this value was based on an analysis of catch-curve data from the Ross Sea fishery using the Chapman-Robson estimator (WG-FSA-SAM-06/8).

3.33 The Working Group noted the intention of Dr Candy to investigate each of the BODE and CCODE models in the estimation of  $M$  for Division 58.5.2 toothfish in order to evaluate the performance of these models in providing realistic estimates of  $M$  and the uncertainty of these estimates. The Working Group encouraged Members to investigate refinements to the data and methods for estimating  $M$ .

#### Age- versus length-based harvest control rules

3.34 WG-SAM-10/12 compared age- and length-based HCRs for icefish in South Georgia, to determine whether the length-based approach could be reliably used to generate catch recommendations. An age-based operating model was used to generate a distribution of initial numbers-at-age to which an age-based HCR (which implemented the operating model and therefore reproduced the underlying population dynamics exactly) was applied. The initial numbers-at-age were also converted to numbers-at-length, and two length-based HCRs applied. The length-based methods used two different length-transition matrices described in Hillary (2010) and Punt et al. (1997).

3.35 The Working Group noted that estimates of catch limits from the age- and length-based HCRs were essentially the same in the first year, with the length-based methods more conservative in the second year. Both length-based HCRs (using the different length transition matrices) produced comparable results.

3.36 The Working Group concluded that the length-based approach, with the method described in Hillary (2010) of generating the length transition matrix, was suitable for determining catch limits.

3.37 The Working Group recommended that the code be validated and a worked example be provided and verified for WG-FSA-10. The worked example will be undertaken by the authors of WG-SAM-10/12, while Dr Candy volunteered to undertake the validation.

3.38 The Working Group noted that the method will be further evaluated as part of a wider study on management strategies in icefish in the near future.

## Minimally realistic food-web modelling

3.39 The Working Group considered WG-SAM-10/21 describing the conceptual basis of work in progress to produce a minimum realistic model for investigating trophic relationships between *D. mawsoni* and its demersal fish prey on the Ross Sea slope, some of which are also caught as by-catch by the fishery. The model is intended as a tool to generate plausible hypotheses regarding trophic interactions between demersal fish, and to examine the potential for trophic impacts associated with changes in abundance arising from the fishery. The Working Group welcomed work to progress the model and encouraged its authors to seek collaboration with other interested Members.

## VULNERABLE MARINE ECOSYSTEMS

### VME modelling and evaluation tools

4.1 WG-SAM-10/19 described a spatially explicit Schaeffer production model designed to be used to simulate key processes of VME taxa population dynamics and bottom fishing effort, and to evaluate the effects of various management strategies. The paper included case studies using actual fishing effort distributions in the Ross Sea region, and projecting similar future effort patterns, to simulate impacts on VME taxa under different management strategies. VME taxa were distributed spatially with reference to hypothetical depth preferences and to the benthic bioregionalisation described in WG-EMM-10/30. Management strategy options considered in the case studies included no management and a move-on rule similar to that prescribed in Conservation Measure 22-07 but with alternate by-catch trigger thresholds and alternate areal closure sizes.

4.2 The Working Group welcomed the development of the model and recommended further development to evaluate strategies for avoiding significant adverse impacts on VMEs.

4.3 WG-SAM-10/9 described version 2 of Patch, a simulation model in R for evaluating spatial management strategies to conserve the structure and function of ecosystems, proposed as a potential tool to inform management within CCAMLR on strategies to avoid significant adverse impacts on VMEs. The paper includes a revised manual for Patch, the code for which is available from the Secretariat.

4.4 The Patch model has been considered previously by WG-FSA (SC-CAMLR-XXVIII, Annex 5, paragraph 10.11; WG-FSA-09/42) and WG-SAM (SC-CAMLR-XXVIII, Annex 6, paragraphs 4.8 to 4.19). The updated version described in WG-SAM-10/9 includes the following changes:

- (i) a revised map with layers that can be used to influence the distribution and abundance of targets, patches, disturbance, activities and managers;
- (ii) a reconfigured fishery model to enable better fleet dynamics;
- (iii) a complete manual, including a user guide and programmer's notes;
- (iv) the use of programming objects to streamline programming of the different components.



4.5 The Working Group welcomed the continued progress in the development of Patch. It further noted that Patch is a very complex and flexible modelling package that may be applied to a wide range of ecological and management scenarios.

4.6 The Working Group recommended the development of case studies to assist Members in understanding the way in which Patch will operate with specific reference to bottom fishing impacts on VMEs. The Working Group recommended that specific case studies be developed and presented to WG-EMM and WG-FSA in order for them to be able to assess the use of specific parameters to represent plausible scenarios for management of VMEs and corresponding outputs.

4.7 The Working Group recommended, for both models (paragraphs 4.1 to 4.4), that simple case studies be prepared to illustrate the operation of the models consistent with expectations under extreme scenarios chosen to clearly illustrate the expression of particular input parameters. These will be useful to assist validation of the models.

4.8 The Working Group noted that because spatial correlations in ecology are scale-dependent, the cell size selected for use in simulation models of this kind is important if the model defines biological distributions as a function of cell attributes or in relation to other biological distributions.

4.9 The Working Group noted that WG-EMM is the appropriate body to provide guidance as to the particular spatial and ecological characteristics of VMEs, and that WG-FSA is the appropriate body to comment on interactions with fishing gear. The Working Group recommended that VME simulation methods such as those described in WG-SAM-10/9 and 10/19 should incorporate the advice of WG-EMM and WG-FSA in parameterising the models to characterise 'plausible scenarios'. WG-SAM suggested that WG-EMM and WG-FSA consider what scenarios and performance measures provide a sound basis for evaluating management strategies to avoid significant adverse impacts on VMEs.

4.10 The Working Group noted that the models described in WG-SAM-10/9 and 10/19 remain to be fully validated according to WG-SAM-09 (SC-CAMLR-XXVIII, Annex 6, paragraph 5.11).

4.11 The Working Group noted the advice of WG-SAM-09 (SC-CAMLR-XXVIII, Annex 6, paragraph 5.17) that, for models that have been developed to meet a specific request of the Scientific Committee or Commission on a short deadline, and for which there is insufficient time available for a full evaluation and validation, advice arising from the model should be commensurate with the level of evaluation and validation of the model. On this basis the Working Group recommended that the models described in WG-SAM-10/9 and 10/19 be further developed as a matter of priority, with emphasis on the provision of both plausible and illustrative case studies and necessary validation, to enable use of these models to inform WG-FSA-10 and SC-CAMLR-XXIX, commensurate with the level of model validation that is possible upon review by WG-FSA-10.

#### VME impact assessment methods

4.12 WG-SAM-10/20 described a revised impact assessment framework that estimates the cumulative footprint and impact on VME taxa associated with New Zealand's bottom

longline fishery in the Ross Sea. The Working Group noted the differences in this updated framework relative to the previous version presented by New Zealand (WG-SAM-09/P1). These differences included:

- (i) the impact assessment no longer uses distinct assumption sets to represent the upper and lower bound estimates of footprint and impact; instead it uses prior distributions to represent input assumptions about fishing gear movement in contact with the sea floor, and associated footprints and impacts on VME taxa;
- (ii) the estimated footprint and impact indices are expressed as standard metrics;
- (iii) the impact assessment is applied within spatial boundaries defined by the benthic bioregionalisation described in WG-EMM-10/30;
- (iv) the impact assessment is applied at very fine spatial scales within which the assumption of no systematic relationship between fishing effort and VMEs is thought to be valid.

4.13 The Working Group noted the specific use of the terms ‘footprint’ and ‘impact’ in this framework. These are defined in WG-EMM-10/29 and are recommended to be considered further by WG-EMM.

4.14 The Working Group agreed that the Monte Carlo approach of sampling from distributions to represent input assumptions of the impact assessment framework constitutes an improvement over the previous method of using distinct assumption sets of point estimates to represent upper and lower bounds. However, the Working Group recognised that the nature of these distributions should be properly considered by WG-EMM.

4.15 The impact assessment formula, as described in the framework, is only applied to a single VME taxon; in this case, under an assumed ‘worst-case’ scenario for the most vulnerable taxon. However, the impact index can potentially be applied over multiple taxa or communities. The Working Group agreed that it would be useful to explore potential options for summarising impacts to multiple VME taxa or communities within an impact index.

4.16 The Working Group advised WG-FSA that the framework proposed in WG-SAM-10/20 could be used by individual Members as well as when WG-FSA needs to generate an overall cumulative impact assessment for a particular subarea or division across all Members notifying to participate in new and exploratory fisheries, given specific assumptions with respect to differences in gear configuration and performance.

4.17 The Working Group noted that the assessment in WG-EMM-10/20 examined cumulative historical spatial footprints of all longline deployments at a range of spatial scales and demonstrated that because effort distributions become sufficiently disordered at scales smaller than 10 km pixels, there is likely to be no systematic association between fishing effort and VME taxa at that scale.

4.18 The Working Group recommended that impacts calculated within small-scale pixels should in turn be summarised within biologically meaningful areas to determine if impacts in these areas may be different. It noted that plots of the frequency distribution of pixels in different impact categories would be a useful method for visualising the scales of impacts in different types of areas.

4.19 The Working Group recommended that standard metrics to express effort density, fishing footprint and impact (e.g. as in WG-SAM-10/20) should be used and expressed in common units. This would facilitate comparison between Members' preliminary assessments, as well as standardise inputs to simulation approaches such as those described in WG-SAM-10/9 and 10/19. The Working Group agreed that suitable metrics and units for longlines are as follows:

- (i) effort density for longlines, expressed as km of line per km<sup>2</sup> of seabed area;
- (ii) footprint index, the seabed area contacted by the fishing gear per unit effort, in units of km<sup>2</sup> of seabed per km of line;
- (iii) impact index, the footprint index multiplied by proportional impact within the footprint.

## GENERAL ISSUES

5.1 The Working Group welcomed the presentation of WG-SAM-10/P1 that described the application of the generalised age- and/or stage-structured seabird population dynamics modelling package (WG-SAM-08/P3 that had been previously considered by the Working Group (SC-CAMLR-XXVII, Annex 7, paragraphs 4.21 to 4.24)).

5.2 WG-SAM-10/5 described data quality assurance work under development in the Secretariat that included the use of species distribution metadata and trip report cards for both vessel and observer data. The Working Group agreed that all such developments to improve data quality were important. Furthermore, it suggested that the potential for routinely comparing fine-scale data and VMS data be examined as part of the data validation process.

5.3 WG-SAM-10/18 described a method for determining fishable areas for the seabed using scripted queries of a spatial database. The method uses the full resolution of a specified dataset and user-definable projection (currently South Pole Lambert Equal Area) to generate single polygons and calculate seabed areas for user-defined depth bins. The strength of the process is that subjectively derived contours are not needed and data are not aggregated to reduce the number of cells.

5.4 The Working Group agreed that this method would be useful for developing advice for Subareas 88.1 and 88.2, and noted that the data and method are available for the entire Southern Ocean. The Working Group encouraged specificity in presenting spatial data, especially in reporting the projection used for analysis.

5.5 The database (currently Gebco\_2008 (rel. November 2009)) and the query script is currently available from New Zealand. The Working Group agreed that a formal repository for spatial bathymetric data is needed and recommended that the Secretariat identify appropriate organisations that may already have the infrastructure and expertise to store, manage and make available these types of data and functions, including the potential for future web interfaces. The Working Group further recommended that the Secretariat may be

the appropriate organisation to store metadata and derived GIS layers for routine mapping purposes (such as fishable-area polygons or subarea boundary files) to enhance data sharing and consistency among Members.

5.6 WG-FSA-09 (SC-CAMLR-XXVIII, Annex 5, paragraphs 10.15 and 10.16) had recommended that cumulative effort by gear type, SSRU or subdivision be used to inform the review of proposed bottom fishing activities under Conservation Measure 22-06. The Working Group reviewed software presented as part of WG-SAM-10/22. The R code utilises CCAMLR C2 data, incorporates GIS shapefiles and allows user-definable spatial scales to summarise data for several grouping variables.

5.7 The Working Group welcomed this substantial improvement on previous functions available to WG-FSA, noting that the software is very flexible and includes all of the grouping variables needed for display of fishing effort data, although some code to automatically link appropriate C2 data from different tables would enhance the ease of use.

5.8 The Working Group noted that one of the main purposes of generating effort plots is to visualise the spatial pattern in fishing effort density. It is therefore important, especially for large areas, to project plots to some appropriate projection space, such as an equal area projection. As the code is complex, help files for the functions developed would be useful, and the entire assemblage of functions could be built as an R library. The Working Group also noted that displaying fishing effort, especially for fine-scale analyses, may require plotting individual lines or line segments, or allocating lines or portions of lines to a given cell grid.

5.9 The Working Group encouraged the author of WG-SAM-10/22 to update the functions and submit this for use by WG-FSA at its meeting this year.

## OTHER BUSINESS

### Independent review of the Secretariat's data management systems

6.1 The Working Group reviewed the proposal for an independent review of the Secretariat's data management systems (WG-SAM-10/8), noting that the goal of the proposed review is to provide assurance that CCAMLR's information assets are appropriately managed and protected, and that identified risks, including those which may arise from the Commission's growing needs, are managed and mitigated using an appropriate international standard as the benchmark. The Working Group also noted that the proposed review is part of the Secretariat's broad consideration of an information security policy.

6.2 The Working Group supported the proposed review and agreed that:

- (i) the terms of reference of the review should be cast in the context of the Commission's future requirements;
- (ii) the terms of reference may be broadened to identify opportunities for greater data integration, requirements for GIS-type systems and management of GIS-layer datasets, and consideration of whether Members could assist in bridging identified gaps;

- (iii) the review should also identify the resources required to support its outcomes and the risks of not being able to implement those outcomes.

## Performance Review

6.3 The Working Group recalled that the Scientific Committee had further considered the PRP report (SC-CAMLR-XXVIII, paragraphs 10.5 to 10.11), which included tasks to be considered by WG-SAM. These tasks were considered under 'Future Work' (Section 7).

## FUTURE WORK

7.1 The Working Group recalled its purpose, including that derived from its origins as a subgroup of WG-FSA. It agreed that it had demonstrated there is value in bringing together the quantitative experts across the working groups of the Scientific Committee into a forum for developing, evaluating and validating more complex or non-standard methodologies to be used by the other working groups.

7.2 Although there is overlap with other working groups in order to provide context for its discussions on methods, the Working Group noted that its role is not to replace or duplicate the work of the other working groups. It also noted that not all quantitative issues need to be considered by WG-SAM when there is appropriate expertise available within a working group and the principles for adopting methodologies can be achieved.

7.3 The Working Group noted the increase in the range of tasks that were identified last year (SC-CAMLR-XXVIII, Annex 6, paragraph 6.1) as well as the ongoing discussion of the Scientific Committee on prioritising its work. Rather than considering the individual tasks, the Working Group discussed how best to provide an effective service to the other working groups and the Scientific Committee, a key aspect of which is to maximise the availability of appropriate quantitative expertise to continue its work. These may potentially include:

- (i) greater clarity from other working groups when seeking advice from WG-SAM is required. This should include clear terms of reference rather than a simple recommendation that an issue be passed to WG-SAM for its consideration;
- (ii) the setting of multi-year agendas to allow improved planning and preparation, noting that longer lead times can be advantageous in securing resources for such work;
- (iii) clear prioritisation of, and setting of the agenda for, the work of WG-SAM during the meeting of the Scientific Committee;
- (iv) flexibility in meeting scheduling such that WG-SAM might have a reduced requirement to give advice in some years, compared to other years when, for example, methods need to be reviewed in time for use by WG-FSA in 'assessment years'.

7.4 Some of these issues may be resolved, including variable emphasis on issues from one year to another, by holding meetings of all the working groups simultaneously, but interleaved (as is current practice in the IWC), and could provide a method for creating greater synergies between WG-SAM and the other working groups. It was agreed that this proposal could be considered further by the Scientific Committee, noting that there were potential costs and benefits associated with such a proposal.

7.5 The Working Group agreed that the prioritisation of items for consideration by WG-SAM at its next meeting should take place at the Scientific Committee in order that the comments and recommendations of WG-EMM and WG-FSA can be accommodated.

#### ADVICE TO THE SCIENTIFIC COMMITTEE

8.1 The Working Group's advice to the Scientific Committee is summarised below; the body of the report leading to these paragraphs should also be considered.

8.2 The Scientific Committee is requested to consider whether the format of the report needs to be changed in order to be able to extract an executive summary of recommendations or whether the current format is acceptable.

8.3 The Secretariat was asked to prepare options of different report formats (e.g. SC-CAMLR-XXVIII, Annex 6, paragraph 1.8) that the Scientific Committee could consider.

8.4 WG-SAM has provided advice to WG-EMM on the following items:

- (i) krill integrated assessment (paragraph 2.3)
- (ii) scientific observer programs for krill fisheries (paragraphs 2.6 and 2.19)
- (iii) krill escape mortality (paragraphs 2.22 and 2.23)
- (iv) krill fishable biomass (paragraph 2.26)
- (v) VMEs (see paragraph 8.6 below).

8.5 WG-SAM has provided advice to WG-FSA on the following items:

- (i) strategies for data-poor fisheries for *Dissostichus* spp. (paragraphs 3.6, 3.9, 3.19 to 3.26);
- (ii) HCRs for *Chamsocephalus gunnari* (paragraphs 3.36 and 3.37);
- (iii) VMEs (see paragraph 8.6 below).

8.6 WG-SAM has provided advice to WG-EMM and WG-FSA on the following items:

- (i) VME modelling and evaluation tools (paragraphs 4.6, 4.7, 4.9 and 4.11)
- (ii) VME impact assessment methods (paragraphs 4.14 to 4.16, 4.18 and 4.19).

8.7 WG-SAM referred WG-IMAF to the seabird population dynamics modelling package (paragraph 5.1).

8.8 WG-SAM has provided general advice on the following items:

- (i) bathymetric data (paragraphs 5.4 and 5.5)
- (ii) plotting spatial data (paragraph 5.9)
- (iii) review of the Secretariat's data management systems (paragraph 6.2).

8.9 WG-SAM's advice to the Scientific Committee on its future work program and its relationship with other working groups is provided in paragraphs 7.1 to 7.5. These issues require broader consideration by the Scientific Committee of the timing, agenda and priorities of all working groups.

## ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

9.1 The report of the meeting of WG-SAM was adopted.

9.2 In closing the meeting, Dr Constable thanked the participants for their contributions to the meeting and their work during the intersessional period, the subgroup coordinators for facilitating discussions, and the rapporteurs for bringing together a short focused report. He also thanked Dr Mayekiso and his local organising team for providing a beautiful venue and excellent facilities for the meeting, and the Secretariat for its support.

9.3 Dr Agnew (Scientific Committee Chair), on behalf of the participants, thanked Dr Constable for his excellent work in convening the meeting and leading the discussions.

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(Cape Town, South Africa, 19 to 23 July 2010)

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**AGENDA**Working Group on Statistics, Assessments and Modelling  
(Cape Town, South Africa, 19 to 23 July 2010)

1. Introduction
  - 1.1 Opening of the meeting
  - 1.2 Adoption of the agenda and organisation of the meeting
2. Krill
  - 2.1 Krill integrated assessment
  - 2.2 Krill observer program
  - 2.3 Krill escape mortality
  - 2.4 Krill fishable biomass
  - 2.5 Use of acoustics as relative index of abundance
3. Finfish
  - 3.1 Strategies for data-poor fisheries (toothfish)
  - 3.2 Natural mortality of toothfish
  - 3.3 Age- versus length-based harvest control rules
  - 3.4 Minimally realistic food-web modelling
4. Vulnerable marine ecosystems
  - 4.1 VME modelling and evaluation tools
  - 4.2 VME impact assessment methods
  - 4.3 Evaluation of management strategies for VMEs
5. General issues
  - 5.1 Seabird assessments
  - 5.2 Data quality
  - 5.3 Bathymetric data
  - 5.4 Plotting spatial data
6. Other business
  - 6.1 Review of data management system
  - 6.2 Performance review
7. Future work
  - 7.1 Long-term work plan
  - 7.2 Other issues – agenda
8. Advice to the Scientific Committee
9. Adoption of the report and close of the meeting.

## LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling  
(Cape Town, South Africa, 19 to 23 July 2010)

|                     |   |
|---------------------|---|
| WG-SAM-10/1         | Draft Agenda and Draft Annotated Agenda for the 2010 Meeting of the Working Group on Statistics, Assessments and Modelling (WG-SAM)   |
| WG-SAM-10/4         | Deployment of research hauls in the exploratory fisheries for <i>Dissostichus</i> spp. in Subareas 48.6 and 58.4 in 2009/10<br>Secretariat  |
| WG-SAM-10/5         | Further improvements in data quality (short note)<br>Secretariat  |
| WG-SAM-10/6         | Recommendations on estimating krill escape mortality during fishing operations: the problems and approaches<br>V.K. Korotkov and S.M. Kasatkina (Russia)  |
| WG-SAM-10/7 Rev. 1  | Assessment of fishable krill biomass on the basis of the acoustic surveys results using geostatistical methods<br>S.M. Kasatkina and P.S. Gasyukov (Russia)   |
| WG-SAM-10/8         | Proposal to commission an independent review of the Secretariat's data management systems<br>Secretariat  |
| WG-SAM-10/9         | Update on Patch v2: a simulation program in R for evaluating spatial management strategies to conserve structure and function of ecosystems<br>A.J. Constable (Australia)   |
| WG-SAM-10/10        | Factors to consider in designing a systematic observer program for the krill fishery<br>S. Kawaguchi and A. Constable (Australia)   |
| WG-SAM-10/11 Rev. 1 | Estimation of natural mortality using catch-at-age and aged mark-recapture data: a simulation study comparing estimation for a model based on the Baranov equations versus a new mortality equation<br>S.G. Candy (Australia)<br>( <i>CCAMLR Science</i> , submitted) |

- WG-SAM-10/12 Comparison of age- and length-based harvest control rules for the South Georgia icefish (*Champscephalus gunnari*) fishery  
C.T.T. Edwards, R.M. Hillary, R.E. Mitchell and D.J. Agnew (United Kingdom)
- WG-SAM-10/13 Preliminary reports on stock status and biological information on toothfish obtained from the scientific research survey by *Shinsei Maru No. 3* in 2009/10 in the SE sector of Division 58.4.3b  
K. Taki, M. Kiyota and T. Ichii (Japan)
- WG-SAM-10/14 Preliminary reports on abundance and biological information on toothfish in Divisions 58.4.4a and 58.4.4b by *Shinsei Maru No. 3* in the 2009/10 season  
K. Taki, M. Kiyota and T. Ichii (Japan)
- WG-SAM-10/15 Research plan for toothfish in Divisions 58.4.4a and 58.4.4b by *Shinsei Maru No. 3* in 2010/11  
Delegation of Japan
- WG-SAM-10/16 Distribution and population structure of *Dissostichus eleginoides* and *D. mawsoni* on BANZARE Bank (CCAMLR Division 58.4.3b), Indian Ocean, Antarctic  
K. Taki, M. Kiyota, T. Ichii and T. Iwami (Japan)  
(*CCAMLR Science*, submitted)
- WG-SAM-10/17 Analysis of observer coverage for Japanese krill fishing vessels  
T. Okuda, M. Kiyota and H. Okamura (Japan)
- WG-SAM-10/18 A bathymetric data framework for conservation in the Ross Sea region  
S.J. Parker, B. Wood, S.M. Hanchet and A. Dunn (New Zealand)
- WG-SAM-10/19 Development of methods for evaluating the management of benthic impacts from longline fishing using spatially explicit production models  
A. Dunn, S.J. Parker and S. Mormede (New Zealand)
- WG-SAM-10/20 Revised impact assessment framework to estimate the cumulative footprint and impact on VME taxa of New Zealand bottom longline fisheries in the Ross Sea region  
B.R. Sharp (New Zealand)
- WG-SAM-10/21 Towards a Minimum Realistic Model for investigating trophic relationships between Antarctic toothfish and demersal fish in the Ross Sea, Antarctica  
M.H. Pinkerton, S. Mormede and S.M. Hanchet (New Zealand)

WG-SAM-10/22      *plotImage* – software for producing augmented image plots of spatially referenced data  
J.P. McKinlay (Australia)

Other documents

WG-SAM-10/P1      Fisheries risks to the population viability of black petrel  
(*Procellaria parkinsoni*)  
R.I.C.C. Francis and E.A. Bell (New Zealand)  
(*New Zealand Aquatic Environment and Biodiversity Report*, 51  
(2010), ISSN 1176-9440)

Additional Information

Letter from ICES – Invitation to join a strategic initiative on stock assessment methods (SISAM)





**REPORT OF THE FIFTH MEETING OF THE SUBGROUP  
ON ACOUSTIC SURVEY AND ANALYSIS METHODS**  
(Cambridge, UK, 1 to 4 June 2010)

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**REPORT OF THE FIFTH MEETING OF THE  
SUBGROUP ON ACOUSTIC SURVEY AND ANALYSIS METHODS**  
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## INTRODUCTION

1.1 The fifth meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held at the British Antarctic Survey (BAS), Cambridge, UK, 1 to 4 June 2010. The Convener, Dr J. Watkins (UK), welcomed participants (Appendix A) on behalf of the hosts and outlined local arrangements for the meeting.

1.2 The terms of reference for the meeting focused on the estimation of krill (*Euphausia superba*) biomass ( $B_0$ ) in Area 48 and particularly on the reanalysis of the acoustic data from the CCAMLR-2000 Survey (Appendix B).

1.3 The original calculation of  $B_0$  arising from the CCAMLR-2000 Survey was undertaken at the  $B_0$  Workshop held in La Jolla, USA, in May 2000 (SC-CAMLR-XIX, Annex 4, Appendix G). Since then there have been changes to CCAMLR's recommended protocols for assessing krill target strength (TS) and identifying acoustic targets. As a result, there have been a number of separate recalculations of the data from the CCAMLR-2000 Survey which have generated a number of different biomass estimates.

1.4 In order to complete the reanalysis requested by the Scientific Committee, the following set of analytical steps was identified for SG-ASAM in 2010:

Prior to the meeting –

1. review of the existing calculations of  $B_0$ , and associated uncertainty, to clarify issues relevant to reanalysis;
2. confirm the steps of the new analysis to be undertaken by Members;
3. confirm the validity of the acoustic data and ancillary datasets required for model parameterisation;
4. Members to undertake independent calculations of  $B_0$  using the agreed procedures;

At the meeting –

5. review all documented results of stages 1, 2, 3 and 4 submitted to SG-ASAM;
6. discuss results and add clarification to protocols if necessary;
7. agree a validated  $B_0$  estimate and associated uncertainty and submit the results to the 2010 meeting of WG-EMM.

1.5 The work prior to the meeting was conducted by a Correspondence and Analysis Group. The membership of that group was open to all CCAMLR Members (SC CIRC 10/7),

and consisted of Dr L. Calise\* (Norway), Mr A. Cossio\* (USA), Drs S. Fielding\* (UK), S. Kasatkina (Russia), S. Kawaguchi (Australia), T. Knutsen (Norway), R. Korneliussen (Norway), R. O'Driscoll (New Zealand), D. Ramm\* (Data Manager), K. Reid\* (Science Officer), C. Reiss\* (USA), G. Skaret\* (Norway), Mr Y. Takao\* (Japan), Drs J. Watkins\* (Convener), G. Watters\* (USA) and X. Zhao\* (China). The group's correspondence and data were archived on the CCAMLR website and are available from the Secretariat. Those members of the Correspondence and Analysis Group who attended the meeting are indicated by an asterisk.

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

1.7 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').

## REANALYSIS OF CCAMLR-2000 SURVEY DATA

2.1 The intersessional work conducted by Members covered a wide range of topics, and contributions to the meeting were provided by scientists from Japan, Norway, UK and the USA. Document numbers were not assigned to any of the material developed in preparation for the meeting, but all such material was provided to the Subgroup and used in its discussions. All material prepared for or during the meeting was lodged with the Secretariat.

2.2 The Subgroup agreed to consider Agenda Items 2.1 and 2.2 in parallel, and based discussions on whether and how to revise or modify implementation of protocol for estimating  $B_0$  (Item 2.2), hereafter simply referred to as the protocol, from its review of work undertaken during the intersessional period (Item 2.1).

2.3 The Subgroup noted that its review and, if necessary, revision of how the protocol is implemented should be independent of any actual estimates of  $B_0$  and agreed that it would only compute an estimate of  $B_0$  after it had agreed to all elements of the protocol's implementation.

2.4 The Subgroup reviewed the outline of the protocol provided in SC-CAMLR-XXVIII, Annex 8, Appendix E, and noted that the focus of its work would relate primarily to acoustic data processing and analysis, echo integration, conversion of acoustic backscatter to area biomass estimate, estimation of total biomass from biomass density and estimation of sampling errors. A table identifying issues requiring discussion relating to these topics had been circulated by the Convener during the intersessional period (Table 1), and the rows of this table were used to structure ensuing discussions (these row names thus form a basis for the subsection headings below).

2.5 The terms of reference for the meeting of SG-ASAM called, *inter alia*, for Members to confirm steps of analysis by correspondence and review independent calculations of  $B_0$  (SC-CAMLR-XXVIII, Annex 11) provided by Members. Substantive discussion occurred by correspondence (and is recorded on the SG-ASAM section of the CCAMLR website), this identified a number of issues. Some of these were not resolved prior to the meeting, and, therefore, independent estimates of  $B_0$  were not available for review prior to the meeting.

2.6 The Subgroup noted that Members had independently conducted various confirmatory analyses and reviewed or prepared a substantial amount of the computer code needed to evaluate implementation of the SDWBA protocol and estimate  $B_0$  (SC-CAMLR-XXVIII, Annex 4, paragraph 3.82). By discussing the confirmatory analyses, testing the independently developed pieces of computer code, and cross-checking such code among Members, the Subgroup agreed it should be able to provide a validated estimate of  $B_0$ .

#### Identify set of Echoview files

2.7 The Subgroup verified that all participants possessed the same set of files (distributed as a set of CDs after the CCAMLR-2000 Survey data were originally analysed in 2000) that are used within Echoview to conduct necessary pre-processing such as noise reduction and calibration, and also apply the  $\delta S_v$  target identification windows (these are .ev files). Building on intersessional work conducted by Dr Fielding and Mr Cossio, all these data files were reviewed by the Subgroup and several issues (e.g. inconsistent file names, incorrect binning, integration of bottom echoes) were identified and corrected. Three files were edited at the meeting: Sand06-Atl.ev, SG01-Yuz.ev and SSI01-KyM.ev. A spreadsheet describing changes made to all data files was lodged with the Secretariat.

#### Identify set of .csv files

2.8 After correcting the .ev files for issues identified above (paragraph 2.7), the Subgroup exported a new set of .csv files from Echoview. These .csv files contained data binned in 5 m (depth) by 50-ping interval (equivalent to a horizontal distance of approx. 500 m at 10 knots) and were exported without application of a target identification filter (paragraph 2.36). All these .csv files were lodged with the Secretariat (see documentation for filename convention, paragraph 3.2).

#### Identify the length probability density functions

2.9 The Subgroup agreed that the cluster-specific length probability distribution functions provided in the file LFD 2000 Cluster.xls were correct and could be used to estimate  $B_0$ . These probability density functions are used to generate conversion factors (paragraph 2.38) that translate length-frequency data to biomass. A copy of the .xls file was lodged with the Secretariat, and the Subgroup considered the data contained in the file while conducting its work.

#### Determine which SDWBA model to use

2.10 The Subgroup discussed whether  $B_0$  should be calculated on the basis of the full SDWBA model or the simplified SDWBA model. It was noted that the parameters of the simplified model will change if key parameters in the full model (e.g. parameters describing the orientation distribution, shape etc.) are themselves changed. It was also noted that fitting

the simplified model to output from the full model adds error to the characterisation of TS. Nevertheless, the simplified model can more easily be implemented by non-specialists and, notably, its use is a specified element of the protocol.

2.11 The Subgroup agreed to compute estimates of  $B_0$  using both the full model and the simplified model. The Subgroup noted that the former estimate would likely be preferred on a scientific basis, but acknowledged that the latter estimate is required by application of the protocol.

Define parameters to initialise SDWBA

2.12 The Subgroup reviewed the parameter values provided in Table 2 from the 2009 report of SG-ASAM (SC-CAMLR-XXVIII, Annex 8) and recalled its previous view that in the absence of information about the accuracy of the krill mass density and sound-speed measurements, it should not change the default values for the density contrast  $g$  and the sound-speed contrast  $h$  currently in place when calculating krill biomass (SC-CAMLR-XXVIII, Annex 8, paragraph 19). The Subgroup also came to this conclusion regarding the fatness coefficient and the sound speed in seawater  $c$ . Despite accepting all these parameter values at present, the Subgroup acknowledged that future work to address remaining uncertainties in these parameters would be useful (see Item 4).

2.13 The Subgroup agreed, however, that the parameters defining the orientation distribution (reported as  $N(11^\circ, 4^\circ)$  for the ‘mean’ case in SC-CAMLR-XXVIII, Annex 8, Table 2) would need to be revised. A revision of the orientation distribution was deemed necessary because, during the course of intersessional review and correspondence by Members, several issues were identified in the Matlab code previously used to implement the full SDWBA (the Matlab package named ‘SDWBAPackage20050603’). It was noted that these issues were present, but unidentified, in the code used to estimate  $B_0$  at the 2007 meeting of WG-EMM. Drs Calise and Skaret provided a document titled ‘Verification and investigation of the krill target strength prediction of the SDWBAPackage20050603’, that described the problems identified intersessionally; the document also proposed some solutions. Problems with the previous implementation of the full SDWBA included:

- (i) incorrect position vector  $r$  and ensemble of radii values  $a$  delineating the shape of the standard generic krill (McGehee et al., 1998);
- (ii) incorrect reference length applied when scaling krill with lengths different than the ‘standard’ length of 38.35 mm;
- (iii) inappropriate resampling of the position vector  $r$  needed for frequencies higher than 120 kHz.

2.14 The first error (an error in the ‘shape file’) seems to originate from a confusion between the measured length of the generic krill presented in McGehee et al. (1998) (38.35 mm AT length, front of the eyes to tip of the telson, see Morris et al., 1988) (denoted ‘ $L$ ’ in SC-CAMLR-XXIV, Annex 6, paragraph 11(i)) and the maximum digitised values in the x-dimension of the  $r_0$  vector describing that shape (the digitised length equal to 41.09 mm) (denoted ‘ $l$ ’ in SC-CAMLR-XXIV, Annex 6, paragraph 11(ii)). The body shapes used in SDWBAPackage20050603 and provided by McGehee et al. (1998) are given in Table 2 and

visualised in Figure 1. The Subgroup agreed to revise the shape file for implementing the full SDWBA by using the correct information from McGehee et al. (1998). The revised shape file was lodged with the Secretariat.

2.15 In SDWBApackage20050603 lengths other than the standard length are scaled using the maximum value of digitised shapes from McGehee et al. (1998) as the point of reference (the digitised x-length equal to 41.09 mm,  $l$ , rather than the measured standard length of 38.35 mm,  $L$ ). Based on advice provided by Drs Calise and Skaret, the Subgroup agreed that the scaling factor should, however, be based on the standard length  $L$  itself, and the Matlab script named ‘ProcessKrillEsupSDWBATS.m’ was revised accordingly. The revised script was lodged with the Secretariat.

2.16 Comparable predictions between frequencies from the full SDWBA model require that the spatial resolution of the discrete cylinders describing the shape relative to the ratio between the krill length and the acoustic wavelength is kept constant. Thus, for frequencies higher than the reference frequency (120 kHz), krill shape needs to be re-characterised by adjusting the number of cylinders and the inter-element phase variability. Drs Calise and Skaret determined that the implementation of the position vector resampling, which depended on the Matlab function ‘resample.m’ (from Matlab’s Signal Processing Toolbox), produced points that did not follow the central body line according to the digitised standard krill.

2.17 Evidence for the problematic implementation of the ‘resample.m’ function is provided in Figure 2. The resampled shape was shown to have a greater length than the original shape (these lengths should be equal) and was partly composed of cylinders that were orientated in unnatural directions. The Subgroup determined that the effect of the resampled shape on TS prediction was peaks in TS at incidence angles of about 130°–160° and 190°–220° (Figure 2); this effect was not considered to be consistent with acoustical theory. The Subgroup also noted that resample.m implements a deterministic sampling process that, in this application, is length-independent; thus, all re-characterised body shapes predicted by SDWBApackage20050603 will have shapes that are incorrect and identical to the resampled shape illustrated in Figure 2.

2.18 The Subgroup discussed possible methods to revise the process for re-characterising krill size at frequencies above 120 kHz and agreed to attempt using alternative techniques such as a cubic smoothing spline to interpolate centre positions for cylinders located along the central body line and related radii. As a first approximation, application of the simple cubic spline only on the position vector, retaining the resample.m function for the radii values, was shown to provide a much improved characterisation of krill shape, although all cylinders comprising the new shape had equal width, thus not following the requirement of a constant cylinder length to wavelength ratio (SC-CAMLR-XXIV/BG/3, Equations (6) and (7), Conti and Demer, 2006). The spline-based characterisation of shape at frequencies above 120 kHz was also shown to remove the higher TS levels at incidence angles outside the main scattering lobe, thus making predictions of TS from the re-characterised shape more consistent with acoustical theory (Figure 3). Importantly, the spline-based characterisation of shape was also considered to provide reasonable predictions of TS in the main scattering lobe (Figure 3).

2.19 Given the results presented in Figures 2 and 3, the Subgroup agreed to implement the spline procedure in the full SDWBA model, and code in the Matlab script named ‘BSTS\_SDWBA.m’ was revised accordingly. The revised script was lodged with the Secretariat.

Determine number of model scenarios to run

2.20 The Subgroup agreed that, given the time available to run the full SDWBA model and compute estimates of  $B_0$ , the model scenarios considered at the meeting would be limited to include those based on the mean values and values for  $\pm 1$  SD of fatness coefficient,  $g$ ,  $h$  and  $c$  listed in SC-CAMLR-XXVIII, Annex 8, Table 2. Thus, a total of three scenarios would be run. The Subgroup also agreed to compute new values for the three orientation distributions required by these scenarios, noting that these new orientation distributions would be computed following the procedures outlined in paragraphs 2.21 to 2.29. Table 3 contains parameter values used to run all three scenarios with the full SDWBA model.

Determine availability of method for calculating the orientation

2.21 Conti and Demer (2006) estimated parameters of the orientation distribution by a least-squares ‘inversion’ of the full SDWBA model. SDWBAPackage20050603 does not provide the computer code needed to conduct this inversion, but Dr Fielding provided the Subgroup with Matlab code designed to perform this task. The Subgroup conducted an extensive review of the code provided by Dr Fielding, including line-by-line analyses of the code itself and viewing an extensive variety of diagnostic plots, and concluded that the new code would provide results comparable to those illustrated in Conti and Demer (2006). The Subgroup therefore agreed to implement the inversion code provided by Dr Fielding in its estimation of  $B_0$ ; this code was lodged with the Secretariat.

Identify number of required orientation distributions

2.22 The Subgroup agreed that a single orientation distribution should be derived for the whole survey area rather than for each krill length-frequency cluster (as identified in Siegel et al., 2004). This continued the approach used in previous estimations of  $B_0$  (e.g. Conti and Demer, 2006; WG-EMM-07/30 Rev. 1).

2.23 To undertake the inversion to estimate an orientation distribution, a prediction of  $\delta S_v$  ( $S_{v120\text{kHz}-38\text{kHz}}$ ), derived from the SDWBA model solved with the krill length-frequency distribution for the entire survey area, is required. The Subgroup noted that krill length-frequency distributions for each cluster were held by the Secretariat, however, the Subgroup agreed that a length-density distribution for the entire survey (Figure 6 in Siegel et al., 2004) was the most appropriate dataset to use. This dataset was obtained from Dr Siegel during the meeting and was lodged with the Secretariat.

Identify method of inversion

2.24 The Subgroup agreed to use the least-squares inversion code described in paragraph 2.21 and fit to  $\delta S_v$  ( $S_{v120\text{kHz}-38\text{kHz}}$ ) binned in 1 dB increments. These  $\delta S_v$  values were developed by predicting TS from the full SDWBA model using the length-frequency data selected in paragraph 2.23.



Identify range of orientations (mean, SD) that inversion is to be applied over

2.25 The Subgroup agreed to invert the full SDWBA for all orientation distributions with means incrementing in 1° degree steps between +45° and –45° and SD incrementing in 1° degree steps between 1° and 50°. Searching through the results from these inversions to find the orientation distribution that minimised the sum of squared differences between  $\delta S_v$  predicted from observed length frequencies (paragraph 2.23) and  $\delta S_v$  predicted by the full SDWBA provided the ‘mean’ orientation recorded in Table 4.

Identify which acoustic data to apply the inversion process to

2.26 The Subgroup noted that Demer and Conti (2005), and Conti and Demer (2006) applied the inversion to acoustic data only from the RV *Yuzhmorgeologiya*. The Subgroup agreed that the inversion process should be applied to the complete acoustic dataset.

Identify method for correcting sample-averaging effect on orientation variance

2.27 SC-CAMLR-XXVIII, Annex 8, paragraph 35, points out that the inversion to derive orientation is carried out using measurements of  $S_v$  averaged over 50 pings and 5 m depth intervals. This averaging process reduces the variance by the inverse of the number of independent observations within the averaging interval. Given that there were 50 pings, and hence 50 independent acoustic samples within each averaging interval, the Subgroup agreed that the SD derived directly from the inversion process should be multiplied by  $\sqrt{50}$  to obtain a corrected SD.

2.28 The Subgroup suggested that, in the future, the SD derived from the inversion process should be called the standard error prior to using the averaging interval correction and should only be referred to as the SD after applying the correction.

2.29 SC-CAMLR-XXVIII, Annex 8, paragraph 35, additionally recommended that corrections to the orientation variance should also take account of the mean number of krill within the sampling volume. The Subgroup considered how such an additional correction might be applied. Using an acoustic estimate of krill number introduces a further circularity within the estimation process, and available density estimates of 14–18 g m<sup>-2</sup> from net sampling (Siegel et al., 2004), produce correction factors close to 1. The Subgroup agreed therefore that for this analysis no correction for number of krill in the sampling volume would be applied.

Identify length-frequency data to calculate  $\delta S_v$  windows for target identification

2.30 The Subgroup discussed how it would subset the available length-frequency data to develop  $\delta S_v$  windows for target identification. It was acknowledged that the protocol is somewhat unclear because it simultaneously requires that the subset includes  $\geq 95\%$  of the krill-length probability density function and achieve the smallest  $\delta S_v$  window (SC-CAMLR-XXVIII, Annex 8, Appendix E). In particular, it was not clear whether the intent of the

protocol was that the tails of the length probability density function be symmetrically eliminated (e.g. 2.5% on either side of the mean if selecting 95% of the length probability density function) or to preferentially eliminate observations from one tail over the other (e.g. with the intent to constrain the  $\delta S_v$  windows to the smallest range). The Subgroup felt that including 99% of the krill probability density function would be more likely to include targets that should be identified as krill (particularly small targets), but including 99% of the krill probability density function would not minimise the size of the  $\delta S_v$  windows. While it was acknowledged that '10 mm length classes could be refined [e.g. reduced to 1 mm] to reduce uncertainty' (SC-CAMLR-XXVIII, Annex 8, paragraph 38), the Subgroup also felt that 10 mm windows would be preferable to 1 mm windows. The former window size would allow for krill to be identified acoustically that may have not been captured in the nets. The Subgroup agreed to apply the >95% window in 10 mm bins.

Identify method to create  $\delta S_v$  windows

2.31 The Subgroup discussed whether  $\delta S_v$  windows should be generated from the minimum and maximum krill sizes caught in the net samples or the minimum and maximum dB ranges across the size range of krill sampled. It was agreed that the latter case was preferable since, between 120 and 200 kHz, sound scattering can be in the transition from the Rayleigh range to geometric range and therefore larger krill will not necessarily generate smaller windows.

2.32 The Subgroup recalled the need to revise the parameters of the orientation distribution (paragraphs 2.13 and 2.20) and recognised that this revision would necessitate revision of the  $\delta S_v$  windows that were previously used to identify krill targets (see SC-CAMLR-XXIV, Annex 6, Table 3). The Subgroup therefore agreed to conduct this revision; updated values for  $\delta S_v$  windows used in this analysis are reported in Table 4.

Determine whether two-frequency and three-frequency identification techniques should be applied to the data

2.33 The Subgroup noted that the protocol requires target identification based on three frequencies.

2.34 The Subgroup further noted that negative  $\delta S_v$  values might be estimated from TS models for 120 and 38 kHz, and was concerned that three-frequency target identification may filter out targets that are known to be krill or likely to be krill, particularly when the SD of the orientation distribution is small, and that this may be addressed by validation of target identification (see paragraph 4.1(vii)).

Apply target identification to dataset

2.35 The Subgroup agreed to apply all target identification methods to data binned by 5 m and 50 pings.

#### Integrate data in 1 n mile resets

2.36 The Subgroup agreed that, as the new target identification windows (see Table 4) would be applied in Echoview, then the integration of data into 1 n mile resets would also be undertaken as part of the Echoview processing prior to exporting a final set of Echoview .csv files that would contain the volume backscatter data for targets only attributed to krill (see documentation for filename convention, paragraph 3.2).

#### Apply latitude correction to data

2.37 The Subgroup noted that code for applying a latitude correction had been developed at the  $B_0$  Workshop in June 2000. The Subgroup agreed that there was no need to change this code and that this step would be undertaken as described in SC-CAMLR-XIX, Annex 4, Appendix G, paragraph 3.51.

#### Generate conversion factors using length/weight/TS relationships

2.38 The Subgroup noted that a correction to the computation of conversion factors had been described in WG-EMM-07/30 Rev. 1 (Table 1). The Subgroup agreed to apply this correction.

#### Generate transect krill densities

2.39 The Subgroup processed the transect krill densities and the code used to do this was lodged with the Secretariat.

#### Generate $B_0$ estimates for each model run

2.40 Having agreed to all the revisions in the elements in the protocol implementation (paragraph 2.3), the Subgroup generated  $B_0$  estimates with associated Jolly and Hampton CVs using the full SDWBA and the simplified SDWBA (Table 4).

2.41 Although the protocol suggested the use of the simplified model, the Subgroup advised that the output from the full SDWBA was preferred on a scientific basis because fitting the simplified model to results from the full model introduced additional errors and uncertainty into estimates of TS that could propagate through to errors in target identification (paragraph 2.10).

2.42 The Subgroup agreed that the intersessional work and model exploration conducted at this meeting had shown that the value for  $B_0$  provided at the 2007 meeting of WG-EMM was incorrect and that the difference in that value and the value of  $B_0$  from the full SDWBA provided during this meeting arose simply as a result of the correction of errors that were included in the calculation in 2007.

## Exploration of uncertainty

2.43 The Subgroup noted that the process to produce the results presented in Table 4 were manually and computationally intensive and took 15 h to complete and that this limited the ability to explore the implications of changing key parameters (fatness coefficient,  $h$ ,  $g$ , shape and orientation; see Table 3) on the estimation of  $B_0$ .

2.44 In the initial exploration of the  $\pm 1$  SD scenarios (paragraph 2.20) the Subgroup recognised that the complex interactions involved meant that the ‘ $\pm 1$  SD’ should not be considered as  $\pm 1$  SD in the estimate of  $B_0$ . Therefore, the Subgroup agreed that to fully evaluate uncertainty in  $B_0$ , a probability density function of  $B_0$  would be required (paragraph 4.1(viii)).

## DOCUMENTATION OF THE ACOUSTIC PROTOCOLS

3.1 The Subgroup did not have an opportunity to consider the provision of additional documentation of the acoustic protocols but agreed that the documentation developed during the meeting and the changes to the protocol described in section 2 provided a sufficiently open and detailed description of the acoustic protocol and improvements made to it during 2010.

3.2 The documentation developed during the meeting was placed on the CCAMLR website and will be presented to WG-EMM.

## FUTURE WORK

4.1 The Subgroup:

Methodological improvements –

- (i) agreed that the protocol for orientation inversion currently provides no statistical indication of the goodness-of-fit between estimated  $\delta S_v$  ( $S_{v120\text{kHz}-38\text{kHz}}$ ) values with distributions of orientation generated from model inversion and observed  $\delta S_v$  ( $S_{v120\text{kHz}-38\text{kHz}}$ ) values;
- (ii) agreed that the addition of the 70 kHz frequency should be encouraged (SC-CAMLR-XXVI, Annex 8, paragraphs 9 and 11), noting that krill backscattering at 70 kHz still falls in the Rayleigh scattering region and so comparisons with 38 and 120 kHz can be used to make inferences about krill size;
- (iii) agreed on the importance of measurements of both  $g$  and  $h$  during acoustic surveys but recognised the practical difficulties of making measurements at-sea. However, given the relationship between  $g$  and  $h$ , *in situ* measurements and estimates of only one of these parameters may be useful in itself. The Subgroup recommended a strategy involving further land-based work to define simple classification of  $g$  and  $h$  based on maturity and sex stage to identify which

investigations would be desirable and feasible to conduct at sea. The land-based work might include work on aquarium-held samples and laboratory measurements of biochemical composition;

- (iv) encouraged further work to more appropriately define the shape and position of the discretised cylinders according to krill body shape and scattering properties, noting the potential for considerable differences in the acoustic properties of the carapace and thoracic segments;
- (v) recognised that there remained some ambiguity as to whether the angle of orientation ( $\theta$ ) is related to the angle of acoustic incidence ( $\phi$ ) by  $90 - \theta$  or  $270 + \theta$  in the part of the Matlab code SDWBAPackage20050603 used to determine the average orientation (Figure 4). However, analysis of the difference produced by using  $90 - \theta$  or  $270 + \theta$  with an  $N(-20^\circ, 28^\circ)$  orientation distribution indicated that the difference in average TS would be very small (Table 5);
- (vi) suggested that the clarification of the relationship between of incidence angle ( $\phi$ ) and the orientation angle ( $\theta$ ) would be useful, especially in the context of the development of different representations of krill shape.

Validation of the target identification –

- (vii) agreed that there was a need to validate the target identification procedure with *in-situ* data and recalled that it had suggested that a library of echograms validated by external verification, including target hauls, be assembled for this purpose (SC-CAMLR-XXVIII, Annex 8, paragraph 90(ii)).

Developments –

- (viii) experience during the meeting with the range of possible sources of variability and the time taken to run the model iterations highlighted the need for efficient streamlined code that could be implemented in a Monte-Carlo simulation to produce a probability density function of  $B_0$  estimates.

General –

- (ix) acknowledged that, while continued improvements in the protocol were encouraged, the implications of changes in the protocol on the compatibility of existing time series of acoustic data should be considered during all such developments.

## RECOMMENDATIONS TO THE SCIENTIFIC COMMITTEE

5.1 The Subgroup advice to the Scientific Committee is contained in paragraphs 2.40 to 2.44.

5.2 In addition, the Subgroup noted that an appropriate parameterisation of the revised protocol could be applied to acoustic survey data for krill from other areas where catch limits are in place and where those surveys were conducted in accordance with the CCAMLR-2000 Survey protocols.

## ADOPTION OF REPORT

6.1 The report of the meeting was adopted.

## CLOSE OF THE MEETING

7.1 Dr Watkins thanked all participants for their contributions and involvement in the meeting, including the preparatory work. The meeting had included an all-night session and the individual contributions were outstanding.

7.2 Dr Watters, on behalf of the Subgroup, thanked Dr Watkins for his expertise and guidance during the meeting. The Subgroup also thanked Mr Cossio and Drs Fielding and Reiss for their expertise in conducting the complex and computationally intensive model runs.

7.3 The meeting was closed.

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Table 1: Issues considered by SG-ASAM during preparatory work.

| Step        | Task  | Proposed community action  | Query  |
|-------------|---|--|--|
| Data        |   |  |  |
| 1           | Identify set of Echoview files to work from   | The community to agree that all Echoview processing steps undertaken in 2000 were correct.   |  |
| 1.a         | Identify set of .csv files to work from   | The community to agree a set of working files.   | <p>(1) For those nations working in Matlab (or external to Echoview for target identification) it would be useful to use just one set of agreed .csv files (per frequency) of calibrated data (with no target id mask applied).</p> <p>(2) Data exported should be in 50 pings by 5 m exports to conform with original id method.</p> <p>(3) If above (2) then new method (code) will be needed to resample from 50 pings to 1 n mile after target identification, outside of Echoview.</p>  |
| 2           | Identify the length probability density functions (for each cluster and total) to use | The community to agree on one set of length probability density functions.   | (1) Have all the errors been found in the length frequency data?   |
| 3           | Make available to the community   | CCAMLR to set up FTP site of all up-to-date files.   |  |
| SDWBA model |   |  |  |
| 4           | Determine which SDWBA model equation to use and who has access                        | Community to agree the use of the full SDWBA model rather than creating a new set of simplified coefficients.  | <p>(1) Do all nations have the required code?</p> <p>(2) Can we make the code available?</p>   |
| 5           | Define parameters to initialise SDWBA   | Community to agree on using parameters from SC-CAMLR-XXVIII, Annex 8, Table 2 (for mean and SD limits of fatness, $g$ and $h$ ) and confirm correct parameterisation of the model. | <p>(1) Identify correct shape descriptors for model.</p> <p>(2) If shape descriptors were incorrect, then orientation inference was incorrect.</p>   |
| 6           | Determine number of model scenarios to run  | Community to agree number of shape, and reflection coefficient permutations to run and the frequency range to examine the model over.  | <p>(1) Should the community run the model once using the mean parameters, three times using the mean and 1 SD above and below the mean, or six times using the combination of fatness and reflection coefficients?</p> <p>(2) Should the community work out the orientation for just the mean values of fatness and reflection coefficient or for each combination?</p> <p>(3) Should the community work out the frequency identification windows for just the mean values of fatness and reflection coefficients or for each combination?</p> |

(continued)

Table 1 (continued)

| Step                         | Task   | Proposed community action  | Query   |
|------------------------------|--|--|---|
| 7                            | Archive SDWBA model code   | Community to agree on SDWBA code to use/used and lodge version with CCAMLR.  | Suggest add to FTP site.  |
| Orientation inversion method |  |  |   |
| 8                            | Determine which nations currently have a method for calculating the orientation                          | Community to offer up appropriate code for calculating the <i>in situ</i> orientation of krill.  |   |
| 9                            | Identify whether one orientation calculated for the whole of the Scotia Sea or per cluster area (i.e. 3) | Community to agree whether inversion process applied to the whole of the Scotia Sea or by size class clusters identified in Hewitt et al., 2004. | (1) Conti and Demer (2006) calculated both but applied only the $N(11,4)$ distribution – which do the community want to work with?  |
| 10                           | Identify method of inversion   | Community to agree method of inversion and identification of best fit.   | (1) Agree $\delta S_v$ window size classes to be used (suggest 1 dB).<br>(2) Agree method for identifying best fit (e.g. least squares best fit method).  |
| 11                           | Identify range of orientations (mean, SD) that inversion is to be applied over                           | Community to identify range of orientations that inversion is to be applied over.  | (1) Should it be over all orientations?   |
| 12                           | Identify which acoustic data to apply the inversion process to   | Community to agree which acoustic data the inversion is applied to.  | (1) Demer and Conti (2005) applied inversion only to data from the RV <i>Yuzhmorgeologiya</i> – should it be Scotia Sea wide (or size class cluster wide)?  |
| 13                           | Identify method for correcting sample-averaging effect on orientation variance                           | Community to agree how correction should be applied.   | SC-CAMLR-XXVIII, Annex 8, paragraph 35, noted that the inversion was carried out using measurements of $S_v$ averaged over 50 ping and 5 m intervals. By averaging over larger areas, the variance is reduced. The Subgroup recommended that these values should be corrected to take account of this effect. |
| 14                           | Archive orientation inversion method   | Community to agree on inversion method and lodge code with CCAMLR.   | Suggest add to FTP site.  |
| Target identification        |  |  |   |
| 15                           | Identify length-frequency data to calculate $\delta S_v$ windows for target identification               | Community to agree length-frequency range from which $\delta S_v$ windows created for target identification.                                     | (1) Community to identify what range of length-frequency data (e.g. 95 or 99%) should be used for calculating $\delta S_v$ window.<br>(2) Community to determine whether size range windows should be in 1 mm or 10 mm increments when determining $\delta S_v$ window ranges.                                |

(continued)



Table 1 (continued)

| Step                                | Task  | Proposed community action  | Query   |
|-------------------------------------|---|--|---|
| 16                                  | Identify method to create $\delta S_v$ windows  | Community to agree method of generating $\delta S_v$ window.   | (1) Is the window generated from the minimum and maximum krill sizes or the minimum and maximum dB ranges across the size range of krill sampled?   |
| 17                                  | Determine whether two-frequency and three-frequency identification techniques should be applied to the data | Community to identify whether just three-frequency identification windows applied or whether the two-frequency window is undertaken as well.   | (1) If the TS model was incorrectly parameterised, then previous two-frequency efforts may potentially have changed.                                |
| 18                                  | Apply target identification to dataset  | Community to apply target identification to 50 ping by 5 m dataset.  |   |
| 19                                  | Archive identification windows  | Community to lodge a set of target identification windows with CCAMLR.   | Suggest add to FTP site.  |
| Integration and latitude correction |   |  |   |
| 20                                  | Integrate data in 1 n mile resets   | Community to integrate data in 1 n mile resets (SC-CAMLR-XIX, Annex 4, Appendix G, paragraph 3.48).  |   |
| 21                                  | Apply latitude correction to data   | Community to apply latitude correction to each n mile reset (SC-CAMLR-XIX, Annex 4, Appendix G, paragraph 3.51).                               |   |
| 22                                  | Archive any integration code outside of Echoview and latitude correction                                    | Community to lodge code with CCAMLR.   | Suggest add to FTP site.  |
| Create conversion factor            |   |  |   |
| 23                                  | Generate conversion factors using length/weight/TS relationships  | Community to generate conversion factors.  | (1) $CF = \sum f_i \times W(L_i) / \sum f_i \times \sigma(L_i)$ where $W$ = weight and $L$ = length and $f_i$ is frequency of the $i$ th $L$ class. |
| 24                                  | Archive associated code and a table of CF values for each modelled output                                   | Community to lodge values and code with CCAMLR.  |   |
| Generate $B_0$                      |   |  |   |
| 25                                  | Generate transect krill densities   | Community to generate transect krill densities (SC-CAMLR-XIX, Annex 4, Appendix G).  |   |
| 26                                  | Generate $B_0$ estimates for each model run   | Community to generate $B_0$ estimate for Scotia Sea according to Jolly and Hampton survey method defined in SC-CAMLR-XIX, Annex 4, Appendix G. |   |
| 27                                  | Archive $B_0$ estimate/s  | Community to lodge values and any associated code with CCAMLR.   |   |

Table 2: The position vector  $r$  (including components  $x$ ,  $y$  and  $z$ ) and the radii values ( $a$ ) delineating the generic krill shape used in the SDWBA package, and the original shape presented by McGehee et al. (1998).

|    | SDWBApackage20050623 |        |     |        | Original McGehee et al. 1998 |        |     |        |
|----|----------------------|--------|-----|--------|------------------------------|--------|-----|--------|
|    | $x$                  | $y$    | $z$ | $a$    | $x$                          | $y$    | $z$ | $a$    |
| 1  | 38.3500              | 0      | 0   | 0      | 41.0898                      | 0      | 0   | 0      |
| 2  | 36.8563              | 0.9149 | 0   | 0.2147 | 39.4844                      | 0.9869 | 0   | 0.2332 |
| 3  | 34.0464              | 1.7924 | 0   | 0.6525 | 36.4767                      | 1.9244 | 0   | 0.6996 |
| 4  | 29.4160              | 2.4552 | 0   | 1.1296 | 31.5116                      | 2.6381 | 0   | 1.2174 |
| 5  | 26.6247              | 2.4365 | 0   | 1.3537 | 28.5230                      | 2.6165 | 0   | 1.4550 |
| 6  | 23.5253              | 2.4552 | 0   | 1.4470 | 25.2043                      | 2.6375 | 0   | 1.5557 |
| 7  | 20.6967              | 2.3059 | 0   | 1.5964 | 22.1774                      | 2.4691 | 0   | 1.7105 |
| 8  | 17.7000              | 2.2498 | 0   | 1.5497 | 18.9680                      | 2.4145 | 0   | 1.6630 |
| 9  | 15.1888              | 2.0538 | 0   | 1.6524 | 16.2722                      | 2.2034 | 0   | 1.7714 |
| 10 | 12.8456              | 1.8484 | 0   | 1.9044 | 13.7607                      | 1.9890 | 0   | 2.0400 |
| 11 | 10.5304              | 1.6897 | 0   | 1.7551 | 11.2867                      | 1.8110 | 0   | 1.8838 |
| 12 | 8.4672               | 1.6897 | 0   | 1.6524 | 9.0740                       | 1.8127 | 0   | 1.7703 |
| 13 | 6.6468               | 2.0631 | 0   | 1.3816 | 7.1265                       | 2.2155 | 0   | 1.4823 |
| 14 | 2.9687               | 2.4739 | 0   | 1.1016 | 3.1881                       | 2.6530 | 0   | 1.1851 |
| 15 | 0                    | 3.5568 | 0   | 0.5508 | 0                            | 3.8150 | 0   | 0.5946 |

Table 3: Parameters used in the SDWBA model to estimate error in the prediction of krill TS, where number of cylinders ( $n_0$ ) = 14, krill length ( $L_0$ ) = 38.35 mm and phase variability ( $\phi_0$ ) =  $\sqrt{2}/2$ . Note that all parameter values, except those for orientation, are from SC-CAMLR-XXVIII, Annex 8, Table 2.

|  | -1 SD  | Mean   | +1 SD  |
|--|--------|--------|--------|
| Fatness coefficient*                             | 1      | 1.4    | 1.7    |
| Density contrast ( $g$ )                         | 1.029  | 1.0357 | 1.0424 |
| Sound-speed contrast ( $h$ )                     | 1.0255 | 1.0279 | 1.0303 |
| Sound speed in water ( $c$ ; m s <sup>-1</sup> ) | 1461   | 1456   | 1451   |

\* Incorrectly described as ‘Radius of cylinders ( $r_0$ )’ in SC-CAMLR-XXVIII, Annex 8, Table 2.

Table 4: Orientation, target identification windows, estimated  $B_0$  and CV from simplified and full model runs using the input parameters from Table 3. LF cluster: length-frequency cluster (see paragraph 2.30); n/c: not calculated; mt: million tonnes.

| Parameter                      | -1 SD                    | Mean                     | +1 SD                   |
|--------------------------------|--------------------------|--------------------------|-------------------------|
| Orientation (mean,SD)          | $N(-17^\circ, 28^\circ)$ | $N(-20^\circ, 28^\circ)$ | $N(11^\circ, 28^\circ)$ |
| Simplified model               |                          |                          |                         |
| Target identification windows  |                          |                          |                         |
| LF cluster 1 (20–40 mm)        |                          |                          |                         |
| $\delta S_{v120-38}$           | n/c                      | 8.7 to 15.9              | n/c                     |
| $\delta S_{v200-120}$          | n/c                      | -3.5 to 2.5              | n/c                     |
| LF clusters 2 and 3 (30–60 mm) |                          |                          |                         |
| $\delta S_{v120-38}$           | n/c                      | -0.6 to 13.8             | n/c                     |
| $\delta S_{v200-120}$          | n/c                      | -3.5 to 2.2              | n/c                     |
| $B_0$                          | n/c                      | 87.2 mt                  | n/c                     |
| CV (Jolly and Hampton)         | n/c                      | 14.6 %                   | n/c                     |
| Full model                     |                          |                          |                         |
| Target identification windows  |                          |                          |                         |
| LF cluster 1 (20–40 mm)        |                          |                          |                         |
| $\delta S_{v120-38}$           | 12.1 to 15.1             | 8.7 to 14.3              | 5.5 to 13.8             |
| $\delta S_{v200-120}$          | -1.7 to 5.7              | -5.3 to 3.9              | -5.0 to 2.0             |
| LF clusters 2 and 3 (30–60 mm) |                          |                          |                         |
| $\delta S_{v120-38}$           | 7.0 to 13.7              | 0.4 to 12.0              | 0.0 to 10.3             |
| $\delta S_{v200-120}$          | -5.5 to 2.9              | -5.3 to 1.4              | -5.0 to 1.3             |
| $B_0$                          | n/c                      | 60.3 mt                  | n/c                     |
| CV (Jolly and Hampton)         | n/c                      | 12.8 %                   | n/c                     |

Table 5: Difference of orientation-averaged TS at two acoustic incidence angles.

| Estimated orientation distribution, $N(-20, 28)$ |                          |                |                  |
|--|--------------------------|----------------|------------------|
| TS(dB)   | Acoustic incidence angle |                | Difference of TS |
|  | 90 - $\theta$            | 270 + $\theta$ |                  |
| 38 kHz   | -82.6                    | -82.7          | 0.1              |
| 120 kHz  | -73.8                    | -73.6          | -0.1             |
| 200 kHz  | -78.6                    | -78.3          | -0.3             |

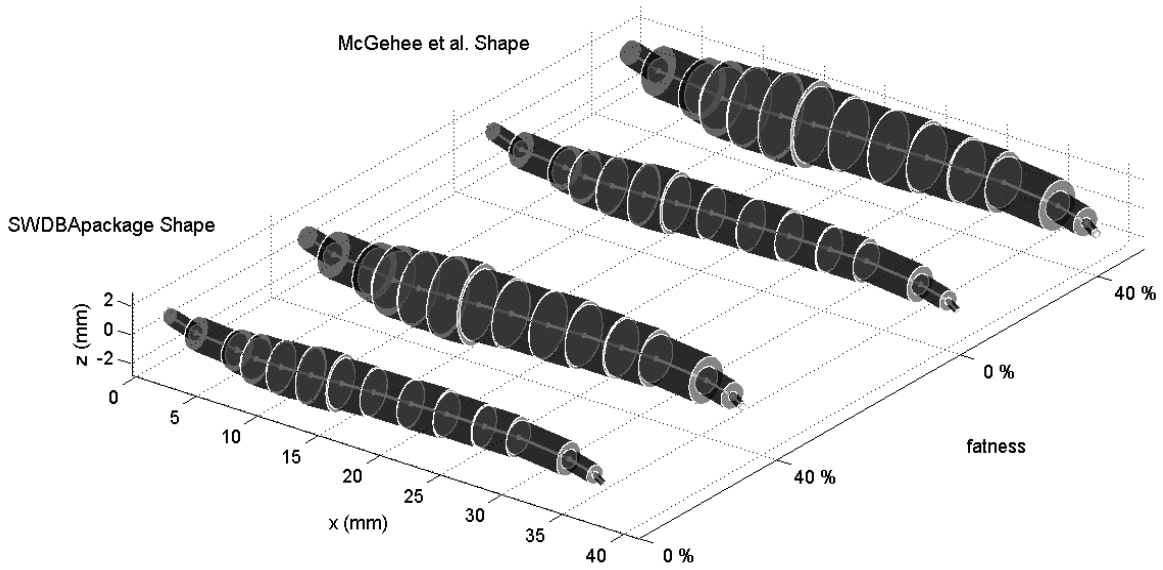


Figure 1: Illustration of the SDWBA package shape and the original McGehee et al. (1998) shape, parameterised with 0 and 40% increase in fatness, modelled to determine the SDWBA TS prediction of krill with standard AT length of 38.35 mm.

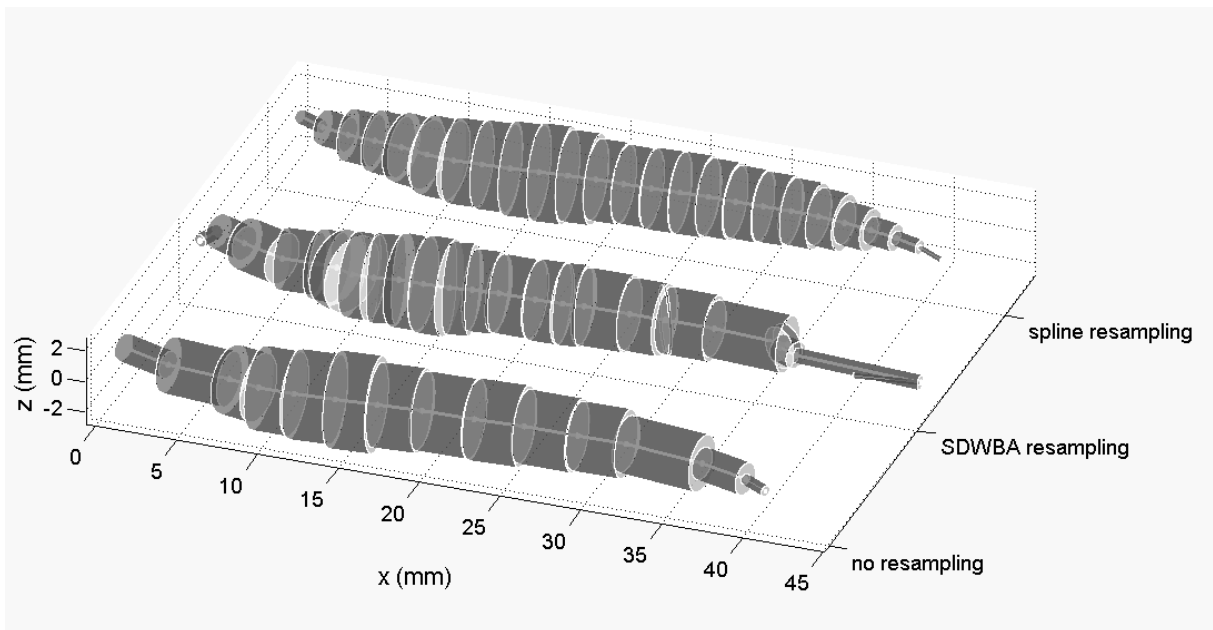


Figure 2: Illustration of the original McGehee et al. (1998) shape modelled at 200 kHz with the standard parameters without resampling process (no. cylinders = 14), resampled (no. cylinders = 24) by the SDWBA package using the Matlab resample.m function and using the simple cubic spline interpolation along the x-dimension with equidistant steps.

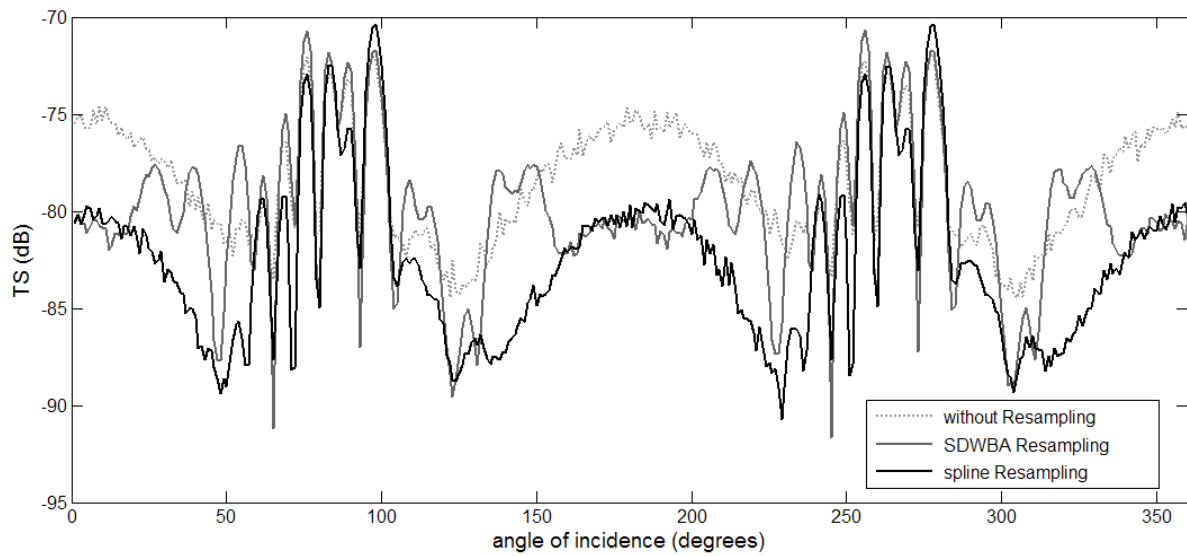


Figure 3: Predicted SDWBA TS versus angle of incidence for the original McGehee et al. (1998) modelled at 200 kHz with the standard parameters without resampling process (no. cylinders = 14), resampled (no. cylinders = 24) by the SDWBA package using the Matlab resample.m function and using the simple cubic spline interpolation along the x-dimension with equidistant steps.

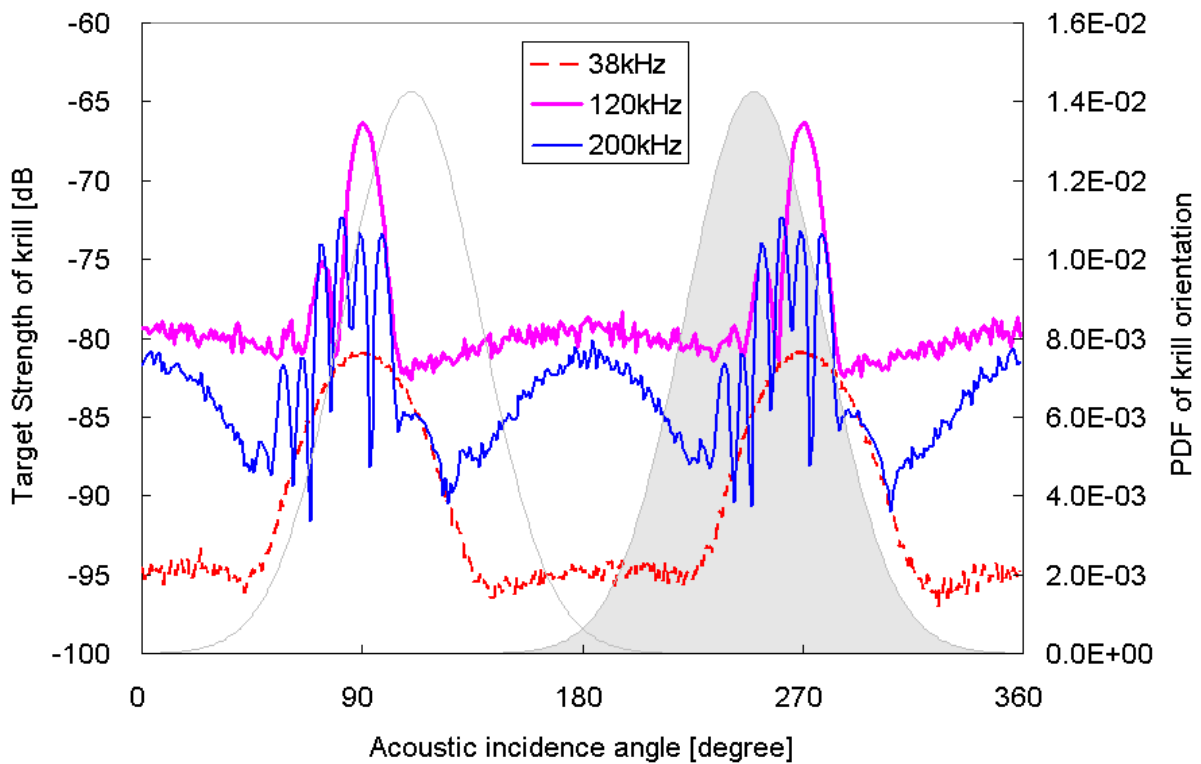


Figure 4: Estimated TS directivity and orientation of krill. Krill length is 38.5 mm.

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(Cambridge, UK, 1 to 4 June 2010)

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**TERMS OF REFERENCE**

Subgroup on Acoustic Survey and Analysis Methods  
(Cambridge, UK, 1 to 4 June 2010)

The Scientific Committee recommended the following terms of reference for the meeting of SG-ASAM in 2010 (SC-CAMLR-XXVIII, Annex 11):

- (i) Review documentation of the acoustic protocol for the preparation of estimates of acoustic biomass.
- (ii) Undertake a reanalysis of CCAMLR-2000 acoustic survey data including:
  - (a) confirm steps of analysis by correspondence prior to the next meeting;
  - (b) review the independent calculations of  $B_0$  from the CCAMLR-2000 Survey undertaken by Members including all correspondence between Members as appropriate to clarify relevant issues;
  - (c) review all the documented results of (b) submitted to SG-ASAM 2010;
  - (d) discuss results and add clarification to protocols if necessary;
  - (e) agree a validated  $B_0$  estimate and associated uncertainty from the CCAMLR-2000 Survey and submit to the 2010 meeting of WG-EMM.
- (iii) Lodge a validated dataset, model code and model runs with the Secretariat.



**AGENDA**

Subgroup on Acoustic Survey and Analysis Methods  
(Cambridge, UK, 1 to 4 June 2010)

1. Introduction
  - 1.1 Opening of meeting
  - 1.2 Meeting terms of reference and adoption of the agenda
2. Reanalysis of CCAMLR-2000 data
  - 2.1 Review analysis undertaken by correspondence prior to the meeting
  - 2.2 If necessary complete or modify analysis as appropriate
  - 2.3 Agree a revised estimate of  $B_0$  and associated uncertainty
3. Documentation of the acoustic protocols
  - 3.1 Discuss existing documentation and add clarification where necessary arising from consideration of Agenda Item 2
4. Future work
5. Recommendations to the Scientific Committee
6. Adoption of report
7. Close of the meeting.



**REPORT OF THE WORKING GROUP ON  
ECOSYSTEM MONITORING AND MANAGEMENT**  
(Cape Town, South Africa, 26 July to 3 August 2010)



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**REPORT OF THE WORKING GROUP ON  
ECOSYSTEM MONITORING AND MANAGEMENT**  
(Cape Town, South Africa, 26 July to 3 August 2010)

## INTRODUCTION

### Opening of the meeting

1.1 The 2010 meeting of WG-EMM was held at the National Research Aquarium, Cape Town, South Africa, from 26 July to 3 August 2010. The meeting was convened by Dr G. Watters (USA) and local arrangements were coordinated by Mr J. Khanyile, Department of Environmental Affairs (DEA), South Africa.

1.2 Dr Watters opened the meeting and welcomed the participants (Appendix A). He thanked Dr M. Mayekiso, Deputy-Director General, DEA, for hosting the meeting, and welcomed Mr A. Wright, CCAMLR Executive Secretary, to the meeting.

### Adoption of the agenda and organisation of the meeting

1.3 The provisional agenda was adopted without change (Appendix B).

1.4 The Working Group formed a krill subgroup (coordinator: Dr Watters) and a VME subgroup (coordinator: Dr S. Parker, New Zealand) which considered matters under Agenda Items 2 and 3.1 concurrently.

1.5 The Working Group considered discussions from two meetings held during the 2009/10 intersessional period:

- WG-SAM (Annex 4)
- SG-ASAM (Annex 5).

1.6 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.

1.7 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 4.

1.8 The report was prepared by Drs C. Jones (USA), S. Kasatkina (Russia), S. Kawaguchi (Australia), B. Krafft (Norway), P. Penhale (USA), D. Ramm (Data Manager), K. Reid (Science Officer), C. Reiss (USA), B. Sharp (New Zealand), P. Trathan (UK), J. Watkins (UK) and Watters.

Feedback from previous meetings of the Commission, the Scientific Committee and the working groups

1.9 Dr Watters outlined the feedback from previous meetings of the Commission, Scientific Committee and other working groups which had been used to structure WG-EMM's agenda, and highlighted key requirements for advice on:

- scientific observation of the krill fishery (SC-CAMLR-XXVIII, paragraph 6.28);
- krill escape mortality (SC-CAMLR-XXVIII, paragraphs 4.13 to 4.15);
- krill  $B_0$  and precautionary yield estimates (SC-CAMLR-XXVIII, paragraphs 3.3 to 3.7);
- VMEs (e.g. SC-CAMLR-XXVIII, paragraphs 4.247 to 4.252);
- MPAs (e.g. SC-CAMLR-XXVIII, paragraphs 3.28 to 3.33);
- a three-year work plan for the Working Group (SC-CAMLR-XXVIII, paragraph 14.2).

## KRILL

### Krill biology and ecology

2.1 WG-EMM-10/P8 described a plausible model of krill population dynamics at South Georgia and indicated that the timing and magnitude of recruitment has been a primary driver of inter- and intra-annual variability of krill biomass in the region. Results from the model also indicate that competition between the fishery that operates during winter and krill predators that forage during summer may occur despite the temporal separation of these activities.

2.2 WG-EMM-10/P9 and 10/P10 provide models that describe the spatial distribution of krill swarm types based on environmental factors. The Working Group agreed that while the krill fishery currently focuses its operations on shelf regions due to the relatively high predictability of locating fishable krill swarms compared to offshore areas, additional information on the predictability of fishable krill swarms offshore would facilitate the development of management measures to distribute fishing effort in space.

2.3 In considering these papers, the Working Group recalled the importance of understanding krill population dynamics and the overall population structure of krill for an integrated assessment, and noted the increasing amount of information, both from observations and models, that could assist in the development of an integrated assessment of krill.



## New monitoring efforts

2.4 WG-EMM-10/9 outlined a proposal to conduct research surveys in Subarea 48.2 for the next five years using the Norwegian krill fishing vessel *Saga Sea*. WG-EMM-10/20 outlined plans by Argentina to study the ecology and monitor the abundance of euphausiid larvae in the Weddell Sea–Scotia Sea Confluence (parts of Subareas 48.1 and 48.2).

2.5 The Working Group welcomed Norway’s proposal for a krill fishing vessel to commit five days each year for the next five years to conduct a research survey. In considering the proposal, WG-EMM suggested that the research be conducted using similar standards (e.g. a set of parallel acoustic transects that are run every year) to annual scientific surveys undertaken by the US AMLR Program and the British Antarctic Survey in Subareas 48.1 and 48.3 respectively.

2.6 The Working Group agreed that a regular survey in Subarea 48.2 would complement the annual surveys conducted by the US AMLR Program and the British Antarctic Survey. Together these three surveys could form an integrated monitoring effort extending across the Scotia Sea and linking three areas containing major concentrations of krill that are the focus of the present commercial fishery. Such an integrated effort could also make an important contribution to the Southern Ocean Observing System (SOOS) and provide valuable information for use within analyses of the international ICED Program (Integrating Climate and Ecosystem Dynamics – [www.iced.ac.uk](http://www.iced.ac.uk)).

2.7 The Working Group advised that:

- (i) the timing of the Norwegian survey should be before the start of the fishery, preferably in mid-January, to align the survey timing to the other survey efforts in Area 48. Conducting the survey before the start of fishing operations will ensure that conduct of the research effort is less likely to be impeded by ice;
- (ii) a set of transects similar to those run by the US AMLR Program in 2008 (Figure 1) would be appropriate to conduct a krill survey within the proposed time frame of five days. In order to avoid confounding of the results due to advection of krill, the survey effort would best start from the east and work towards more western transects. If time permits, it would be preferable to have transects extended northwards beyond 60°S, and to add an extra transect to the west of the transects illustrated in Figure 1 if possible;
- (iii) acoustic data collection should, if possible, be done using a calibrated scientific echosounder using 38 and 120 kHz. Acoustic data collection is encouraged 24 hours per day, however, only data collected during the daytime should be used for subsequent estimation of krill biomass;
- (iv) net sampling should be conducted at standard stations located every 20 n miles along transects. Following protocols from the CCAMLR-2000 Survey, each net haul should be an oblique tow sampling from the surface down to 200 m (or within 20 m of the bottom if the water is shallower than 200 m). The use of a Norwegian macroplankton trawl net (38 m<sup>2</sup> mouth area, 3 mm mesh size) was considered appropriate to provide length-frequency data on krill, although attention to ensure adequate sub-sampling of large catches will be required;

- (v) hydrographic data should be collected by XBT or CTD. As a minimum, collection of temperature profile data is recommended to estimate sound velocity profiles, which are essential for processing acoustic data. Such profiles could be collected using XBTs, although the use of a CTD would provide additional information to characterise water masses in the area, which may assist in the interpretation of variability in krill biomass;
- (vi) nutrient measurements were deemed not practical.

2.8 The Working Group thanked Argentina for its proposal in WG-EMM-10/20 and noted that the Weddell Sea–Scotia Sea Confluence is historically known as an area with high densities of larval krill that are variable in time and space. Monitoring in this area has the potential to provide useful data on krill recruitment processes that are indicative of spawning biomass.

2.9 In order for WG-EMM to provide detailed advice on the development of the program, and how best the information developed from a monitoring effort could be utilised, further details on how other zooplankton within the same size range as larval krill (e.g. copepods, amphipods and other euphausiids such as *Thysanoessa macrura*) can be separated from krill larvae when using acoustic methods would be required. The Working Group also suggested that consideration be given to using a CPR in the monitoring effort.

2.10 The Working Group encouraged Argentina to report on survey efforts conducted during the forthcoming intersessional period to WG-EMM and to provide further details on intentions to conduct repeat surveys in following years, including additional information on how vessels of opportunity may be used so that the implications of such a sampling design might be considered.

## The krill fishery and scientific observation of the fishery

### Fishing activity

#### 2008/09 season

2.11 Five Members fished for krill in Area 48 during the 2008/09 fishing season and reported a total catch of 125 826 tonnes; two vessels used the continuous fishing system. The largest catch of krill was taken from the South Orkney West (SOW) SSMU in Subarea 48.2 (89 184 tonnes), and the remainder of the catch was taken predominantly in Subarea 48.1, notably 19 691 tonnes from Antarctic Peninsula Bransfield Strait East (APBSE) SSMU and 2 745 tonnes from the Antarctic Peninsula East (APE) SSMU. The Working Group noted that this is only the second time that fishing has been reported from SSMU APE; previously, 25 tonnes of krill were taken in 1995/96 (WG-EMM-10/5).

## 2009/10 season

2.12 As of the start of the WG-EMM meeting, 10 of the 11 krill fishing vessels licensed by Members (People's Republic of China, Japan, Republic of Korea, Norway, Poland and Russia) have fished in Area 48 during the 2009/10 fishing season. The total catch reported to May 2010 was 108 550 tonnes, most of which has been taken from Subareas 48.1 and 48.2 between February and May. Approximately 40% of the catch has been taken by two vessels using the continuous fishing system. Based on the current cumulative catch trajectory as at the end of May (Figure 2 and paragraph 2.15), the forecast of the total catch of krill for the current season is 150 000–180 000 tonnes (WG-EMM-10/5), and data available at the time of the meeting indicated that, by the end of June 2010, the total catch had reached ≈140 000 tonnes. The final catch will be higher than forecast if current catch rates continue beyond July.

2.13 The Working Group noted that the Secretariat provides forecast closure dates once the catches in a fishery (or area) exceed 50% of the respective catch limits. This season, for the first time ever, the catch of krill in Subarea 48.1 has exceeded 50% of the apportioned trigger level (155 000 tonnes), and the Secretariat has begun providing a forecast closure date for the fishery in this subarea. Currently, the closure date is estimated to occur after the end of the fishing season.

2.14 The Working Group also noted the current requirement for vessels to begin reporting catches at 10-day intervals once the catch reaches 80% of the trigger level (CM 23-06). The Working Group advised the Scientific Committee that the reporting requirements in CM 23-06 are not consistent with the spatial allocation of the trigger level among subareas and should be revised accordingly.

### Trends in the krill fishery

2.15 The Working Group noted that approximately 80% of the krill catch was taken between April and July (Figure 2), and this temporal distribution of catches had typified the fishery over the last two decades. Information from the fishery suggested that this preference for fishing during the winter may be related to increased spatio-temporal stability of krill concentrations on the fishing grounds, as well as the desire to minimise catches of 'green krill' feeding on phytoplankton.

2.16 The Working Group noted a marked increase in the daily catch-rate capacity in recent years by vessels using the continuous fishing system (up to 800 tonnes per day per vessel), as well as vessels using conventional trawls (including vessels that use pumps to clear the codend) (up to 400 tonnes per day per vessel) (Figure 3).

2.17 Voluntary reporting of transshipments in the krill fishery (motivated by the introduction of CM 10-09 in 2008) was reported in WG-EMM-10/5. The Working Group noted that further reporting of information on transshipments would help increase understanding about the operation of the fishery.

## Notifications for 2010/11

2.18 Seven Members submitted notifications for a total of 15 vessels intending to participate in krill fisheries in Subareas 48.1, 48.2, 48.3 and 48.4, and Divisions 58.4.1 and 58.4.2, during the 2010/11 fishing season. No notifications were submitted for participation in exploratory krill fisheries during 2010/11. The total notified level of catch of krill in 2010/11 is 410 000 tonnes.

2.19 This is the third year in which the Working Group has reviewed details from krill fishery notifications. The Working Group thanked the Secretariat for translating notifications submitted in languages other than English; these translations enabled the Working Group to fully evaluate every notification.

2.20 The Working Group noted that all the notifications had sufficient information and advised the Scientific Committee that these notifications meet the requirements in CM 21-03.

2.21 The Working Group also noted the range of methods notified for determining the estimate of green weight of krill caught, and advised the Scientific Committee that standardisation of methods is required to achieve better estimates of catch. Further, the Working Group reiterated that the conversion factor required in the notifications is the factor that converts catch in volume to mass (SC-CAMLR-XXVIII, Annex 4, paragraphs 3.45 and 3.49). The Working Group also noted that a range of conversion factors (7.6 to 10.0) related to meal production were reported in the notifications, and further information from Members would be required to clarify the basis for these values.

## Data reporting

### Fine-scale catch and effort (C1) data

2.22 The Working Group noted the delays in the submission of C1 data from the Polish-flagged vessel that fished during 2008/09 and 2009/10 (WG-EMM-10/5). The Secretariat advised that the data from March to May 2010 had been submitted immediately prior to the meeting of WG-EMM, and that Poland is currently working to submit the data from 2008/09.

## Analysis of data from the krill fishery

### *Maxim Starostin*, Subarea 48.2

2.23 WG-EMM-10/8 reported on fishing activity by the Russian trawler *Maxim Starostin* during 2009 near the South Orkney Islands (Subarea 48.2), and WG-EMM-10/16 further presented spatial distributions and size/age compositions of Antarctic krill (*Euphausia superba*) from catches made during January–March in both the 2008/09 and 2009/10 seasons.

2.24 In considering WG-EMM-10/8, the Working Group noted that inferences based on the catches (or lack thereof) of age 1+ krill need to consider the size selectivity of commercial nets.

2.25 Conventional trawls may be more size selective than continuously pumped trawls because the higher volumes of krill in the codend might force smaller individuals out of the net. Differences between vessels among suction effects of pumps in the codends may also affect size selectivity. The Working Group reiterated the importance of acquiring more detailed information on the operation of all fishing methods.

2.26 The Working Group was informed that, in the future, the *Maxim Starostin* may switch fishing gear according to swarm types. The vessel may use the continuous fishing system when fishing large swarms and switch to conventional trawling when fishing smaller swarms.

#### Historical data

2.27 The Working Group noted the value of fishery-dependent data and reiterated advice from WG-SAM that data from the fishery will be useful for estimating size-specific fishing mortality rates (Annex 4, paragraph 2.7). The Working Group further noted that fishery-dependent data need to be standardised, quality controlled and organised so that they are available for further systematic analysis.

2.28 The Working Group recalled that last year Ukraine had processed and submitted haul-by-haul catch and effort data from 57 krill fishing trips conducted by vessels from the former Soviet Union. Further processing and validation of these data has been delayed due to the Secretariat's limited data management resources and high workload. The Working Group was informed that this task is currently scheduled for completion in early 2011, and looked forward to reviewing the data in the future.

#### Escape mortality

2.29 The Working Group recalled that the Scientific Committee recommended that there should be a concerted effort to estimate escape mortality in the krill fishery through evaluation of existing information and the continued development of existing models (SC-CAMLR-XXVIII, Annex 4, paragraphs 3.5 and 3.6). Three papers were presented to address this problem.

2.30 WG-EMM-10/10 described a field study of krill escape mortality using fine-meshed chafers that would collect data necessary to estimate by-catch and escape mortality of krill, larval and juvenile fish, and other species of euphausiids. At least five experiments (preferably three per month) to estimate escape mortality of each commercial trawl per fishing season were proposed.

2.31 WG-EMM-10/18 recommended field studies on krill escape mortality, including data collection and processing using the complex application of fine-meshed chafers and acoustic methods to estimate the total amount of krill passing through the trawl. Details of the chafer design and how chafers might be mounted to the trawl were provided. The paper also raised the need for an operating manual to achieve appropriate levels of accuracy and precision for krill escape mortality estimates.

2.32 The Working Group considered the proposed work and noted that data collection on escape mortality should be supported by the development of the operating manual. The Working Group endorsed the experimental work on krill escape mortality to be undertaken on board the Russian vessel *Maxim Starostin* as an important contribution to this issue. It looked forward to receiving a report at a future WG-EMM meeting and encouraged other Members to participate in such work.

2.33 WG-EMM-10/19 reported on an analysis, based on field and modelling data, of trawl catchability and escape mortality in relation to the krill fishery. The Working Group discussed the modelling results presented and noted that it would be important to compare the field and modelling data.

2.34 To define krill escape mortality, estimates of both the total amount of krill passing through the meshes and the proportion of these krill that become moribund through the escape process are required. The Working Group recognised that there are practical difficulties in separating krill killed during escapement from those that escaped from the trawl without fatal injuries, but then subsequently died in the chafer. However, the Working Group noted that krill passing through small meshes are likely to be damaged even when they appear visually viable. Therefore the Working Group agreed that, without evidence to the contrary, it would be appropriate to assume that all krill escaping through the small mesh would not survive the process.

2.35 The Working Group noted that estimates of escape mortality in the krill fishery require a quantitative understanding of the process of krill passage from the trawl mouth to the codend. This process will be influenced by many factors, including:

- fishing gear construction
- vessel speed and hauling/veering rates of the trawl
- towing duration
- quantity of krill in the codend
- krill density and distribution in the trawl swept volume.

2.36 The Working Group noted that elaborating a standard approach to collecting and processing data on escape mortality would be necessary to achieve an appropriate level of accuracy and precision.

2.37 The Working Group agreed that the documents on krill escape mortality would be useful guidance for developing an operating manual to detail the required standard approaches to investigating the escape mortality of krill (Annex 4, paragraphs 2.20 to 2.23), and that this could also contain measurements that could be used by scientific observers.

2.38 The Working Group asked Russia and Ukraine to submit documents to ad hoc TASO outlining field study approaches to investigate the krill escape mortality and its implication for the workload of scientific observers. The Working Group requested that TASO review this manual (once developed) to determine the practicality of its implementation.

2.39 The Working Group was informed that the Institute of Marine Research in Norway has applied for funding to support a pilot study to develop a mathematical model, based on demographic data on *E. superba*, to quantify size selection through different trawl nets. This pilot study is intended to provide baseline data for a larger study involving comparative *in situ*

trawling experiments, including testing existing and newly developed trawl gear (from the pilot project), with acoustic measurements and video monitoring in a flume tank. The larger study will also evaluate performance of the same fishing gear on the krill fishing grounds in the Southern Ocean and include sampling krill within and outside the nets.

## CPUE

2.40 The Working Group welcomed WG-EMM-10/17 that included an analysis of the temporal dynamics of standardised CPUE based on CCAMLR fishery data from Subareas 48.1 to 48.3, including 15 SSMUs. The Working Group noted that various factors (e.g. vessel, product, season, swarm types, krill condition, by-catch) were likely to influence CPUE and suggested that examining different measures of CPUE, that included different ancillary data, might provide a means of interpreting indices of CPUE. The Working Group encouraged further analysis of CPUE, including the development of summary indices of CPUE, from the krill fishery, noting that these analyses could be very useful in understanding the relative importance of areas to the historical krill fishery.

## Scientific observation

2.41 WG-EMM-10/4 presented a summary of observations on board krill trawlers operating in the Convention Area. The Working Group considered the format of the summary so that it could be effectively utilised in deliberations and analyses regarding observer deployment in the krill fishery, and requested that statistics on the level of observer coverage be included.

2.42 The Working Group agreed that turning the information contained in Table 1 of WG-EMM-10/4 into a map, or possibly an animation, would help to visualise observer coverage in time and space.

## Observer deployment

### 2008/09 season and prior seasons

2.43 Eight scientific observer logbooks from five out of six vessels that operated during the 2008/09 fishing season were submitted to CCAMLR. At present, the CCAMLR database holds scientific observer data from 57 logbooks summarising observations made between 1999/2000 and 2008/09 in Subareas 48.1, 48.2, 48.3 and 48.4.

### Current season

2.44 The Secretariat has received 10 notifications of the placement of CCAMLR scientific observers appointed in accordance with CM 51-06 on krill fishing vessels in Area 48 during 2009/10 (WG-EMM-10/4). It was clarified that each of the Chinese vessels that operated in the current season carried three observers.

## Observer coverage in the krill fishery

2.45 WG-SAM recommended that WG-EMM develop a table indicating time–area strata where variability in the size structure of the krill population is highest (Annex 4, paragraph 2.11) and, thus, where higher levels of observer coverage would be required. Such a table would provide useful guidance on how a systematic program of observer coverage could be optimised to yield data that would be most useful in an integrated assessment for krill (Annex 4, paragraph 2.11).

2.46 Observers are required to provide a variety of important data (e.g. data on the by-catches of larval fishes, seabirds and marine mammals, as well as the size composition of the catch in different locations and time), and the requirements for optimising sampling coverage and intensity may vary depending on the questions that are to be addressed with the data that are collected.

2.47 The Working Group recalled that the current instructions for observers on krill fishing vessels (SC-CAMLR-XXVII, Annex 4, paragraph 4.48) provide a mechanism for the spatial distribution of sampling to occur at spatial scales that are smaller than the subarea scale (hereafter referred to as strata).

2.48 As has been advised in previous years, data collected during an initial period of systematic observer coverage are needed to characterise underlying variability and assist with the design of an observer program in the long term (SC-CAMLR-XXVI, Annex 4, paragraphs 4.44 to 4.47). A two-year program with sampling effort distributed across potential time–area strata would be a useful start to establishing baseline data on the variability of krill size structure and other biological parameters.

2.49 WG-EMM suggested, for the 2010/11 and 2011/12 fishing seasons, the following three options to distribute observers among 50% of all time–area strata in a manner consistent with the requirements of CM 51-06 (Table 1).

- (i) **Option 1:** divide all notified vessels into two approximately equal-sized groups; divide the fishing season into two six-month periods, and require observer coverage according to Table 1.
- (ii) **Option 2:** divide the fishing season into four quarters and divide periods in which all vessels would be required to carry observers according to Table 1.
- (iii) **Option 3:** require 50% coverage of vessels, and at least 20% coverage of hauls, for each time–area stratum fished throughout the two fishing seasons.

2.50 Recalling that the advice from the Working Group and the Scientific Committee remains that 100% observer coverage across all vessels is the best way to achieve systematic observer coverage, WG-EMM noted the following consequences of adopting each of the three options listed in paragraph 2.49 (all of which would provide less than 100% coverage).

**Option 1** allows cross-vessel comparisons within each group of vessels but may not allow cross-group comparisons. Between-year comparisons in any subarea or spatial stratum may also be made.



**Option 2** allows cross-vessel comparisons and an assessment of interannual variation for the time–area strata in which observations are collected. Increased coverage will also occur in areas where there is substantial variation in the size structure of krill and where there have been the fewest previous observations from historically important fishing grounds (Subareas 48.1 and 48.2). However, data might not be collected from about half of the time–area strata. Furthermore, if there are large shifts in the spatial distribution of the fishery between years and between areas where all vessels are required to carry observers, less than 50% coverage may be achieved over all time–area strata.

**Option 3** allows consideration of interannual variation for all the time–area strata in which fishing occurs, however, it may not allow cross-vessel comparisons.

2.51 The Working Group noted that the Commission had agreed to review CM 51-06 in 2010 based on the advice from WG-EMM and WG-SAM. In considering its recommendations above, the Working Group noted that the options outlined in paragraph 2.49 and illustrated in Table 1 could be modified to accommodate changes in levels of observer coverage.

2.52 The Working Group requested that ad hoc TASO consider the time budget for observers in the krill fishery and advise whether 20% haul coverage could be achieved by increasing the number of hauls observed per five-day period.

Estimates of  $B_0$  and precautionary yield for krill

Estimation of  $B_0$

2.53 Dr Watkins, Convener of the fifth meeting of SG-ASAM, provided a summary and review of the results from that meeting. The Subgroup focused on the estimation of krill biomass ( $B_0$ ) from a reanalysis of the acoustic data from the CCAMLR-2000 Survey.

2.54 Through a combination of pre-meeting correspondence and meeting discussions, the Subgroup assessed and revised the protocol that had been provided by SG-ASAM-09 (SC-CAMLR-XXVIII, Annex 8, Appendix E). A number of issues relating to the protocol were identified by SG-ASAM-10 (Annex 5, Table 1) and corrections/modifications were made to the protocol or the associated computer code. Solutions to the major issues are summarised below:

- (i) Computer code was modified to account for a series of errors relating to the parameterisation of krill shape within the SDWBA model (Annex 5, paragraphs 2.13 to 2.19).
- (ii) Inspection and validation of code used to undertake the SDWBA inversion to estimate the orientation distribution of krill from the acoustic data was carried out (Annex 5, paragraphs 2.21 to 2.26).
- (iii) A method for correcting the sample-averaging effect on orientation variance was implemented (Annex 5, paragraphs 2.27 to 2.29).

- (iv) It was recognised that changing SDWBA code and revising orientation distribution required recalculation of target identification windows (Annex 5, paragraphs 2.30 to 2.35).

2.55 A revised estimate of krill biomass ( $B_0$ ) from the CCAMLR-2000 Survey of 60.3 million tonnes with a sampling CV of 12.8% was generated using the full SDWBA model (Annex 5, Table 4). The Subgroup advised that the output from the full SDWBA was preferred on a scientific basis because fitting the simplified model to the results from the full model introduced additional errors and uncertainty into estimates of TS that could propagate through to errors in target identification (Annex 5, paragraph 2.41).

2.56 Noting SG-ASAM's justification for the use of the full SDWBA model, rather than the simplified model, the Working Group recommended that, in the future, estimates of  $B_0$  should use the full SDWBA model in preference to the simplified model.

2.57 The Working Group recognised the significant amount of work conducted by SG-ASAM both during pre-meeting correspondence and during the meeting to ensure that a fully validated estimate of biomass was formulated.

2.58 The Working Group discussion of the recalculation of  $B_0$  focused on two main areas: the technique used to generate the krill orientation distribution and the lack of an estimate of total uncertainty in the estimation of  $B_0$ .

2.59 As described by SG-ASAM-10 (Annex 5, paragraphs 2.25 to 2.28), the parameters of the krill orientation distribution are estimated by a least-squares 'inversion' (or fit) of the full SDWBA model. This includes comparison of the distribution of dB differences (the difference between acoustic backscatter at 120 and 38 kHz,  $S_{v120kHz-38kHz}$ ) for the CCAMLR-2000 acoustic data with model-derived dB difference distributions (one for each orientation angle and standard deviation) generated using the probability density function of krill length sampled during the survey. Figure 4 shows the curve generated from the field data and the model-derived curve using the best fitting orientation parameters.

2.60 The Working Group noted that Figure 4 did not provide any goodness-of-fit statistic and sought further clarification from members of SG-ASAM present about the appropriateness of both the model and the fitting procedure. Discussions of these issues had also taken place at SG-ASAM and the Subgroup had concluded that:

- (i) the new inversion code would provide results comparable to those illustrated in Conti and Demer (2006) (Annex 5, paragraph 2.21);
- (ii) a statistical indication of goodness-of-fit was an important next step (Annex 5, paragraph 4.1(i)).

2.61 The CV provided with the recalculation of  $B_0$  represents the sampling error. It includes no estimate of the uncertainty associated with the model (methodological errors including uncertainty in TS and target identification). While SG-ASAM had intended to explore aspects of model uncertainty, the processes to produce a single  $B_0$  estimate were manually and computationally intensive and precluded any investigation in a reasonable time frame (Annex 5, paragraph 2.43). In addition, the Subgroup recognised that complex interactions within the model meant that a full evaluation of uncertainty in  $B_0$  would require a

probability density function of  $B_0$  (Annex 5, paragraph 2.44) and that this would only be achieved once streamlined efficient code that could be implemented in Monte-Carlo simulation was available (Annex 5, paragraph 4.1(viii)).

2.62 Having considered the issues discussed above, the Working Group agreed that the recalculated  $B_0$  estimate of 60.3 million tonnes with a sampling CV of 12.8%, derived using the full SDWBA, now represented the best estimate of krill biomass ( $B_0$ ) during the CCAMLR-2000 Survey.

2.63 The Working Group further agreed that the presently calculated uncertainty in the  $B_0$  estimates (CV = 12.8%) would be at best the lower limit. Given that an estimate of total uncertainty was not available at this meeting, the Working Group considered how best to proceed.

2.64 The Working Group concluded that a sensitivity analysis using the GYM to investigate the effect of differing levels of total uncertainty on the precautionary catch limit would be appropriate. The GYM was run with three levels of the CV in  $B_0$  to simulate the inclusion of both sampling error and increasing levels of methodological error (Table 2).

2.65 The Working Group agreed that the relatively small effect on the harvest rate of increasing total CV indicated that while there is a need to investigate methodological uncertainty in the acoustic method, the estimates of  $\gamma$  were relatively insensitive to differences in total uncertainty, therefore the present results, and particularly the present CV, could be used to provide a robust estimate of the precautionary catch limit.

2.66 The Working Group noted that similar conclusions had been reached when uncertainty in the variance of  $B_0$  had been discussed in 1995 and a sensitivity analysis conducted with the KYM (SC-CAMLR-XIV, Annex 4, paragraphs 4.53 to 4.56).

2.67 However, the Working Group also noted that as CV increases there is a switch in the  $\gamma$  that is used to calculate the precautionary catch limit.

#### Estimation of precautionary catch limits for krill

2.68 The Working Group agreed with the conclusion of SG-ASAM-10 ‘that the intersessional work and model exploration conducted at this meeting had shown that the value for  $B_0$  provided at the 2007 meeting of WG-EMM was incorrect and that the difference in that value and the value of  $B_0$  from the full SDWBA provided during this meeting arose simply as a result of the correction of errors that were included in the calculation in 2007’ (Annex 5, paragraph 2.42).

2.69 Based on the advice from SG-ASAM of the revised  $B_0$  estimate for Subareas 48.1 to 48.4 (60.3 million tonnes with a survey CV of 12.8%; paragraph 2.55) and  $\gamma$  (0.093; Table 2), the Working Group generated a new precautionary catch limit of 5.61 million tonnes for Subareas 48.1, 48.2, 48.3 and 48.4 and agreed that this would be appropriate for a revision of CM 51-01.

2.70 The Working Group noted that the current trigger level (620 000 tonnes) is not linked to the assessment of  $B_0$ .

2.71 The Working Group considered the status of biomass estimates for Divisions 58.4.1 and 58.4.2 and noted the recommendation of SG-ASAM (Annex 5, paragraph 5.2) that with appropriate parameterisation the revised protocol could be applied to these areas to generate new estimates of  $B_0$  and, hence, precautionary catch limits. However, the Working Group noted that such recalculations were not possible at this meeting and that given the present or likely notified catch for these regions, the present  $B_0$  values and catch limits should remain until the appropriate reanalysis can be carried out.

#### Reviewing parameters used in the GYM

2.72 The Working Group agreed that it was timely to consider a review of the parameters used in the GYM because, although the parameters had been reviewed in 2007, the only changes to those used to set the precautionary catch limit since 1995 had been the survey CV (SC-CAMLR-XXVI, Annex 4). However, the Working Group agreed that a full review of these parameters would not be possible during the present meeting.

2.73 The Working Group recalled the discussions on recruitment variability that had taken place at previous meetings (see for example SC-CAMLR-XIV, Annex 4, paragraphs 4.42 to 4.45; SC-CAMLR-XV, Annex 4, paragraphs 3.51, 3.52, 6.20 to 6.24 and 7.6 to 7.15; SC-CAMLR-XXVI, Annex 4, paragraph 2.33) and noted that there had been no changes to the recruitment parameter since 1995 and so the GYM presently was based on recruitment data collected prior to 1994.

2.74 The Working Group considered whether the degree of recruitment variability presently used in the model was an underestimate, and whether recruitment variability was likely to have been changing over time as a result of the ongoing environmental changes in the Southern Ocean.

2.75 The Working Group agreed that a full review of recruitment variability and its implementation within the GYM was desirable but would not be possible during the meeting. The Working Group, however, agreed that a sensitivity analysis, similar to that conducted for uncertainty in  $B_0$  estimation, would be undertaken during the meeting.

2.76 The sensitivity of harvest rate to increased levels of recruitment variability (using CV values of 1.5 (19.8%) and 2 (25.2%) times the present CV of 12.6%) was investigated using 10 001 iterations of the GYM (Table 3). These results indicate that the  $\gamma_2$  (escapement gamma) was relatively insensitive to increasing levels of recruitment variability but  $\gamma_1$  (stable recruitment gamma) showed a marked decrease as recruitment CV increased. However, the Working Group also noticed that with further increase in recruitment CV the GYM terminated prematurely. This error occurred at different recruitment CV levels with varying numbers of iterations.

2.77 The Working Group noted there was insufficient time to fully explore why the parameter bounds for recruitment variability in the sensitivity trials caused the GYM to cease running. The Working Group requested that the Secretariat, with the help of members

familiar with the assessment, document this for the next meeting. The Working Group agreed that the inclusion of a time series of year-class strengths in the GYM assessment would be useful to explore.

2.78 The Working Group considered the application of the current three-stage decision rule currently used by CCAMLR to determine the precautionary catch limit for krill and noted that for stocks such as krill that experience high interannual variability in abundance, the probability with which the biomass may fall below 20% of the initial biomass may be greater than 0.1 even in the absence of fishing. This would result in a  $\gamma_1$  being equal to 0 and hence a modification of this part of the decision rule may be required provided that the objectives in Article II can still be met. Given also the potential impact of climate change on recruitment variability, the Working Group agreed that both the recruitment variability and the specification of the current decision rule relating to the maintenance of stable recruitment should be investigated.

## SPATIAL MANAGEMENT TO FACILITATE THE CONSERVATION OF MARINE BIODIVERSITY

### Vulnerable marine ecosystems

3.1 The Working Group agreed that, in the future, advice on bottom fisheries and strategies to avoid significant adverse impacts on VMEs should be organised within the structure of the 'Report on Bottom Fisheries and Vulnerable Marine Ecosystems' endorsed by the Scientific Committee in 2009. WG-EMM-10/15 provided a draft template and work plan for that report, noting that, unlike Fishery Reports as produced by WG-FSA, the Bottom Fishery Report will need to be assembled from the outputs of WG-SAM, WG-EMM and WG-FSA. The template includes types and locations of existing bottom fisheries, details of registered VMEs and Risk Areas, assessments of impacts to VMEs, strategies to avoid significant adverse impacts on VMEs, as well as strategies to provide management advice that is robust to uncertainty.

### Management framework

3.2 WG-EMM-10/29 presented a proposed set of definitions for terms specifically relevant to the management of VMEs in the CAMLR Convention Area using an exposure-effects risk assessment framework. The Working Group agreed that these definitions enhance a common understanding of terminology related to VMEs. The Working Group recommended the adoption of definitions of fragility, vulnerability, threat, footprint, impact and ecological consequence. Some members felt that the flow diagram in Figure 1 of WG-EMM-10/29 was useful for illustrating the relationships among the terms, although some terms require further consideration. The Working Group agreed to refer the paper to WG-FSA for further discussion.

3.3 The agreed definitions are as follows:

**Fragility** – The susceptibility of an organism (or habitat) to impact (physical damage or mortality) arising from a particular interaction with a particular type of threat

(e.g. bottom trawls or longlines). Fragility refers to an intrinsic physical property of the organism and the nature of the threat, without reference to the actual presence or intensity of the threat.

Example: Tall, brittle organisms would be more fragile as a result of shearing forces exerted by lateral longline movement than low profile or flexible organisms.

**Vulnerability** – The susceptibility of species (or habitat) to impact by a particular type of threat over time, without reference to the actual presence or intensity of the threat. Vulnerability incorporates fragility but also includes other spatio-temporal and ecological factors affecting the resistance or resilience of the species (or habitat) to impact and/or the potential for recovery from impact over time (e.g. longevity, productivity/growth rate, dispersal and colonisation, rarity, community/habitat patch size, succession and spatial configuration).

Example: A species with high fragility but, as a population, also has high productivity (i.e. rapid growth, reliable and abundant recruitment) would have lower vulnerability than species with comparable fragility and slower growth, or with comparable fragility and infrequent, or lags, in recruitment.

**Threat** – An anthropogenic perturbation (e.g. bottom fishing) that can be expected to exert an impact on vulnerable organisms or habitats. The level of threat reflects factors extrinsic to the organism or habitat (e.g. intensity of fishing effort).

**Impact** – Change in status to a particular population, habitat or other identifiable component of an ecosystem, arising from mortality or damage associated with a threat over time. Conceptually, impact is the product of vulnerability and threat.

Example: A highly vulnerable organism in an area with no fishing experiences no impact. An organism with low vulnerability in an area of moderate fishing intensity experiences relatively low to moderate impact.

**Fishing footprint** – The area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km<sup>2</sup> seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint.

**Ecological consequence** – The magnitude of ecological effects likely to arise from a particular level of impact. For example, impacts to VMEs may affect benthic-pelagic coupling, the availability of three-dimensional structural habitat for associated species, reproductive output of benthic organisms, succession in the benthic assemblage or the viability of the affected population. Ecological consequence is a function of the level of impact.

3.4 The Working Group noted that estimates of fragility might encompass examination of how different forces exerted by the fishing gear (e.g. from hooks, anchors, snoods and mainline) might affect different types of organisms in different locations. The Working Group further noted that estimating fragility is conceptually straightforward, but that

vulnerability incorporates spatio-temporal patterns and dynamic processes that may not be measurable in the field and is likely to be best assessed using a simulation modelling approach.

3.5 The Working Group discussed the concept of ‘risk’, noting that it may be a different concept from considering solely the likelihood of ecological consequences of an impact. It will need to incorporate consideration of both current impacts and the potential for impacts in the future given a proposed management strategy. It also noted that in defining risk, consideration will need to be given to conceptual issues concerning the relationships between impact, ecological consequence and significant adverse impacts, especially in relation to integrating potential impacts in time and space, and uncertainty. The Working Group recommended that WG-FSA further consider the definition of risk.

3.6 With respect to bottom fishing effects on VMEs, the Working Group agreed that there are currently data available to inform estimates of impact, but that the functional form of the relationship between impact and ecological consequence is currently unknown, and that various hypothetical forms of the relationship between impact and ecological consequence may be plausible (see Figure 5), including linear, non-linear, stepwise or a variety of other forms; any of which may be taxon or assemblage specific.

3.7 WG-EMM-10/7 provided an up-to-date summary of VME notifications made under CMs 22-06 and 22-07. The Working Group welcomed the report and thought the content was extremely useful. The Working Group recommended that summary statistics be developed by the Secretariat to aid in assessing the reporting of VME units by vessels or VME taxa by observers.

3.8 The Working Group agreed that additional information, such as summary maps of actual VME units reported, would be useful in identifying VME clusters and providing additional information that could be useful in understanding the spatial extent of VMEs or VME indicators. The Working Group noted that reporting of VME indicator units varied among vessels and recommended the Secretariat develop data summaries to inform comparisons of VME by-catch among vessels or fleets fishing in the same region, as well as by SSRU.

3.9 The Working Group noted that VME Risk Area data are rapidly accumulating, and that the availability of these data is restricted to Members. The Working Group noted that the rules for the release of VME data in the public domain requires further consideration by the Scientific Committee and Commission.

### Impact assessments

3.10 WG-SAM-10/20 described a revision of the impact assessment framework from Sharp et al. (2009) that estimates the cumulative footprint and impact on VME taxa associated with New Zealand’s bottom longline fishery in the Ross Sea. WG-EMM noted that WG-SAM had requested that WG-EMM consider the nature of the distributions used to represent input assumptions of the impact assessment framework regarding footprint and fragility (Annex 4, paragraphs 4.12 to 4.19).

3.11 The Working Group welcomed the developments set out in WG-SAM-10/20 and agreed that it was important to develop a test statistic that could be used to confirm the extent to which spatial distributions of fishing effort within a pixel become random with different pixel sizes. The Working Group further recommended that summaries of effort concentration as depicted in WG-SAM-10/20, Figure 6, should be expressed as estimated impact rather than effort density on the x-axis, and that the variation in the estimated impact levels associated with each pixel should be incorporated in some way.

3.12 The Working Group noted that the R code that can be used to generate and plot probability density functions, similar to those illustrated in WG-SAM-10/20, is available from the Secretariat as the R-library 'Iapdf'.

3.13 WG-EMM-10/33 presented the UK's preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on VMEs in the Ross Sea. A 'Benthic Impacts Camera System' (BICS) unit from the Australian Antarctic Division (AAD) (see WG-EMM-10/24 and paragraphs 3.25 and 3.26 below) was deployed on six sets of a longline vessel operating in Subarea 48.3. Data from these video deployments were analysed for longitudinal and latitudinal movement of the fishing line in order to estimate the fishing footprint. Information from BICS was also used to inform preliminary estimates of fragility within the standard footprint for two VME indicator taxa – gorgonians and stylasterids. Gorgonians in this study had an estimated standard-footprint fragility of 22% and were observed to rebound after being bent over by the line, due to their flexible body form. In contrast, standard-footprint fragility was estimated at 78% for stylasterids, which tended to be smaller, more brittle and easily dislodged from the rocks.

3.14 The Working Group noted that the UK reported that the identity and approximate abundance of VME taxa viewed by the camera were consistent with the types of VME by-catch retrieved from the lines at the surface, but that these observations did not enable quantitative estimates of the relationship between seafloor densities of VME taxa and the quantities observed on board.

3.15 The Working Group welcomed these field observations and encouraged continued research by Members to inform estimates of fragility and gear performance used to inform impact assessments. The Working Group recommended that future research of this kind should systematically vary the position of the camera on the line, and that researchers consider recording all relevant site-specific or deployment-specific variables that may influence the extent and nature of interactions between fishing gear and benthic organisms and their observation at the surface, e.g. depth, slope, substrate, weather, ice conditions, current speed and current direction relative to observed line movement, along with the quantities of by-catch landed in the segments related to the location of the camera unit.

3.16 WG-EMM-10/23 provided an update of efforts to quantify the dynamics and extent of interactions between fishing gears and marine benthos in Division 58.5.2 as well as several areas in Division 58.4.1. The key components required for such assessment include a seascape (i.e. application of 'landscape ecology' to the sea, relating to ecology of spatial units and the relationships between such units), vulnerability and impact assessment, as well as evaluation of potential management strategies. Details of each of these steps are summarised, and a summary of progress to date and a schedule of completion of tasks are provided.



3.17 The Working Group welcomed this paper and agreed that the large-scale effort of this research plan will be valuable in assessing the extent to which bottom fishing may exert significant adverse impacts on VMEs. The Working Group noted that the research is currently in the data collection and analysis phase, and that the final report should be available in 2011. It also noted that this work is part of an ongoing program of work by AAD, designed to explore key spatial management issues specific to the ecology of benthic organisms in the Southern Ocean.

3.18 Following the request of WG-SAM to consider the probability density functions for fragility (Annex 4, paragraphs 4.12 and 4.13), the Working Group noted that there is insufficient information to prescribe the actual form of the function for fragility in the impact assessments, and that the function may need to incorporate other variables.

3.19 The Working Group considered that a useful approach to estimating input functions for footprint and fragility could include using a hierarchy of information sources. For example, expert knowledge and the application of ecological first principles, such as those set out by WS-VME-09 (SC-CAMLR-XXVIII, Annex 10, Table 1), may be useful for characterising some aspects of these parameters, or for extending empirical observations of particular taxa to inform estimates for other taxa expected to have similar physical properties. More empirically derived data (e.g. laboratory experiments or other physical measurements) could provide a more precise description of gear performance and the nature of resistance to, and resilience from, disturbance for particular taxa. Finally, experimental observations in the field, such as those described in WG-EMM-10/23, 10/24 and 10/33, provide field-based empirical observations to estimate the nature and extent of contact between bottom fishing gear and benthic organisms, and associated fragility of VME taxa.

3.20 The Working Group noted the advice of WG-SAM (Annex 4, paragraphs 4.12 to 4.19) that combined cumulative impact assessments, following the sequential framework described in WG-SAM-10/20, be completed by WG-FSA. Following this advice, the Working Group recommended that the impact assessment method presented in WG-SAM-10/20 could be used by WG-FSA, taking account of advice in paragraph 3.11, to generate an overall impact for a fishery, including a cumulative assessment across all gear types.

3.21 The Working Group also recommended that Members undertake their preliminary assessments using this method and using standard metrics and units adopted by WG-SAM (Annex 4, paragraph 4.19). The Working Group noted that justification should also be given for the input functions used in their assessments.

3.22 The Working Group recommended that, in the absence of information that can be used to provide the shape of the probability density function for fragility, the functions utilised in WG-SAM-10/20, as well as information derived from the research trials described in WG-EMM-10/33 (mean fragility of 22% for gorgonians and 78% for stylasterids), could be used by WG-FSA to conduct an overall impact assessment for an area. The Working Group further noted that impact assessments could be summarised for various strata or locations as desired, such as vulnerable habitats identified using available data, e.g. contiguous habitats (paragraphs 3.30 to 3.34).

## Identification of vulnerable habitats

3.23 WG-EMM-10/25 described a sampling program to quantitatively characterise the distribution, abundance and species composition of macrobenthic invertebrate fauna from 11 geographic areas of the HIMI region. The area was characterised from either beam trawl or benthic sled collections undertaken from 2003 to 2008. Preliminary analyses suggest that biological contrast is evident among areas; many taxa and assemblages exist in more than one area but significant heterogeneity also exists within areas. Analyses also suggest the presence of spatially restricted and/or endemic vulnerable taxa. The Working Group noted that Australia is currently using this information in evaluating the marine reserve and conservation zone established in Division 58.5.2 in 2003.

3.24 The Working Group noted that a variety of methods could be used to examine the potential spatial extent of particular taxa, but that conclusions on whether taxa are spatially restricted or endemic are highly dependent on both sampling intensity and taxonomic resolution. The Working Group agreed that such conclusions should take account of the associated sampling intensity and taxonomic aggregation, as well as the potential for Type 1 and Type 2 errors.

3.25 WG-EMM-10/24 described BICS, a compact, autonomous underwater video camera system designed for deployment on fishing gear to observe interactions of the gear with benthos and benthic habitats, but also able to be deployed as an independent drop camera.

3.26 The Working Group noted that the camera system allows rapid, efficient and inexpensive collection of quantitative and qualitative data about benthic habitats and associated communities, and has also provided direct observations of other biological phenomena, including krill mating behaviour. The Working Group welcomed the development of the camera system, noting that it has now been successfully deployed by scientific observers, and encouraged its further use (e.g. see paragraphs 3.13 to 3.15). The Working Group further requested that ad hoc TASO comment on how well the cameras might be deployed during commercial fishing operations.

3.27 WG-EMM-10/27 described the analysis of VME taxa by-catch data by New Zealand longline vessels fishing in the Ross Sea on a segment basis relative to catch rates of Antarctic toothfish (*Dissostichus mawsoni*). The analysis detected no functional correlation between the presence of six individual VME taxa and the catch of *D. mawsoni* at the scale of an individual line segment (c. 1.2 km). These results are consistent with the results of WS-VME-09/7, which found no functional correlation between total VME units and the catch of *D. mawsoni* at the scale of entire longline sets (c. 7 km). The Working Group noted that within the spatial and environmental envelope of the fishery, the results of WG-EMM-10/27 suggested that if a relationship exists between the occurrence of the six analysed VME taxa and *D. mawsoni*, then the relationship is unlikely to be strong.

3.28 The Working Group noted that it is unlikely that adult toothfish in the fishing grounds would be strongly associated with particular benthic invertebrate taxa, and that a relationship with benthic taxa may be more likely for other demersal fish species or perhaps juvenile *D. mawsoni*, which have been shown to be negatively buoyant and more likely to exploit benthic habitats (Near et al., 2003).

3.29 The Working Group considered the extent to which fishery data are reliable for exploring these kinds of environmental relationships and noted that environmental correlations of this kind are scale dependent, such that a relationship is guaranteed at the largest scales but virtually impossible at the smallest scales, as described in WG-SAM-10/20. Also, such analyses are dependent on the degree to which commercial operations can sample benthic taxa. WG-EMM-10/28 showed that sponges and gorgonians are regularly sampled but that the detectabilities of other taxa by commercial longline gear are unknown. The Working Group agreed that it is highly unlikely that the extent to which benthic taxa may share a similar environmental envelope with the fishery (e.g. similar depth preference) can be addressed using fishery-dependent data.

3.30 WG-EMM-10/28 characterised the spatial scale of benthic invertebrate habitats in fished areas of the Ross Sea region, and assessed the utility of sponge and gorgonian by-catch data on longlines as a means of monitoring encounters with those communities. This analysis revealed contrasting areas of habitat conditions, e.g. (i) large areas of dense fishery effort where by-catch was consistently zero, (ii) areas in which by-catch of sponges and gorgonians was dispersed, and (iii) areas where by-catch observations of sponge and/or gorgonians were clustered. The Working Group agreed that, for areas with high densities of effort, consistent zero by-catch observed indicates sponge or gorgonian habitats are at densities lower than for areas where the by-catch of those taxa was observed. The Working Group noted that conclusions on the spatial distribution of by-catch may change as more data are analysed; only two years of data from a subset of vessels are available at present.

3.31 WG-EMM-10/28 included spatial proximity analyses and analysis of underwater video transects to characterise: (i) the reliability of longlines as a sampling tool for sponges and gorgonians; (ii) the average spatial scale of observed habitat patches; and (iii) the average detectability of habitat patches.

3.32 The Working Group noted that the probability of catching a particular taxon with a longline hook may be very low, but the chance of capture with a line segment containing 1 000 hooks can be much higher, although this probability may be affected by the likelihood of the line segment intersecting a habitat patch either through line orientation or patch shape and sizes.

3.33 The Working Group agreed that the analysis described in WG-EMM-10/28 was useful for quantitatively describing spatial habitat distributions with fishery by-catch data. The Working Group noted that the paper provided some of the first available analysis to describe the spatial mosaic of habitat patches in the fished area, i.e. the detectability of habitat patches and size estimates of some sponge and gorgonian habitats. These estimates can be helpful in informing spatially explicit simulation modelling.

3.34 The Working Group noted that further application of the method described in WG-EMM-10/28 could be used to inform a number of tasks that rely on assumptions about the spatial mosaic within which VME taxa habitats occur, e.g. SC-CAMLR-XXVIII, paragraphs 4.252(ii), (v) and (vi). Furthermore, in areas where effort density is sufficiently high to enable clear delineation of habitat patches, the results of the method could be used to spatially constrain the application of the bottom fishery impact assessments to particular areas of interest. The Working Group recommended that the method be applied to other VME taxa where sufficient samples are available, to assess if longlines constitute a reliable sampling tool for those taxa.

3.35 The Working Group noted that several existing Risk Areas appear in close spatial association, indicating the potential existence of a larger habitat patch. Similar analyses could be used to justify aggregating Risk Areas to encompass the actual patch size.

3.36 The Working Group noted the advice of SC-CAMLR-XXVIII, paragraph 4.251(vi), seeking advice on alternative trigger levels for a range of VME taxa, including distinction between ‘heavy’ and ‘light’ taxa because of the low likelihood of triggering a Risk Area based on ‘light’ taxa. The Working Group agreed that trigger levels may be too high for some communities composed primarily of ‘light’ VME taxa, but that information necessary to determine appropriate trigger levels is currently lacking.

3.37 The Working Group noted that setting appropriate trigger levels relies on estimating the relationship between VME by-catch observed on board the vessel and the abundance of actual VME taxa density on the seafloor.

3.38 The Working Group noted that investigation of alternate trigger levels for different taxa could consider ecological characteristics (e.g. vulnerability, abundance, diversity, contribution to ecosystem function, rarity) important in determining the need to avoid impacting the area. The Working Group concluded that developing taxon-specific trigger levels appropriate to the goal of identifying vulnerable habitats will require the consideration of factors affecting observed levels of VME taxa and their vulnerability.

3.39 In the absence of the information necessary to inform alternate trigger levels, the Working Group agreed that management strategy evaluation approaches, such as those described in WG-SAM-10/9 and 10/19, may be useful to devise strategies that are robust despite uncertainties about the abundance and catchability of different VME taxa.

3.40 The Working Group noted the advice of SC-CAMLR-XXVIII, paragraph 4.251(ii), regarding development of a process by which Risk Areas should be reviewed. The Working Group agreed that such a review process should include reference to all available information indicative of the nature, abundance and ecological importance of the area, including:

- (i) ecological characteristics of the VME taxa encountered at the Risk Area, along with the likely characteristics of the benthic community, including consideration of the organisms present and their life histories, rarity and ecological structure and function, and how the Risk Area relates to the distributions of those taxa in the wider area;
- (ii) benthos by-catch data in the vicinity of the Risk Area;
- (iii) the reliability of longline by-catch for the taxa in question as indicators of a VME;
- (iv) the environmental, bathymetric or topographic context of the Risk Area location (e.g. submarine canyon, seamount etc.) with reference to known habitat associations;
- (v) diversity and abundance of taxa in the local area, to incorporate the potential ecological importance of multi-species assemblages;

- (vi) the actual and/or likely level of threat to the habitat or location, and associated footprint and impact estimates;
- (vii) the overall management framework in place to avoid significant adverse impact on VMEs.

3.41 The Working Group recommended that CCAMLR encourage Members and fishers to collect new information wherever possible to inform the continued assessment of vulnerable habitats. Establishing the link between catch rates and organism density on the seafloor for each vulnerable taxon will be important to document the actual distribution and abundance of these habitats and identifying areas with no vulnerable habitats. Deployment of drop cameras as described in WG-EMM-10/24 in and near existing Risk Areas, or by systematically mapping habitats using cameras deployed from fishing vessel platforms could provide valuable data to characterise the distribution of vulnerable habitats.

#### Review of notifications of encounters with VMEs under CM 22-06

3.42 WG-EMM-10/14 notified the encounter of two potential VMEs from a fishery-independent research trawl survey in the South Orkney Islands, following the guidelines set out in CM 22-06, Annex 22-06/B. The notifications were justified with reference to anomalously high densities of pterobranchs and sea pens for two survey stations. The Working Group welcomed the work conducted in preparing the notification.

3.43 The Working Group noted that pterobranchs and sea pens were identified as indicator taxa by the Workshop on VMEs (SC-CAMLR-XXVIII, Annex 10). The observed densities of both taxonomic groups were considerably higher than in other locations across the survey area (i.e. more than four standard deviations greater than the mean density for all non-zero locations), and were also noted by scientists on board to be considerably higher than in other areas of the southern Scotia Arc region.

3.44 The Working Group noted that sampling benthic organisms within a survey area will yield a range of abundances and that conclusions regarding anomalously high densities should include consideration of sampling design, intensity and spatial scale of effort from which the distribution of densities is generated.

3.45 The Working Group noted that when assessing the extent to which particular observations are anomalous within a range of observations, it is important to assume appropriate density distributions, and that a lognormal distribution may be more appropriate than a normal distribution for abundance data. The Working Group further noted that, with existing data, the observed densities cannot be related to ecological importance or contribution to ecosystem function, which are other intrinsic factors that contribute to vulnerability. For some assemblages, rarity and vulnerability may be high and densities may be low. Under these circumstances, identification of VMEs may need to consider factors other than anomalously high values.

3.46 The Working Group noted that the survey design used to collect the data in WG-EMM-10/14 was described in WG-EMM-09/32, and was conducted at a sufficiently large spatial scale, was well stratified across a range of environmental variables potentially

affecting VME taxa abundance, and was of sufficient sampling intensity that the Working Group could reasonably conclude the observed high densities were indicative of true anomalously high abundances of the VME taxa and not merely artefacts of sampling design.

3.47 The Working Group agreed that as a precautionary measure, designation of these two areas as registered VMEs is warranted unless additional information becomes available demonstrating that these areas do not constitute VMEs.

3.48 The Working Group agreed that a number of approaches could be used to justify the notification of a potential VME under CM 22-06, including (but not limited to): (i) anomalously high densities of VME taxa (taking account of sampling considerations as described in paragraph 3.44); (ii) observed rare or unique benthic communities; (iii) high diversity of VME taxa; (iv) benthic communities likely to be of particular importance for ecosystem function or species' life cycles; or (v) benthic communities with other characteristics likely to be vulnerable to bottom fisheries activities. Spatial scale and sampling considerations of any of these approaches should also be taken into consideration. The Working Group recommended further discussion of these types of approaches to provide guidance for future notifications.

3.49 The Working Group noted that there are a number of relevant definitions, characterisations and possible criteria that could be used to identify VMEs described in the WS-VME-09 report (SC-CAMLR-XXVIII, Annex 10) and that additional approaches could be developed in the future. The Working Group suggested that notification of encounters of VMEs through fishery-independent research activities should not be constrained by the format of CM 22-06, Annex 22-06/B, and that additional supplemental information supporting the designation of a VME could be supplied. Because notifications can be supported through a variety of approaches, the rationales used may not be transferable to other notifications, such that each case should be considered on its own merits in assisting CCAMLR to achieve its objectives of avoiding significant adverse impacts.

#### Evaluating management strategies

3.50 The Working Group noted that there were two papers with direct relevance to this agenda item. WG-SAM-10/9 described version 2 of Patch, a simulation model in R for evaluating spatial management strategies to inform management within CCAMLR on strategies to avoid significant adverse impacts on VMEs. WG-SAM-10/19 described a spatially explicit Schaefer production model designed to be used to simulate key processes of VME taxa population dynamics and bottom fishing effort, and to evaluate the effects of various management strategies.

3.51 The Working Group noted that it was requested by WG-SAM to evaluate simple case studies that could illustrate the operation of the models consistent with expectations under extreme scenarios to clearly illustrate the expression of particular input parameters (Annex 4, paragraph 4.7), and that WG-EMM is the appropriate body to provide guidance as to the particular spatial and ecological characteristics of VMEs (*ibid.*, paragraph 4.9). The Working Group further noted that it was asked to consider what scenarios and performance measures provide a sound basis for evaluating management strategies to avoid significant adverse

impacts on VMEs. The Working Group was unable to conduct any evaluations during the course of the meeting as the model scenarios had not yet been developed but encouraged this work to be submitted to WG-FSA.

3.52 In considering potential scenarios, the Working Group first took into account the objectives that surround evaluating spatial management strategies to avoid significant adverse impacts on VMEs. The Working Group noted the time frames set out in Article II of the CAMLR Convention and the FAO Guidelines for Deep Sea Fisheries on the High Seas, and agreed that some VME taxa and systems may have lower productivity than those for which these management objectives were initially developed. The Working Group agreed that modelling studies could be helpful in assessing benthic ecosystem dynamics and functions, and could aid in understanding the time scales necessary to reverse significant adverse impacts on VMEs. The Working Group agreed that strategies should be investigated that can meet the objectives in Article II. These strategies could include spatial management strategies, but could also consider mitigation strategies in the same way that strategies have been developed to mitigate seabird by-catch, such that the fishery can operate in areas with potentially vulnerable species, but that interactions are able to be kept to an appropriate level.

3.53 The Working Group noted that there were several factors that require consideration when performing these evaluations, including temporal scales, spatial scales and whether the framework is considering individual species or ecosystem effects. With respect to plausible operating models, the Working Group noted that plausible scenarios will need to include consideration of life-history characteristics, ecological theory, patch dynamics of sessile organisms and interaction between the fishery and habitat. The Working Group noted that currently it was likely to be easier to evaluate individual taxa in the first instance as opposed to system-based approaches.

3.54 The Working Group agreed that operating models may be used to identify and characterise the types of data that need to be collected in order to monitor and further develop options for management strategies, including mapping of habitats, to allow the development of open and closed fishing areas over particular types of VMEs, and therefore allow the measurement of the effects of bottom fisheries on VMEs.

3.55 The Working Group explored eight different factors that could be considered in developing case studies and identified the ranges of those factors that would be a priority:

| Factor                                      | Range   |
|---|---|
| Succession                                  | None, literature range<br>(consistent with factors in patch dynamics and spatial distribution)  |
| Productivity                                | Low ( $r = 0.01$ ) to high ( $r = 0.20$ )   |
| Dispersal                                   | None, literature range  |
| Target species and VME taxa correlation     | Negative, None, Positive, Separate spatial scales<br>(fish at larger scale than VMEs) – in all cases distinguish between causal versus incidental correlation |
| Gear impact (footprint*fragility)           | Impact assessment range   |
| Spatial distribution of habitats            | Random, restricted (several scales)   |
| Management action<br>Current/new approaches | None, current, in-season versus annual step closures;<br>representative closed areas  |
| Fleet dynamics                              | Uniform random, incorporating target correlation<br>(ideal free), historical  |

3.56 The Working Group recommended that these case studies, which should include extreme scenarios to clearly illustrate the expression of particular input parameters as well as values for plausible scenarios, be explored and presented along with a detailed description of the parameter values used for each scenario for consideration by WG-FSA this year.

#### Report of VMEs

3.57 WG-EMM-10/15, as previously introduced, provided a draft template and work plan for the 'Report on Bottom Fisheries and Vulnerable Marine Ecosystems' that was requested by WG-FSA last year. The Working Group agreed that the draft template was useful and well structured, and made a number of suggestions that will be incorporated into the draft template. The Working Group noted that much of the content of the template can be populated based on the WG-EMM and WS-VME reports, as well as several tables from WG-EMM-10/7.

3.58 The Working Group further agreed that the Report on Bottom Fisheries and VMEs could be split into two documents. The first document could contain the status of ecological knowledge relating to VMEs across the CAMLR Convention Area. It is expected that this document would change slowly with time as new information becomes available. The second document would contain information that is updated annually by the Secretariat and the Scientific Committee working groups, akin to Fishery Reports.

#### Protected areas

3.59 In 2009, the Scientific Committee identified a set of milestones designed to lead to the establishment of a representative system of MPAs (RSMMPA) by 2012 (SC-CAMLR-XXVIII, paragraph 3.28).

3.60 The Scientific Committee agreed to, as identified in Milestone (i), 'by 2010, collate relevant data for as many of the 11 priority regions as possible (and other regions as appropriate), and characterise each region in terms of biodiversity patterns and ecosystem processes, physical environmental features and human activities'.

#### Circumpolar scale

3.61 WG-EMM-10/34 illustrated the application of a methodology for systematic conservation planning at the circumpolar scale. A circumpolar habitat classification of the Antarctic marine ecosystem was developed using the following datasets: (i) bioregional outputs of the 2006 Hobart Workshop (Grant et al., 2006); (ii) geomorphological features (O'Brien et al., 2009); and (iii) depth biomes based on GEBCO data. MARXAN was used as a decision-support tool to identify areas of conservation priority. Several results are presented in order to demonstrate a proof of concept that conservation planning can be applied at the Southern Ocean scale.

3.62 The Working Group observed that this approach added to past efforts, but noted that biological datasets were currently available that could be included in future bioregionalisation



efforts, although this may be area-specific. For example, the 2010 Census of Antarctic Marine Life workshop (Villefranche CAML Biogeographic Synthesis Workshop, 18 to 21 May 2010) considered a strategy for studying large-scale biogeographic patterns of benthic and pelagic organisms, including fish and top predator species using data found in SCAR MarBIN. Such data sources could be used to inform future bioregionalisation efforts.

3.63 The Working Group questioned whether some of the inputs used in WG-EMM-10/34 were independent or confounded. For example, outputs from the Hobart Workshop and depth biomes are both strongly influenced by depth. Caution was therefore advised in interpreting the results of the analysis described in WG-EMM-10/34. It was also suggested that separate benthic and pelagic bioregionalisations would be useful, consistent with the advice of the CCAMLR Bioregionalisation Workshop (SC-CAMLR-XXVI, Annex 9).

3.64 The Working Group noted that presentation of results will need to be compatible with the spatial scales of the input data but recognised that outputs in WG-EMM-10/34 were intended to show levels of heterogeneity at the circumpolar scale.

3.65 The Working Group also noted that the early results of the analysis showed some correspondence with the 11 CCAMLR priority areas (SC-CAMLR-XXVII, paragraph 3.55(iv) and Annex 4, Figure 12). It agreed that this kind of analysis will provide an interesting and useful perspective on bioregionalisation and systematic conservation planning at the circumpolar scale. The authors were encouraged to continue their work, making improvement where appropriate, and to report progress to future workshops and meetings.

3.66 The Working Group provided the following specific suggestions to assist the authors in their work:

- (i) generate separate bioregionalisations for the pelagic and benthic environments;
- (ii) carefully select a limited number of environmental variables for use in the bioregionalisations, to avoid false resolution arising from the intersection of too many variables;
- (iii) avoid the selection of multiple variables that are themselves highly correlated;
- (iv) segregate the bioregionalisation outputs into separate biogeographic provinces, on the basis of known oceanographic or ecological boundaries;
- (v) use biological distributions to represent areas of particular priority for conservation, represented as separate overlays;
- (vi) clearly define conservation objectives with reference to both bioregionalisations and to separate biological layers, such that different areas represent different value levels for protection.

## Eastern Antarctica

3.67 To date, there has been no consideration by CCAMLR of an RSMMPA in Eastern Antarctica. Recognising the paucity of data for the region, WG-EMM-10/26 compiled relevant available data and developed a proposal for an RSMMPA between 30°E and 150°E and from the coast to 60°S. The proposed RSMMPA contains seven areas selected for their respective contributions to the protection of differing pelagic and benthic values. Covering 37% of the region, it aims to achieve low fragmentation of areas, develop efficient boundaries for management purposes, and provide reference areas, particularly for CEMP and for evaluating climate change impacts on Antarctic marine ecosystems. The authors identified that the proposal would be unlikely to impede rational use within the region, including for *E. superba* and *D. mawsoni*. A process for updating the boundaries as new information becomes available is suggested in the paper. The data layers used in the analyses will be available from the Secretariat.

3.68 WG-EMM-10/26 assessed the comprehensiveness of the RSMMPA by considering the pelagic and benthic bioregionalisations as well as regional ecological barriers that structure Eastern Antarctica. Bioregionalisation methods described by Grant et al. (2006) were employed. For the pelagic bioregionalisation, data for depth, SST and sea-ice cover were used. For the benthic bioregionalisation, data for depth and geomorphological feature types were incorporated. The ecological barriers considered in the definition of large-scale biogeographic provinces included the oceanographic fronts of the Antarctic Circumpolar Current, the gyres in coastal waters, the near-surface winds and sea-ice movement. The adequacy of the RSMMPA was assessed by considering the location of resources, scales of food webs and variability and long-term trends. The representativeness of the RSMMPA was also considered. In considering comprehensiveness, adequacy and representativeness (CAR) the paper explored the underlying ecological principles that are necessary to meet these requirements.

3.69 The Working Group noted that the RSMMPA detailed in WG-EMM-10/26 had been developed in line with the principles of systematic conservation planning. The proposed RSMMPA is based on a scaled approach that has the potential to help CCAMLR understand the effects of fishing and other human impacts, and in maintaining the importance of CAR values (SC-CAMLR-XXIV, Annex 7, paragraph 14) in the regions, providing information in a structured manner both within and outside fished areas.

3.70 The Working Group noted that the nine pelagic ecotypes and 12 benthic ecotypes described in WG-EMM-10/26 had been selected because this number provided large-scale habitat proxies that were considered to be representative of Eastern Antarctica and were analogous to scales selected in comparable analyses elsewhere (e.g. at Heard Island). The Working Group recognised that it was difficult in practice to place boundaries around ecosystems, as the edges of habitats are often characterised by gradients and the biogeographical ranges of species do not necessarily match the boundaries described by habitat proxies. The Working Group noted that scale was important and that the analyses of Eastern Antarctica attempted not to over-interpret the available data.

3.71 The Working Group noted that the hierarchical analytical methods presented in WG-EMM-10/26 could allow a greater number of pelagic and benthic ecotypes to be selected than the numbers finally used. However, the authors considered that an RSMMPA based on a greater number of areas would have a high probability of producing similar results, as greater

heterogeneity would lead to greater numbers of smaller areas that may need to be included in an RSMMPA in order to achieve the CAR principles. The authors also noted that in order to meet the monitoring requirements for CEMP and to measure climate change impacts, large areas would be needed to encompass the ecosystem processes and these would best be achieved in reference areas where fishing does not occur.

3.72 The authors of WG-EMM-10/26 explained that the RSMMPA incorporated ecological boundaries that were determined using environmental components including wind, oceanographic circulation and sea-ice, all of which are processes that delineate oceanographic boundaries characterised by gradients. Despite spatial uncertainty associated with these ecological boundaries, they are thought to reflect known regional biological distributions in Eastern Antarctica. Different biogeographic provinces are known to exist in Eastern Antarctica; however, existing biological data remain inadequate to precisely position boundaries between the different provinces. The boundaries used in the RSMMPA were positioned using the best available data, but further data would help to more precisely locate their positions.

3.73 The Working Group recalled that differences between local populations could be substantial; for example, differences between the benthos in adjacent marine canyon systems were known to be considerable in some situations. However, such small-scale biological diversity might not be reflected in habitat proxies for species distributions, such as in sea-surface temperature. Consequently, it is likely that smaller-scale heterogeneity will be present within the regions identified in the paper.

3.74 The Working Group recognised that the proposed RSMMPA was developed to satisfy the principles of CAR and utility and then evaluated for its impact on rational use, including research, shipping and fishing. It agreed that ecosystem values satisfying CAR and utility might not necessarily be eroded by some human activities, but that other activities might impact on those values. Where ecological values were not eroded, there was no reason to limit those human activities. However, if ecological values were eroded by human activities, it would potentially compromise the utility of the RSMMPA as a reference for understanding the ecosystem effects of fishing or the consequences of climate change to Antarctic marine ecosystems.

3.75 The Working Group noted that the RSMMPA comprised 37% of the region in Eastern Antarctica. It recognised that the areal extent was not predetermined as a target but that it was the emergent cumulative consequence of satisfying the principles of CAR and the requirements for ensuring that the reserve system would have utility as reference areas. The Working Group recognised that this was consistent with previous discussions SC-CAMLR-XXIV, paragraphs 3.54(i) and (iv.a) (iv.b).

3.76 The Working Group noted that krill stocks in Prydz Bay and elsewhere in Eastern Antarctica were of potential interest to fishing operators (paragraph 2.18), but that these stocks had not been exploited for some years. Further, the authors noted that the proposed RSMMPA is unlikely to limit access to these krill stocks given the structured design of the RSMMPA and the oceanography of the region. The design of the RSMMPA was such that it provided for matching open and closed areas that could be used to monitor the effects of fishing.

3.77 The Working Group also noted that *D. mawsoni* stocks in Eastern Antarctica were of interest to fishing operators and that the stocks have been exploited for some years through the exploratory fisheries in Divisions 58.4.1 and 58.4.2. The authors further noted that there was no known stock structure in the toothfish population; also, that given the mobility of individual toothfish, the proposed RSMPA is unlikely to limit access to the stock. The Working Group noted that the design of the RSMPA may allow CCAMLR to undertake a structured experiment to compare fished areas and unfished areas. It recognised that an experimental approach could be helpful in managing fish stocks as this may provide information that would otherwise be difficult to collect. The Working Group also recognised that refining the boundaries of the RSMPA (e.g. so boundaries better coincide with those of the SSRUs in Eastern Antarctica) may assist with such comparisons but the potential consequences for achieving the CAR principles would also need to be considered.

3.78 The Working Group noted that socio-economic issues and rational use may need to be considered further for this region (paragraphs 3.117 and 3.121).

3.79 The Working Group recognised that MPAs are often established with multiple objectives. At the time that a representative system of MPAs is established, there may be a hierarchy of conservation objectives, with specific objectives for the wider system and other smaller-scale objectives for individual MPAs.

3.80 The Working Group accepted that the purpose outlined in WG-EMM-10/26 was to satisfy the principles of CAR but also to achieve regional utility for CEMP and monitoring climate change impacts. To determine whether the latter objective might be achievable, the Working Group suggested that the authors of the paper, and other authors developing proposals for MPAs in the future, better characterise options for the spatial and temporal extent of monitoring throughout the region of interest.

3.81 The Working Group thanked the authors of WG-EMM-10/26 for their valuable contribution, acknowledging that the approach outlined in the paper had enabled WG-EMM to enhance its understanding of issues involved in establishing an RSMPA in CCAMLR waters by 2012.

### The Ross Sea

3.82 The Working Group reviewed two separate contributions to characterise biodiversity patterns, develop bioregionalisations and conduct other scientific work to support the establishment of an RSMPA in the Ross Sea and the south Pacific sector of the Southern Ocean. One of these focused on Priority Area 11 and was presented in a set of three papers (WG-EMM-10/11, 10/12 and 10/P11); the other considered a region including portions of Priority Areas 10 and 11 and was presented in WG-EMM-10/30. Both contributions represented collaborative work by many different scientists.

3.83 Information on environmental and biodiversity patterns is presented in WG-EMM-10/11. This covers physics, mainly geology, glaciology, water mass circulation, sea-ice and climate change effects. Information on lower trophic levels is also presented, including information on microbial communities and benthic communities; information on mid-trophic levels includes data on zooplankton and fish; while information on upper trophic levels

includes data on squid, *D. mawsoni*, cetaceans, seals (Ross seals (*Ommatophoca rossii*), crabeater seals (*Lobodon carcinophagus*), leopard seals (*Hydrurga leptonyx*) and Weddell seals (*Leptonychotes weddellii*)), penguins (Adélie penguins (*Pygoscelis adeliae*) and emperor penguins (*Aptenodytes forsteri*)) and other seabirds (petrels and albatrosses). The authors attempted to synthesize the patterns of distribution in Table 2 on page 50 of the paper.

3.84 The Working Group thanked the authors for their valuable compilation of data and suggested that it would be useful if the data layers could be made available to other Members if requested. It noted that the compilation of data was only feasible because of the long and diverse history of scientific endeavour in the Ross Sea, and that this will facilitate the work of systematic conservation planning. The Working Group also noted that much of the data described in WG-EMM-10/11 originated from sources not generally available to CCAMLR, including from university-based researchers.

3.85 The Working Group noted that many of the data layers described in WG-EMM-10/11 were comparable to a number of the data layers described in WG-EMM-10/30, but that there was not a complete overlap. It recommended that the authors of both papers correspond intersessionally, and consider whether it was possible to develop integrated data products and a further level of synthesis for the CCAMLR 2011 MPA Workshop (paragraphs 3.119 to 3.130). The Working Group noted that more recent data on some species were available for endemic finfishes that might be incorporated in time for 2011.

3.86 WG-EMM-10/12 reported on the results of analyses describing the niche occupancy of various predators in the Ross Sea region, considering three important components: (i) their projected spatial distribution and overlap; (ii) their capacity to utilise different parts of the water column (foraging depth); and (iii) diet. Species for which distributions were modelled included cetaceans (Antarctic minke whale (*Balaenoptera bonaerensis*) and Ross Sea killer whale (*Orcinus orca*) – ecotype C), seals (crabeater seal and Weddell seal), penguins (Adélie penguin and emperor penguin) and other seabirds (light-mantled sooty albatross (*Phoebetria palpebrata*), Antarctic petrel (*Thalassoica antarctica*) and snow petrel (*Pagodroma nivea*)). Leopard seals and killer whale ecotype A/B, were not included because of their rarity and lack of adequate sightings data. Adequate data for modelling Arnoux's beaked whales (*Berardius arnuxii*), *D. mawsoni* and colossal squid (*Mesonychoteuthis hamiltoni*), which are also important predators, were not available. Predator distribution patterns were modelled at a resolution of 5 km<sup>2</sup>, using environmental data and species presence data. A machine learning, 'maximum entropy' modelling algorithm (MAXENT) was used to model spatial patterns of the probability of species' occurrence. These data were then used to identify areas of importance to species in a conservation prioritisation framework. Data on diving depth and diet were taken from the literature.

3.87 WG-EMM-10/12 reported that three patterns of spatial use in the Ross Sea were apparent: (i) use of the shelf break, which includes the outer continental shelf and slope; (ii) full use of both the shelf and the slope; and (iii) use of the Marginal Ice Zone (pack-ice surrounding the Ross Sea post-polynya). Diet composition overlapped extensively, but the use of foraging space was partitioned by dive depth.

3.88 The authors noted that the suite of predators studied used the entire shelf and slope in a mosaic, although not necessarily during the same season. Spatial modelling of species

richness indicated that the outer shelf and slope, as well as the deeper troughs in the Ross Sea shelf and in the vicinity of Ross Island, were particularly important to the upper trophic level taxa of the Ross Sea.

3.89 The Working Group recognised that the authors of WG-EMM-10/12 had accomplished a considerable amount of complex spatial modelling that could be very valuable for informing a systematic conservation planning process. It agreed that further development would be very valuable and encouraged further submissions to the Working Group. The Working Group also noted that there were various technical issues that would be valuable to address, in particular regarding the use of additional or alternate input variables, assessing model sensitivity to various input parameters, and validation of spatial predictions. The Working Group noted that similar issues had been addressed in the development of WG-EMM-10/P14, and encouraged intersessional correspondence between the relevant authors (see also paragraph 3.82).

3.90 WG-EMM-10/30 presented the outcomes of a ‘Bioregionalization and Spatial Ecosystem Processes of the Ross Sea Region’ expert workshop hosted by New Zealand and attended by 21 international scientists with a wide range of relevant expertise. The region within which outputs are bounded is defined as 150°E–150°W, and north to 60°S, which includes most of CCAMLR MPA Priority Area 10 and all of Priority Area 11. Analytical methods for the bioregionalisation were as in Grant et al. (2006) and SC-CAMLR-XXVI, Annex 9, i.e. automated environmental classification using cluster analyses of environmental datasets, iteratively selected and validated with reference to expert knowledge and spatial biological data. Outputs from the Ross Sea workshop include the following:

- (i) a fine-scale benthic bioregionalisation, with 17 benthic bioregions;
- (ii) a fine-scale pelagic bioregionalisation, with 18 pelagic bioregions;
- (iii) a list and map of 27 spatially bounded ecosystem processes of particular importance for conservation of the regional ecosystem, including areas containing: spatially fixed oceanographic processes (3); flexible pelagic processes related to ice dynamics (4); concentrations of dominant pelagic middle trophic species supporting higher trophic levels (3); spatially constrained top predator foraging areas (4); processes/areas of particular importance for *D. mawsoni* (4); processes/areas of particular importance for other fish (3); and benthic processes/areas of particular importance (6).

3.91 The Working Group noted that WG-EMM-10/30 illustrated an approach to support spatial planning in a region with abundant scientific data available. In particular, the authors of WG-EMM-10/30 made direct use of a large amount of biological data, both to validate the bioregionalisations and as separate overlays to depict ecosystem processes which may constitute areas of particular importance in their own right. The Working Group noted that this is one of the strengths of the regional-scale bioregionalisation approach, allowing approaches and methods to be tailored as appropriate to each region, to fully utilise available data.

3.92 The Working Group noted that the pelagic and benthic bioregionalisations benefitted from the availability of more than 60 environmental data layers, including multiple alternate depictions of important dynamic ecosystem drivers (e.g. sea-ice) and custom-generated layers

to depict particular variables deemed most important for influencing spatial biological patterns. The selection, retention and transformation of environmental data layers to drive the bioregionalisation was iteratively adjusted with reference to available biological data until bioregionalisation outputs accurately depicted important ecological patterns in areas where patterns were known, at as fine a resolution as possible without depicting false resolutions.

3.93 The pelagic bioregionalisation utilised variables representing three main drivers: depth, water mass characteristics and sea-ice dynamics. The benthic bioregionalisation utilised variables representing five main drivers: depth, seafloor water temperature, factors affecting substrate (current speed and benthic rugosity), deposition of pelagic production (ice cover, as a proxy for available light) and iceberg scour.

3.94 The Working Group noted that the bioregionalisations will inform the design of a system of MPAs to meet the objective of representativeness, but the 27 ecosystem process areas are depicted as separate overlays, and may constitute conservation objectives in their own right within a systematic conservation planning framework. The Working Group further noted that some areas will be more important than others, and that setting appropriate protection levels for different areas should consider the ecological importance of the processes in the area and the size or precision with which the area is defined.

3.95 The Working Group noted that many of the identified ecosystem processes or areas of importance overlie the Ross Sea shelf and slope. The authors noted that this probably reflects the ecological importance of the shelf and slope area relative to other areas, but also the availability of scientific data.

3.96 The Working Group observed that the bioregionalisation described in WG-EMM-10/30 included both Priority Areas 10 and 11 and questioned why these areas were grouped together, especially since datasets available for each area were quite different. The authors responded that the bioregionalisations themselves were each executed in an imposed hierarchical fashion, with a first-order split defined at the continental shelf break to capture this dominant ecological contrast, and subsequent classifications carried out separately for the shelf environments and for the deeper northern environments. Subsequent identification of important ecosystem properties were depicted for the whole region to illustrate the connectivity of ecosystem function between shelf/slope and areas further north. It was noted that the CCAMLR statistical area scheme already identified the larger area.

3.97 The Working Group noted that the Ross Sea shelf and slope are preferentially utilised by fish, seabirds and marine mammals, which exhibit different utilisation patterns in different seasons and at different life-history stages but that specific top predator foraging areas are depicted in WG-EMM-10/30 only for those areas where predators are spatially constrained during the nesting/pupping season (penguins and Weddell seals), and/or where the potential exists for trophic overlap with the toothfish fishery (Weddell seals and Type C killer whales). The Working Group noted that important foraging areas for unconstrained predators are represented separately as generic ecosystem processes influencing productivity (e.g. the Ross shelf front, the Ross Sea polynya edge) or as concentrations of key pelagic prey species (silverfish and krill).

3.98 The Working Group noted that WG-EMM-10/30 identified several areas on the shelf and shelf slope that are thought to be particularly important for *D. mawsoni*. Toothfish are the

target of the Ross Sea longline fishery but are also ecologically important in their own right, e.g. as a principal finfish predator, such that these areas may be used to inform both spatial protection objectives and rational use objectives simultaneously.

3.99 The Working Group noted that WG-EMM-10/30 depicted only ecological patterns without reference to human activities, but that the systematic conservation planning process is explicitly designed to consider cost-benefit trade-offs between protection and rational use. The question arose as to the potential of catch or CPUE data being used in the current bioregionalisation process. The authors noted that spatially explicit fishing effort distributions are available for the entire history of the Ross Sea toothfish fishery, and distribution modelling for demersal fish species, including *D. mawsoni*, is being progressed. Fishery-independent data would also be of great assistance when considering the species.

3.100 The Working Group thanked the authors of WG-EMM-10/30 for their valuable contribution, and encouraged them to build on this work in the development of a spatial management proposal in advance of the CCAMLR MPA Workshop in 2011 (paragraphs 3.119 to 3.130).

3.101 In considering systematic conservation planning efforts in the Ross Sea Region, the Working Group recommended that it would be valuable if collaboration and integration between the research teams currently supporting separate efforts to characterise patterns of biodiversity and ecosystem processes occurred prior to the development of any proposal for area protections. The Working Group agreed that a synthesis of the separate efforts presented this year would be expected to support the development of a comprehensive and effective spatial management plan to achieve CCAMLR objectives.

#### Other areas

3.102 A new initiative by France is now under way to develop marine spatial planning options for both Kerguelen and Crozet Islands. This initiative will consider environmental and biological data through a bioregionalisation analysis. It is envisaged that both benthic and pelagic species will be included in analyses across a range of trophic levels. Data describing human activities will also be incorporated. Having developed a set of spatially resolved data layers, different decision-support tools will be used to develop a spatial management framework.

3.103 A similar initiative by the UK is also under way for Subarea 48.3. This initiative will also consider a range of data, including data describing environmental and biological processes and human activities in a systematic conservation planning framework.

3.104 A project by the US AMLR Program is also under way for the Antarctic Peninsula region. This initiative will also consider a range of data to develop a spatial management framework.



## General discussion on MPAs

### Terminology relevant to the bioregionalisation and systematic conservation planning process in CCAMLR

3.105 The Working Group recalled that the whole CAMLR Convention Area is managed and protected, but that there are areas within the Convention Area that require further special consideration. Such areas were considered by the CCAMLR MPA Workshop in 2005 and endorsed by the Scientific Committee (SC-CAMLR-XXIV, paragraphs 3.54 and 3.55).

3.106 The Working Group also recalled that the ideas, concepts and terminology used by CCAMLR to describe the spatial planning process and any level or levels of protection afforded by CAMLR conservation measures were to fulfil the objectives of CCAMLR as specified in Article II of the Convention and may not relate to terminology used elsewhere.

### Using common ecological terminology in relation to systematic conservation planning

3.107 The Working Group noted that the terms ‘Representative Systems of MPAs’ and ‘Representative Network of MPAs’ have been used interchangeably in past reports of the Scientific Committee, WG-EMM and various workshops. This history has caused some confusion and the Working Group noted its preference for the term ‘Representative System of MPAs’. This preference was based on noting that the word ‘network’ implies MPAs will be connected in space and this is not necessarily required to achieve the objectives for the CCAMLR system.

3.108 The Working Group recognised that it was currently not feasible to develop a single set of terms that would adequately and accurately describe the classification of ecosystem components, processes and properties across all scales in all spatial systematic conservation planning projects, because different projects are likely to apply different methodologies consistent with available data. However, the Working Group agreed that it would help increase understanding amongst the CCAMLR community if practitioners of spatial systematic conservation planning could, to the extent possible, utilise a common set of terms in relation to ecosystem components, processes and properties, and clearly define whatever terms are used. It also agreed that it would further increase understanding if common terminology could be used in relation to scale-based ecological components and if such terminology made it evident whether biological and/or physical components were being considered. Examples of useful hierarchical terminologies include those recently developed by Last et al. (2005). The Working Group recommended that practitioners should always be careful to ensure that adopted terms accurately correspond to the actual methodologies or outputs to which they are applied.

### Issues related to bioregionalisation

3.109 The Working Group recognised that as CCAMLR developed experience with spatial systematic conservation planning it would be able to develop advice for new practitioners and details of good practice. At present much of the good practice used within the CCAMLR

community was the result of experience developed at the Hobart Bioregionalisation Workshop in 2006 (Grant et al., 2006), the CCAMLR Bioregionalisation Workshop (SC-CAMLR-XXVI, Annex 9) and in efforts undertaken by Members within EEZs or at a regional scale (e.g. Lombard et al. (2007); CM 91-03; SC-CAMLR-XXVIII/14; WG-EMM-10/26 and 10/30).

3.110 The Working Group reviewed submitted approaches to date and agreed that Members planning to undertake bioregionalisation and systematic conservation planning in the CAMLR Convention Area could:

- (i) where biological data is lacking, use bathymetric, oceanographic or climatological data indicative of biogeographic boundaries to define large-scale biogeographic provinces within which spatial planning will occur separately (as in WG-EMM-10/26);
- (ii) where biological and other spatial data are available, use appropriate datasets to locate areas containing ecosystem processes that may constitute conservation objectives in their own right and represent these areas as separate spatial overlays (as in WG-EMM-10/30);
- (iii) generate separate pelagic and benthic bioregionalisations (as in WG-EMM-10/26 and 10/30);
- (iv) for pelagic bioregionalisations, consider the selection of the following three large-scale environmental drivers: (a) depth, (b) water mass characteristics, and (c) dynamic ice behaviour (as in WG-EMM-10/26 and 10/30).

#### Appropriate use of decision-support tools

3.111 The Working Group recalled that the Scientific Committee had endorsed the use of MARXAN as one tool that was considered appropriate for use in systematic conservation planning (SC-CAMLR-XXVII, paragraph 3.55(iii)). Further, that the use of MARXAN had been deemed appropriate in the development of the recently adopted South Orkneys Southern Shelf MPA (SC-CAMLR-XXVIII, paragraph 3.19). However, The Working Group recognised that MARXAN had limitations (as described in Ardron et al., 2008) and therefore may not be appropriate for use in all conservation planning situations. The Working Group also recognised that all planning tools probably had analogous sets of limitations.

3.112 The Working Group noted that the systematic conservation planning process is designed to be a transparent method by which costs and benefits associated with different spatial planning proposals can be evaluated. The Working Group noted that so long as objectives and constraints are explicitly defined with reference to spatially explicit layers, then alternate solutions can be evaluated objectively relative to one another without the use of decision-support tools such as MARXAN.

3.113 The Working Group noted that CCAMLR was focused on developing a system of MPAs that would protect areas with specific characteristics (SC-CAMLR-XXIV, paragraphs 3.54 and 3.55). It recognised that it was the ecological properties within such areas that were the key focus, rather than the size of the area *per se*. The Working Group

recalled that for the South Orkneys MPA, a sensitivity analysis had been used and this was a valuable process in setting reserve size. However, it noted that the size of an area may be important where resilience to a changing environment was a key issue.

3.114 In determining the size of a reserve or protected area, the Working Group noted that objective criteria provided a useful starting point, but that more subjective considerations based on expert knowledge may need to be made to take account of uncertainty.

#### Systematic conservation planning in relation to climate change

3.115 The Working Group noted that monitoring of ecosystem components and processes within an individual MPA, including stocks of fish and krill, may not increase CCAMLR's ability to respond to climate change processes if done in isolation. Further, it recognised that a system of MPAs may not help with conserving ecosystem components, if climate processes changed rapidly and the areas are small. However, the Working Group considered that larger areas may be more resilient than smaller areas, particularly if they were also protected from harvesting. A structured system of protected areas would have an additional benefit, in that it could provide an opportunity to examine, in a systematic way, the impacts of fishing in the context of environmental change. It was also noted that a system of undisturbed areas around the Southern Ocean could be used to monitor the effects of climate change impacts on Southern Ocean marine ecosystems while taking account of regional differences in those impacts.

#### Rational use

3.116 The Working Group reiterated that it is important to be clear about objectives for spatial management design, with reference to conservation goals and effects on rational use, and to clearly identify how achievement of the objectives will be assessed, taking account of uncertainty. It is important that the underlying rationale for spatial management be transparent.

3.117 The Working Group agreed that it was important for both the Scientific Committee and Commission to provide guidance on how to address the topic of rational use in the development of an RSMMPA. It requested that the topic of rational use be discussed at the 2010 meetings of the Scientific Committee and Commission.

3.118 The Working Group recommended that a paper be developed for the Scientific Committee following a framework similar to that in WG-EMM-10/26, but considering, in particular, how scientific issues relating to rational use may be considered in this process. Such a framework could be applicable to a broad range of regions. Ideally, this paper would be developed through a collaborative process that involved interested Members so that a paper would be presented for broader discussion at the Scientific Committee. Dr A. Constable agreed to facilitate this process.

## MPA workshop in 2011

3.119 WG-EMM-10/31 presented a preliminary proposal, developed by the MPAs Special Fund Correspondence Group, for a CCAMLR workshop on MPAs to be convened in 2011 and supported by the MPA Special Fund. This workshop will fulfil Milestone (ii) in the list of agreed milestones and provide information to assist Members in achieving other milestones contributing towards the development of an RSMMPA by 2012 (SC-CAMLR-XXVIII, paragraph 3.28). The workshop proposal includes terms of reference, suggested outputs, required expertise and logistical/financial considerations for discussion by WG-EMM.

3.120 The workshop output may be a report for consideration by SC-CAMLR (and possibly by WG-EMM depending on workshop timing and venue). The report may include a summary of progress to date on existing and proposed MPAs in the Convention Area, advice on the use of specific tools, methodologies or datasets appropriate to the work, recommendations on draft MPA proposals that might be submitted to the workshop and a work program for the identification of MPAs in priority regions and other regions.

3.121 The Working Group considered the scope of the MPA workshop, specifically whether or not the terms of reference should include a consideration of socio-economic aspects of MPA designation. It was acknowledged that while policy aspects of the establishment of MPAs were most appropriately addressed at the Commission, characterising trade-offs to meet multiple objectives, including objectives for protection and rational use, are an integral part of the process of developing an RSMMPA at the WG-EMM and Scientific Committee levels. It was concluded that there are technical aspects in the development of MPAs that involve socio-economic issues so the topic should be incorporated into the terms of reference at an appropriate level.

3.122 The Working Group recalled discussion of the approach used in the development of the East Antarctica proposed system of MPAs (WG-EMM-10/26). The series of questions used to ensure CAR was achieved were viewed as a useful framework in which to discuss goals that might seem in conflict, such as conservation and rational use. The framework of questions could facilitate a discussion of cost-benefit trade-offs, which are an integral part of systematic conservation planning. The authors were encouraged to submit these questions to the next meeting of the Scientific Committee for further consideration.

3.123 Whilst discussing the principles of CAR, the Working Group noted that WG-EMM-10/26 had helped clarify many of the issues related to the development of an RSMMPA in the Convention Area. It therefore endorsed this approach for future use by others as one approach, among others, which could be useful in developing an RSMMPA (SC-CAMLR-XXVII, Annex 4, paragraph 3.59).

3.124 In discussing whether a system of MPAs was likely to be representative, the Working Group considered that a focus at the level of ocean basins is appropriate. The Working Group agreed that the CCAMLR statistical areas would be satisfactory in the first instance. This would enable CCAMLR to better understand whether the biological diversity was adequately represented within the CAMLR Convention Area.

3.125 The Working Group discussed the utility of monitoring as a tool for understanding whether an RSMMPA was achieving the goal of protecting identified values. Monitoring has the potential to not only provide data required to evaluate success, but also to provide data

that can be used in revising management plans over time should changes in an MPA be observed, or changes in values for which protection was provided. For example, monitoring can provide data that can help address the current uncertainty with regard to climate change.

3.126 The Working Group reviewed the proposed terms of reference in WG-EMM-10/31 and recommended that the terms of reference be:

- (i) To review progress on the development of a representative system of Marine Protected Areas (RSMPA) in the CAMLR Convention Area, including consideration of:
  - (a) recently designated MPAs and other spatial protection/management measures;
  - (b) proposals for new MPAs and other spatial protection/management measures.
- (ii) To share experience on different approaches to the selection of candidate marine sites for protection, including consideration of:
  - (a) types of scientific information that could be used for the identification of areas of conservation importance;
  - (b) use of bioregionalisation and other data compilations, e.g. characterisations of priority regions in terms of biodiversity patterns and ecosystem processes, physical environmental features and human activities; and representation of particular biological distributions and ecosystem processes as separate overlays;
  - (c) identification of conservation objectives appropriate to different regions; with reference to particular data layers and metrics against which achievement of objectives might be assessed;
  - (d) identification of the value of particular areas for rational use;
  - (e) methods for identifying and prioritising candidate marine sites for protection, including the means by which conservation and rational use objectives might be addressed;
  - (f) use of decision-support tools or approaches.
- (iii) To review draft proposals for MPAs or an RSMPA in the CAMLR Convention Area, submitted for this purpose, such that Members developing proposals can incorporate feedback from the workshop and revise their proposals accordingly in advance of SC-CAMLR in 2011.
- (iv) To develop a work program for further developing an RSMPA in each statistical area, including consideration of:

- (a) regions in which further work to identify MPAs is now required, based on current progress and considering the 11 priority regions and other regions as appropriate;
- (b) collaboration with the Committee on Environmental Protection towards a harmonised approach to the development of RSMPAs south of 60°S.

3.127 The Working Group recommended the following list of workshop outputs:

- (i) Summary of progress on developing an RSMMPA, which could include:
  - (a) the current status of existing and proposed MPAs in the Convention Area;
  - (b) updated consideration of priority regions in which further work to identify MPAs could be focused;
  - (c) recommendations on draft MPA proposals.
- (ii) Work program for finalising recommendations on an RSMMPA for the Commission meeting in 2012.

3.128 The Working Group discussed practical aspects of the workshop, including the length of time required for a successful outcome, as well as timing and location of the workshop. The Working Group agreed that a five-day workshop would be necessary to address the terms of reference and produce a final report. It was noted that a factor which contributed to the success of the two previous stand-alone MPA workshops for the Convention Area was the ability of participants to prepare and focus on just one theme. Alternatively, holding the workshop in conjunction with WG-EMM and WG-SAM would allow for savings in travel costs for participants and the Secretariat.

3.129 Difficulty in setting a date for the MPA workshop in 2011 will result from other planned meetings or workshops scheduled for the same year (paragraphs 6.4 to 6.7). The Working Group recognised that the Scientific Committee will need to address this difficulty at its 2010 meeting. It was recommended that the MPA Correspondence Group produce a circular to the Scientific Committee to identify issues related to holding the MPA workshop so that Members would be fully prepared for a discussion at the 2010 meeting of the Scientific Committee.

3.130 The Working Group recognised the value of inviting technical experts to participate in the MPA workshop. Representation from amongst a broad range of CCAMLR Members was considered to be important. The Working Group agreed that organisations with appropriate experience for this workshop could be invited, including SCAR, CEP and the IUCN. Also, experts providing scientific papers submitted to the workshop to address elements of the terms of reference could be invited, subject to the Scientific Committee Rules of Procedure. Another recommendation was to include those with expertise in bioregionalisation, systematic conservation planning and the development of high-seas MPAs. It was suggested that key material documenting CCAMLR's progress in the development of an RSMMPA be provided prior to the workshop. This would be particularly useful for those coming from a

non-CCAMLR background. The Working Group recommended that the MPA Correspondence Group engage in a discussion to identify potential experts for discussion at the 2010 meeting of the Scientific Committee.

### Cape Shirreff ASPA

3.131 A revised management plan for ASPA No. 149, Cape Shirreff and San Telmo Islands, Livingston Island, South Shetlands Islands, was presented for consideration by the Working Group (WG-EMM-10/21). Protection to this area, which includes a site at which CEMP data have been collected since 1994, is afforded through the Antarctic Treaty. The management plan, which is undergoing its required periodic review, includes updated information on biological communities and provides greater protection with the addition of a preferred air access zone.

3.132 Values to be protected under the original Antarctic Treaty designation in 1966 included the diversity of fauna and flora, particularly marine mammals. The area was subsequently afforded protection by CCAMLR through its designation as a CEMP site in 1994 under the provisions of CM 91-01 (CM 91-02 (1994)). In an effort to harmonise protection under the ATS and to avoid duplication of management plans, protection under CCAMLR was rescinded with the lapse of CM 91-02; protection continues under the ATS with the management plan of ASPA No. 149 (SC-CAMLR-XXVIII, Annex 4, paragraph 5.29).

3.133 Due to CCAMLR interest in continued protection of a site where CEMP data are collected, the proponents of the ASPA (Chile and the USA) requested comments from CCAMLR prior to submission to the ATCM for approval of the revised management plan.

3.134 The Working Group welcomed the opportunity to review the revised management plan for Cape Shirreff and recommended that the Scientific Committee approve the revised plan for ASPA No. 149.

### ADVICE TO THE SCIENTIFIC COMMITTEE AND ITS WORKING GROUPS

4.1 The Working Group provided advice to the Scientific Committee and other working groups on the following topics:

- (i) Krill –
  - (a) in-season catch and effort reporting in krill fisheries (paragraph 2.14);
  - (b) notifications for krill fisheries in 2010/11 (paragraphs 2.20 and 2.21);
  - (c) field studies to investigate krill escape mortality (paragraph 2.38);
  - (d) scientific observer coverage in krill fisheries (paragraphs 2.49 to 2.52);

- (e) use of SDWBA in estimating  $B_0$  (paragraph 2.56);
  - (f) revised estimate of  $B_0$  in Subareas 48.1 to 48.4 (paragraph 2.62);
  - (g) revised precautionary catch limit for krill in Subareas 48.1 to 48.4 (paragraphs 2.68 to 2.71);
  - (h) further consideration of the three-stage decision rule for determining precautionary catch limits for krill (paragraph 2.78).
- (ii) VMEs –
- (a) terminology relevant to the management of VMEs (paragraphs 3.3 and 3.5);
  - (b) summary of notifications made under CMs 22-06 and 22-07 (paragraphs 3.7 and 3.8);
  - (c) access to VME data (paragraph 3.9);
  - (d) development of impact assessments (paragraphs 3.20 to 3.22);
  - (e) deployment of camera systems by scientific observers for collecting data on benthic habitats and associated communities (paragraph 3.26);
  - (f) development of assessments of vulnerable habitats (paragraphs 3.40 and 3.41);
  - (g) VMEs notified under CM 22-06 (paragraphs 3.46 to 3.49);
  - (h) report on bottom fisheries and VMEs (paragraph 3.58).
- (iii) Protected areas –
- (a) terminology in relation to bioregionalisation and systematic conservation planning (paragraphs 3.105, 3.106 and 3.108);
  - (b) approaches to bioregionalisation and systematic conservation planning (paragraph 3.110);
  - (c) rational use (paragraphs 3.116 to 3.118);
  - (d) MPA Workshop in 2011 (paragraphs 3.126 to 3.130);
  - (e) revised management plan for ASPA No. 149, Cape Shirreff and San Telmo Islands (paragraph 3.134).
- (iv) Future work –
- (a) format, duration and timing of the meeting of WG-EMM in 2011 (paragraphs 3.126 and 5.3);



- (b) three- to five-year science plan (paragraphs 5.5 to 5.8, 5.11 and 5.12).
- (v) Other matters –
  - (a) consideration of the Global Environment Facility (GEF) capacity building in CCAMLR-related science (paragraph 6.3);
  - (b) five-day catch and effort reporting for research activities notified under CM 24-01 (paragraph 6.13);
  - (c) succession planning (paragraph 6.14).

## FUTURE WORK

5.1 The Working Group considered the following draft agenda for its meeting in 2011 (WG-EMM-10/1):

2. MPA Workshop
3. Ecosystem effects of fishing for krill
  - 3.1 The krill fishery and scientific observation
  - 3.2 Krill-dependent predators (standard methods, STAPP, CEMP Review)
  - 3.3 Climate impacts
  - 3.4 Feedback management strategies for the krill fishery
  - 3.5 Tasks resulting from the CCAMLR Performance Review
4. Ecosystem effects of fishing for finfish.

5.2 Dr Watters presented a series of options for the structure of the Working Group meeting in 2011 (Table 4) that addressed the current priorities for the Working Group and the desire to restrict the duration of the meetings.

5.3 The Working Group agreed that the choice of the format and duration of its meeting next year should be considered by the Scientific Committee and that such considerations should identify the standing item that there is a requirement for WG-EMM to provide advice to the Scientific Committee on an annual basis, as well as those items where advice is not required each year.

5.4 Given the proposed agenda for 2011, the Working Group agreed that WG-EMM-10/P1 to 10/P5, 10/P15 and 10/P16 on higher predators at the Prince Edward Islands, as well as WG-EMM-10/22 and 10/P7 on the myctophid fish in the South Georgia area, would be carried forward to 2011, pending consideration of the agenda by the Scientific Committee.

5.5 The Working Group discussed the development of mechanisms to increase the effectiveness of its meetings and to ensure that it can deliver the science required to provide advice requested by the Scientific Committee in a timely manner. This included developing both a strategic plan that identified the science areas that would need to be delivered over the next 3–5 years, as well as a tactical strategy to ensure that the science objectives in the strategic plan were delivered. This tactical strategy would include identifying groups or individuals, including the Secretariat, that could undertake to deliver the required work in the timeframe described in the strategic plan.

5.6 Such a plan would facilitate the work of scientists progressing different areas of work and would also assist the Secretariat in allocating time and resources to support that science.

5.7 The Working Group agreed that providing greater clarity in the rationale for the science priorities of the Working Group and the Scientific Committee would help in increasing engagement in the work and would also be helpful in developing a greater understanding of the work of CCAMLR.

5.8 The following items of future work were identified during the current meeting:

- (i) Krill issues –
  - (a) Escape mortality experiments and manual (e.g. paragraph 2.32)
  - (b) Recruitment variation and decision rules (paragraph 2.78)
  - (c) Integrated assessment (e.g. paragraph 2.3)
  - (d)  $B_0$  and precautionary catch limits for Divisions 58.4.1 and 58.4.2 (paragraph 2.71).
  
- (ii) VME issues –
  - (a) Review Risk Areas and notifications from research cruises (paragraphs 3.40 and 3.48)
  - (b) Triggers for light and heavy taxa (paragraphs 3.36 to 3.39)
  - (c) Spatial scales (e.g. paragraph 3.30)
  - (d) Parameterisations for models and impact assessments (paragraphs 3.54 to 3.56).
  
- (iii) MPA issues –
  - (a) Further synthesis for the Ross Sea (paragraphs 3.85 and 3.101)
  - (b) Progress science to support other proposals (e.g. paragraphs 3.102 to 3.104)
  - (c) Prepare for MPA workshop (e.g. paragraphs 3.129 and 3.130).

The Working Group recommended that these items be included in the considerations of the Scientific Committee while addressing the issues raised in paragraphs 5.1 to 5.3.

5.9 Prof. D. Butterworth (South Africa) indicated that, based on recent experience with anchovy fisheries in South Africa, he may be able to provide work to address the issues identified in paragraph 5.8(i.b), although he noted that this would be dependent on obtaining appropriate resources to undertake this work.

5.10 In response to a request from Dr R. Crawford (South Africa), the Working Group noted that data from predators, other than those species currently included in CEMP, may be very useful in the proposed review of CEMP, as well as in monitoring to detect the effects of climate change.

5.11 The Working Group agreed that the following items should be considered for inclusion on the agenda for the meeting of WG-EMM in 2012, contingent on the discussion of priorities and the progress made on other items during 2011 and encouraged Members to contribute to this work:

- (i) MPAs –
  - (a) by 2011, submit proposals for areas for protection to the Scientific Committee;
  - (b) by 2012, submit proposals on an RSMMPA to the Commission.
- (ii) Krill and krill predators –
  - (a) integrated assessment
  - (b) feedback and spatial management
  - (c) decision rules and climate change.

5.12 The Working Group requested that the Scientific Committee consider whether various spatial management approaches, including inter alia, MPAs, VMEs, ASPAs and ASMAs, could be integrated.

## OTHER BUSINESS

6.1 Dr A. Naidoo (South Africa) advised the Working Group that South Africa had approached the GEF for advice on accessing GEF funding to support capacity building in science in the Southern Ocean and the Antarctic. The areas of initial interest to South Africa included climate change, conservation planning, particularly in relation to MPAs, oceanographic processes and fishery monitoring and building capacity to engage more fully in science processes in CCAMLR. It was noted that South Africa is about to acquire a new research vessel that will be deployed to support South African research effort in the Southern Ocean, and that this effort could foreseeably involve other countries with a mutual interest in such research.

6.2 The Working Group welcomed a presentation by Dr D. Vousden (South Africa/UNDP) that described how GEF considered the South African approach to be compatible with the strategy for funding support under Objectives 3 and 4 of the GEF International Waters Focal Area within the fifth replenishment cycle of GEF. GEF had provided advice to South Africa concerning elaboration of the concept for further consideration. GEF noted that other CCAMLR Members, including Argentina, Chile, India, Namibia and Uruguay, would be eligible for GEF funding support within a multilateral initiative to build capacity in Antarctic and Southern Ocean science. South Africa advised its intention to engage these developing countries and other potential partners in further developing this draft concept.

6.3 The Working Group considered that, while there is a need to consider the proposal in the context of CCAMLR's priorities, GEF resources could be utilised for broadening participation of GEF-eligible countries in the work of CCAMLR. Management of the krill fishery in the South Atlantic Ocean, climate change and ecosystem monitoring are among areas of the proposal of direct relevance to WG-EMM while other components would involve other working groups. How funding might be allocated would be considered during further development of the project. The Working Group expressed general support for the concept and looked forward to further information being presented to the next meeting of the Scientific Committee.

## Planned workshops associated with the work of WG-EMM

6.4 Dr J. van Franeker (European Union) informed the Working Group of a workshop entitled ‘Antarctic Krill in a Changing Ocean’ to be hosted in The Netherlands, funded by the European Union, in April/May 2011. The Working Group noted the broad aims of the proposed workshop. It suggested that a useful item for consideration would be an update of the analyses of the relationship between krill and sea-ice in order to better understand the trends presented in Atkinson et al. (2004). The Working Group requested the workshop organisers to provide an update of plans for the Scientific Committee this year.

6.5 Dr Watters informed the Working Group of ongoing discussion with the Lenfest Foundation in respect of two workshops designed to contribute towards the development of feedback management of krill. It is proposed that the first of these workshops would examine how krill dynamics and variability are linked across Area 48 with the second examining the monitoring of the consequences of this variability in krill.

6.6 Dr Constable informed the Working Group of two workshops being planned by ICED, the first of which, on monitoring the effects of climate change, was scheduled for September 2011, while the second, on model development, was scheduled for the first half of 2012.

6.7 The Working Group agreed that there is a need for coordination of the increasing number of workshops being planned in order to maximise the potential synergies for the work of CCAMLR.

## Southern Ocean Observing System

6.8 The Science Officer informed the Working Group of correspondence from the Executive Director of SCAR seeking input from CCAMLR scientists in the development of the scientific rationale and strategy for the Southern Ocean Observing System (SOOS) ([www.scar.org/soos/](http://www.scar.org/soos/)) and encouraged all interested parties to provide feedback ([soos@scar.org](mailto:soos@scar.org)) before 1 October 2010.

## *CCAMLR Science*

6.9 The Working Group agreed that the ranking of *CCAMLR Science* as 16 out of the 42 journals in the Fisheries subject category of the Thomson Reuters Journal Citation Reports (WG-EMM-10/13) was a reflection on the quality of science undertaken in CCAMLR.

6.10 In response to comments from the Science Officer about the need to delay publication of some papers by a year because of the annual publication cycle of the journal, the Working Group considered whether greater flexibility in the publication of the electronic version of the journal might be possible if it was not tied to the publication of a hard-copy volume. The Secretariat agreed to examine the implications of changing the publication cycle of both the electronic and hard-copy versions.

## Working Group papers

6.11 The Working Group discussed the potential for making working group papers publicly available, noting that this would contribute to the transparency of the CCAMLR decision-making process. While there was support for the principle of making papers more available, there was recognition that it was important to have clarity in the process of how working group papers are to be dealt with in order to maintain the current high standard of work submitted to the working groups. The Secretariat undertook to prepare a discussion paper for consideration by the Scientific Committee on this subject.

6.12 The Working Group welcomed the proposed single Document Submission Form (WG-EMM-10/13, Appendix 1) proposed by the Secretariat (as a replacement for the two separate forms currently required).

## Conservation Measure 24-01

6.13 The Working Group noted that currently CM 24-01 requires the notification of very small catches taken during research surveys and that such reporting is not the intention of the measure. The Working Group suggested that, in order to address this issue, the existing conservation measure should be modified.

## Succession planning

6.14 The Convener informed the Working Group that he intended to continue in the role for two more years in order that there was sufficient time to identify a replacement. The Working Group agreed that the following items would be useful for discussion by the Scientific Committee in respect of the convenership of working groups:

- (i) fixed terms for conveners of working groups would allow for more effective successional planning;
- (ii) a mentoring role, including a hand-over year when the incumbent and the incoming convener shared the role;
- (iii) the development of clear instructions on the role of conveners that could be made available to new conveners, and broader distribution of this material to meeting participants would provide a greater understanding of the conduct of the meeting.

## ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

7.1 The report of the meeting of WG-EMM was adopted.

7.2 In closing the meeting, Dr Watters thanked the participants for their contributions to the meeting and their work during the intersessional period, Dr Parker for facilitating the

subgroup discussions on VMEs, and the rapporteurs for bringing together a short focused report. He also thanked Dr Mayekiso and his local organising team for providing a beautiful venue and excellent facilities for the meeting, and the Secretariat for its support.

7.3 Dr Trathan, on behalf of the participants, thanked Dr Watters for his work in preparing for, and convening the meeting, and leading the discussions, including the subgroup discussions on krill.

7.4 The meeting was closed.

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Table 1: Options for observer coverage in the krill fishery during the 2010/11 and 2011/12 fishing seasons. Light grey cells indicate time–area strata with 100% coverage of vessels and 20% coverage of hauls. Dark grey cells indicate time–area strata with at least 50% coverage of vessels and 20% coverage of hauls. Months are indicated by letters (e.g. DJF indicates December, January, and February). See paragraph 2.49 for additional details.

| <b>Option 1</b> |   |      |  |      |
|-----------------|---|------|--|------|
| Year 1          |   |      |  |      |
| Group A         | 48.1  | 48.2 | 48.3   | 48.4 |
| Period 1        | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| Period 2        |   |      |  |      |
| Group B         | 48.1  | 48.2 | 48.3   | 48.4 |
| Period 1        | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| Period 2        |   |      |  |      |
| Year 2          |   |      |  |      |
| Group A         | 48.1  | 48.2 | 48.3   | 48.4 |
| Period 1        | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| Period 2        |   |      |  |      |
| Group B         | 48.1  | 48.2 | 48.3   | 48.4 |
| Period 1        | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| Period 2        |   |      |  |      |
| <b>Option 2</b> |   |      |  |      |
| Year 1          |   |      |  |      |
| Months          | 48.1  | 48.2 | 48.3   | 48.4 |
| DJF             | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| MAM             | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| JJA             |   |      | 100% vessels – 20% hauls in each stratum visited |      |
| SON             |   |      |  |      |
| Year 2          |   |      |  |      |
| Months          | 48.1  | 48.2 | 48.3   | 48.4 |
| DJF             | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| MAM             | 100% vessels – 20% hauls in each stratum visited              |      |  |      |
| JJA             |   |      | 100% vessels – 20% hauls in each stratum visited |      |
| SON             |   |      |  |      |
| <b>Option 3</b> |   |      |  |      |
| Year 1          |   |      |  |      |
| Months          | 48.1  | 48.2 | 48.3   | 48.4 |
| DJF             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| MAM             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| JJA             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| SON             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| Year 2          |   |      |  |      |
| Months          | 48.1  | 48.2 | 48.3   | 48.4 |
| DJF             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| MAM             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| JJA             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |
| SON             | Not less than 50% vessels – 20% hauls in each stratum visited |      |  |      |

Table 2: Sensitivity of harvest rates to increasing the overall CV in the estimate of  $B_0$  (based on 10 001 iterations for each CV). The CV in recruitment is fixed at 12.6% in all cases.

| CV survey | CV methodological | CV total | $\gamma$   | Harvest rate |
|-----------|-------------------|----------|------------|--------------|
| 12.8%     | 0%                | 12.8%    | $\gamma_2$ | <b>0.093</b> |
|           |                   |          | $\gamma_1$ | 0.121        |
| 12.8%     | 22.2%             | 25.6%    | $\gamma_2$ | <b>0.094</b> |
|           |                   |          | $\gamma_1$ | 0.114        |
| 12.8%     | 49.6%             | 51.2%    | $\gamma_2$ | 0.098        |
|           |                   |          | $\gamma_1$ | <b>0.094</b> |

Table 3: Sensitivity of harvest rates to increasing levels of recruitment variability. The overall CV in the estimate of  $B_0$  is fixed at 12.8% in all cases.

| CV recruitment | $\gamma$   | Harvest rate |
|----------------|------------|--------------|
| 12.6%          | $\gamma_2$ | <b>0.093</b> |
|                | $\gamma_1$ | 0.121        |
| 17.0%          | $\gamma_2$ | 0.092        |
|                | $\gamma_1$ | <b>0.072</b> |

Table 4: Proposed options for the meeting of WG-EMM in 2011.

| 1 week that includes MPA Workshop <sup>1</sup>                       | 1 week but separate MPA Workshop <sup>1</sup>                        | 2 weeks that include MPA Workshop | 2 weeks but separate MPA Workshop                                       |
|--|--|-----------------------------------|---|
| MPA Workshop   | Krill-dependent predators (Standard Methods, STAPP, CEMP Review)     | MPA Workshop                      | Full agenda from preliminary draft (SC CIRC 10/31)                      |
| Review data from krill fishing season and notifications <sup>2</sup> | Tasks from CCAMLR Performance Review OR Climate Change               | Items from second column          | More krill (e.g. integrated assessment, recruitment and decision rules) |
| Review VME Risk Areas and notifications                              | Review data from krill fishing season and notifications <sup>2</sup> |                                   |   |
|  | Review VME Risk Areas and notifications                              |                                   |   |

<sup>1</sup> Would require two additional days to prepare and adopt report.

<sup>2</sup> Would limit discussion to review of summary papers prepared by the Secretariat.



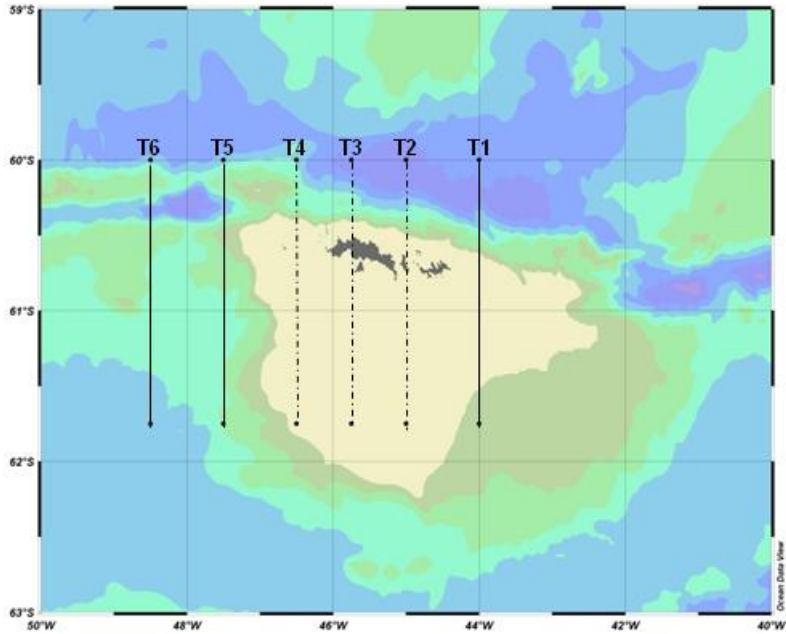


Figure 1: Bathymetry of the South Orkney Islands with transect locations used by the US AMLR Program during an acoustic survey conducted in 2008 and presented as a potential sampling design for a proposed survey by the Norwegian krill fishing vessel *Saga Sea*. Dashed lines represent transects that may have to be altered to transit around islands. All transects have northernmost waypoints at 60°S and southernmost waypoints at 61.75°S. Longitudes for Transects 1 (T1) through 6 (T6) are, respectively, at 44°W, 45°W, 45.75°W, 46.5°W, 47.5°W and 48.5°W.

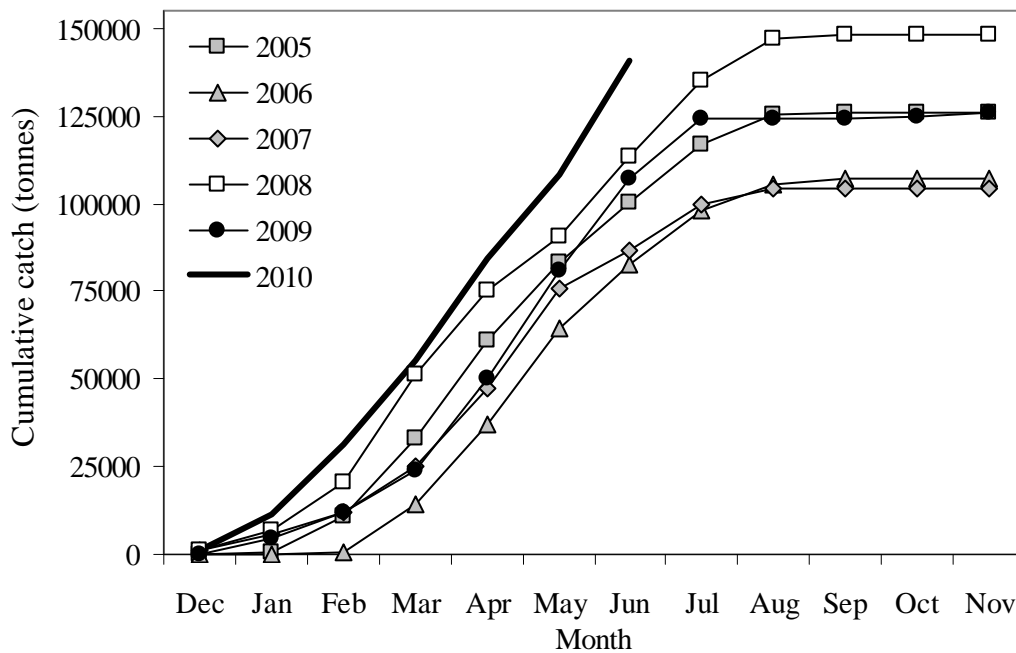


Figure 2: Monthly cumulative catch of krill in Area 48 in each season since 2004/05. Source: monthly catch and effort reports to June 2010.

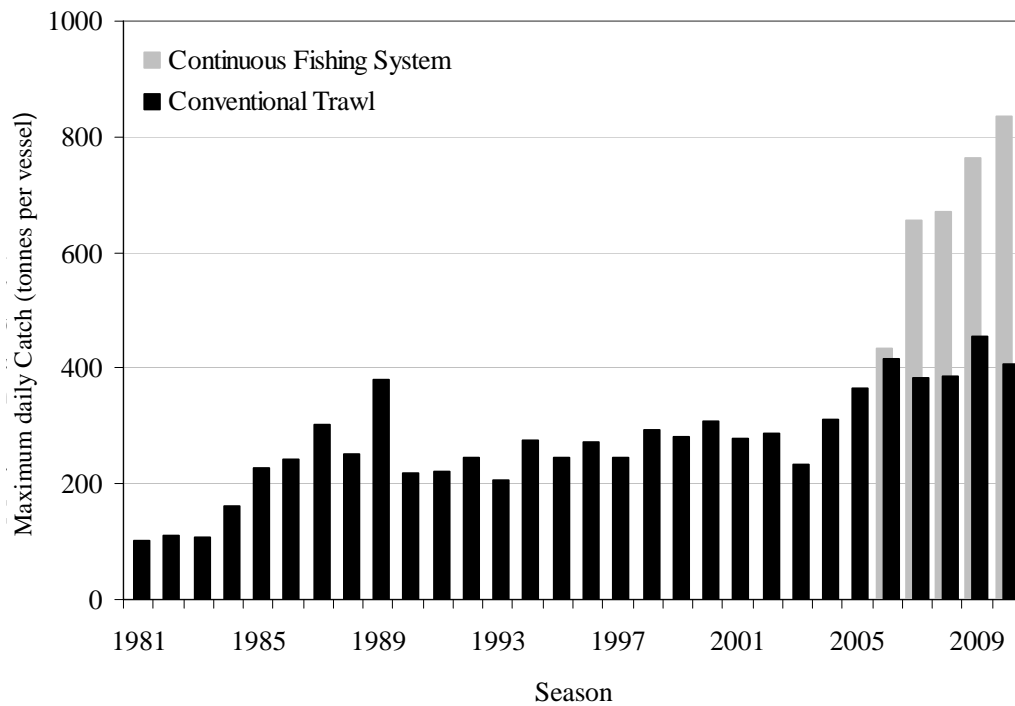


Figure 3: Maximum daily catch of krill (tonnes per vessel) reported from Area 48 since 1980/81. Source: C1 data.

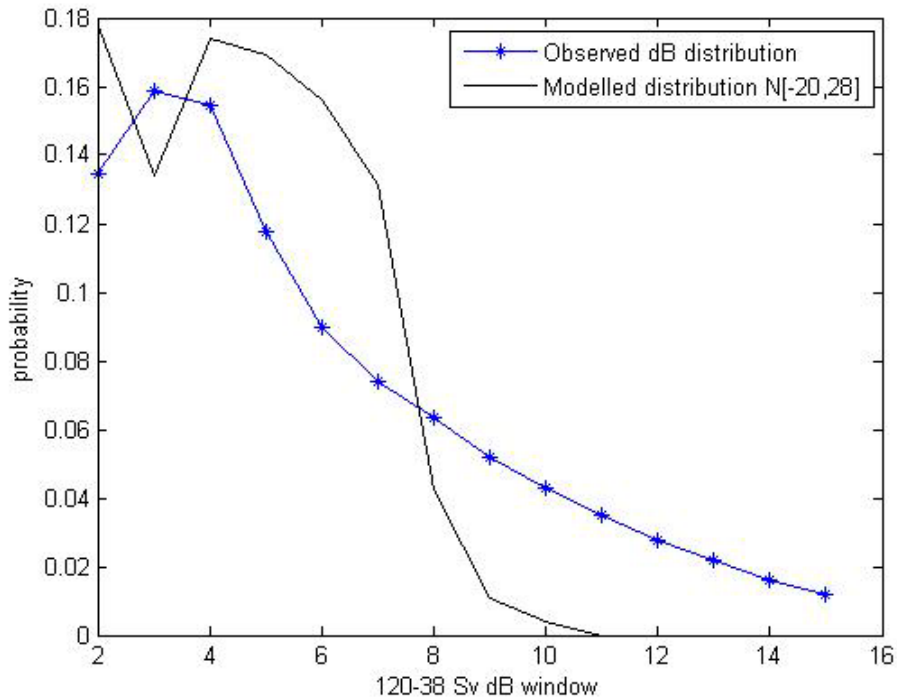


Figure 4: Observed and modelled dB-difference distributions for the best-fitting krill orientation distribution. The observed distribution is derived from the difference in acoustic backscatter for 120 and 38 kHz from the entire synoptic survey. The modelled distribution is generated from the SDWBA model with an orientation distribution with a mean of  $-20^\circ$  and a standard deviation of  $28^\circ$ .

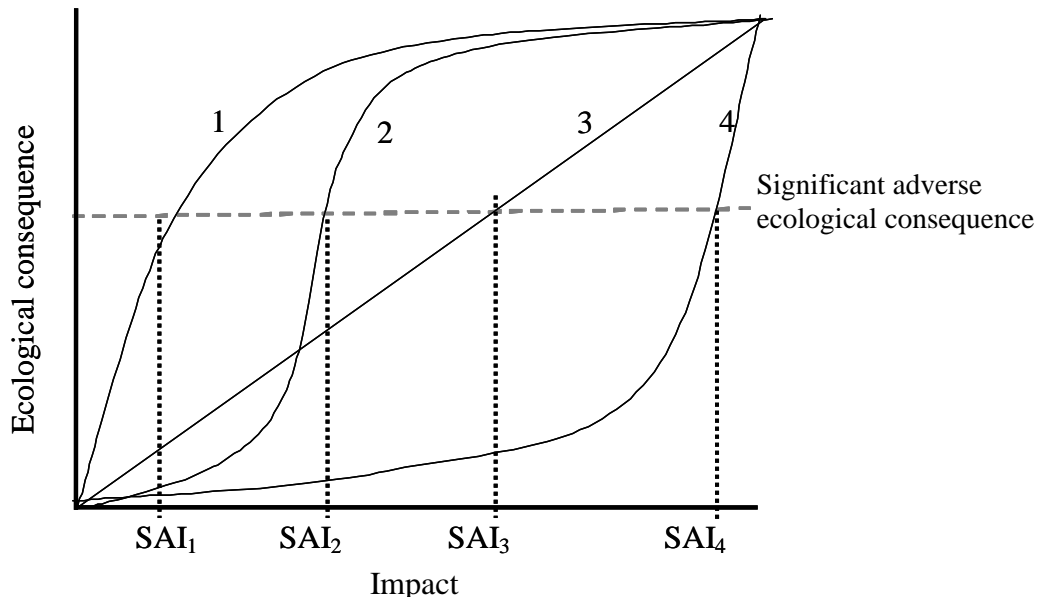


Figure 5: Alternative hypothetical forms of the relationship between impact and ecological consequence. 'Significant adverse impact' (SAI) refers to the level of impact that would constitute a significant adverse ecological consequence.

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\* Denotes partial attendance/capacity building/special interest.

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**AGENDA**

Working Group on Ecosystem Monitoring and Management  
(Cape Town, South Africa, 26 July to 3 August 2010)

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. Ecosystem effects of fishing for krill
  - 2.1 Krill
  - 2.2 The krill fishery and scientific observation of the fishery
  - 2.3 Estimates of  $B_0$  and precautionary yield for krill
3. Spatial management to facilitate the conservation of marine biodiversity
  - 3.1 Vulnerable marine ecosystems
  - 3.2 Protected areas
4. Advice to the Scientific Committee and its working groups
5. Future work
6. Other business
7. Adoption of the report and close of the meeting.

## LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management  
(Cape Town, South Africa, 26 July to 3 August 2010)

|              |  |
|--------------|--|
| WG-EMM-10/1  | Draft Preliminary Agenda for the 2010 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)   |
| WG-EMM-10/2  | List of participants   |
| WG-EMM-10/3  | List of documents  |
| WG-EMM-10/4  | Summary of observations aboard krill trawlers operating in the Convention Area<br>Secretariat  |
| WG-EMM-10/5  | Krill fishery report: 2010 update<br>Secretariat   |
| WG-EMM-10/6  | Summary of notifications for krill fisheries in 2010/11<br>Secretariat   |
| WG-EMM-10/7  | Summary of VME notifications made under Conservation Measures 22-06 and 22-07<br>Secretariat   |
| WG-EMM-10/8  | Results of krill fishery in Subarea 48.2 in the 2009 season based on data of the Russian vessel <i>Maxim Starostin</i><br>S.Yu. Gulyugin, V.E. Polonskiy and S.M. Kasatkina (Russia)   |
| WG-EMM-10/9  | The importance of obtaining annual biomass information in CCAMLR Subarea 48.2 to inform management of the krill fishery<br>N. Jensen (Norway), R. Nicoll (Australia) and S.A. Iversen (Norway)   |
| WG-EMM-10/10 | On the need to determine the level of krill escapement mortality in the Antarctic krill fishery<br>L. Pshenichnov and G. Milinevsky (Ukraine)  |
| WG-EMM-10/11 | Ross Sea Biodiversity, Part I: validation of the 2007 CCAMLR Bioregionalisation Workshop results towards including the Ross Sea in a representative network of marine protected areas in the Southern Ocean<br>D.G. Ainley, G. Ballard and J. Weller (USA) |
| WG-EMM-10/12 | Ross Sea Bioregionalisation, Part II: Patterns of co-occurrence of mesopredators in an intact polar ocean ecosystem<br>G. Ballard, D. Jongsomjit and D.G. Ainley (USA)   |

- WG-EMM-10/13      *CCAMLR Science*: an update and suggested changes to document handling/submission  
Secretariat
- WG-EMM-10/14      High densities of pterobranchs and sea pens encountered at sites in the South Orkney Islands (Subarea 48.2): two potential VMEs  
S.J. Lockhart and C.D. Jones (USA)
- WG-EMM-10/15      Report on bottom fisheries and vulnerable marine ecosystems: draft template and workplan  
WG-FSA Subgroup on VMEs
- WG-EMM-10/16      Distribution and size-age composition of Antarctic krill in the South Orkney Islands region (CCAMLR Subarea 48.2)  
D.O. Sologub and A.V. Remeslo (Russia)  
(*CCAMLR Science*, submitted)
- WG-EMM-10/17      Interannual variability of standardised index of krill abundance in Area 48 according to CCAMLR fishery statistics database  
P.S. Gasyukov and S.M. Kasatkina (Russia)
- WG-EMM-10/18      Recommendations on estimating krill escape mortality during fishing operations: the problems and approaches  
V.K. Korotkov and S.M. Kasatkina (Russia)
- WG-EMM-10/19      Review of Russian investigations of krill escape through the meshes of commercial trawls: approaches to estimating gross removal at krill fishery  
S.M. Kasatkina (Russia)
- WG-EMM-10/20      Monitoring krill larvae at the Weddell-Scotia confluence  
E. Marschoff, N.S. Alescio, D. Gallotti and G. Donini (Argentina)
- WG-EMM-10/21      Revised Management Plan for Cape Shirreff ASPA 149  
P.A. Penhale (USA) and V. Vallejos Marchant (Chile)
- WG-EMM-10/22      Annual changes in species composition and abundance of myctophid fish in the north of South Georgia (CCAMLR Subarea 48.3), Antarctica, during austral winter from 2002 to 2008  
T. Iwami, M. Naganobu, K. Taki and M. Kiyota (Japan)  
(*CCAMLR Science*, submitted)
- WG-EMM-10/23      Update on the 'Demersal interactions with marine benthos in the Australian EEZ of the Southern Ocean: an assessment of the vulnerability of benthic habitats to impact by demersal gears' project  
G.P. Ewing, D.C. Welsford and A.J. Constable (Australia)

- WG-EMM-10/24 Using compact video camera technology for rapid deep-sea benthic habitat assessment  
G.P. Ewing, R. Kilpatrick, A.J. Constable and D.C. Welsford (Australia)
- WG-EMM-10/25 Quantitative assessment of benthic fauna and assemblages in the Heard Island and McDonald Islands region  
T. Hibberd, D.C. Welsford, A.J. Constable, K. Moore and S. Doust (Australia)
- WG-EMM-10/26 Elaborating a representative system of marine protected areas in eastern Antarctica, south of 60°S  
A.J. Constable, B. Raymond, S. Doust, D. Welsford and K. Martin-Smith (Australia)
- WG-EMM-10/27 Is toothfish catch correlated with the catch of vulnerable benthic invertebrate taxa?  
S.J. Parker and M.H. Smith (New Zealand)  
(*CCAMLR Science*, submitted)
- WG-EMM-10/28 Spatial scales of benthic invertebrate habitats from fishery by-catch and video transect data in the Ross Sea region  
S.J. Parker, R.G. Cole and S.M. Hanchet (New Zealand)
- WG-EMM-10/29 A glossary of terms relevant to the management of Vulnerable Marine Ecosystems (VMEs) in the CCAMLR Area  
B.R. Sharp and S.J. Parker (New Zealand)
- WG-EMM-10/30 Bioregionalisation and spatial ecosystem processes in the Ross Sea region  
B.R. Sharp, S.J. Parker, M.H. Pinkerton (New Zealand) (lead authors) also B.B. Breen, V. Cummings, A. Dunn (New Zealand), S.M. Grant (United Kingdom), S.M. Hanchet, H.J.R. Keys (New Zealand), S.J. Lockhart (USA), P. O'B. Lyver, R.L. O'Driscoll, M.J.M. Williams, P.R. Wilson (New Zealand)
- WG-EMM-10/31 Proposal for a CCAMLR Workshop on Marine Protected Areas (2011)  
MPA Special Fund Correspondence Group
- WG-EMM-10/32 Proposal for GEF (Global Environment Facility) funding to support capacity building and training to the GEF-eligible countries with Antarctic interests  
South Africa
- WG-EMM-10/33 Preliminary assessment of the potential for the proposed bottom fishing activities to have significant adverse impact on vulnerable marine ecosystems  
United Kingdom

- WG-EMM-10/34 Demonstrating proof of concept of the application of systematic conservation planning at the circumpolar scale  
D. Beaver, R. Nicoll, G. Llewellyn, P. Harkness, C. Hellyer and J. Turner (ASOC-WWF)
- Other Documents
- WG-EMM-10/P1 Recent trends in numbers of four species of penguins at the Prince Edward Islands  
R.J.M. Crawford, P.A. Whittington, L. Upfold, P.G. Ryan, S.L. Petersen, B.M. Dyer and J. Cooper  
(*Afr. J. Mar. Sci.*, 31 (3) (2009): 419–426)
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C.M. Waluda, M.A. Collins, A.D. Black, I.J. Staniland and P.N. Trathan  
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A. Van Cise (Editor)  
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G.J. Rickard, M.J. Roberts, M.J.M. Williams, A. Dunn and M.H. Smith (2010)  
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M.H. Pinkerton, A.N.H. Smith, B. Raymond, G.W. Hosie, B. Sharp, J.R. Leathwick and J.M. Bradford-Grieve  
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M.N. Bester, P.G. Ryan and J. Visagie  
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WG-EMM-10/P16

Intra-archipelago moult dispersion of southern elephant seals  
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G.J.G. Hofmeyr  
(*Afr. J. Mar. Sci.*, 31 (3) (2009): 457–462)

**REPORT OF THE AD HOC TECHNICAL GROUP  
FOR AT-SEA OPERATIONS**  
(Hobart, Australia, 11 to 15 October 2010)

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**REPORT OF THE AD HOC TECHNICAL GROUP  
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## INTRODUCTION

### Opening of the meeting

1.1 The third meeting of ad hoc TASO was held in Hobart, Australia, from 11 to 15 October 2010. The meeting was co-convened by Mr C. Heinecken (South Africa) and Dr D. Welsford (Australia).

1.2 The Co-conveners welcomed participants (Appendix A).

### Terms of reference, conduct of the meeting and adoption of the agenda

1.3 The Technical Group recalled its terms of reference as agreed by the Scientific Committee (SC-CAMLR-XXVII, paragraph 6.7).

1.4 The report was prepared by Mr M. Exel (Australia), Mr Heinecken, Dr S. Kawaguchi (Australia), Mr J. Moir Clark (UK), Ms K. O'Regan (Australia) and Mr B. Sims (New Zealand). Text that provides advice on future work to the Scientific Committee has been highlighted without repeating it in full in Item 5.

1.5 The provisional agenda was adopted (Appendix B).

### Review of materials submitted by Members

1.6 Documents submitted to the meeting are listed in Appendix C.

1.7 The Technical Group noted that, in response to the request by the Scientific Committee (SC-CAMLR-XXVIII, paragraph 6.12), four Members (Australia, France, Spain and the UK) submitted materials to assist with the development of baseline requirements for accrediting observer programs. These submissions had been appended to TASO-10/5.

1.8 The Technical Group noted that the Scientific Committee recommended that the development of baseline requirements to accredit observer programs be undertaken in 2010 (SC-CAMLR-XXVIII, paragraph 6.11), and agreed that this would form the substantial part of its work at this meeting.

1.9 Mr Moir Clark presented the UK submission, annexed to TASO-10/5, which provided a framework for evaluating the assessment criteria set out in SC-CAMLR-XXVIII/BG/9, including how the baseline requirements can be qualitatively assessed.

1.10 The Technical Group noted that the UK submission provided a useful template which could be used as a basis to develop a matrix through which observer programs could be assessed. It was decided that each of the key assessment criteria would be scored on a three-tier basis:

- (i) exceed minimum standard
- (ii) meet minimum standard
- (iii) below minimum standard.

1.11 The Technical Group agreed that to be accredited, a program must achieve the minimum standard on each of the assessment criteria. Programs could also ‘exceed minimum standard’ on particular criteria if they were considered to show examples of best-practice.

1.12 The Technical Group also considered that accreditation should include a qualitative analysis of the training materials provided, including the training manual, training delivery material, descriptions of practical training and any associated assessment of learning.

1.13 Mr N. Gasco (France) presented a paper covering France’s observer program outlining the procedures it had in place for at-sea observer monitoring. This included giving observer feedback on both the quantitative and qualitative aspects of data collected on a weekly basis such as the number of toothfish measured, tagging rates and size of fish tagged. On a trip basis, photos taken for cetacean identification are assessed for quality. Debriefing procedures include rating the quality of the biometric data collected and testing seabird identification skills to assess the reliability of seabird data collected by each observer. In addition, France informs observers of ongoing scientific research and outcomes of recent meetings of interest through publication of an ‘Observer Bulletin’. This provides the observers with feedback on how data collected by them is being used.

1.14 Ms O’Regan presented a paper reviewing Australia’s observer program which focused on the recruitment and selection of observers, including any prior skills required. A second round of checks includes first aid and medicals. The initial training phase is run over a 2–5 day period that qualifies observers to work in the domestic fishery. After one year in the domestic fishery, and following additional training in relevant subjects, these observers would qualify for deployment in the Antarctic fishery. Data-quality reports are done for each observer, on a trip-by-trip basis, which includes information on any equipment or database problems during the trip. At-sea data checking includes analysis of data recording, positional data and the bin sizes of otoliths collected. Australia holds an annual conference which brings in experts from different fields, for example, fishery managers, biology experts, industry figures and observers.

1.15 Mr Sims recalled TASO-09/9 which provided a pro-forma framework for the provision of observer program information to TASO, and presented a summary of the New Zealand observer training program, including observer recruitment, observer assessment criteria, at-sea supervision and graduated deployment from simple to complex fisheries. The rigorous recruitment process requires observers to undergo two interviews, psychometric testing and three weeks of training, and they must pass a final exam before being employed. On average, less than 10% of applicants are selected for observer training. It was noted that experience of approximately six months of sea time, including at least 30 sea days’ observation of domestic within-zone demersal longline fisheries, is required prior to an observer being considered for deployment in Antarctic fisheries. During a season while at

sea, observers report in on a five-day basis; these reports can be used to cross-check vessel reports. To meet the CCAMLR requirements, all vessels have on board one national observer and one international observer who work in 12-hour shifts to collect the required data.

1.16 Mr Heinecken presented TASO-10/8, submitted by Chile, on its national observer program which deploys national observers over a wide range of regions along the Chilean coast. The emphasis of the paper was on data-checking and data-quality systems where a team of 11 staff are employed in the computer science department to carry out the required checks and analyses of submitted data. In outlining Chile's recruitment, it was noted that positions were publicly advertised and that observers are legally appointed by the Government.

1.17 The Technical Group noted that aspects of the Chilean observer programs are accredited to ISO 9001:2000. The Technical Group noted that ISO 9001:2000 is not an observer-specific standard, but rather applies to business and administrative processes and remarked that this sort of standard may be useful to apply to components of other observer programs. The Technical Group also noted that it was unclear in the Chilean submission as to whether it applies to CCAMLR observers.

1.18 On behalf of the authors, Dr Welsford presented the text of Spain's training course for its toothfish fishery. Although the paper included some details that helped the Technical Group understand observer programs from different Member States, the discussion was limited to the translation. However, it was noted that Spain's program was based around relevant sections of the conservation measures and resolutions.

1.19 Mr Heinecken presented TASO-10/9 on behalf of the authors. This gave information on the newly established Chinese course which was run earlier this year for krill fisheries. The observer training program is run under the auspices of the Bureau of Fishery, Ministry of Agriculture. It was noted that the two observer training courses were held in conjunction with the training courses for vessel crew members and included representatives from the fishing industry. A total of 150 people attended these two courses. To date, six observers have been placed on two vessels (three on each). Data have been submitted to CCAMLR in the correct format as specified in the Scheme of International Scientific Observation.

1.20 The Technical Group expressed its thanks to the People's Republic of China as a new Member for developing a program and submitting the information. TASO also noted that the observers had been certified by the Chinese Government and it asked for more information as to how this process may help with accrediting CCAMLR international scientific observer programs.

1.21 Mr Heinecken presented a description of South Africa's CCAMLR observer program. Where possible, observers are required to participate in the domestic fishery before being eligible for training for the CCAMLR program. The training includes specific instruction on the sampling requirements for CCAMLR fisheries and an understanding of the CCAMLR conservation measures. Assessment is based on practical case studies where the observers are required to conform to conservation measures for specific areas and capture 'dummy' data into the log sheets.

1.22 Dr T. Okuda (Japan) presented an outline of Japan's observer program for krill and toothfish fisheries in the CCAMLR area. The krill observer program has been operational

since the 1989/90 fishing season. It was initially focused on fish by-catch and has since been adapted to reflect the CCAMLR Scheme of International Scientific Observation. During 2009, the Japanese observer program was updated to ensure data that were collected from the 2009/10 season are submitted to CCAMLR according to the observer scheme. The toothfish observer program is run to assist the CCAMLR international observer who also works on the vessel. Japan's program is supported financially by the Government to ensure the independence of data collection and resource management. The Government issues a certification at the end of the course to show the observer has reached the required level of competency. The observer program consists of:

- nomination and selection
- training course work
- certification
- briefing for deployment
- support of on-board activities
- data and sample treatment
- debriefing.

1.23 Japan currently operates one vessel in CCAMLR toothfish fisheries and one vessel in CCAMLR krill fisheries. Observers are deployed on the krill vessel for one 70–90 day trip per season, with the vessel returning to port to embark and disembark observers. Observers are deployed on all toothfish trips and can be on board for up to five months.

## DEVELOPMENT OF A PROCESS FOR ACCREDITING OBSERVER PROGRAMS PARTICIPATING IN THE CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

### Development for an accreditation process and timeline

2.1 The Technical Group noted the need for an accreditation process for CCAMLR international scientific observer programs to review both program outputs in terms of data quality, along with program inputs, including institutional arrangements, at-sea support, briefing and debriefing, quality assurance and observer training.

2.2 The Technical Group recommended that initial accreditation be provided to successful programs for five years, after which time a program would be required to undergo a complete review and re-accreditation process.

2.3 The Technical Group recommended that the Scientific Committee consider establishing an annual review of a subset of data, target species data for example, collected by CCAMLR international scientific observer programs as a mechanism to monitor the performance of accredited programs for review and feedback purposes. A reduced annual review would require standardisation, potentially through the development of automated data-quality metrics. The Technical Group noted that WG-SAM has recommended the development of such data-quality metrics (SC-CAMLR-XXVIII, Annex 6, paragraph 5.10). Any such standardised data-quality metrics could also be used to review data collected by national observers and vessels if the Scientific Committee considered this useful. The Technical Group also recommended the Scientific Committee consider a process for



providing feedback to, and reviewing of, the CCAMLR international scientific observer programs whose data is found, through review or data-quality metrics checks, to be consistently below the minimum acceptable standard.

2.4 The Technical Group requested that the Scientific Committee consider the following process for programs seeking accreditation:

- (i) The CCAMLR Secretariat collate and hold information and materials submitted by Members' observer programs seeking accreditation. The Secretariat would undertake an initial determination as to the presence or absence of the component required of a CCAMLR international scientific observer program to achieve accreditation. If any components are missing, then the Secretariat will notify the applicant that they must be provided before review for accreditation is undertaken. The Secretariat will not make any evaluation as to whether those components present meet the minimum standard required.
- (ii) Once information is supplied on all the mandatory criteria to be assessed, a review panel, determined by the Scientific Committee, will review this material and evaluate whether the program meets the minimum standards required, using the baseline standards developed by TASO (Table 1). Representatives from the program seeking accreditation would be made available to the review panel so that any questions regarding the submission can be answered. Once the review is complete, advice will be provided to the Scientific Committee on the results of the review.

2.5 The Technical Group considered TASO could potentially undertake the review panel function in the accreditation process, and asked that the Scientific Committee give consideration to the following issues:

- (i) the value of continuity in the participation of Members in TASO to ensure consistency in the accreditation review process;
- (ii) a mechanism for handling conflicts of interest amongst participants, such as commercial conflicts of interest;
- (iii) the financial implications for Members to participate in TASO for the purpose of observer accreditation review;
- (iv) the timing of submissions by Members' observer programs in relation to the timing and work program of future TASO meetings and other relevant bodies of the Commission.

2.6 The Technical Group requested that the Scientific Committee consider a dispute-resolution procedure, which could take the form of an independent and external panel, reviewing the material supplied by a program and the accreditation assessment under dispute, to determine a final outcome, where the review panel or the Scientific Committee is unable to do so.

2.7 The Technical Group agreed that accreditation of all current CCAMLR international scientific observer programs could be completed in 3–4 years, and that once the Scientific Committee has approved the baseline standards checklist and accreditation process, observer programs would be able to apply for accreditation immediately.

2.8 The Technical Group recommended that the accreditation process also include a requirement that feedback be provided to the Member if accreditation is declined, in order to support applicants to improve their program before reapplying.

2.9 The Technical Group agreed that accreditation will provide recognition of the quality of Members' programs.

2.10 The Technical Group noted that it could undertake a review of the baseline standards and accreditation process after the full implementation of the accreditation process, including feedback from CCAMLR and individual Members on the process and baseline standards developed by the Technical Group this year.

#### Establishment of baseline standards for observer recruitment, training and performance management

2.11 The Technical Group agreed that the table provided in the UK submission annexed to TASO-10/5 would provide a useful template as the basis for articulating all the elements of a baseline standard for accrediting observer recruitment, training and performance management, as well as for developing a checklist to accredit observer programs.

2.12 The Technical Group identified the management components of a CCAMLR international scientific observer program that CCAMLR would need to evaluate for accreditation. These components included institutional arrangements, recruitment checks, observer briefings, at-sea support, debriefing and quality assurance. A set of assessment criteria were then developed for each of these management components and added to the original assessment criteria developed in SC-CAMLR-XXVIII/BG/9 (see Table 1).

2.13 Each of the assessment criteria was categorised according to whether the Technical Group considered it to be 'Mandatory' or 'Desirable' for a CCAMLR international scientific observer program. Baseline standards for each assessment criteria were then developed and a description of what would determine whether an assessment criteria achieves 'Below minimum standard', 'Meets minimum standard' or 'Exceeds minimum standard'.

2.14 Where an assessment criteria was categorised as 'Desirable', the Technical Group identified that where a program provided evidence that it addressed such criteria, it should automatically be considered to exceed minimum standard.

2.15 Where an assessment criteria was categorised as 'Mandatory', the Technical Group identified that it could either fall below the minimum standard, meet the minimum standard or exceed the minimum standard. For some assessment criteria, however, the Technical Group agreed that it was only possible to evaluate whether an observer program either met or did not meet the minimum standard required.

2.16 The Technical Group agreed that for programs to be accredited it would need to achieve the minimum standard in all the mandatory criteria. The Technical Group considered that, although not necessary for accreditation, desirable criteria should also be included in the assessment matrix to demonstrate the components that contribute to what may be considered a best-practice program.

2.17 The Technical Group recognised that the training element of the observer program operates as a sub-component of Institutional Arrangements under the Management Components section of Table 1. The Technical Group considered that the observer training sub-components necessary for a CCAMLR international scientific observer program include the CAMLR Convention, Role of the Scientific Observer, Vessel and Fishing Operations, Species Identification, Sampling Techniques and Data Handling.

2.18 The Technical Group requested that the Scientific Committee consider the application of Table 1 as a checklist for the accreditation of any CCAMLR international scientific observer programs.

2.19 The Technical Group noted that the ultimate test of the success of an observer program would be the provision of comprehensive and consistently high-quality data for use by the Scientific Committee, such as in the stock assessments performed by WG-FSA. The Technical Group noted that data currently submitted to the Secretariat are routinely checked for basic errors (see also WG-SAM-09/5). The Technical Group agreed that a process whereby assessment of program data quality, to allow feedback to technical coordinators and the Scientific Committee and its working groups was needed.

2.20 The Technical Group requested that WG-EMM and WG-FSA consider which comprehensive data subsets should be reviewed at regular intervals (e.g. tagging data, target and by-catch length-frequency data), to provide this feedback. The Technical Group noted that such reviews would enable the review of the baseline standards for observer programs, along with the quality of data outputs with respect to their intended use.

2.21 The Technical Group noted that as the accreditation process was focusing on the CCAMLR Scheme of International Scientific Observation, it was important to be able to distinguish whether data were collected by national or CCAMLR international scientific observers on vessels where both operate. The Technical Group requested that the Secretariat modify the CCAMLR scientific observer forms to ensure this was possible.

## INTERACTION WITH OTHER WORKING GROUPS

3.1 The Technical Group noted that the Scientific Committee and its working groups could all call on the expertise of TASO to address issues that fall under its terms of reference. It recalled that in previous meetings it had been able to successfully address specific technical questions referred to it by WG-FSA, WG-IMAF and WG-EMM.

3.2 The Technical Group further considered that meeting in parallel to working groups, such as WG-FSA in 2010, had advantages in that specific technical questions that arose in the working group could be referred to TASO and commentary could be provided effectively in real time. However, it agreed that, due to the contrast in the terms of reference for TASO and

WG-FSA, it would be inappropriate for joint sittings of WG-FSA and TASO without the endorsement of the Scientific Committee and consideration of the format and timing of future meetings.

## PRACTICAL IMPLEMENTATION OF DATA COLLECTION AT SEA

4.1 Mr Moir Clark presented TASO-10/7 on the development of an observer educational DVD for CCAMLR observers deployed in the Subareas 48.3, 88.1 and 88.2 toothfish longline fisheries. The video material covers daily work schedule, biological sampling, specialised tagging/recapture and skates identification. The Technical Group noted that the DVD was still being developed and requested that on completion, the UK make it available to other Members through the Secretariat. The Technical Group suggested that other Members may consider developing similar training aids for other CCAMLR fisheries.

4.2 TASO-10/6 was also presented by Mr Moir Clark, proposing the inclusion of the identification of oiled birds in the training for CCAMLR scientific observers. As there is currently no specific requirement to record oiled bird sightings, observers have typically recorded sightings in the comments section of their cruise report. The paper noted that the CCAMLR Marine Debris Hydrocarbon Soiling form has been used for reporting oil, paint, tar or petroleum for land-based surveys and this could be used by observers to record soiled birds observed at sea.

4.3 The Technical Group agreed observers and operators be encouraged to report oiled birds and requested that the Secretariat link the form to the observer page for easy access. It also requested that WG-IMAF consider the utility of current data collected by observers on oiled birds.

4.4 TASO-10/4 was presented by Mr Gasco and provided detailed gonad-stage identification plates for *Dissostichus eleginoides*, and proposed collaborative work to develop a set of CCAMLR plates for use at sea to sex and stage toothfish consistently. The Technical Group agreed that compilation of such an ID guide should be undertaken and requested WG-FSA to assess the value of a standardised guide for gonad staging.

4.5 The Technical Group discussed the desirability of compiling other such observer ID guides and materials for observer reference, such as area-specific by-catch photoguides, and agreed this should be pursued as part of the medium-term strategic development of observer reference material.

4.6 The Technical Group agreed that the video and photographic materials presented during the meeting are also valuable for both observer training and as reference materials when deploying observers. It was requested that the Secretariat place such materials, submitted by Members, on the 'Members Only' section of the CCAMLR website and notify technical coordinators that this material is available.

## Resources for species identification and observer training

4.7 Mr Gasco introduced a package of over 350 photographs that included, inter alia, pictures for species identification of fish, seabirds and marine mammals. The package also includes training pictures illustrating observers' tasks such as tagging, biological sampling and assessment of seabird abundance, with an electronic program which any series of photographs can be inserted into and used for self-training or testing. A further program was presented that can be used to calculate twilight at any selected geographical coordinates.

4.8 The Technical Group noted CCAMLR could, where appropriate, make such information available for training and educational purposes. It further noted that these materials could not be considered as CCAMLR-endorsed resources. The country of origin and contact information for each Member who submits material would therefore be required to be kept up-to-date to ensure enquires can be directed appropriately. The Technical Group requested the Scientific Committee to give consideration to hosting this material on the CCAMLR website, noting that this may have financial implications.

4.9 WG-FSA-10/25, presented by Mr A. Dunn (New Zealand), reported on fisheries and biological information for skates caught in the Ross Sea region during the Year-of-the-Skate, and provided parameter estimates, including tag loss rates. It noted that retardation of growth due to tagging was not detected. The paper recommended future focused research programs, such as Year-of-the-Skate, to be carried out at specific intervals, such as every five years.

4.10 The Technical Group noted that it is important for the observer workload to be taken into account when tasking observers to collect information, while ensuring consistent data is collected without compromising its accuracy. In response to the information provided in WG-FSA-10/25, the Technical Group agreed that it would be practical to:

- improve skate identification and recording;
- measure total length, pelvic length and disk width of all skates sampled;
- bring skates to the roller before release to improve tagging and help with tag identification;
- continue use of T-bar tags to ensure continuity in the data returned by skate tagging programs.

4.11 WG-FSA-10/32, presented by Dr S. Hanchet (New Zealand), summarised the current fishery-dependent data collection in the Ross Sea and proposed medium-term research objectives for this region. The proposal also included a draft fishery-dependent medium-term data collection plan. The Technical Group was asked to comment on any gaps, sampling rate adequacy and its approach to the items to be collected by observers. The paper further recommended the development of research plans for specific areas and fisheries.

4.12 The Technical Group noted that ensuring randomness when collecting a sample was more difficult when small sample sizes were required. The Technical Group noted that this should be taken into account when analysing such data. The Technical Group also agreed that sampling instructions need to be as clear as possible for the observer to understand and implement.

4.13 To facilitate clear instructions, the Technical Group agreed that the format of the template used in Table 3 of WG-FSA-10/32 provided a way of clearly articulating the different data types and sample sizes observers are asked to collect. The Technical Group also requested that the Scientific Committee consider using WG-FSA-10/32, Table 3, as a template to set out research plan collection requirements in the relevant sections of the fishery-specific conservation measures.

4.14 WG-FSA-10/23, also presented by Dr Hanchet, reported problems in distinguishing between the two toothfish species of smaller size (<100 cm TL) in Subareas 88.1 and 88.2. It noted that some reports of small *D. mawsoni* were likely to be *D. eleginoides*. The paper recommended that observers be made aware of this issue, and that the historical species identification be independently checked through examination of a subsample of otoliths collected from these small fish, noting that otoliths can be used to discriminate between toothfish species.

4.15 The Technical Group noted that scientific observers need to be able to distinguish between the two species when caught together, and that observer training should emphasise the importance of making this distinction. It was noted that guidance on distinguishing between the two species is provided in section 14 of the *Scientific Observers Manual* (Draft 2010).

4.16 TASO-10/10, presented by Dr S. Parker (New Zealand), reported on the accuracy of VME taxa classification by New Zealand scientific observers. The research showed that taxa classification was generally accurate, except for confusion between two sponge classes and stony and dead stylasterid coral. Misclassification of non-VME taxa as VME taxa was minor.

4.17 The Technical Group noted that VME taxa identification training increased the accuracy of identification in 2009/10 when compared to the identification success rates of New Zealand scientific observers in 2008/09. It was also noted that training should be region-specific due to regional difference in species composition.

4.18 In response to the information provided in TASO-10/10, the Technical Group agreed it was practical that:

- VME taxa by-catch be recorded for every observed line segment, including if by-catch was zero;
- the two classes of Porifera be combined as they cannot be reliably separated in the field;
- vessels record whether weight or volume was used to measure each VME indicator unit recorded.

The Technical Group also agreed that the name of the observer identifying the taxa on a line segment should be recorded to allow observer accuracy to be evaluated.

4.19 WG-FSA-10/33 submitted by New Zealand and presented by co-author Dr Welsford presented evidence for a new undescribed grenadier species (*Macrourus* spp.) found in the Southern Ocean using DNA barcoding as part of the IPY and the Bar Code of Life Database program. The conclusion was supported by meristic and morphological differentiation of the new species. *Macrourus* spp. had been identified as *M. whitsoni* in the past.

4.20 The Technical Group recommended that the *Scientific Observers Manual* should note areas where the distribution of *M. whitsoni* and the new undescribed species overlap, that a species code should be allocated, and the field characteristics such as difference in number of rows of teeth and body colour, be included in the species identification guide.

#### Request from WG-EMM

##### Manual for krill escape mortality observation

4.21 The Technical Group was requested by WG-EMM to review the manual for krill escape mortality observation by Russia and Ukraine (once developed) and comment on its practicality and implication for the workloads of scientific observers (Annex 6, paragraph 2.38). The manual was not received for consideration at the current meeting, so it was not possible for the Technical Group to comment on it. The Technical Group looked forward to receiving the manual for consideration in the future.

##### Time budget for krill observer coverage

4.22 WG-EMM requested that TASO consider the time budget for observers in the krill fishery and advise whether 20% haul coverage could be achieved by increasing the number of hauls observed per five-day period (Annex 6, paragraph 2.52).

4.23 TASO noted that there were different sampling regimes in place for fish by-catch and for krill biological sampling. The Technical Group agreed that from a workload point of view, in general, for conventional trawl, 20% haul coverage for biological sampling (fish and larval fish by-catch) should be feasible within the period when observers are on board. However, as the current number of days allocated for biological sampling for krill is restricted to five days within every 20-day period (as in the current instruction in the krill e-form), a maximum of 25% coverage in total would be achievable only if the observer sampled every haul during this period. Given that an observer has other tasks, it is unlikely that the observer can achieve a total of 20% by sampling only five days in every 20-day period.

4.24 The Technical Group further noted that vessels employing the continuous pumping method undertake 12 haul units per day since one haul unit is defined as a 2-hour period. Some trawlers using the continuous pumping method can tow two nets simultaneously, in which case 24 equivalent haul units occur per day. Achieving the same proportional level of coverage as the observers on conventional trawlers with a single observer may therefore be difficult. The Technical Group further noted that it is not possible to specify what level of haul coverage and data collection is achievable for the abovementioned continuous pumping trawl methods without further information about how the operational differences of each method variation is taken into account for percent coverage calculation.

4.25 The Technical Group requested WG-EMM to provide clearer descriptions of the data collection and coverage required for each of the observation items, for example, using the template as set out in WG-FSA-10/32, Table 3.

## Estimation of drip loss from krill catch

4.26 Following a request from WG-EMM, a method to record the ‘drip loss’ of krill was presented by Mr Moir Clark. This allows for the accurate determination of the green weight of krill as it accounts for any excess water in the catch. Krill vessels are required to state in their notifications the method that they use to directly estimate the green weight of krill caught, however, at the moment it is unclear how the water content is reflected in the green weight estimate. It was requested that observers record if drip loss is taken into account when green weight estimates are made and, where possible, to measure it.

4.27 The Technical Group agreed that a section for recording drip loss should be added to the observer logbook and these data should be collected on a regular basis during the trip where possible.

## Use of underwater camera for observation

4.28 The Technical Group was tasked by WG-EMM to comment on how readily the benthic impact camera system (BICS) might be deployed by CCAMLR scientific observers during commercial fishing operations (Annex 6, paragraph 3.26). The camera system was described by Dr Welsford and Ms O’Regan and they noted that it was relatively simple for vessel crews and observers to use. They further noted that it is provided along with an operations manual and a training DVD. Mr Exel also noted that Australian vessels had found the cameras straightforward to operate in Division 58.5.2 (Heard and McDonald Islands) when the vessel’s crew and observer work together. Mr Moir Clark noted that BICS had also been successfully deployed by an observer operating on an autoline vessel in Subarea 48.3.

4.29 The Technical Group noted that the Scientific Committee would need to consider if camera deployments would need to be a routine item for the CCAMLR observer program or a discrete research program undertaken by individual Members.

4.30 The Technical Group noted that so far BICS has been deployed on autoline and trawl gear in Division 58.5.2 and on autoline gear in Subarea 48.3, and its operation on other gear types, such as Spanish longlines, is untested. The Technical Group also noted the following potential issues in operating such a camera from commercial vessels operating in Olympic fisheries, and that these issues should be considered by CCAMLR:

- financial implications and liabilities for vessels deploying cameras;
- risks to the camera in deploying such a system in some high-seas fishery operations, such as where sea-ice is present;
- data storage, management and ownership;
- managing camera deployments alongside other observer tasks.

4.31 Dr Welsford noted that while the administration of routine camera deployments had not yet been resolved, any issues should not be insurmountable where there is a will to collect the data that SC-CAMLR requires to ensure its fisheries satisfy Article II of the Convention.



4.32 The Technical Group noted that future developments in electronic monitoring of fishery operations, and for research activities, was likely to make the use of such technologies more accessible. It was also noted that electronic technologies are being used in other fisheries for monitoring by-catch and wildlife interactions. The Technical Group requested that the Scientific Committee consider the evaluation, administration and application of such technologies as they are developed.

## FORMAT OF FUTURE MEETINGS AND PRIORITIES FOR FUTURE WORK

5.1 The Technical Group agreed that its future work plan would be likely to continue to focus on evaluating the performance of the observer accreditation process it has developed this year, as well as items referred to it by the Scientific Committee and its working groups and SCIC under its terms of reference (SC-CAMLR-XXVII, paragraph 6.7).

5.2 The Technical Group noted that meeting for a full week had greatly assisted with addressing the issues on its agenda this year in greater depth, as well as facilitating the attendance of industry representatives and other experts that may not have been able to attend a shorter meeting. The Technical Group agreed, however, that as it was an ad hoc group and the Scientific Committee and its working groups had many other substantive issues to address, it may not be possible or appropriate to have a week-long meeting of TASO every year.

5.3 It also noted that meeting in parallel with other groups, such as WG-FSA in 2010, and between WG-SAM and WG-EMM in previous years, had enabled involvement by delegates from those meetings. It also recognised that some participants in the working groups may not have been able to participate in TASO discussions due to the workloads in those other groups.

5.4 The Technical Group also recalled that its meetings greatly facilitated the interaction of technical coordinators, observers, vessel operators, scientists and other experts, and that hosting of future meetings by a Member could make a significant contribution to the development of CCAMLR international scientific observer programs in that region.

5.5 Therefore, the Technical Group requested that the Scientific Committee consider an appropriate timing and location for its future meetings, taking into account the benefits of having meetings of sufficient length to hold substantive discussions and enable the appropriate experts to participate.

## OTHER BUSINESS

6.1 There was no other business.

## CLOSE OF MEETING

7.1 The report of the third meeting of ad hoc TASO was adopted.

7.2 In closing the meeting, the Co-conveners thanked the Secretariat staff for their work and support during the meeting and also for their work in supporting the observer program during the year.

7.3 The Co-conveners also thanked the technical coordinators and asked them to convey their appreciation to the observers for all their hard work during the year.

7.4 The Co-conveners also thanked the participants for their diligent work during the meeting.

7.5 On behalf of the participants, Dr Kawaguchi thanked the Co-conveners for their hard work. He noted that it was the first time that TASO had held a week-long meeting and the work and depth of the discussions had been very productive.

Table 1: CCAMLR international scientific observer program components and assessment criteria matrix for baseline standards consisting of (1) Management components and (2) Training. In the proposed process for observer program accreditation, a Member would submit evidence against which each criteria can be assessed.

| Observer program components       | Assessment criteria   | Desirable / mandatory | Exceeds minimum standard   | Meets minimum standard  | Below minimum standard   |
|-----------------------------------|---|-----------------------|--|---|--|
| <b>(1) Management components</b>  |   |                       |  |   |  |
| <b>Institutional arrangements</b> | Association and conflict of interest of the observer organisation with industry | M                     | Not applicable   | Program has no financial interest in, or relationship with, any vessel or business harvesting or processing products from a CCAMLR fishery other than the provision of the observer service.          | Program has direct/indirect financial interest in a company within or outside the CCAMLR fishery.  |
|                                   | Observer program national endorsement   | M                     | Not applicable   | Program has endorsement from a Member.  | Program does not have endorsement from a Member.   |
|                                   | Training  | M                     | Not applicable   | Training program meets all mandatory training assessment criteria as laid out in section (2) Training.  | Training program does not meet all mandatory training assessment criteria as laid out in section (2) Training.   |
|                                   | Infrastructure and record keeping   | M                     | Program provides dedicated infrastructure to support observer deployment, logistics, record keeping and data management. | Program provides infrastructure supporting observer deployment, logistics, record keeping and data management.  | Program does not provide sufficient infrastructure to support observer deployment, logistics, record keeping and data management.  |
|                                   | Information security  | M                     | Not applicable   | Protocols in place that conform to terms of the CCAMLR Scheme of International Scientific Observation, paragraphs D(d)(i–ii).<br>Authorised access control to premises, data and information systems. | Insufficient protocols in terms of the CCAMLR Scheme of International Scientific Observation, paragraphs D(d)(i–ii).<br>Insufficient access control to premises, data and information systems. |
| <b>Recruitment checks</b>         | Observer Code of Conduct  | M                     | Not applicable   | Program has process in place to ensure that applicants conform to the CCAMLR Scheme of International Scientific Observation, as specified in paragraph D(a)(iv).                                      | Program has no process in place to ensure that applicants conform to the CCAMLR Scheme of International Scientific Observation, paragraph D(a)(iv).  |
|                                   | Physical and mental health  | M                     | Not applicable   | Program has adequate physical and psychological health assessment requirements in place.  | Program does not have physical and psychological health assessment requirements in place.  |

| Observer program components | Assessment criteria                                   | Desirable / mandatory | Exceeds minimum standard  | Meets minimum standard   | Below minimum standard  |
|-----------------------------|---|-----------------------|---|--|---|
| <b>Briefing</b>             | Provision of gear and equipment                       | M                     | Program provides appropriate personal and safety gear for working in cold conditions unless predetermined that it is provided by the vessel. Sampling equipment provided that will facilitate optimum performance of tasks expected from observers. | Program provides appropriate personal and safety gear for working in cold conditions unless predetermined that these are provided by the vessel. Sufficient sampling equipment for observers to carry out their tasks. | Program does not provide adequate personal and safety gear for working in cold conditions. Gear provided is not sufficient for adequate sampling. |
|                             | Support literature and detailed sampling instructions | M                     | Program ensures observers are supplied with relevant up-to-date CCAMLR manuals and data reporting forms. Additional supporting literature is also provided.   | Program ensures observers are supplied with relevant up-to-date CCAMLR manuals and data reporting forms.   | Program does not supply relevant CCAMLR manuals and data reporting forms.   |
| <b>At-sea support</b>       | Monitoring observer performance                       | D                     | Program has processes in place to monitor observer performance (tasks and data collected) and provide rapid feedback.   | Not applicable   | Not applicable  |
|                             | Communications  | M                     | Program has established communication protocols for observers at sea; in addition, observers are provided with independent means of communication.  | Program has established communication protocols for observers at sea to communicate with their controlling authorities.  | Program has no established communication protocols for observers at sea.  |
| <b>Debriefing</b>           | Data submission and reporting                         | M                     | Not applicable  | Program has protocols to ensure timely submission of CCAMLR data and reports to the Designating Member.  | Program does not have protocols to ensure submission of CCAMLR data and reports to the Designating Member.  |
|                             | Observer feedback on vessel                           | D                     | Program has protocols for internal observer reports on vessel performance and working conditions with respect to at-sea operations.   | Not applicable   | Not applicable  |

| Observer program components     | Assessment criteria  | Desirable / mandatory | Exceeds minimum standard  | Meets minimum standard  | Below minimum standard  |
|---------------------------------|--|-----------------------|---|---|---|
| <b>Quality assurance</b>        | Data quality assurance   | M                     | Program ensures comprehensive range and logic checks are performed on data prior to submission.   | Program ensures basic range and logic checks are performed on data prior to submission.   | Program does not perform checking of data.  |
|                                 | Observer performance feedback                                  | D                     | Program has protocols in place to provide observers with feedback on performance for future skill development.  | Not applicable  | Not applicable  |
|                                 | Vessel operator feedback                                       | D                     | Program has protocols for vessel operator feedback on observer performance with respect to at-sea operations.   | Not applicable  | Not applicable  |
| <b>(2) Training</b>             |  |                       |   |   |   |
| <b>CCAMLR Convention</b>        | Membership, inception, structure, management                   | D                     | Observers are trained about CCAMLR, including the structure, history, ecosystem monitoring, Article II, processes, and how CCAMLR fits into the Antarctic Treaty System.  | Not applicable  | Not applicable  |
| <b>Role of CCAMLR observers</b> | Duties and responsibilities of observers and the vessel's crew | M                     | Detailed briefings on key crew and observer roles (distinction / demarcation / shared components) provided.<br>Knowledge of the importance of observers for CCAMLR and how their data are used by the working groups. | CCAMLR observer-specific responsibilities are explained to the observers, but no detailing of shared activities / research activities of the crew / vessel. | Lack of training in observer duties and responsibilities.                               |
|                                 | Conservation measures  | M                     | Not applicable  | Trained in CMs for the fishery they will be working in and provided with reference material to help use them.   | Provided copies of relevant CMs with no instruction or training on their applicability. |

| Observer program components          | Assessment criteria  | Desirable / mandatory | Exceeds minimum standard   | Meets minimum standard   | Below minimum standard   |
|--------------------------------------|--|-----------------------|--|--|--|
| <b>Role of scientific observers</b>  | Code of Conduct of observers as contained in the text of the scheme  | M                     | Not applicable   | Provides full briefing on the requirements of the observer Code of Conduct.  | Provided copies of observer Code of Conduct with no instruction or training.   |
|                                      | Conflict avoidance and resolution  | D                     | Training in conflict resolution and how working in a stressful environment impacts people. Observers briefed on the culture(s) on board the vessel they are to be deployed on.                             | Not applicable   | Not applicable   |
|                                      | Functions, tasks and scientific priorities to be carried out on board vessels operating in the Convention Area | M                     |  | Training provided in relation to the fishery the observer is to be deployed in. This covers all requirements of the associated fishery CMs and scientific programs, including the most recent priorities / aspects from the last Scientific Committee meeting. | Provided with copies of CMs with no interpretation or training on CMs, functions, tasks and scientific priorities to be carried out on board vessels operating in the Convention Area. |
| <b>Vessel and fishing operations</b> | Fishing methods  | M                     | Training in all aspects of CCAMLR fishing methods and practical training provided in gear configuration and deployment.  | Sufficient training in specific aspects of CCAMLR fishing methods and gear with reference material provided for the fishery the observer is to be deployed in.   | Instruction in gear terminology insufficient to understand key fishing methods.  |
|                                      | Location determination   | M                     | Observers given good working knowledge of bridge electronics to allow them to independently determine vessels location (position, depth, course) and other fishing reference information. Carries own GPS. | Sufficient training given to allow observers to interpret GPS and other navigational instruments to determine and confirm position.  | Insufficient training given in navigation skills to allow observers to reliably determine vessel location.   |
|                                      | Identification of various types of fishing gear, their component parts and how to measure these                | M                     | Sufficient training to understand all fishing gears used in the Convention Area, whether they meet the requirements under the CMs and why it is important that they do so.                                 | Training provided on the specific gear to be used by the vessel on which the observers will be deployed to ensure effective application of relevant CMs.   | Insufficient training provided on the specific gear to be used by the vessel on which observers will be deployed to ensure effective application of relevant CMs.                      |

| Observer program components          | Assessment criteria   | Desirable / mandatory | Exceeds minimum standard  | Meets minimum standard   | Below minimum standard   |
|--------------------------------------|---|-----------------------|---|--|--|
| <b>Vessel and fishing operations</b> | Construction and use of gear used for mitigation of by-catch to CCAMLR specifications | M                     | Training given on the requirements for mitigation of by-catch and how these are applied with respect to the CMs. Background given as to why these are necessary and the history of their development in the Convention Area.                                  | Training given on the requirements for mitigation of by-catch and how these are applied with respect to the CMs.                           | Insufficient training provided to report on whether mitigation measures meet the minimum requirements according to the CMs |
|                                      | Health and safety at sea  | M                     | Observers instructed in the working conditions on fishing vessels operating in the Convention Area and potential health and safety issues. Observers participate in formal training courses (e.g. first aid, safe working practices in the seafood industry). | Observers instructed in the working conditions on fishing vessels operating in the Convention Area and potential health and safety issues. | Insufficient training provided to prepare observers for working safely on vessels in the Convention Area.                  |
|                                      | Waste disposal  | M                     | Instruction in MARPOL regulations and appropriate CMs, noting environmental effects of discarded waste.   | Instruction in appropriate CMs.  | Told to collect information on waste disposal with no supporting references / instructions provided.                       |
| <b>Species identification</b>        | Identify target and main by-catch species within the Convention Area                  | M                     | Training provided to enable species identification to the level required by CCAMLR. Training provided in use of identification keys and morphometric analyses.  | Training provided to enable species identification to the level required by CCAMLR.  | Insufficient training to identify species or use charts / keys.  |
|                                      | Marine mammal and seabird identification and behaviour                                | M                     | Training provided to enable species identification to the level required by CCAMLR. Training provided in use of identification keys morphometric analyses.  | Training provided to enable species identification to the level required by CCAMLR.  | Insufficient training to identify species or use charts / keys.  |

| Observer program components | Assessment criteria  | Desirable / mandatory | Exceeds minimum standard   | Meets minimum standard   | Below minimum standard  |
|-----------------------------|--|-----------------------|--|--|---|
| Sampling techniques         | Sampling and types of measurement                                | M                     | Training in the CCAMLR requirements as set out in the <i>Scientific Observers Manual</i> and updated annually. Training in statistical techniques and sampling theory, including their utility for CCAMLR.     | Training in the CCAMLR requirements as set out in the <i>Scientific Observers Manual</i> and updated annually. | Insufficient training to effectively sample and measure.  |
|                             | Obtaining and preserving samples                                 | M                     | Practical and theoretical training to collect samples and preserve them as required by CCAMLR. Ability to reconcile samples with location data. Background given into why samples are collected.               | Practical and theoretical training to collect samples and preserve them as required by CCAMLR.                 | Insufficient training to collect samples and preserve them.                                     |
|                             | Determination of conversion factors from product to green weight | M                     | Training provided to enable accurate measurement of green and processed weights of products. Background given as to the use of conversion factors for quota management and stock assessment.                   | Training provided to enable accurate measurement of green and processed weights of products.                   | Insufficient training to identify processing types and product states.                          |
|                             | Sexing of species / Use of sexual maturity scales                | M                     | Provide practical training in sexing and maturity stages of species. Provision of guides clearly outlining scientific requirements and instruction on how to use them. Explanation why the data are collected. | Provision of reference guides and instructions to sex and stage species.                                       | Observers instructed to sex and stage species but no formal training provided.                  |
|                             | Tagging and tag retrieval  | M                     | Observers instructed they must tag fish, record recaptures and photograph recaptured tags. Observers informed why they are tagging and how it is used in stock assessments.                                    | Observers instructed they must tag fish, record recaptures and photograph recaptured tags.                     | Observers told they must tag fish and record recaptures with no instruction as to how to do it. |



| Observer program components | Assessment criteria                             | Desirable / mandatory | Exceeds minimum standard   | Meets minimum standard   | Below minimum standard   |
|-----------------------------|---|-----------------------|--|--|--|
| Sampling techniques         | Observations of seabirds and marine mammals     | M                     | Observers given practical training in identification of marine mammals and seabirds, dead or alive. Background information on mitigation measures and how CCAMLR's CMs have reduced mortalities. | Observers given training and guides in identification of marine mammals and seabirds, dead or alive.             | Observers told to collect information on seabirds and marine mammals with no training. |
|                             | Determining species composition                 | M                     | Observers instructed to sample catch for species composition, details given on how to do it and how the information is used by CCAMLR.   | Observers instructed to sample catch for species composition, details given on how to do it.                     | Observers told to sample catch for species composition with no training.               |
|                             | Monitoring discards                             | M                     | Observers instructed to monitor discards, details given on how to do it and how the information is used by CCAMLR.   | Observers instructed to monitor discards, details given on how to do it.   | Observers told to monitor discards with no training.                                   |
|                             | Monitoring effort                               | M                     | Observers instructed to monitor effort, details given on how to do it, what a standard unit of effort is and how the information is used by CCAMLR.  | Observers instructed to monitor effort, details given on how to record this.                                     | Observers told to monitor effort with no training.                                     |
|                             | Gathering meteorological and oceanographic data | D                     | Being aware of meteorological and oceanographic instruments on board fishing vessels, how to read them and why the information is collected.   | Not applicable   | Not applicable   |
|                             | Collecting data on vessel sightings             | M                     | Observers told to collect information on vessels sighted and instructed what information to collect if possible. Instruction in recording specific vessel features.                              | Observers told to collect information on vessels sighted and instructed what information to collect if possible. | Observers told to collect information on vessels sighted, no instruction provided.     |

| Observer program components | Assessment criteria  | Desirable / mandatory | Exceeds minimum standard   | Meets minimum standard   | Below minimum standard   |
|-----------------------------|--|-----------------------|--|--|--|
| <b>Data handling</b>        | Completion of cruise reports   | M                     | Observers shown how to complete cruise report and encouraged to provide relevant supplementary information. Instructed on how the information in the reports is used.            | Observers shown how to complete cruise report.   | Observers given cruise reports without any training on how to complete them.   |
|                             | Utilisation of CCAMLR data forms and importance of adhering to CCAMLR format | M                     | Observers given practical experience of entering data into electronic CCAMLR data forms. Training given in spreadsheet / database usage, including security and backing up data. | Observers given practical experience of entering data into electronic CCAMLR data forms. | Observers told to enter data into spreadsheet / database without any training. |

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(Hobart, Australia, 11 to 15 October 2010)

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**AGENDA**

Ad Hoc Technical Group for At-Sea Operations  
(Hobart, Australia, 11 to 15 October 2010)

1. Introduction
  - (i) Opening of the meeting
  - (ii) Terms of reference, conduct of the meeting and adoption of the agenda
  - (iii) Review of materials submitted by Members
  - (iv) Appointment of rapporteurs and overview of the process for developing and adopting the report
2. Development of a process for accrediting observer programs participating in the CCAMLR Scheme of International Scientific Observation
  - (i) Development for an accreditation process and timeline
  - (ii) Establishment of baseline standards for observer recruitment, training and performance management
  - (iii) Preparation of a checklist to accredit observer programs
3. Interaction with other working groups
4. Practical implementation of data collection at sea
5. Format of future meetings and priorities for future work
6. Other business
7. Close of meeting.

**LIST OF DOCUMENTS**

Ad Hoc Technical Group for At-Sea Operations  
(Hobart, Australia, 11 to 15 October 2010)

|            |   |
|------------|---|
| TASO-10/1  | Draft Agenda for the 2010 Meeting of the ad hoc Technical Group for At-Sea Operations   |
| TASO-10/2  | List of Participants  |
| TASO-10/3  | List of Documents   |
| TASO-10/4  | Gonad stages identification plate: proposal for collaborative work<br>N. Gasco (France)   |
| TASO-10/5  | Information from Members on observer training programs<br>Secretariat   |
| TASO-10/6  | Observer training: recording oiled birds<br>J. Moir Clark (UK)  |
| TASO-10/7  | CCAMLR observer program training video<br>J. Moir Clark and R. Benedet (UK)   |
| TASO-10/8  | Scientific Observer Program (SOP) in Chile<br>O. Guzman (Chile)   |
| TASO-10/9  | The Chinese observer training program for the krill fishery in the<br>Convention Area<br>X. Zhao and L. Xu (People's Republic of China)   |
| TASO-10/10 | Evaluation of VME taxa classification by scientific observers<br>from New Zealand vessels in the Ross Sea Antarctic toothfish<br>longline fishery during the 2009/10 season<br>D.M. Tracey, M.E. Carter and S.J. Parker (New Zealand) |





**REPORT OF THE WORKING GROUP  
ON FISH STOCK ASSESSMENT**  
(Hobart, Australia, 11 to 22 October 2010)



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<sup>1</sup> Appendices E to T are published only in electronic format ([www.ccamlr.org/pu/e/e\\_pubs/fr/drt.htm](http://www.ccamlr.org/pu/e/e_pubs/fr/drt.htm)).

APPENDIX S: Fishery Report: *Champscephalus gunnari*  
South Georgia (Subarea 48.3)

APPENDIX T: Fishery Report: *Champscephalus gunnari*  
Heard Island (Division 58.5.2)





**REPORT OF THE WORKING GROUP  
ON FISH STOCK ASSESSMENT**  
(Hobart, Australia, 11 to 22 October 2010)

## OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 11 to 22 October 2010. The Convener, Dr C. Jones (USA), opened the meeting and welcomed participants (Appendix A). Mr A. Wright (Executive Secretary) extended his welcome and wished the meeting success in its current round of deliberations.

## ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The agenda of the meeting was discussed and adopted without change (Appendix B). It was agreed to focus discussions on bottom fishing activities and VMEs (subitem 9.1) during the first week of the meeting.

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 Paragraphs dealing with advice to the Scientific Committee and its working groups have been highlighted. A list of these paragraphs is provided in Item 13.

2.4 The report was prepared by the Working Group participants.

2.5 Selected components of WG-FSA's work were developed intersessionally and during the meeting by the following subgroups:

- Subgroup on Assessments (coordinator: Mr A. Dunn, New Zealand);
- Subgroup on New and Exploratory Fisheries (coordinator: Dr S. Hanchet, New Zealand);
- Subgroup on By-catch (coordinators: Mr J. Fenaughty, New Zealand, and Dr R. Mitchell, UK);
- Subgroup on Biology and Ecology (coordinators: Drs M. Belchier, UK and L. Pshenichnov, Ukraine);
- Subgroup on Tagging (coordinator: Dr D. Agnew, UK and Scientific Committee Chair);
- Subgroup on the Scientific Observer Program (coordinators: Dr R. Leslie, South Africa and Mr J. Roberts, UK);
- Subgroup on VMEs and Ecosystem Management (coordinators: Drs A. Constable Australia and B. Sharp, New Zealand).

2.6 The information used in developing the assessments is provided in the Fishery Reports (Appendices F to T). These reports will be published on the CCAMLR website ([www.ccamlr.org](http://www.ccamlr.org) – go to 'Publications', see 'Fishery Reports').

## REVIEW OF AVAILABLE INFORMATION

### Data requirements specified in 2009

3.1 Since WG-FSA-09 the Secretariat has further developed procedures, databases and data forms at the request of the Commission and the Scientific Committee and its working groups, including:

- (i) development of data forms and associated guidelines, including a new form for daily catch and effort reporting in exploratory fisheries (except krill), revision of the 'CCAMLR VME Taxa Classification Guide' and associated guidelines, species list and VME sections in the catch and effort reporting forms and the fine-scale data forms, and consequential updates to database tables and entry forms (WG-FSA-10/4 Rev. 1);
- (ii) processing of fishery and observer data from 2009/10, including data from the fisheries at Prince Edward and Marion Islands (South African EEZ in Subareas 58.6 and 58.7 and Area 51), Kerguelen Islands (French EEZ in Division 58.5.1) and Crozet Islands (French EEZ in Subarea 58.6) – these data have undergone limited and preliminary validation prior to the meeting, and further validation will be conducted in the forthcoming intersessional period;
- (iii) allocation of starting positions of research hauls in the exploratory fisheries in Subareas 48.6 and 58.4 (WG-SAM-10/4; see also Item 5.1);
- (iv) updating of fishery and observer information reported in the Fishery Reports (see Item 5);
- (v) developing a proposal to commission an independent review of the Secretariat's data management systems (CCAMLR-XXIX/13; see Item 12).

3.2 The Working Group acknowledged the important role of fishing crews, scientific observers and Members in collecting and processing CCAMLR data, and the Secretariat's work in managing these data (see also Item 12).

### Fisheries information

#### Catch and effort in 2009/10

3.3 The 2009/10 fishing season started on 1 December 2009 and will end on 30 November 2010, and fishing was still in progress in some areas. Members' fishing vessels operated in the fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*Dissostichus eleginoides* and/or *D. mawsoni*), krill (*Euphausia superba*) and crab (*Paralomis* spp.), and catches reported to 24 September 2010 are summarised in Table 1 (see also SC-CAMLR-XXIX/BG/1).

3.4 In 2009/10, the Secretariat monitored 153 catch limits for species groups (target and by-catch species) in SSRUs, SSRU groups, management areas, divisions and subareas (CCAMLR-XXIX/BG/10 Rev. 1). This included forecasting fishery closures once the catch

of a managed species exceeded 50% of its catch limit. As of 24 September 2010, 12 fishing areas and four fisheries had been closed by the Secretariat (CCAMLR-XXIX/BG/10 Rev. 1, Table 2), and all of these closures were triggered by catches of *Dissostichus* spp. approaching their respective catch limits.

3.5 Catch limit overruns (i.e. the catch exceeded the catch limit) occurred for *D. eleginoides* in Subarea 48.3 (Management Area B: overrun 3 tonnes, total catch 100.3% of the limit) and *Dissostichus* spp. in Division 58.4.1 (SSRU E: overrun 1 tonne, total catch 103% of the limit), Division 58.4.2 (SSRU A: overrun 23 tonnes, total catch 177% of the limit; whole fishery: overrun 23 tonnes, total catch 133% of the limit), and Subarea 88.1 (SSRUs H, I and K: overrun 38 tonnes; total catch 102% of the limit; whole fishery: overrun 20 tonnes, total catch 101% of the limit).

3.6 Scientific observers appointed under the CCAMLR Scheme of International Scientific Observation were deployed on all vessels targeting finfish in the Convention Area, and some vessels targeting krill, in 2009/10 (WG-FSA-10/5 Rev. 2 and 10/8; see also Items 5 and 10).

3.7 The incidental mortality of seabirds observed in fisheries in the Convention Area in 2009/10 is summarised in Tables 2 and 3.

3.8 There was no incidental mortality of marine mammals or entanglements observed in fisheries in the Convention Area in 2009/10 (WG-FSA-10/5 Rev. 2, Tables 9 and 14).

3.9 WG-FSA-10/P1 was referred to next year's meeting of WG-IMAF where it can be considered in full.

#### Estimates of catch and effort from IUU fishing

3.10 Estimates of IUU catches in the Convention Area were prepared by the Secretariat based on information submitted by 30 September 2010 (Table 4; see also WG-FSA-10/6 Rev. 1). The agreed deterministic method used to estimate IUU fishing effort was based on reports submitted by Members of sightings by surveillance operations and legal fishing vessels, and catch rates of licensed vessels. The IUU catch was allocated between *D. eleginoides* and *D. mawsoni* based on the known location of sightings of IUU activities and the proportion of each species reported in the CCAMLR database for the subareas and divisions where IUU fishing occurred (SC-CAMLR-XXVIII, Annex 5, paragraph 3.23).

3.11 The Working Group recommended that, to the extent possible (e.g. IUU fishing in Subarea 88.1 in 2007/08 which was known to have occurred in SSRU A), the allocation of IUU catch between *D. eleginoides* and *D. mawsoni* be based on the proportion of each species in the SSRUs where IUU fishing occurred.

3.12 The estimated catch history of *Dissostichus* spp. taken by IUU longlining and gillnetting activities in the Convention Area was updated using new information on estimated catch rates for gillnets (Tables 5 and 6).

3.13 The shift in IUU fishing activities, from high levels in Divisions 58.5.1 and 58.5.2 and Subareas 58.6 and 58.7 in the late 1990s and early 2000s, to Divisions 58.4.1, 58.4.2 and 58.4.3b in recent seasons was noted; IUU fishing activities appeared concentrated in Divisions 58.4.1 and 58.4.2 in 2009/10 (Table 5).

3.14 The Working Group reiterated its concern about IUU fishing and the use of gillnets in the Convention Area. The estimation of removals of toothfish and other species by gillnets is problematic and confounded by soak times and ghost fishing. Further information and approaches may be required to better document the extent of IUU fishing (see Item 7).

#### Catch and effort data for toothfish fisheries in waters adjacent to the Convention Area

3.15 Catches of *D. eleginoides* from fisheries outside the Convention Area, and reported in the CDS in 2008/09 and 2009/10, are summarised in Table 7. Most of the catch of *D. eleginoides* taken outside the Convention Area was from Areas 41 and 87.

#### Inputs for stock assessment

3.16 WG-FSA-10/12 reported on the *C. gunnari* survey in Division 58.5.2 (also referred herein as Heard and McDonald Islands) conducted during 2010. New parameters for a von Bertalanffy growth model were proposed, based on additional recent data relating age and length. This was further considered in Item 4, including whether growth rates could be changing with time.

3.17 WG-FSA-10/26 undertook a retrospective analysis of the fishing trips that would be selected for use in Subarea 88.1 and Subarea 88.2 SSRUs A and B (also referred herein as the Ross Sea) *D. mawsoni* assessment on the basis of data-quality metrics for individual trips (SC-CAMLR-XXVIII, Annex 5, paragraph 3.49). The paper examined if the same trips were selected when applying the method over successive years and concluded that application of the method resulted in a generally stable selection of trips over time. The final datasets are considered unlikely to be biased towards trips releasing tagged fish in areas most easily accessible to the fishery (and where tags might be more likely to be recovered).

3.18 WG-FSA-10/38 reported on an annual groundfish survey conducted in Subarea 48.3 in 2010. Survey design was similar to that employed for previous years, noting that sampling effort was allocated to five area and two depth strata based on respective strata CVs, but actual allocation also resulted to some degree from the logistical constraints of using a commercial survey platform. The mean biomass estimated for *C. gunnari* in 2010 increased relative to the 2009 survey estimate; a 3+ cohort remained dominant, but there was also an increase in the proportion of 1+ and 2+ age classes in the population. This increase in biomass was unexpected considering the low availability of krill to *C. gunnari* in the area in 2009 evidenced by dietary analysis. The survey also identified the first evidence since 2003/04 of toothfish recruitment at Shag Rocks, of fish 30–40 cm (putative age 2+ fish). The authors were uncertain why this cohort of fish was not evident during the 2009 survey.

3.19 WG-FSA-10/39 provided input information for the assessment of *D. eleginoides* in Subarea 48.4 North. Of particular note to the 2010 assessment, CASAL estimates a higher  $L_{\infty}$  (approximately 160 cm) than that currently assumed for the Subarea 48.3 population. This increased maximum size has flow-on effects to estimated productivity, however, yield estimates were quite similar to previous years.

3.20  $L_{\infty}$  in this instance is being estimated from length-frequency data, and should be validated using data from aged fish when practical. This would also address the question of whether multiple age classes might be contributing to the strong cohort recruited to the population in the early 1990s.

3.21 Catch distributions of *D. eleginoides* and *D. mawsoni* showed that *D. eleginoides* dominate catches in the northern part of Subarea 48.4 South and are likely to be part of a southern extension of the population present in Subarea 48.4 North. This split in the distributions was thought to coincide with a region of hydrographic change along the island chain. Given that two assessments are currently undertaken, one for each of the species, it would be desirable for the assessments to better account for the distributions of the species rather than adhere to the boundaries for the division as they are currently defined.

3.22 The Working Group recommended that an exploratory analysis on the extent to which separate assessments, based on the observed distributions of the species, would impact future advice to the Scientific Committee regarding the appropriateness of the location of the north-south boundary in Subarea 48.4.

3.23 WG-FSA-10/41 presented two estimation models for natural mortality ( $M$ ) from mark-recapture and age data in the Division 58.5.2 *D. eleginoides* fishery, using data from the main trawl ground and the methods described in WG-SAM-10/12. The Working Group agreed that simulations in WG-SAM-10/12 showed that the CCODE method was more robust than the BODE method, and concluded that the estimate of  $M = 0.155 \text{ y}^{-1}$  from the model for *D. eleginoides* in Division 58.5.2 was a credible estimate.

3.24 The Working Group agreed that the database framework to summarise bathymetric point data presented in WG-SAM-10/18 was useful for deriving bathymetric maps, depth data, and spatially explicit polygons of specified depth ranges in a GIS framework. The database and processing methods were demonstrated for the Ross Sea, but are broadly applicable to the entire Southern Ocean.

#### Deliberations on tagging

3.25 Stock assessments using mark-recapture data rely on good matching of tag recovery with release events. More than 90% of all recoveries can now be matched. Significant improvements to matching have been seen since the Secretariat started to manage the distribution of tags to vessels, as the Secretariat has developed its matching methods, and as interaction between data users, data providers and the Secretariat has improved.

3.26 The Working Group emphasised the importance of returning photos or physical tags to the Secretariat, and preferably both, to aid matching. Otoliths from tagged fish may also be returned to the Secretariat where they will be stored (see paragraph 8.24).

3.27 The Working Group noted that if otoliths from tagged fish could be photographed alongside the tag, this would allow for positive species identification.

3.28 Details of the tagging rates, cumulative tagging rates and tag overlap statistics for the new and exploratory fisheries for the 2009/10 season are discussed further in paragraphs 5.17 and 5.18.

3.29 All required tagging rates are currently expressed in terms of tags per tonne. Some vessels translate this into tags per number of fish, which generates very smooth cumulative tag-release plots and might generate better overlap between tag and catch length frequencies. The Working Group considered that for all current tagging programs, expressing the required rate in terms of tags per tonne should continue so as not to disturb current practices, but in future some fisheries might be better regulated in terms of tags per number of toothfish.

3.30 The Working Group reviewed the experiences with skate tagging in the second-year extension of the Year-of-the-Skate. Reports from observers indicate that application of the protocol in respect of CCAMLR-XXVII, paragraph 4.55: ‘all skates should be brought on board or alongside the hauler to be correctly identified, scanned for tags and for their condition to be assessed’ has been sporadic. The Working Group did not recommend a continuation of the Year-of-the-Skate, but noted that it is important to continue to scan all skates for tags. Consequently, the Working Group recommended some changes to the relevant CMs to take account of these recommendations (see paragraphs 6.26 to 6.28 for details):

CM 41-01, Annex C, paragraph 2(v). **All skates shall be brought on board or alongside the hauler to be correctly identified, scanned for tags and for their condition to be assessed. All toothfish shall be examined for the presence of tags.** Recaptured tagged fish (i.e. fish caught that have a previously inserted tag) shall not be re-released, even if at liberty for only a short period.

3.31 The Working Group recommended that the Secretariat translate existing signs and information about the tagging program into the languages commonly spoken by the crew on board vessels active in exploratory fisheries, in addition to the CCAMLR official languages.

3.32 In using tagging data in assessments, various tag-specific parameters must be determined, such as tag-induced growth retardation, immediate post-tag mortality and tag loss. The Working Group noted that these parameters had originally been determined early in the tagging programs. Since then, significant changes have occurred to the programs, including improvements in fish handling and the expertise of observers and crew, as well as the presence of many more tags and recapture years. The Working Group recommended periodic review of these parameters to establish whether they should be adjusted for more recent tagging events compared to early tagging events.

## PREPARATION FOR ASSESSMENTS AND ASSESSMENT TIMETABLE

### Report from WG-SAM

4.1 WG-SAM provided advice to WG-FSA on the following topics:

- (i) strategies for data-poor fisheries for *Dissostichus* spp. (Annex 4, paragraphs 3.6, 3.9 and 3.19 to 3.26);
- (ii) harvest control rules for *C. gunnari* (Annex 4, paragraphs 3.36 and 3.37);
- (iii) VME modelling and evaluation tools (Annex 4, paragraphs 4.6, 4.7, 4.9 and 4.11);
- (iv) VME impact assessment methods (Annex 4, paragraphs 4.14 to 4.16, 4.18 and 4.19).

4.2 The Working Group agreed to consider these issues under the respective agenda items. In particular, the Working Group took note of the need to review the data collected from research hauls in exploratory toothfish fisheries (see paragraph 5.27).

#### Review of preliminary stock assessments

4.3 The Working Group discussed preliminary assessment papers for *D. eleginoides* and *D. mawsoni* in Subarea 48.4, and *C. gunnari* in Subarea 48.3 and Division 58.5.2, in preparation for the assessments reported under Item 5.3.

##### *D. eleginoides* northern South Sandwich Islands (Subarea 48.4 North)

4.4 WG-FSA-10/39 reported an updated CASAL stock assessment for the northern area of the South Sandwich Islands stock of *D. eleginoides*. The catch limit of 41 tonnes had been obtained by mid-April with a total of 232 fish tagged, for an average of 5.8 fish tagged per tonne. There were 18 tag recaptures in the 2009/10 season, with a total of 72 tags recaptured over all seasons. Catch-at-length data indicated the vulnerable biomass was predominantly composed of one large cohort that recruited in or around 1992.

4.5 The Working Group recommended that the most recent year over which relative year-class strengths were estimated be changed to 2002 rather than 2010, because that was the most recent year for which information on relative recruitment was available to the model.

4.6 Options for assessing *D. eleginoides* around Saunders Island (at the northern end of Subarea 48.4 South) were discussed. The Working Group noted that, in future, it may be more appropriate to include it in the assessment of *D. eleginoides* in Subarea 48.4 North (paragraphs 3.19 to 3.22).

##### *Dissostichus* spp. southern South Sandwich Islands (Subarea 48.4 South)

4.7 WG-FSA-10/40 reported on a preliminary stock assessment for the southern area of the South Sandwich Islands based on CPUE depletion analyses, CPUE and area comparisons, and results from a tagging study. The Working Group noted that the results indicated localised stock depletions, and potentially a lower stock size of *Dissostichus* spp. in the southern area than previously assumed.

*C. gunnari* South Georgia (Subarea 48.3)

4.8 WG-FSA-10/37 reported on a length-based model as an alternative to the age-based model to estimate catch limits for *C. gunnari* in Subarea 48.3 (Annex 4, paragraphs 3.36 and 3.37). The assessment uses survey data on length densities and biomass density without the need to identify age-specific cohorts as required by the age-based model used in previous assessments.

4.9 The Working Group discussed whether using finer length bins might improve the match between length- and age-based assessments. It was agreed that changing the size of length bins might be considered in the future but would be unlikely to substantially change the model estimates.

4.10 The Working Group also agreed that boxplots of bootstrap samples of biomass estimates after a period of burn-in would be a useful method of summarising the uncertainty around these estimates.

4.11 The Working Group noted that the issue of bias in both age- and length-based assessments needs to be explored further and encouraged Members to undertake this work in the intersessional period.

*C. gunnari* Heard and McDonald Islands (Division 58.5.2)

4.12 WG-FSA-10/12 reported on a preliminary assessment of *C. gunnari* in the Heard and McDonald Islands, using both the current and a revised growth model. The density of fish in each age class was estimated using the CMIX procedure and the estimate of yield was obtained using the GYM. A new 2+ cohort was detected and the paper noted that it was expected that the 2010/11 fishery will focus on this cohort.

4.13 The Working Group discussed whether the parameter estimates from the revised growth model were tracking population change in response to the environment or were due to changes in the way the CMIX method identified cohorts. Showing the data used to calculate both the new and the current growth curves was recommended.

*D. eleginoides* Kerguelen Island (Division 58.5.1)

4.14 An outline of data available for the development of a formal stock assessment for the Kerguelen Plateau was considered. Data available include an estimate of biomass from a random stratified trawl survey in 2006, catch-at-length frequencies, CPUE time series from commercial fisheries, and tag-recapture data from 2006 to 2010.

4.15 Since 2006, 12 774 fish had been double-tagged (at a rate of one per tonne) by the fishery, and a total of 587 of these tagged fish have been recaptured. In addition, 102 tagged fish were recaptured that had been tagged in Division 58.5.2.



4.16 The Working Group encouraged the development of an integrated assessment model and recommended that a descriptive summary of the input data, the model stock and structural assumptions, and parameter values be submitted to WG-FSA.

4.17 The Working Group encouraged Members to collaborate on the development of a stock assessment for the area.

#### Assessments to be carried out and assessment timetable

4.18 Assessment approaches taken for the assessed fisheries were based on the preliminary assessment submissions, issues identified during the course of WG-FSA, as well as subgroup discussions. The Working Group agreed to undertake updated assessments for the following fisheries:

- (i) *Dissostichus* spp. in Subarea 48.4 (comprising *D. eleginoides* in Subarea 48.4 North and *Dissostichus* spp. in Subarea 48.4 South);
- (ii) *C. gunnari* in Subarea 48.3;
- (iii) *C. gunnari* in Division 58.5.2.

4.19 The Working Group agreed that the assessments for *D. eleginoides* in Subarea 48.4 North will use the CASAL framework, and for *C. gunnari* will use the short-term projection approach. Specific information on input data and assessment methodologies for each assessed fishery and the review of information for the *Dissostichus* spp. experimental fishery in Subarea 48.4 South are presented in Item 5.3.

4.20 The Working Group considered the preliminary assessments for the fisheries for *C. gunnari* in Subarea 48.3 (WG-FSA-10/37) and Division 58.5.2 (WG-FSA-10/12). It was agreed that these assessments would be reviewed during the meeting and the information used to develop the management advice for these fisheries.

4.21 The Working Group reviewed the fisheries for *Dissostichus* spp. in Subareas 48.3, 88.1 and 88.2 and Division 58.5.2, and agreed, under the current arrangement for multi-year management, that no new assessments for these fisheries were necessary this year.

4.22 The Working Group did not update assessments for *D. eleginoides* fisheries in Division 58.5.1, Subarea 58.6 (Crozet) and Subareas 58.6/58.7 (Prince Edward Island).

4.23 All assessment work was undertaken by primary authors of preliminary assessments, and reviewed independently. Tasks of independent reviewers are listed in WG-FSA-06/6, paragraph 6.3. The outcomes of the assessments were reported in the Fishery Reports (Appendices F to T).

## ASSESSMENTS AND ASSESSMENT ADVICE

### Development of a research framework for data-poor fisheries

5.1 The term ‘data-poor fisheries’ was considered by the Working Group as referring to a fishery for which a robust stock assessment that provides advice on catch limits according to CCAMLR decision rules has not been developed due to lack of information.

5.2 The Working Group recalled general principles and requirements for CCAMLR sponsored research (SC-CAMLR-XXVII, paragraphs 8.9 and 8.10), the characteristics of a well-designed research program (SC-CAMLR-XXVIII, Annex 6, paragraphs 2.34 to 2.40), and the recommendations of WG-SAM-10 for WG-FSA in assessing any research fishery design and the data requirements for a stock assessment (Annex 4, paragraphs 3.20 and 3.23).

5.3 The Working Group agreed that its objective for data-poor fisheries is to develop management advice on catch levels consistent with Article II of the CAMLR Convention. At present, robust assessments of stock status of toothfish are lacking in many areas (e.g. Subareas 48.6 and 58.4).

5.4 The Working Group identified that the system of SSRUs (open and closed areas) may need to be revised in order to improve the capacity for estimating stock status of *D. mawsoni*. This is further considered in developing research plans below when trying to identify areas of greatest importance to address specific research questions.

5.5 The Working Group recalled issues with the development of a tag-recapture-based assessment, including:

- (i) high levels of post-tagging mortality of tagged fish (e.g. the effect of depredation, or the health and condition of released fish);
- (ii) insufficient overlap in the length frequency of the tagged fish and the landed catch (i.e. the tag overlap statistic);
- (iii) insufficient overlap in the location of fish tagged and released and the location of the majority of the commercial catch;
- (iv) poor scanning (tag detection) rates;
- (v) the effect of IUU fishing on tag-based abundance estimation.

5.6 The Working Group recalled issues with the use of CPUE indices, including that:

- (i) a single point index or short time series of CPUE cannot be used to estimate abundance;
- (ii) a longer time series may reflect changes in fisher behaviour or experience rather than changes in abundance;
- (iii) CPUE can be highly variable in areas of low abundance;

- (iv) there has been insufficient overlap of vessels and types of gear (e.g. autoline, Spanish longline, or trotline), both spatially and temporally to enable standardisation of CPUE;
- (v) the performance of some types of gear (e.g. trotline) was not well understood.

5.7 The Working Group recalled that the characteristics of successful assessments included the use of well-designed experiments to develop an integrated tag-based assessment of *Dissostichus* spp. in Subarea 48.4 (SC-CAMLR-XXVIII, paragraph 4.87), and the use of a multi-national multi-year tag-based assessment for Subareas 88.1 and 88.2. In recalling these successful experiments, the Working Group agreed that concentrating tagging effort spatially was a key factor that led to the success of the tag-based assessment. Further, the Working Group noted that successful assessments in Subarea 48.3 and Division 58.5.2 have also included data collected from trawl surveys.

5.8 The Working Group noted the previous successful work to standardise survey requirements amongst CCAMLR Members, including developing standard methods for demersal fish trawl surveys (SC-CAMLR-XI, paragraph 3.20) and for acoustic surveys (SC-CAMLR-XVII, paragraphs 5.4 to 5.14).

5.9 The Working Group noted that both the ability of vessels to meet an appropriate research standard and the calibration between vessels' data would need to be considered in developing a research plan. For example, in a tagging program, the calibration would need to consider:

- (i) survivorship of fish as a result of the fishing method being used
- (ii) evaluation of the likelihood of released tagged fish being available for recapture.

5.10 The Working Group agreed that the development of a generalised work plan would assist Members in developing proposals, individually or in a multinational program, that would satisfy the CCAMLR-sponsored research principles above.

5.11 The Working Group agreed that the generalised work plan for implementing research in data-poor fisheries would be:

1. Define the objective and appropriate field and analytical methods. For example, sampling platforms may be longline or trawl and these may be fishery dependent or independent.
2. Review which areas are best candidates for spatially constrained research activity and evaluate how large the research areas need to be.
3. Review the best candidate designs for the spatial and temporal coverage of the research activity, including for example, areas of habitat and movement of *Dissostichus* spp.
4. Use the available data and information to evaluate nominated vessels and gear types for their appropriateness for use in these research activities, including for example, vessel and gear performance in producing tag-release and recapture data.

5. Develop standard research protocols and methods for calibrating vessels and observers that would participate in the research activities. For example, the requirements could include the number of tags to be released in nominated locations, and a suitable spatial plan for distributing effort.
6. An evaluation of the amount of catch necessary for the research, and its consequences for the stock.
7. Where the research is for more than one year, undertake an annual review of the research, including a review of the performance of the research program, preliminary analyses to evaluate how well the research will meet the research objectives, and determine if adjustments are required or whether the program should cease.

5.12 The Working Group recommended that some specific elements of the work plan be considered as a high-priority focus topic for WG-SAM in the coming intersessional period according to following terms of reference:

WG-SAM focus topic: work plan for implementing research proposals for data-poor fisheries. To consider:

- (i) methods for evaluating the capability of vessels and gear types to contribute to research outcomes and for calibrating vessels and gears, including specific case studies relevant to current exploratory fisheries such as in tag-recapture programs;
- (ii) proposed research designs and data collection protocols for estimating stock status in data-poor fisheries;
- (iii) methods for assessing stock status in data-poor fisheries.

#### New and exploratory fisheries

5.13 Seven exploratory longline fisheries for *Dissostichus* spp. were agreed for the 2009/10 season (CMs 41-04 to 41-07 and 41-09 to 41-11), an exploratory trawl fishery for *E. superba* in Subarea 48.6 (CM 51-05), and exploratory fisheries for crab in Subareas 48.2 and 48.4 (CMs 52-02 and 52-03 respectively). Activities in these fisheries are summarised in Table 1.

5.14 Nine Members notified 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 the 2010/11 season (Table 8). Another Member (France) withdrew its notifications in Subareas 88.1 and 88.2 prior to the meeting.

5.15 The Working Group did not attempt to determine whether the notifications for exploratory fisheries satisfied the requirements of the notification procedure (CM 21-02); this, it believed, should be done by SCIC. It did, however, note that many of the notifications provided very little information on the research to be undertaken as part of the exploratory fishery.

5.16 Unstandardised CPUE data for *Dissostichus* spp. caught in exploratory longline fisheries between 1996/97 and 2009/10 are summarised in Table 9.

5.17 Under CM 41-01, each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. in 2009/10 was required to tag and release *Dissostichus* spp. at a specified rate per tonne (Table 10). All vessels achieved the required tagging rate. Consideration of the cumulative tag-releases prepared by the Secretariat showed that in exploratory fisheries all vessels released tags continuously, at or above the required rates, throughout their fishing trips.

5.18 Length-frequency overlap statistics calculated using the approach outlined in SC-CAMLR-XXVIII, Annex 5, paragraph 5.13, showed that in all subareas/divisions except Divisions 58.4.1 and 58.4.3b, at least one vessel had achieved a high ( $\geq 60\%$ ) overlap between tag-release length frequency and catch-weighted length frequency (Table 11). Many vessels have improved their performance over the last three years, some significantly (Table 12). For example, the *Tronio* improved from 20% in 2009 to 62% in 2010 and the *Hong Jin No. 707* from 26% in 2009 to 47% in 2010. There are still some vessels whose overlap statistic is low ( $< 30\%$ ) – *Insung No. 1* in Subarea 88.1, *Jung Woo No. 2* in Subarea 88.1 and *Jung Woo No. 3* in Subarea 88.2 – although it should be noted that the latter vessel achieved a medium overlap in the other statistical area in which it fished (Table 11). Furthermore, although *Insung No. 1* achieved a medium score for *D. eleginoides* in Subarea 48.6, it failed to tag any of the 2 404 much larger *D. mawsoni* caught in the same subarea, making it impossible to estimate a statistic. Examples of low, medium and high overlap statistics are given in Figure 1.

5.19 The Working Group recalled its advice last year (SC-CAMLR-XXVIII, Annex 5, paragraph 5.16) that tagging large numbers of small fish in these exploratory fisheries would have very limited use for the estimation of abundance. This is because it would take many years before these small fish are fully selected in the fishery. Consequently, it is extremely important that vessels strive to achieve as high an overlap as possible between length frequencies of captured and tagged fish, particularly where current overlap is low or medium (see discussion in paragraph 3.29). The marked improvement from last year is encouraging, and shows that further improvements could be made.

5.20 The Working Group agreed that some vessels showed a very low level of commitment to tagging larger toothfish and that this was having a serious impact on the efficacy of the tagging program. It also recalled that a paper had been submitted to WG-FSA in 2007 which outlined methods by which large toothfish could be tagged in good condition (WG-FSA-07/36). In noting the methods described in this paper, and paragraph 5.18 above, the Working Group agreed that there was no reason why all vessels should not be able to score a high overlap statistic in all subareas and divisions. The Working Group recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

5.21 Recalling its advice from last year, the Working Group again recommended that the method developed to evaluate the degree of mismatch between the length-frequency distribution of the tagged fish and that of the fish caught, as outlined in paragraphs 5.18 and 5.19, could be used to assess consistency with CM 41-01, Annex C, and referred this to SCIC for further consideration.

5.22 In the 2009/10 season, 5 289 *Dissostichus* spp. were reported to have been tagged and released in the exploratory longline fisheries (Table 13), and 305 tags were recovered

(Table 14). As in previous years, most tags have been recaptured from Subareas 88.1 and 88.2. Out of a total of 11 000 tags reported to have been released in Subareas 48.6 and 58.4, there have been only 56 (0.2%) recaptures. In contrast, recapture rates of 4.2% and 7.9% have been reported for Subareas 88.1 and 88.2 respectively.

5.23 To determine whether the spatial mismatch between tags and subsequent fishing effort was a possible reason for the lack of tag-recaptures in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, the Working Group reviewed the annual distribution of tags and subsequent fishing effort in these areas (Figure 2). The results suggested a moderate overlap of where the tags were released and where the effort was subsequently carried out, suggesting that spatial overlap was not the primary problem. Despite the low level of tags recaptured from Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, the program continues to provide information on the movement of tagged fish throughout Subarea 58.4.

5.24 The Working Group also noted that there were various other possible reasons for the lack of recaptures, including depredation of the tagged fish by marine mammals, release of fish in poor condition due to the capture and subsequent handling methods, and removals through IUU fishing.

5.25 Each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 in 2009/10 was required to complete 10 research hauls (each comprising 3 500–5 000 hooks and separated by a distance of at least 5 n miles) on entering an SSRU in the exploratory fishery. The Secretariat allocated starting positions for research sets in the exploratory fisheries in Subareas 48.6 and 58.4 (except in Division 58.4.3b where positions were specified in CM 41-07). For each of the 12 notifying vessels, up to eight starting positions were provided for each of two fishing strata in each SSRU notified, and vessels were required to complete five research hauls in each stratum (total of 10 research hauls per SSRU); 1 133 starting positions were allocated for 84 vessel–SSRU combinations.

5.26 Three vessels fished in these exploratory fisheries in 2009/10, and deployed a total of 129 research hauls in accordance with the conservation measures and allocated positions (WG-SAM-10/4). Overall the vessels adhered to the research fishing protocol, and it was noted that:

- (i) sea-ice along the Antarctic coastline had prevented some vessels from reaching allocated positions in the continental SSRUs (e.g. 486D, 5841C and 5841G); however, the vessels were able to deploy research hauls in alternative positions determined by vessels;
- (ii) the deployment of research hauls in alternative positions determined by vessels had resulted in some hauls being set in depths greater than 2 500 m;
- (iii) some vessels did not achieve the required five hauls per stratum.

5.27 The Working Group noted that the use and implementation of research hauls had been reviewed by WG-SAM (Annex 4, paragraphs 3.5 to 3.9) and that it had provided the following comments and recommendations:

- (i) Is there sufficient spatial and temporal overlap in research hauls such that a CPUE standardisation (accounting for, inter alia, the effect of vessel, gear type and line orientation to bathymetry) will be possible in the near future?
- (ii) Is there further stratification of research hauls (e.g. to account for areas where sea-ice may be a problem) required to ensure data collected during research hauls can be used to estimate abundance, distribution and population dynamics of toothfish in Subareas 48.6 and 58.4 in the near future?
- (iii) WG-SAM considered ways to alleviate fishing vessels' difficulties in reaching allocated research haul locations in ice-bound areas, and agreed that the current single allocation of starting positions could be augmented, in areas of sea-ice, by providing each vessel with up to three random lots of start positions for the required research hauls in a given SSRU.

5.28 Since 2002/03, a total of 1 654 research hauls had been made in the exploratory fisheries in Subareas 48.6 and 58.4 (Table 15), and the Working Group agreed there was likely to be sufficient data available by 2011 to review these data at its next meeting.

5.29 The issue of imposing additional fishing mortality due to research catch on a stock that may be depleted was investigated in WG-FSA-10/42 Rev. 1. The paper showed that in a simulated depleted population of *D. eleginoides*, it is possible for population status to remain depressed for several years after fishing ceases before beginning to recover, and that research catches can influence the probability of stock recovery within 20 years. The actual effects will depend on the population dynamics specified in the model, the population size, and the level of depletion assumed. The level of research catch that can influence the probability of recovery to the target biomass within 20 years can be very small (<1% of total pre-exploitation stock biomass), and may constrain the catch needed for some research survey designs.

5.30 Length-frequency data are frequently collected from fisheries where routine stock assessments are not available. WG-FSA-10/43 assessed the utility of using length-frequency data in isolation to make robust conclusions about stock status. The paper examined length-frequency data and several derived indices from length data, such as mean length, 75th percentile length, and the proportion of mature fish, and how variable the relationship was with stock status. The analysis showed that interpretation of trends in length-frequency data as indicators of stock status can be misleading and should be avoided.

5.31 WG-FSA-10/32 presented a method for determining and summarising data collection requirements. The paper summarised the data collection requirements (including catch and effort data, length, sex, gonad stage sampling, tagging and VME reporting requirements) from vessels and observers currently in place in Subareas 88.1 and 88.2.

5.32 The Working Group noted that these data are collected for use in scientific research, the results of which are used to inform the Commission in achieving its goals, and welcomed the approach used in the paper of using power analyses and other quantitative methods to evaluate the relative utility of different sampling levels for each data type. The Working Group noted that there were some refinements to the method that might be taken in determining an appropriate number of samples.

5.33 The Working Group agreed that the data collection requirements presented in Table 3 of WG-FSA-10/32 provided a useful summary of the data collection requirements in Subareas 88.1 and 88.2, and that such a table would be a useful summary to have for all CCAMLR fisheries.

5.34 The Working Group recommended that the Scientific Committee request the Secretariat to prepare a table of the data collection requirements for each new and exploratory fishery that summarises the data collected, frequency of data collection (i.e. samples per thousand hooks), and the rationale for that frequency, following the format outlined in Table 16. These tables would be used by WG-FSA in 2011 to review the data collection requirements in each fishery, and would be included within the fishery reports as a description of the data collection required.

Development of advice on catch limits for *Dissostichus* spp.

*Dissostichus* spp. Subarea 48.6

5.35 Two Members (Japan and the Republic of Korea) and three vessels fished in Subarea 48.6 SSRUs D and E in 2009/10. The precautionary catch limit for *Dissostichus* spp. was 200 tonnes north of 60°S (SSRUs A and G) and 200 tonnes south of 60°S (SSRUs B–F). Information on this fishery is summarised in Appendix F.

5.36 The combined SSRUs B, C, D, E and F were closed on 21 March 2010 (catch limit for *Dissostichus* spp.: 200 tonnes; final reported catch: 197 tonnes). The combined SSRUs A and G (catch limit for *Dissostichus* spp.: 200 tonnes; reported catch to date: 98 tonnes) are currently open and one vessel was fishing. There was no evidence of IUU fishing in 2009/10.

5.37 The number of tag-recaptures increased in Subarea 48.6 in 2009/10. However, the Working Group noted that there are still very few tag-recaptures from this subarea, and that no progress could be made on assessments of *D. eleginoides* in Subarea 48.6.

5.38 The Working Group noted that the overlap in size frequency of tagged fish with the overall size frequency of fish caught was medium for two vessels and high for one vessel which fished in 2009/10 (Table 12). It was also noted by the Working Group that one vessel which had fished in SSRUs A and G, where both species of *Dissostichus* occur, had not tagged any *D. mawsoni* (see Appendix F, Figure 3). The Working Group recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

5.39 Three Members (Japan, Republic of Korea and South Africa) and a total of six vessels notified their intention to fish for toothfish in Subarea 48.6 in 2010/11.

5.40 The Working Group recommended that all measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2009/10, be retained for the exploratory fisheries in Subarea 48.6.



5.41 The Working Group agreed that it could provide no new advice on catch limits for this subarea. It noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

#### *Dissostichus* spp. Division 58.4.1

5.42 Two vessels from two Members (Japan and the Republic of Korea) fished in the exploratory fishery in Division 58.4.1 in 2009/10. The precautionary catch limit for toothfish was 210 tonnes in three SSRUs (C: 100 tonnes, E: 50 tonnes and G: 60 tonnes), of which 196 tonnes were taken between 1 December 2009 and 20 February 2010. Information on this fishery is summarised in Appendix G.

5.43 High levels of IUU fishing have been reported in 2005/06 and 2006/07 and an estimated IUU catch of 910 tonnes was taken in 2009/10.

5.44 Vessels were required to tag and release *Dissostichus* spp. at a rate of three fish per tonne of green weight caught and both vessels achieved the target rate. A total of 5 012 *D. mawsoni* and 314 *D. eleginoides* have been tagged and released in Division 58.4.1, and 20 *D. mawsoni* and one *D. eleginoides* have been recaptured in that division. In 2009/10, 615 *D. mawsoni* and 12 *D. eleginoides* were tagged with three *D. mawsoni* and one *D. eleginoides* recaptured.

5.45 The Working Group noted that vessels in Division 58.4.1 had a medium level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught (Table 12). The Working Group recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

5.46 Five Members (Japan, Republic of Korea, New Zealand, South Africa and Spain) and a total of 11 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2010/11.

5.47 The Working Group recommended that all measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2009/10, be retained for the exploratory fisheries in Division 58.4.1.

5.48 The Working Group agreed that it could provide no new advice on catch limits for this division. It noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

5.49 In progressing a research plan to develop *D. mawsoni* assessments for Division 58.4.1, the Working Group encouraged Members to collaborate in the intersessional period to progress elements of the generalised work plan (paragraphs 5.1 to 5.12). Further, the Working Group also noted that a special research area that could be investigated in this process could be the combined SSRUs F and G in Division 58.4.1. Possible canyons and submarine features in this area could be investigated for their importance to *D. mawsoni*. Research in both these SSRUs may provide an opportunity to compare the characteristics of an area with a known history of fishing with an area that has been closed over the same period.

*Dissostichus* spp. Division 58.4.2

5.50 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.2 was limited to Japanese, Korean, New Zealand, Spanish and Uruguayan vessels using longlines only. Only one Member (the Republic of Korea) fished in the division and reported a catch of 93 tonnes. SSRU E was closed on 17 February 2010 (SSRU E catch limit for *Dissostichus* spp.: 40 tonnes; final reported catch: 40 tonnes), and SSRU A and consequently the fishery was closed on 24 February 2010 (SSRU A catch limit for *Dissostichus* spp.: 30 tonnes; final reported catch: 53 tonnes). The other SSRUs (B, C and D) were closed to fishing. Information on this fishery is summarised in Appendix H.

5.51 The fishery targeted *D. mawsoni* and operated in SSRUs A and E in 2009/10. It was estimated that 432 tonnes of *D. mawsoni* were taken by IUU fishing in 2009/10.

5.52 A total of 291 toothfish were tagged and released in 2009/10 and no tagged toothfish were recaptured (Tables 13 and 14). The vessel in Division 58.4.2 achieved the target tagging rate of three tags per tonne of green weight with a high level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught (Table 12).

5.53 Five Members (Japan, Republic of Korea, New Zealand, South Africa and Spain) and a total of eight vessels notified their intention to fish for toothfish in Division 58.4.2 in 2010/11.

5.54 The Working Group noted that the vessel in Division 58.4.2 achieved the target tagging rate of three tags per tonne of green weight with a high level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught.

5.55 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2009/10, be retained for the exploratory fisheries in Division 58.4.2.

5.56 The Working Group agreed that it could provide no new advice on catch limits for this division. It noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

5.57 In progressing a research plan to develop *D. mawsoni* assessments for Division 58.4.2, the Working Group encouraged Members to collaborate in the intersessional period to progress elements of the generalised work plan (paragraphs 5.1 to 5.12).

*Dissostichus* spp. Division 58.4.3a

5.58 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.3a was limited to Japanese and Korean vessels using longlines only. The precautionary catch limit for toothfish was 86 tonnes, but no vessel participated in this fishery. Information on this fishery is summarised in Appendix I.

5.59 There was no evidence of IUU fishing in 2009/10.

5.60 No toothfish were tagged and released in 2009/10 and no tagged toothfish were recaptured during that season.

5.61 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2010/11.

5.62 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2008/09, be retained for the exploratory fisheries in Division 58.4.3a.

5.63 The Working Group agreed that it could provide no new advice on catch limits for this division. It noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

#### *Dissostichus* spp. Division 58.4.3b

5.64 In 2009/10, the exploratory fishery for *Dissostichus* spp. in Division 58.4.3b was limited to research fishing conducted by Japanese, Korean, South African and Uruguayan vessels using longlines only, and no more than one vessel per country was permitted to fish at any one time. In November 2007, the division was divided into two SSRUs: A north of 60°S and B south of 60°S. In November 2008 the area north of 60°S was further subdivided into four SSRUs (A, C, D and E). The precautionary catch limit for *Dissostichus* spp. in the fishery was set to zero tonnes in each SSRU. An additional limit of 72 tonnes was set for research fishing between 1 December 2009 and 31 March 2010 within four designated sampling sectors (CM 41-07, Annex A, Figure 1). Information on this fishery is summarised in Appendix J.

5.65 In 2009/10, one Member (Japan) and one vessel participated in research fishing. The vessel operated in the southeastern sampling sector and reported a total catch of 14 tonnes of *Dissostichus* spp. (*D. eleginoides*: 2 tonnes, *D. mawsoni*: 12 tonnes).

5.66 Information on IUU activities indicated that 171 tonnes of toothfish were taken in 2009/10.

5.67 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2008/09, be retained for the exploratory fisheries in Subareas 48.6 and 58.4.

5.68 The vessel in Division 58.4.3b had only a medium level of overlap in the size frequency of tagged fish with the overall size frequency of fish caught (Table 12). The Working Group recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

5.69 The Working Group considered a research fishing proposal tabled by Japan during WG-FSA-10. Under the plan, research fishing is proposed to occur over a lattice of 88 equi-spaced grid points (7.5 n mile<sup>2</sup> cell size), centred on the four research areas (NW, NE, SW and SE) defined for the 2009/10 fishing season in Division 58.4.3b (also referred herein

as BANZARE Bank). A total catch limit of 71 tonnes was calculated using a comparative CPUE method with point parameter estimates for biomass and CPUE determined from the north of Subarea 48.4, longline CPUE rates for different fishing gears used in Division 58.4.3b and Subarea 48.4, and the assumption that the current spawning biomass is 20% of the virgin spawning biomass.

5.70 The Working Group recalled that previous analyses of fishery data, and a research longline survey undertaken across the division by Australia in 2008, have shown that the stock seems comprised of predominantly older, larger fish. The Working Group also recalled that the rapid depletion of the southern area of the division had resulted in it being closed to fishing three years after the fishery commenced, and that no smaller size classes have so far been observed in the fishery, indicating there is unlikely to be recruitment to the area. The longline survey also noted very low catch rates across the northern area of the division. The Working Group also recalled its discussion in 2009 regarding catch rates and stock status (SC-CAMLR-XXVIII, Annex 5, paragraphs 5.56 to 5.64) and the advice provided by WG-SAM-10 (Annex 4, paragraphs 3.19 to 3.26) in relation to a similar research proposal using the comparative CPUE method for Divisions 58.4.4a and 58.4.4b (also referred herein as Ob and Lena Banks) (WG-SAM-10/15). In particular, this advice notes that calculation of biomass estimates by comparative CPUE methods is underpinned by several assumptions, including similar catchability of different gear types between target and reference areas, similar size distributions of stocks between areas, and similar proportions of total biomass that are mature in both areas. The Working Group noted that some of these assumptions are known to be violated in the case of Division 58.4.3b and Subarea 48.4. For example, BANZARE Bank seems to be dominated by larger mature fish compared with Subarea 48.4, and the relationship between different longline gear types and selectivity and catch rates remains poorly understood.

5.71 The Working Group concurred with the general advice provided by WG-SAM-10 in relation to using the comparative CPUE method for estimating biomass, and provided some specific advice in the case of the 2011 research proposal by Japan to conduct research fishing on BANZARE Bank. This advice included:

- (i) The assumptions used in the calculation of available biomass, and the uncertainties associated with them, should be investigated using simulation methods (e.g. bootstrap or Monte Carlo) in order to determine credible estimates of the distribution of biomass. Such an evaluation should incorporate known variation in catch rates for different gear types within and between areas, and variation in biomass estimates from the reference area.
- (ii) Known differences in stock structure between reference and target areas should be incorporated by stratifying the calculation of available biomass by species (both *D. eleginoides* and *D. mawsoni* are found at BANZARE Bank) and by length class to account for these differences.
- (iii) The proposal currently assumes a target area of fishable seabed shallower than 1 500 m for the purposes of estimating available biomass, however, the area to be fished comprises only about half of this area. The latter area should be used for the purposes of this calculation, or the survey should be spread out to cover the entire area used to estimate biomass.

- (iv) The biomass estimate determined for Subarea 48.4 arose from fishing in areas including depths greater than 1 500 m. Using this biomass for the purposes of estimating available biomass in Division 58.4.3b should account for this difference in depth structure of the fishery. For example, the biomass estimate for Subarea 48.4 could be scaled by a factor equal to the area <1 500 m divided by total area, or the biomass estimated for Division 58.4.3b should be extended to include similar fishable depth as experienced in Subarea 48.4 (with survey positions adjusted accordingly).
- (v) There is merit in repeat sampling of the same survey points over multiple time points to provide a time series of catch rate data for this area. Research fishing of the same sample points in the southeastern sector on BANZARE Bank by Japan would provide a time series of catch rate data collected by the same vessel using identical methods.
- (vi) The distribution and abundance of *Dissostichus* spp. were surveyed only in the southeastern sector by a Japanese vessel and were not clarified in the other three sectors in the 2009/10 survey. Dr K. Taki (Japan) noted the need of the consecutive survey for all four sectors.

5.72 The Working Group recalled previous advice provided by the Scientific Committee (SC-CAMLR-XXVIII, paragraph 4.165) noting the need for research plans to deliver data that would lead to stock assessments. The proposal by Japan acknowledged the need to move toward tag-based assessments, and suggested that the proposed research fishing for 2011 will lead to this objective. However, in reviewing a similar plan for Divisions 58.4.4a and 58.4.4.b (WG-SAM-10/15), Annex 4, paragraph 3.25, noted that without a minimum estimate of biomass it is very difficult to determine the total number of tags required to be released, or subsequent tagging rates for proposed removals to achieve biomass estimates with target CVs as recommended previously (SC-CAMLR-XXVIII, Annex 6, paragraph 2.35(ii)). Applying the simulation methods noted above (paragraph 5.71(i)) would help to resolve this issue. It was also noted that research proposals should ideally summarise known information about the status of a stock in an area proposed for research fishing, including fishing history and stock structure (e.g. length–weight relationships, age/length-at-maturity, age structure).

5.73 The Working Group concluded that further analyses, as described above, should be undertaken to determine a plausible distribution of available biomass, thereby accounting for the considerable uncertainties inherent in applying the comparative CPUE method. Notwithstanding this analysis, the Working Group concurred with the advice of WG-SAM (Annex 4, paragraph 3.26) for research proposals to consider the possibility of conducting trawl surveys as an alternative method to using longline methods for establishing initial biomass estimates that could be used to inform the design of longer-term tagging programs.

5.74 The Working Group noted that good progress had been made in developing a research framework for data-poor fisheries (paragraphs 5.1 to 5.12). With respect to the Japanese research proposal, the Working Group drew the attention of the Scientific Committee to paragraphs 5.71(i)–(vi) above.

5.75 A total of 60 toothfish were tagged and released in 2009/10, including eight *D. eleginoides* and 52 *D. mawsoni*. One tagged toothfish (*D. eleginoides*) was recaptured during the 2009/10 season.

5.76 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3b in 2010/11.

5.77 WG-FSA-10/45 updated WG-SAM-10/13 to describe a survey undertaken in accordance with CM 41-07 in order to determine the stock status and biological characteristics of toothfish populations on BANZARE Bank. Scientific fishing was undertaken by Japan in the southeastern sector during 2009, and results indicated that CPUE was lower than for previous seasons' catch rates from the northwestern sector. CPUE rates observed in the survey were lower than those observed for commercial fishing. The Working Group noted that this indicated that the abundance of fish in the survey area was low, and that higher CPUE observed in previous seasons may be a reflection of the aggregated nature of commercial fishing, whereby fishers aggregate to areas where catch rates are highest, but that other factors, such as removals by IUU fishing, could also be contributing to these results.

5.78 The Working Group noted that the sampling design undertaken for the proposed research in Division 58.4.3b was not submitted for review by any SC-CAMLR working group, and recommended that future research plans be reviewed by WG-FSA.

5.79 WG-FSA-10/47 reported on the distribution and population structure of *Dissostichus* spp. on BANZARE Bank, determined from data arising from exploratory longline fishing during 2007 to 2009. Results indicated *D. eleginoides* was typically found in shallower waters than *D. mawsoni*, and that larger fish (predominantly female) were found deeper. Based on the size distribution of catches, the study concluded that recruitment to BANZARE Bank is unlikely and that the population may consist primarily of adults migrating from other areas. The Working Group noted that this study only used data from a single vessel. However, the conclusions of the paper seemed consistent with previous work on the biology and ecology of toothfish in this area, such as that described in WG-FSA-08/57. The Working Group recommended that authors of such reviews should consider collaborating to synthesise current knowledge.

5.80 The Working Group recommended that the catch limits for Division 58.4.3b be retained for 2010/11. The Working Group could not reach consensus on advice for additional catch for research fishing.

5.81 The Working Group noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

#### *Dissostichus* spp. Subareas 88.1 and 88.2

5.82 Five Members (Argentina, Republic of Korea, New Zealand, Spain and the UK) and 12 vessels fished in the exploratory fishery in Subarea 88.1. The fishery was closed on 9 February 2010 and the total reported catch of *Dissostichus* spp. (excluding research fishing) was 2 870 tonnes (101% of the limit) (Appendix K, Table 3). The following SSRUs were closed during the course of fishing:

- SSRUs B, C and G closed on 23 December 2009, triggered by the catch of *Dissostichus* spp. (total catch 370 tonnes; 100% of the catch limit);

- SSRUs J and L closed on 29 January 2010, triggered by the catch of *Dissostichus* spp. (total catch 358 tonnes; 96% of the catch limit);
- SSRUs H, I and K closed on 9 February 2010, triggered by the catch of *Dissostichus* spp. (total catch 2 142 tonnes; 102% of the catch limit).

The IUU catch for the 2009/10 season was estimated to be 0 tonnes.

5.83 Eight Members (Argentina, Japan, Republic of Korea, New Zealand, Russia, Spain, UK and Uruguay) and a total of 20 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.1 in 2010/11.

5.84 Four Members (Argentina, Republic of Korea, Spain and the UK) and five vessels fished in the exploratory fishery in Subarea 88.2. The fishery closed on 31 August 2010 and the total reported catch of *Dissostichus* spp. was 314 tonnes (55% of the limit) (Appendix K). The IUU catch for the 2009/10 season was estimated to be 0 tonnes.

5.85 Seven Members (Argentina, Republic of Korea, New Zealand, Russia, Spain, UK and Uruguay) and a total of 18 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2010/11.

5.86 The Fishery Report for *Dissostichus* spp. in Subareas 88.1 and 88.2 is in Appendix K. In 2005, the Working Group recommended that Subareas 88.1 and 88.2 be split into two areas for stock assessment purposes: (i) the Ross Sea, and (ii) SSRU 882E.

5.87 Vessels were required to tag and release *Dissostichus* spp. at a rate of one fish per tonne of green weight caught and all vessels achieved the required target rate. However, the tagging overlap statistic varied widely between vessels ranging from 20% to 87% (Table 12). The Working Group recommended that the issue of achieving compliance with the tagging requirements of CM 41-01, Annex C, be considered by SCIC.

5.88 WG-FSA-10/23 summarised catches of *D. mawsoni*, *D. eleginoides* and by-catch species from the Ross Sea, including data from the most recent 2009/10 season. Catches were mainly taken from SSRUs 881C in the north, 881H, 881I on the slope, and 881J on the shelf. Unstandardised catch per hook showed no trend over the course of the fishery.

5.89 A more detailed characterisation of *D. eleginoides* catches in the north of the Ross Sea fishery was carried out for the first time. Catches of *D. eleginoides* have mainly come from the northwest of the Ross Sea (WG-FSA-10/23). Catches were quite high in the early part of the fishery, particularly in 2001, but have been relatively low since then. The catch rates for *D. eleginoides* have been much higher in SSRU 881A than the other SSRUs.

5.90 The paper noted that there may have been problems in distinguishing between the two toothfish species in both observer and C2 data in SSRUs 881A, 881B and 881C. In particular, a number of fish smaller than 100 cm had been identified as *D. mawsoni*, but investigations of otoliths from these fish would probably suggest that they were *D. eleginoides*. The Working Group suggested analysts who find substantial anomalies in reported locations of catches of *Dissostichus* spp. report these to the Secretariat. It noted that there were several mechanisms by which the identity could be independently verified, including length–weight relationships, length–frequency distributions, GSI indices and appearance of the otoliths.

5.91 *Dissostichus eleginoides* in Subarea 88.1 are clearly at the southern edge of their range, only extending into the northwest corner of Subarea 88.1 in any significant numbers. The fishery catches very few fish less than 50 cm, therefore the origin of *D. eleginoides* in this area is unclear. It is possible that these fish may be related to *D. eleginoides* around Macquarie Island as one *D. eleginoides* tagged at Macquarie Island was caught in SSRU 881B in 2007.

5.92 WG-FSA-10/23 also raised the possibility of developing a time series of relative abundance of recruitment using a longline research survey. It noted that the main objectives would be to (i) detect changes in relative abundance of recruitment over time, (ii) determine the level of recruitment variability, and (iii) determine autocorrelation in recruitment. The paper identified several areas where such a survey could be carried out, and suggested it could be carried out periodically using a standardised method and gear.

5.93 The Working Group agreed that such a time series of relative recruitments from a well-designed survey could be a useful input into the Ross Sea stock assessment model. The Working Group requested that Members develop a survey design to meet these objectives and submit it to WG-SAM and/or WG-FSA for evaluation. They also requested that the Scientific Committee consider how such a survey might be carried out, without compromising fishing activities, in the austral summer fishing season.

5.94 WG-FSA-10/32 proposed medium-term research objectives, the associated data collection requirements, and the development of a preliminary data collection plan for the toothfish fishery in Subareas 88.1 and 88.2. The paper focused on the data collection requirements (including catch and effort data, length, sex, gonad stage sampling, tagging and VME reporting requirements) from vessels and observers currently in place. The preliminary plan is presented in Table 16.

5.95 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of one toothfish per tonne, be retained for the exploratory fisheries in Subareas 88.1 and 88.2. It also encouraged the further development of the data collection plan for these fisheries.

5.96 In accordance with the advice of the Scientific Committee in 2009, the assessment for Subareas 88.1 and 88.2 was not updated. The Working Group agreed that the management advice on catch limits for Subareas 88.1 and 88.2 could be carried forward from last year.

#### Management advice to the Scientific Committee

5.97 The Working Group recommended that some specific elements of the work plan be considered as a high-priority focus topic for WG-SAM in the coming intersessional period (paragraph 5.12).

5.98 The Working Group agreed that some vessels showed a very low level of commitment to tagging larger toothfish and that this was having a serious impact on the efficacy of the tagging program. It also recalled that a paper had been submitted to WG-FSA in 2007 which outlined methods by which large toothfish could be tagged in good condition (WG-FSA-07/36). In noting the methods described in this paper, and paragraph 5.18 above, the Working Group agreed that there was no reason why all vessels should not be able to score a high



overlap statistic in all subareas and divisions. The Working Group recommended that the Scientific Committee once again strongly urge Members to request their vessels to fully comply with all aspects of CM 41-01, Annex C, in particular with respect to the size and species of toothfish being tagged.

5.99 The Working Group recommended that the Scientific Committee request the Secretariat to prepare a table of the data collection requirements for each new and exploratory fishery that summarises the data collected, frequency of data collection (i.e. samples per thousand hooks), and the rationale for that frequency following the format outlined in Table 16. These tables would be used by WG-FSA in 2011 to review the data collection requirements in each fishery, and would be included within the fishery reports as a description of the data collection required.

5.100 The Working Group recommended that all measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne and the requirement for research hauls as used in 2009/10, be retained for the exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a.

5.101 The Working Group recommended that it could provide no new advice on catch limits for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a. It noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

5.102 In progressing a research plan to develop *D. mawsoni* assessments for Division 58.4.1, the Working Group encouraged Members to collaborate in the intersessional period to progress elements of the generalised work plan (paragraphs 5.1 to 5.12). Further, the Working Group noted that a special research area that could be investigated in this process could be the combined SSRUs F and G in Division 58.4.1. Possible canyons and submarine features in this area could be investigated for their importance to *D. mawsoni*. Research in both these SSRUs may provide an opportunity to compare the characteristics of an area with a known history of fishing with an area that has been closed over the same period.

5.103 In progressing a research plan to develop *D. mawsoni* assessments for Division 58.4.2, the Working Group encouraged Members to collaborate in the intersessional period to progress elements of the generalised work plan (paragraphs 5.1 to 5.12).

5.104 The Working Group noted that the sampling design undertaken for the proposed research in Division 58.4.3b was not submitted for review by any SC-CAMLR working group, and recommended that future research plans be reviewed by WG-FSA.

5.105 WG-FSA-10/47 reported on the distribution and population structure of *Dissostichus* spp. on BANZARE Bank, determined from data arising from exploratory longline fishing during 2007 to 2009. The Working Group recommended that authors of such reviews should consider collaborating to synthesise current knowledge.

5.106 The Working Group recommended that the catch limits for Division 58.4.3b be retained for 2010/11. The Working Group could not reach consensus on advice for additional catch for research fishing, and noted that a research plan was being developed which could provide advice in the future (paragraphs 5.1 to 5.12).

5.107 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of one toothfish per tonne, be retained for the exploratory fisheries in Subareas 88.1 and 88.2. It also encouraged the further development of the data collection plan for these fisheries.

5.108 In accordance with the advice of the Scientific Committee in 2009, the assessment for Subareas 88.1 and 88.2 was not updated. The Working Group agreed that the management advice on catch limits for Subareas 88.1 and 88.2 could be carried forward from last year.

#### Management advice to SCIC

5.109 Recalling its advice from last year, the Working Group again recommended that the method developed to evaluate the degree of mismatch between the length-frequency distribution of the tagged fish and that of the fish caught, as outlined in paragraphs 5.18 and 5.19, could be used to assess consistency with CM 41-01, Annex C, and referred this to SCIC for further consideration.

#### Closed Fishery – Ob and Lena Banks Division 58.4.4

5.110 The longline fishery for *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b began as a new fishery in 1997/98 (CM 138/XVI) (Appendix L). These divisions were managed as a single area and a catch limit for *Dissostichus* spp. applied to fishing north of 60°S, and in waters outside areas of national jurisdiction. In 1999 the divisions were subdivided into SSRUs A, B, C and D.

5.111 In 2002, the Commission expressed concern regarding the low levels of stocks of *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b and the high levels of IUU fishing in that region (CCAMLR-XXI, paragraph 11.36). Consequently, the Commission prohibited directed fishing for *Dissostichus* spp. in these divisions and the fishery for *Dissostichus* spp. was closed (CM 32-10). The Commission agreed that such prohibition shall apply at least until further scientific information is gathered and reviewed by the Scientific Committee and WG-FSA.

5.112 In 2007/08 and 2009/10, a Japanese-flagged longliner conducted research fishing in accordance with a research plan submitted under CM 24-01. The vessel caught 77 tonnes of *D. eleginoides* and <1 tonne of *D. mawsoni* in 2007/08, and 59 tonnes of *D. eleginoides* in 2009/10.

5.113 Individual *D. eleginoides* were tagged and released by a Japanese-flagged vessel conducting research fishing in Divisions 58.4.4a and 58.4.4b in 2007/08 and 2009/10 (Table 2). A total of 639 *D. eleginoides* have been tagged and released, and one fish has been recaptured. Fish were tagged at a rate of 3.6 fish per tonne of green weight caught. CPUE in 2009/10 was 0.139 kg/hook compared with 0.108 kg/hook as described in WG-FSA-10/46. The allowable catch of 60 tonnes was taken in 94 hauls, leaving 17% of survey sites unfished.

5.114 A revised research proposal was reviewed by WG-SAM (Annex 4, paragraphs 3.23 to 3.25). During the WG-FSA-10 meeting, Japan further revised the research proposal

(WG-FSA-10/49) to survey *Dissostichus* spp. in 2010/11 as part of a 3–5 year tagging experiment. To accommodate a lower catch level and to maximise the number of tags recaptured, the spatial extent of the survey was reduced to two SSRUs, the number of sets reduced to 71 sets in a higher-density grid (7.5' latitude × 15' longitude), and the estimated catch reduced to 53 tonnes. A tagging rate of five fish per tonne would be used.

5.115 When seeking to develop a survey series to collect the data needed for an assessment of stock status, a design that generates the most robust index of stock status while minimising the risk to the stock is desired. This is paramount for stocks which may already be depleted. The Working Group discussed several logistical and scientific constraints of the survey design, including:

- (i) It is important to maximise the number of tagged fish released. Instead of tagging five fish per tonne, tagging every 'Nth' fish could both increase the tagging rate and maximise the tag overlap statistic.
- (ii) In areas where depredation may occur, the survey design needs to be flexible, to allow the vessel to move to avoid interactions with marine mammals, and the total mortality due to the survey should include the biomass removed through depredation.
- (iii) The area surveyed needs to be commensurate with the level of catch permissible given the best available information on stock status. Concentrating effort in small areas may provide a higher probability of subsequent recovery of tags. However, this may have other effects, such as:
  - (a) influencing the probability of recovering tags deployed elsewhere
  - (b) causing local depletion of a small area through intensive survey catch
  - (c) influencing the ability to extrapolate catch rates to the entire stock area
  - (d) constraining the ability of the vessel to move to avoid depredation.
- (iv) The procedure of estimating spawning stock biomass using the relative CPUE of a reference area was reviewed and considered inappropriate because the equation requires assuming similar productivity and selectivity in the two areas, that CPUE is actually indexing abundance in each area, and that the areas are representing the same habitat type (e.g. depth zone). In addition, error associated with each term would need to be included in the resulting estimate. These issues were summarised by WG-SAM-10 (Annex 4, paragraphs 3.23 to 3.25), and are also described in the advice regarding the proposed research plan for Division 58.4.3b (paragraphs 5.64 to 5.81).
- (v) The level of catch allowed can be the most constraining factor on the resulting survey design, and if too low in a mark-recapture experiment, could result in the failure to release or recapture an adequate number of tags to estimate biomass.

#### Management advice

5.116 An alternative method of estimating a precautionary research survey catch was described in WG-FSA-09/44, and developed further in WG-FSA-10/42 Rev. 1. At the

meeting, the estimated  $B_0$  value and the current stock biomass were calculated using this method for two stock status scenarios. Population status in each case was projected forward using the GYM (configured using stock parameters from WG-FSA-10/48, and the mean age of first and full selection by the research catch, as 8 and 11 years).

- (i) Scenario 1 used the estimated total catch history (legal and IUU) and assumed the biomass in 2010 to be 20% of  $B_0$ . An estimate of  $B_0$  was then calculated at 7 900 tonnes. Using the relationship in Figure 3 of WG-FSA-10/42 Rev. 1, representing a precautionary research catch, 0.62% of  $B_0$  is 49 tonnes.
- (ii) Scenario 2 used the same catch history and assumed the status at the end of the bulk of IUU fishing (in 2002) was 20% of  $B_0$ .  $B_0$  was then back-calculated to be 9 200 tonnes. This scenario then assumes some recovery through a forward projection, estimating the biomass in 2010 to be 33% of  $B_0$ . A precautionary catch limit (as for scenario 1) is then 1.05% of  $B_0$ , or 97 tonnes.

5.117 These scenarios assume that the actual level of stock depletion is due to IUU fishing in each scenario, the level of stock depletion did not impact the stock-recruit dynamics, the IUU catch history is correct, and the growth function is the same as that used for the *D. eleginoides* stock in Division 58.5.2. The Working Group agreed that these estimates are very uncertain and should be treated with caution. The knowledge of stock dynamics at low population sizes is very limited, and previous experience with recovery of depleted notothenioid fishes suggests recovery can be a very slow process.

5.118 Several other recommendations were made to improve the proposed survey design and to maximise the value of the scientific information resulting from the survey:

- (i) It is important to continue comparative trials of trotline and Spanish longline gear configurations. A single vessel deploying both gears provides an optimal comparison of the physical condition of fish captured using each gear configuration.
- (ii) Further, the condition of toothfish should be recorded when the fish is brought on board (as for skates). These data will allow the relative condition of fish captured with trotline and Spanish longline to be assessed, and also will allow the condition of tagged fish to be analysed.
- (iii) Vessel operators should record any observations of depredatory marine mammals to understand influences of depredation on catch rates and also the survival of the released toothfish.
- (iv) The allocated catch should be divided between the two SSRUs to be surveyed. The Working Group recommended that fishing effort be concentrated in SSRUs B and C because these SSRUs contain the most deployed tags, maximising the probability of tag recovery.
- (v) The Working Group encouraged Japan to continue the ageing work conducted on otoliths collected as part of this research.
- (vi) The research proposal details the collection of data concerning toothfish age, maturity, and stomach contents, length-frequency distributions of by-catch

species, VME indicator taxa identification, temperature-depth profiles, and detailed bathymetry. The Working Group encouraged these data to be analysed and presented at future WG-FSA meetings.

#### Research plans notified under CM 24-01

5.119 Mr T. Jung (Republic of Korea) presented a research plan proposed to be undertaken in the closed SSRUs 883A–C (WG-FSA-10/9), and noted that the proposal includes a plan by two longline vessels to conduct 190 hauls catching up to a total 190 tonnes of toothfish, and collect data on the size, catch rates and diet of toothfish, fish by-catch and VMEs, as well as tagging toothfish at a rate of five per tonne. Russia had also proposed to conduct research fishing in closed SSRUs 882A and 883A–C, using a single longline vessel. Russia proposed to conduct 10 hauls and take up to 10 tonnes of toothfish in SSRU 882A, and to conduct 20 hauls and take up to 65 tonnes of toothfish in Subarea 88.3. The proposed research would collect data on size, age, diet, reproduction and genetics of toothfish, as well as on fish and benthic invertebrate by-catch, tag toothfish at a rate of three per tonne, and tag skates.

5.120 The Working Group recalled the advice of the Scientific Committee for evaluating CCAMLR-sponsored research (SC-CAMLR-XXVII, paragraphs 8.9 to 8.11), and the advice of WG-SAM on estimating stock size in data-poor fisheries (Annex 4, paragraphs 3.19 to 3.26). It noted that it was unclear how the current proposals would address the need for an assessment in Subarea 88.3, in particular as the analyses in WG-FSA-10/43 and experience from exploratory and research fishing in Subareas 48.6 and 58.4 indicated the length distribution and catch rate data were unlikely to contribute to an assessment in the next three to four years. It further agreed that research on benthic communities may be more effectively conducted by camera work and research trawls.

5.121 The Working Group recalled that Chilean and New Zealand vessels had previously conducted research fishing in the closed SSRUs in Subarea 88.3. The results of both surveys indicated that the toothfish population in this area was dominated by juvenile fish <100 cm in length (WG-FSA-05/53; Arana and Vega, 1999). It was also noted that in the Chilean survey, catch rates were very low, with 302 kg of toothfish caught from over 50 000 hooks set, indicating the density of toothfish across the area is very low, across a depth range of 600–2 550 m.

5.122 The Working Group recalled its previous advice that the best way to develop an assessment in data-poor areas was to carry out a tagging program (SC-CAMLR-XXVIII, Annex 6, paragraph 2.34). It also noted that as Subarea 88.3 was very large, any tagging program would be most successful where the tagging was initially concentrated in a small area. It also noted that fishing in a smaller area would require a smaller catch allocation.

5.123 The Working Group recalled that the tag-recapture programs in Subareas 48.6 and 58.4 had been unsuccessful, and noted that many vessels showed low overlap between the size of fish tagged and the catch. It agreed that the vessels conducting a tag-recapture program in a closed area should have a proven record of successful participation in tag-recapture programs in open areas.

5.124 It was also noted that toothfish captured from the trotline method may have lower survivorship when tagged and released if they receive multiple hook wounds. The Working Group agreed that experiments to determine post-capture mortality rates from trotlines could be pursued in open areas where such vessels already operate.

5.125 The Working Group noted that the Russian proposal included reference to developing an assessment using the TISVPA. The Working Group reiterated its advice for the TISVPA to be evaluated by WG-SAM (SC-CAMLR-XXVIII, Annex 5, paragraph 4.16).

5.126 The Working Group agreed that the research proposed was unlikely to lead to an assessment for these areas. The Working Group agreed that future proposals for research to develop assessments in the closed areas of SSRU 882A and Subarea 88.3 would benefit from consideration of the generalised approach to conducting research for data-poor fisheries (paragraphs 5.1 to 5.12).

#### Assessed fisheries

##### *Dissostichus eleginoides* South Georgia (Subarea 48.3)

5.127 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Appendix M.

5.128 Following the advice of the Scientific Committee (SC-CAMLR-XXVIII, paragraph 4.82), the assessment was not updated in 2010.

#### Management advice

5.129 In the 2009/10 fishing season, five vessels fished within the five-day early extension (26–30 April). One vessel caught two birds. The average catch is therefore 0.4 birds per vessel. The Working Group advised therefore that, according to CM 41-02, paragraph 6(i), the 2010/11 fishery could start on 21 April 2011.

5.130 The Working Group did not undertake an assessment of this stock in 2010, and had no additional management advice. It therefore recommended that CM 41-02 be carried forward in its entirety for the 2010/11 fishing season.

##### *Dissostichus* spp. South Sandwich Islands (Subarea 48.4)

5.131 A tagging experiment has been conducted in Subarea 48.4 North over the last five years. This experiment was extended to Subarea 48.4 South in the 2008/09 fishing season.

5.132 The catch limits for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 North in the 2009/10 season were 41 tonnes and 0 tonnes (except for scientific purposes) respectively, with recorded catches of 40 tonnes and 0 tonnes respectively. The northern fishery was closed when the catch limit was reached. The catch limit for *Dissostichus* spp. in Subarea 48.4 South in the 2009/10 season was 75 tonnes, with a recorded catch of 74 tonnes. The fishery report for *D. eleginoides* in Subarea 48.4 is contained in Appendix N.

5.133 Subarea 48.4 South is in the second year of a three-year experiment. No full assessment is currently available. There was some evidence of localised depletion around particular islands and seamounts close to the northern boundary of Subarea 48.4 South (WG-FSA-10/40). A preliminary assessment using the limited number of tag-recaptures to date and CPUE/area comparisons with Subarea 48.4 North suggest a vulnerable population of between 600 and 1 500 tonnes. This is about half the size of the estimate that was made in 2009, after the first season of fishing, which was based only on CPUE/area comparison (WG-FSA-09/18).

5.134 Taking into account the revised preliminary population assessment, the Working Group recommended a reduced 30 tonne catch limit during the third year of the experiment.

#### Management advice

5.135 The Working Group recommended the following limits for toothfish and by-catch in Subarea 48.4:

##### Subarea 48.4 North –

- (i) a catch limit of 40 tonnes for *D. eleginoides*;
- (ii) the continued prohibition of the taking of *D. mawsoni* other than for scientific research purposes;
- (iii) maintenance of catch limits for by-catch species, with a limit for macrourids of 6.5 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 2 tonnes (5% of the catch limit for *D. eleginoides*).

##### Subarea 48.4 South –

- (i) a catch limit of 30 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined);
- (ii) maintenance of a move-on rule for by-catch species, with a macrourid trigger of 150 kg and 16% of the catch of *Dissostichus* spp., and a trigger for rajids set at 5% of the catch of *Dissostichus* spp.

5.136 The Working Group recommended that the mark-recapture experiment in Subarea 48.4 South be continued for the 2010/11 season with a reduced catch limit of 30 tonnes. Further, the Working Group noted that it would be desirable to discourage any possible concentration of effort on the northern islands in Subarea 48.4 South.

5.137 The Working Group recommended that where *D. mawsoni* and *D. eleginoides* are caught on the same line in Subarea 48.4 South, the majority of the tags released within the required tagging rate should be on *D. mawsoni*.

*Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)

5.138 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Appendix O.

5.139 The catch of *D. eleginoides* reported for this division to 31 August 2010 was 2 977 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2009/10 season was zero inside the French EEZ. Some IUU fishing may occur outside the EEZ as reported in WG-FSA-08/10 Rev. 2.

5.140 During the 2006 survey, 639 fish were tagged and 12 135 fish were tagged from the longline fishery, 587 fish were recaptured from French tagging and 102 fish from Division 58.5.2 tagging so far. During the 2009/10 season, 194 tagged fish were caught on longlines, 177 French tags and 17 Australian tags. A cooperative work between France and Australia has been conducted (May 2009, Paris) on analyses of catch, effort and other data to be used to progress understanding of fish stocks and fishery dynamics for Divisions 58.5.1 and 58.5.2.

5.141 The CPUE standardisation for Division 58.5.1 was not updated by the Working Group.

5.142 The Working Group noted that France has made progress on a stock assessment of the area using CASAL. The development of a stock assessment model is ongoing, and France intends to present the model to a future meeting of WG-FSA. The Working Group encouraged other Members to assist France in undertaking the stock assessment of *D. eleginoides* in this division, including consideration of metapopulation structure in the Indian Ocean (SC-CAMLR-XXII, paragraphs 7.11 to 7.13). In addition, it also encouraged cooperative work in the intersessional period between French and Australian scientists on analyses of catch and effort data and other data that could be used to progress understanding of fish stocks and fishery dynamics for Divisions 58.5.1 and 58.5.2 and Subarea 58.6.

Management advice

5.143 The Working Group encouraged the estimation of biological parameters for *D. eleginoides* in Division 58.5.1 and the development of a stock assessment for this area. The Working Group also encouraged France to continue its tagging program in Division 58.5.1.

5.144 The Working Group recommended that avoidance of fishing in zones of specific high rates of abundance in by-catch should also be considered.

5.145 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)

5.146 The Fishery Report for *D. eleginoides* in Division 58.5.2 is contained in Appendix P.



5.147 Following the recommendation by the Scientific Committee, the toothfish assessment for *D. eleginoides* in Division 58.5.2 was not updated. The Working Group noted that the *D. eleginoides* stock assessment in this division will be updated in 2011.

#### Management advice

5.148 The Working Group did not undertake an assessment of this stock in 2010, and had no additional management advice. It therefore recommended that CM 41-08 be carried forward in its entirety for the 2010/11 fishing season.

#### *Dissostichus eleginoides* Crozet Islands (Subarea 58.6)

5.149 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Appendix Q.

5.150 The catch of *D. eleginoides* reported for this subarea to October 2010 was 512 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2009/10 season was zero inside Subarea 58.6.

5.151 The CPUE series for this fishery was not updated by the Working Group.

#### Management advice

5.152 The Working Group encouraged the estimation of biological parameters for *D. eleginoides* in Subarea 58.6 (French EEZ), and the development of a stock assessment for this area. The Working Group encouraged France to continue its tagging program in Subarea 58.6.

5.153 The Working Group recommended that avoidance of zones of specific high by-catch abundance should also be considered.

5.154 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.

#### *Dissostichus eleginoides* Prince Edward and Marion Islands (Subareas 58.6 and 58.7)

5.155 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 inside the South African EEZ is contained in Appendix R.

5.156 The catch limit of *D. eleginoides* in the South African EEZ for the 2009/10 season was 450 tonnes for the period from 1 December 2009 to 30 November 2010. The catch reported for Subareas 58.6 and 58.7 as of 5 October 2010 was 84 tonnes, all of which was taken by longlines. There was no evidence of IUU catch in 2009/10.

5.157 The CPUE series was not updated by the Working Group.

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

5.158 Dr Leslie noted that South Africa is considering the adoption of an operational management procedure (SC-CAMLR-XXVII, Annex 7, paragraphs 6.1 to 6.3) approach as a basis for provision of management advice, and a catch limit for 2010 has not been set as yet, but it is likely to be in the range of 250–450 tonnes. Details are provided in Appendix R.

5.159 In 2005, the Scientific Committee noted that the advice on the appropriate levels of future catch provided in WG-FSA-05/58 (see also WG-FSA-06/58 and 07/34 Rev. 1) was not based on the CCAMLR decision rules. Therefore, the Working Group was unable to provide management advice for the fishery in the South African EEZ at the Prince Edward Islands. The Working Group recommended that CCAMLR decision rules also be used in estimating yields for this fishery. The proposed operational management procedure addresses the concerns over the sensitivity of the ASPM to weightings used for different data sources and the estimation of recruitment levels for forward projections.

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

5.160 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 Working Group therefore recommended that the prohibition of directed fishing for *D. eleginoides*, described in CMs 32-10, 32-11 and 32-12, remain in force.

*Champsocephalus gunnari* South Georgia (Subarea 48.3)

5.161 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Appendix S.

5.162 In the 2009/10 fishing season, the catch limit set for *C. gunnari* in Subarea 48.3 was 1 548 tonnes. During the 2009/10 season, the fishery caught 12 tonnes by the end of October 2010.

5.163 In January 2010, the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-10/38) (see also paragraph 3.18). The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

5.164 The Working Group agreed that a short-term assessment should be implemented using the length-based method described in WG-FSA-10/37 to calculate future catch limits in accordance with the CCAMLR decision rules for icefish.

5.165 The fixed parameters for the assessment remained unchanged from 2009.

#### Management advice

5.166 The Working Group recommended that the catch limit for *C. gunnari* should be set at 2 305 tonnes in 2010/11 and 1 535 tonnes in 2011/12 based on the outcome of the short-term assessment.

#### *Champscephalus gunnari* Heard Island (Division 58.5.2)

5.167 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Appendix T.

5.168 The catch limit of *C. gunnari* in Division 58.5.2 for the 2009/10 season was 1 658 tonnes for the period from 1 December 2009 to 30 November 2010. The catch reported for this division as of 5 October 2010 was 365 tonnes.

5.169 A large 3+ year class, probably the result of spawning by the 4+ year class dominant in 2006, was observed to dominate the population in the survey undertaken in April 2009.

5.170 The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2010 survey, using the revised growth parameters described in WG-FSA-10/12. All other parameters were the same as in previous years.

5.171 The Working Group recalled its advice to the Scientific Committee last year that the catch limit for *C. gunnari* in Division 58.5.2 for 2010/11 be zero (SC-CAMLR-XXVIII, Annex 5, paragraph 5.178). It also noted that the trawl survey conducted in March–April 2010 (WG-FSA-10/12) detected an incoming 2+ year class, and that the short-term projection model was properly applied to generate precautionary yields for the following two seasons based on CCAMLR decision rules. However, the biomass from the survey was very low relative to historic levels, and the short-term projection model as applied will always yield a precautionary yield, no matter what the fishable biomass. The Working Group noted that work remains outstanding from the ‘Workshop on Assessment Methods for Icefish’ (SC-CAMLR-XX, Annex 5, Appendix D) to evaluate whether this strategy will be problematic for stocks of highly variable abundance (de la Mare et al., 1998). The Working Group also noted that this work will contribute to addressing the CCAMLR PRP recommendation whether a rebuilding strategy needs to be employed for such stocks when they have low levels of biomass.

#### Management advice

5.172 The Working Group recommended that the Scientific Committee consider a catch limit for *C. gunnari* in 2010/11 of no more than 78 tonnes.

5.173 The Working Group recommended that other measures in the conservation measure be retained.

#### Other fisheries

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

5.174 The Working Group noted that WG-FSA-09/31 reported the recovery of *Notothenia rossii* populations in Potter Cover, South Shetland Islands, to levels close to that of the early 1980s, however, it cautioned that extrapolation of these findings to a subarea scale was premature.

5.175 On the basis of the results of a multi-species research survey in Subarea 48.2 (WG-FSA-09/19), the Working Group agreed that the populations of previously exploited species, including *C. gunnari* and *N. rossii*, show little sign of recovery despite the closure of the fishery after the 1989/90 season (see SC-CAMLR-XXVIII, Annex 5, paragraph 3.41).

5.176 There was no new information available to the Working Group for the 2009/10 season for these subareas.

#### Management advice

5.177 The Working Group recommended that the existing CMs 32-02 and 32-04 on the prohibition of finfishing in Subareas 48.1 and 48.2 respectively, remain in force.

Crabs (*Paralomis* spp. Subarea 48.3)

5.178 Most fishing for crabs in Subarea 48.3 has proven not to be economically viable due to the large numbers of undersized crabs caught. For example, although the *Kinpo Maru No. 58* caught 112 tonnes of crab in 2002, it also discarded 511 tonnes of undersized crab.

5.179 Toothfish by-catch levels were high in 1995 and 1996 (7 tonnes and nearly 8 tonnes respectively) but were much lower in 2002 (695 kg plus 40 kg discarded toothfish by-catch).

5.180 The fishery for crabs in Subarea 48.3 is subject to CM 52-01 with a catch limit of 1 600 tonnes. On entering the fishery, vessels must undertake an experimental harvest regime, including deploying their first 200 000 pot hours fishing in set areas in an attempt to gather data on abundance.

5.181 In 2009 one vessel notified to fish. However, the vessel only started fishing in August, and stopped fishing only on 15 October. Vessel and observer data have yet to be submitted and could not be analysed by the Working Group.

5.182 For the 2009/10 fishing season, data on catches made before 30 June were required to be submitted for analysis by WG-FSA. The Working Group strongly encouraged Russia to provide a full analysis of the data collected for the 2011 meeting of WG-FSA.

#### Management advice

5.183 The Working Group had no new advice to present to the Scientific Committee on stock status of crabs or the conduct of the fishery in Subarea 48.3.

#### Crabs (*Paralomis* spp. Subarea 48.2)

5.184 An exploratory fishery for crabs was carried out for the first time in Subarea 48.2 during the 2009/10 season. The fishery was prosecuted in accordance with the requirements of CM 52-02, and a total of 79 140 pot hours and 17 sets were completed. Only three *P. formosa* were captured, and the Working Group concluded that the crab fishery in Subarea 48.2 was not likely to be viable.

#### Management advice

5.185 The Working Group recommended that CM 52-02 be allowed to lapse.

#### Progressing scientific issues identified in the PRP Report

5.186 The Working Group considered the requests of the Scientific Committee (SC-CAMLR-XXVIII, paragraphs 10.8 and 10.10).

5.187 In regard to Task 2, the Working Group agreed that it will be able to comment when WG-EMM has developed, through the analysis of observer sampling data, an understanding of the species of larval fish affected and the seasons and areas in which they are caught in krill trawls.

5.188 In regard to Task 3, in particular how to present information on the status of fish stocks, particularly those considered depleted, catch histories could be used in this task but the lack of current fishing may not be an indicator of depletion. In many cases, cessation of fishing has been due to closure of the fisheries by CCAMLR which has generally been because of a lack of information on stock status, or information that stock status was low and that fishing should cease. However, in some cases, e.g. myctophids, the lack of fishing is because the fishing industry has ceased to be interested in the stock.

5.189 The Working Group agreed that a tabulation of available information, including catch history (by decade), the history of surveys (year, location and type), the time series of assessment results (year, type) and the current conservation measure along with appropriate cross-references to management advice, could assist with interpreting stock trajectories.

5.190 With respect to determinations of whether a stock would be considered depleted, the Working Group recalled the terminology now typically used in these discussions elsewhere is whether or not a stock is overfished (its status relative to a target state) combined with whether the current harvest rate would be considered to be too high (termed overfishing and takes account of the productivity of the stock). This is often presented in graphical form with status on one axis and harvest rate on the other.

5.191 Presentations of stock status will need to consider the relationship of the stock to the target and depleted levels in the CCAMLR decision rules. Similarly, current harvest rate will need to be considered with respect to the productivity of the stock. The classification of the harvest rate may need to be further subdivided to account for the need for recovery when a stock is considered overfished.

5.192 An important issue identified by the Working Group is that the target status may change over time as a result of ecosystem change. This is an important consideration in determining current stock status and may be an important issue to consider for managing current fisheries in CCAMLR.

5.193 Acknowledging that the classification of the status of stocks may be difficult to agree, the Working Group requested the Scientific Committee to consider whether levels of certainty could be assigned to classifications in the same way that levels of certainty are ascribed to statements by the Intergovernmental Panel on Climate Change. In this way, statements can be made about the status of stocks and harvest rates and a level of certainty assigned to them.

5.194 The Working Group did not consider Tasks 1 and 5 at its current meeting.

## FISH AND INVERTEBRATE BY-CATCH

6.1 The Working Group discussed the following:

- (i) by-catch in trawl and longline fisheries in the CAMLR Convention Area;
- (ii) the 2009/10 Year-of-the-Skate in new and exploratory fisheries, including –
  - (a) numbers of skates tagged and tag rates
  - (b) biological data collection rates
  - (c) recommendations for a future skate data collection program;
- (iii) focused data collection on macrourids;
- (iv) by-catch mitigation –
  - (a) review of move-on rules in new and exploratory fisheries
  - (b) review of move-on rule in Subarea 48.4;
- (v) papers submitted to WG-FSA-10 with relevance to by-catch;
- (vi) implications of an increase in IUU gillnetting on by-catch.

## By-catch in trawl fisheries

6.2 By-catch in trawl fisheries for icefish and toothfish derived from fine-scale (C1) data are shown in Table 17.

6.3 In Division 58.5.2 trawl fisheries, the by-catch of *Channichthys rhinoceratus* was 55 tonnes (37% of the catch limit), 17 tonnes for rajids (14% of the catch limit), 11 tonnes for *Lepidonotothen squamifrons* (14% of the catch limit), and 3 tonnes *Macrourus* spp. (less than 1% of the catch limit). The combined catch for all other by-catch species was 6 tonnes, indicating that all were individually less than 12% of their catch limit.

## By-catch in longline fisheries

6.4 Total removals of by-catch species reported in fine-scale (C2) data from longline fisheries within the CAMLR Convention Area during the 2009/10 season are summarised in Table 18.

### Rajids

6.5 In 2009/10, reported rajid by-catch was <4% of *Dissostichus* spp. catch and <9.3% as a percentage of the rajid catch limit in most longline fisheries within the Convention Area. However, in those areas where a high proportion of rajids caught are retained and processed (French EEZs: Division 58.5.1 and Subarea 58.6) catches were 10% of *Dissostichus* spp.

### Macrourids

6.6 By-catch rates for macrourids ranged from 0 to 16.9% of the *Dissostichus* spp. catch for the 2009/10 fishing season and were broadly similar to those observed in 2008/09. The highest were in the French EEZs (Division 58.5.1 and Subarea 58.6), and in Subareas 48.4 and 88.2. In Subarea 88.2, macrourid by-catch reached >50% of the by-catch limits; in Subarea 48.4 North, the macrourid catches decreased from 100% of the limit in 2008/09 to 35% of the limit in 2009/10 (see paragraph 6.42).

### Other species

6.7 By-catch of other species in 2009/10 was generally low; <1% *Dissostichus* spp. catch in all areas except Subareas 48.4 South (1.1%) and 88.2 (4.8%). The 16 tonnes attributed to other species in Subarea 48.3 was comprised of *Antimora rostrata*. Other species comprised 0.5% of the toothfish catch in Subarea 88.1, and 4.8% of the toothfish catch in Subarea 88.2 was mainly *A. rostrata*, *Chionobathyscus dewitti* and *Muraenolepis* spp.

## Data reporting for by-catch species

6.8 Comparison of fine-scale (C2) data reported for rajids amongst different subareas and divisions (Table 19) and with scientific observer data (Table 20) highlighted a number of reporting inconsistencies. The most significant of these was the reporting in C2 and observer data of rajids (as well as other by-catch species) as 'Discarded Dead' in areas south of 60°S, where this activity is prohibited (CMs 26-01, 41-04 and 41-11).

6.9 Through more detailed exploration of the data on a vessel-by-vessel basis, discussion with respective Members and examination of observer reports, it was determined that reporting of discards of by-catch species by the vessels and observers concerned was due to misinterpretation of reporting requirements for by-catch that is retained when caught south of 60°S and later discarded as offal when the vessel is north of 60°S.

6.10 The Working Group recommended that further guidance on reporting requirements be provided to both vessels and observers by way of additional detail in the instructions on the relevant data reporting forms as follows:

- C2 Retained: Individuals landed and retained on board the vessel. Some retained product may be disposed at sea at a later date in accordance with conservation measures in force for the relevant subarea or division.
- C2 Discarded: Individuals landed on board the vessel and immediately discarded overboard. This excludes individuals released alive. 'Discards' are defined as whole fish or other organisms returned to the sea dead or with low expectation of survival. Discards are prohibited south of 60°S (see CM 26-01).
- The above changes should also be made to the other relevant C forms (e.g. C1, C3, C5).
- L5 Observed number discarded dead: Observed number caught, landed on board then discarded (including factory discards) during the hauling period. This DOES NOT include individuals released alive or lost, or those individuals which are retained for processing and discarded at a later date.

6.11 The Working Group also recommended that a laminated guide that had been developed for observers and vessel crews in 2009/10 to clarify reporting requirements for skates caught in different conditions, be further developed into a poster specifically directed at new and exploratory fisheries and other areas south of 60°S. This poster could then be distributed with toothfish tag orders. It was noted that there would be budget implications for the Secretariat associated with production of these posters at approximately A\$1 000.

6.12 The other inconsistency in by-catch data noted by the Working Group was greater numbers of by-catch species reported by observers when compared with vessel numbers. It is unclear why such inconsistencies might have arisen. The Secretariat was tasked to investigate these inconsistencies.

6.13 Despite the by-catch reporting issues evident in the 2009/10 data, the Working Group agreed that generally, improvements had been made in reporting of by-catch data, particularly of skates, by both vessels and observers across all areas in the last few years.



## Year-of-the-Skate

6.14 In 2009, it was agreed by the Scientific Committee (SC-CAMLR-XXVIII, paragraph 4.230) that application of protocols for the CCAMLR Year-of-the-Skate should be continued through 2009/10, in order to allow for sufficient data to be collected for preliminary assessments to be made in the future.

6.15 The Year-of-the-Skate included a tagging program for new and exploratory fisheries (CM 41-01, Annex C) in which skate were to be double-tagged at a rate of one skate in every five skates caught, up to a maximum of 500 skates per vessel.

6.16 In order to review whether skate tag rates had been met in 2009/10 or had improved since 2008/09 within new and exploratory fisheries, fine-scale (C2) data for numbers of skate caught were used to generate total numbers of skate hauled (i.e. combining numbers retained, discarded and released) from which a tag rate could be estimated using scientific observer data on numbers of skates tagged.

6.17 During the initial year of the program in 2008/09, an overall tagging rate of 0.23 was achieved, rising to 0.29 in 2009/10 indicating better performance by vessels (see Table 19).

6.18 Individual vessel tag rates, detailed in Table 21, illustrate that the tag rate set by CM 41-01, Annex C, was met for all vessels except one vessel which fished in Division 58.4.3b.

6.19 WG-FSA-10/25 characterised skate catches by vessels fishing in the Ross Sea since 1996/97 and included summaries of tag and other data collected during the two Year-of-the-Skate fishing seasons in 2008/09 and 2009/10. The results of this paper provided very useful feedback on the success of the Year-of-the-Skate.

6.20 WG-FSA-10/25 concluded that centralisation of skate tag management, and databases through the Secretariat, have improved the ability to match tag releases and recaptures and improved the quality of the tagging data available for skate species. The paper also presented findings indicating that tagging skates on board with T-bar tags resulted in lower tag-loss rates than the previous technique of tagging skates in the water with dart tags.

6.21 The Working Group recommended that any further skate tagging should be carried out on board vessels with T-bar tags using protocols developed for the Year-of-the-Skate.

## Biological data collection

6.22 WG-FSA-10/25 also reviewed skate biological data collected between 1996/97 and 2009/10 by vessels fishing within the Ross Sea. The authors concluded that the focused data collection during this two-year period had been instrumental in providing further data for the Ross Sea, particularly length (see also WG-FSA-10/27 for updated length–weight and length–length relationships for *Amblyraja georgiana* and *Bathyraja cf. eatonii*), and tagging data and recommended that similar such data collection programs be repeated in five-year cycles for skates (see paragraph 6.31 and 6.32).

6.23 Comparison of morphometric data in WG-FSA-10/25 collected by observers demonstrated that there remained some inconsistencies in this data. The Working Group recommended that total length, pelvic length and disc width should all be recorded for all skates biologically sampled to aid species identification and to enable retrospective corrections to historical length data for which it was not clear which measurement had been recorded.

6.24 WG-FSA-10/25 also explored skate condition data spanning the period over which a change in hauling protocol was made, so that all skates caught are brought on board or alongside the hauler, in order to increase the ability of crew and observers to identify skate condition and to effectively scan for tags. The results indicated that skate damage had not increased relative to the years prior to implementation of this new handling procedure (i.e. in 2008/09 and 2009/10).

#### Future work program for skates

6.25 The Working Group agreed that the Year-of-the-Skate had been successful in meeting its initial objectives of enhancing data collection and improving tagging performance in order to develop assessments (SC-CAMLR-XXVI, Annex 5, paragraphs 6.34 and 6.35). It was also agreed that such focused data collection programs could be useful for different by-catch species (see paragraphs 6.31 to 6.34 for more discussion).

6.26 The Working Group recommended that the handling procedure implemented in 2008/09 to be made mandatory in new and exploratory fisheries in 2010/11, and sought advice from the Scientific Committee on the following proposal to replace existing text in CM 33-03, paragraph 4:

On all vessels, all skates must to be brought on board or alongside the hauler to be scanned for tags and for their condition to be assessed.

6.27 The Working Group also recommended that the mandatory requirement for tagging skates at a rate of one in every five skates in new and exploratory fisheries should be removed from paragraph 2(iii) in CM 41-01, Annex C; paragraph 13 in CMs 41-04, 41-09 and 41-10; paragraph 11 in CM 41-05; and paragraph 14 in CMs 41-06 and 41-07.

6.28 Although skate tagging would no longer be mandatory in exploratory fisheries, where Members wished to tag skates, the Working Group recommended that protocols already developed during the Year-of-the-Skate be followed. The Working Group requested advice from the Scientific Committee on the following proposal for paragraph 2(vi) to be replaced with the following paragraphs:

(vi) recaptured tagged toothfish should be biologically sampled (length(s), weight, sex, gonad stage), an electronic time-stamped photograph should be taken of the tag removed along with recovered otoliths, detailing the number and colour of the tag;

- (vii) recaptured tagged skates should be biologically sampled (all length(s), weight, sex, gonad stage), two electronic time-stamped photographs should be taken; one of the whole skate with tag attached, and one close-up of the tag detailing the number and colour of the tag.

6.29 The topic of incentives to encourage crew to continue scanning for skate tags in future seasons, such as tag lotteries or rewards on a tag-return basis, was also discussed during the meeting. Difficulties in implementing such schemes within exploratory fisheries where a number of different Member States and fishing companies are involved were considered. These included the means by which an individual crew member might receive the reward, and setting an appropriate reward level to one which would provide an incentive for crew likely to be working under varying salary schemes on different vessels.

6.30 The Working Group also recognised that there were financial implications for the Secretariat in implementing such an incentive scheme, and requested that the Scientific Committee consider the merits of such a scheme and on how best it might be carried out successfully.

#### Focused data collection for macrourids across the Convention Area

6.31 The Working Group discussed WG-FSA-10/32 which detailed plans to develop a Ross Sea medium-term data collection plan and proposed a targeted approach for by-catch species, whereby a particular year is focused on a specific species group. During such focus years which might recur in a cyclical manner (every four to five years), a particular by-catch species would be subjected to a more substantive sampling regime in order to improve knowledge on the distribution, biology and ecology of by-catch species, and to monitor potential longer-term changes in the ecosystem due to fishing, climate change or any other cause. The Working Group concluded that the Year-of-the-Skate program has illustrated the utility of such focused data collection programs (WG-FSA-10/25).

6.32 The Working Group agreed that the principle of focused data collection for particular by-catch species was worth considering when this is seen as important to advance work not currently done and is needed to address unresolved management issues.

6.33 A summary of existing biological data previously collected by scientific observers on macrourids was reviewed during the meeting. The Working Group noted that a considerable amount of data has already been collected on *Macrourus* species across subareas, including over 40 000 records of snout–anal length for *M. whitsoni* for the Ross Sea. WG-FSA-10/33 described *Macrourus* specimens from the Ross Sea originally as *M. whitsoni*. It was noted that potential confusion with species identification remains within the Ross Sea and possibly other high-latitude areas; for example, over 1 000 records listed as *M. carinatus* in Subareas 88.1 and 88.2 are more likely to be *M. whitsoni* based on more recent data (WG-FSA-10/33).

6.34 Dr Hanchet noted that New Zealand is proposing to update the identification guide for fish in the Ross Sea to reflect the identifying features of the two sympatric macrourid species. He also noted that tissue samples will be collected from a subsample of the macrourids identified by observers across the Ross Sea during the 2010/11 season so that observers'

identification can be confirmed. The Working Group encouraged other Members to take a similar approach where possible and noted that a Restriction Fragment Length Polymorphism (RFLP) test had been developed which was a rapid and low-cost way of distinguishing between the two species and could be provided to other laboratories working on these two species in the Convention Area.

6.35 The Working Group proposed that during 2010/11, observers be asked to focus on correctly identifying macrourids to species. The Working Group recommended that consideration be given in 2011 as to whether a fully focused data collection program in 2011/12 on macrourids could be useful across all subareas within the Convention Area. Members were requested to analyse available data to determine key gaps not currently being addressed by observers.

6.36 The Working Group also requested that current data on macrourids in new and exploratory areas (except Subareas 88.1 and 88.2) be characterised to the extent possible by the Secretariat in advance of WG-FSA-11 to illustrate whether or where further data is required. Such a characterisation could include the location of collected otoliths, geographical location of samples collected, and biological parameter analyses. The Working Group also encouraged Members with national research programs to submit similar characterisations of macrourids. It was suggested that this process would clarify whether, or where, focused data collection for macrourids was needed in the future.

6.37 The Working Group requested advice from WG-SAM in 2011 as to assessment methods and data collection required for such assessments on *Macrourus* spp. to aid development of a data collection framework for macrourids in 2011/12.

#### Review of mitigation measures

##### Move-on rules in exploratory fisheries (CM 33-02)

6.38 There were no triggers of the move-on rule in Division 58.5.2.

##### Move-on rules in exploratory fisheries (CM 33-03)

6.39 There were seven instances in Subarea 88.1 and five in Subarea 88.2 during 2009/10 where CM 33-03, paragraph 5, had applied, forcing vessels to move 5 n miles for five days, where the by-catch weight exceeded 1 tonne (Table 22). Review of C2 fine-scale data by the Secretariat indicated that all vessels noted in the table complied with the measure.

6.40 A similar review was also carried out for paragraph 6 (CM 33-03) which excludes a vessel from an SSRU in the event of the *Macrourus* spp. catch exceeding 16% of the catch of *Dissostichus* spp. for any two 10-day periods. Three vessels triggered the exclusion, and all were found to have subsequently moved from the affected SSRU (Table 23).

## Move-on rule in Subarea 48.4 (CM 41-03)

6.41 By-catch limits and move-on rules are included in the annual conservation measure established for Subarea 48.4 (CM 41-03).

6.42 As a result of recommendations at CCAMLR-XXVII, the move-on rule for macrourids in Subarea 48.4 South was modified so that the 16% of toothfish catch trigger would only operate on lines where at least 150 kg of macrourids were caught. In 2009/10, the total catch of macrourids was lower than that in the previous season (11.6 tonnes compared to 14.1 tonnes in the previous season) and the proportion of macrourid move-on trigger sets was considerably lower than would have occurred with the 2008/09 move-on rule (8% sets compared to 70%). The rajid by-catch was 0.9 tonnes, 1.3% of the toothfish catch, and the 5% of toothfish catch move-on rule was triggered on 15% of sets. The Working Group recommended that the move-on rules for macrourids and rajids should remain unchanged in 2010/11.

## Papers submitted to WG-FSA-10 with relevance to by-catch

6.43 WG-FSA-10/34 summarised the spatial and bathymetric distribution of the proportion of different by-catch fish species caught within the French EEZ in longline fisheries. The paper demonstrated the relationship between toothfish CPUE and by-catch; in many areas high by-catch was associated with low CPUE of toothfish.

## IUU gillnetting

6.44 The Working Group noted advice from WG-FSA-10/6 Rev. 1 stating that all IUU vessels sighted in 2009/10 were thought to be using gillnets. In the absence of any qualitative information on the levels and type of by-catch from gillnet fishing, the Working Group could not assess this and urged collection of any information that can reduce the uncertainty and which could inform future deliberations.

## EVALUATION OF THREATS ARISING FROM IUU ACTIVITIES

7.1 The Secretariat provided an estimate of IUU catches of *Dissostichus* spp. for the 2009/10 season to 30 September 2010 (WG-FSA-10/6 Rev. 1). The estimated IUU catch of *Dissostichus* spp. of 1 615 tonnes from the Convention Area was based on information from 11 sightings of seven IUU gillnet vessels in the Convention Area, as well as a review of available information from ports and markets. All IUU vessels reported to be active were believed to be gillnet vessels. There is considerable uncertainty surrounding estimates of IUU catches by gillnet vessels, and the Secretariat had consulted extensively with compliance officers with experience in the Convention Area, as well as officers with experience in gillnet operations in other fisheries (see also paragraph 3.14).

7.2 The active IUU fleet in 2009/10 consisted of a minimum of seven vessels, and was unlikely to consist of more than 10 vessels. These vessels were sighted operating in waters where sea-ice conditions were likely to preclude year-round fishing. The level of surveillance in these areas appears to be at similar levels to previous years.

7.3 The Secretariat advised that it had received no additional information to indicate that IUU catches of toothfish might be significantly in excess of its estimate of 1 615 tonnes. The Working Group expressed its appreciation for the detailed work by the Secretariat in collecting information regarding gillnet fishing.

7.4 The Working Group requested that the Secretariat continue to provide an estimate of IUU removals of *D. eleginoides* and *D. mawsoni*. The Secretariat was also requested to continue to review the index of local vessel density but to report this information to WG-FSA in future only if changes were observed to occur.

7.5 Noting that gillnetting is an indiscriminate and destructive fishing practice and that its impacts remain largely unknown, the Working Group reiterated its deep concern at the use of gillnets in the Convention Area.

## BIOLOGY, ECOLOGY AND DEMOGRAPHY OF TARGET AND BY-CATCH SPECIES

### Review of information available to the meeting

8.1 The Working Group considered 26 papers containing information relevant to this agenda item: WG-FSA-10/11, 10/13, 10/15, 10/17 to 10/22, 10/24, 10/25, 10/27, 10/33 to 10/36, 10/38, 10/44, 10/47, 10/48, 10/50 to 10/52, 10/P2, 10/P3 and 10/P5.

#### Target species

##### *Champscephalus gunnari*

8.2 Feeding rate (WG-FSA-10/18) and diet composition (WG-FSA-10/38) data were presented for the southern Scotia Arc and South Georgia respectively.

##### *Dissostichus eleginoides*

8.3 WG-FSA-10/35 documented an increase in CPUE in closed Management Area A in Subarea 48.3, between 2004 and 2008, which was attributed to an increase in average individual fish weight in the catch. WG-FSA-10/47 provided a characterisation of the catch in Division 58.4.3b. Preliminary estimates of age and growth for fish caught in Divisions 58.4.4a and 58.4.4b were given in WG-FSA-10/48.

### *Dissostichus mawsoni*

8.4 Ageing data derived from scale and otolith reading of historical collections from the Indian Ocean sector were provided in WG-FSA-10/13. WG-FSA-10/22 provided a detailed diet analysis of *D. mawsoni* from the Ross Sea. Results are compared with an earlier study in 2003. WG-FSA-10/36 detailed length-frequency distributions of *D. mawsoni* from Subareas 88.1 and 88.2 and Divisions 58.4.1 and 58.4.2. WG-FSA-10/47 provided a characterisation of the catch in Division 58.4.3b. The results of a histological investigation of gonad maturation in *D. mawsoni* from the Amundsen Sea (Subarea 88.2) were presented in WG-FSA-10/50 and suggest a spawning time in March.

### By-catch and non-target species

8.5 WG-FSA-10/11 presented the results of a study on the diet of *C. dewitti* obtained from toothfish stomachs. The Working Group recognised that this is a valuable method that may prove useful for assessing diets of species with swim bladders that usually evert stomach contents when brought to the surface. WG-FSA-10/17 detailed a preliminary investigation of the feasibility of lead/radium dating in *Chaenocephalus aceratus*. Feeding rates of six species of icefish from the southern Scotia Arc and Antarctic Peninsula were investigated in WG-FSA-10/18. Preliminary estimates of age and growth of *Muraenolepis* spp. and *A. rostrata* from the Ross Sea were presented in WG-FSA-10/19, and a preliminary assessment of age and growth in *Pleuragramma antarcticum* was provided in WG-FSA-10/20.

8.6 Biological information for skates in the Ross Sea, including the data collected in the two Years-of-the-Skate, was summarised in WG-FSA-10/25. Revised estimates of weight-length and length-length regression parameters and length-at-maturity were provided for *A. georgiana* and *B. cf. eatonii* from the Ross Sea in WG-FSA-10/27.

8.7 WG-FSA-10/33 reported on the discovery using molecular methods of a cryptic macrourid species in the Ross Sea.

8.8 WG-FSA-10/34 provided a description of the distribution and catch rates of by-catch species in the French EEZ at Kerguelen Islands (Division 58.5.1). Updated information on the distribution and size structure of demersal fish populations at South Georgia were reported in WG-FSA-10/38. WG-FSA-10/44 provided biological data on the very limited crab catch taken in the exploratory crab fishery in Subarea 48.2. New information on spawning and oogenesis of three by-catch species from the Pacific and Indian Ocean sectors of the Southern Ocean was given in WG-FSA-10/51.

### Published papers

8.9 WG-FSA-10/P2 examined connectivity between populations of *C. aceratus* in the Atlantic sector of the Southern Ocean using otolith microchemistry. WG-FSA-10/P3 analysed data from two trawl surveys to characterise the demersal fish assemblages in the Ross Sea.

## General discussion

8.10 The large increase in biology, ecology and demography papers covering a wide range of species and topics meant it was not possible to fully review all the information they contained at the meeting. The Working Group discussed whether WG-FSA represented the best forum in which to discuss the merits of papers containing information on species of less immediate relevance to the work of WG-FSA. It was agreed that the majority of expertise to assess the content of these papers lay within WG-FSA and this remains the best place to address these papers.

8.11 It was noted that WG-EMM plans to convene a session on trophic interactions in relation to krill at its meeting in 2011, and that papers on dietary ecology of relevant fish species could also be tabled for discussion at that meeting.

8.12 Several papers only provided descriptive geographic references of the location of research and fishing activities. The Working Group urged Members to ensure that future contributions included a reference to CCAMLR statistical area, subarea, division nomenclature. Where descriptive geographic names are used, they should be consistent with the SCAR Composite Gazetteer of Antarctica (<http://data.aad.gov.au/aadc/gaz/scar/>).

8.13 It was recognised that data collected in the CCAMLR fisheries process generate a considerable body of new information on the biology and ecology of target, by-catch and related species, and this should be further encouraged.

8.14 Ad hoc TASO requested advice on whether it was useful for observers to continue collecting macroscopic gonad staging information. The Working Group agreed that these data provide only qualitative information and, where possible, it would be more appropriate to collect gonad weight information using accurate marine scales and record macroscopic stage using a reduced three-point scale. If accurate scales are not available, macroscopic staging, using a multipoint scale, should be continued.

## Species profiles

8.15 The development of species profiles for by-catch species (particularly grenadiers and rajids) and potential resource species (*Pleuragramma*, grenadiers, myctophids) could provide a focus for the submission of biology and ecology papers and identify areas in which further research effort could be targeted. It was agreed that the compilation of species profiles is a major task and should not be left to individuals. The Secretariat was requested to develop outlines for such species profiles and Members were encouraged to submit to WG-FSA contributions to those profiles.

8.16 It is anticipated that the updated species profile for *D. mawsoni* (WG-FSA-10/24) will be available publicly following the upgrade of the CCAMLR website, however, copyright issues could preclude the addition of the species profile for *D. eleginoides* (WG-FSA-10/P5) to the public website in its current published format.

8.17 The role and target audience of the species profiles were discussed and it was noted that they should provide a broad overview and introduction to the biology and ecology of the



species. In conjunction with the development of a web-based, publicly accessible, archive of abstracts of SC-CAMLR working group papers, they should provide a comprehensive resource to highlight the current state of knowledge of the target species.

#### CCAMLR Otolith Network (CON)

8.18 Detailed otolith preparation manuals for the CQFE, USA (WG-FSA-10/15) and NIWA, New Zealand (WG-FSA-10/21) were provided.

8.19 The Working Group welcomed the provision of detailed and comprehensive otolith reading manuals (see paragraph 8.18) from two laboratories that are routinely involved in age determination of *Dissostichus* spp. otoliths. It was noted that there are major differences in otolith preparation and reading methods between laboratories which may restrict the ability to carry out easy inter-laboratory comparisons, although access to paired otoliths could enable comparisons between methods.

8.20 The requirement to validate age readings was re-emphasised and the use of calcium binding markers, such as OTC, on tagged specimens was highlighted as a method by which this could be improved.

8.21 The Working Group noted that the request for Members to submit a detailed inventory of otolith holdings (SC-CAMLR-XXVIII, Annex 5, paragraph 9.5) had been unsuccessful, and urged Members, in particular those operating in new and exploratory fisheries, to submit details of their otolith holdings to the Secretariat, including details of the intended processing of those otoliths.

8.22 The need to obtain reliable and validated age data from Members participating in new and exploratory fisheries was highlighted. The Working Group recalled that it is a requirement of research plans for new and exploratory fisheries to include details of fish ageing to be undertaken.

8.23 It was recognised that Members with no current otolith preparation or reading capacity could develop their own otolith preparation and reading protocols in association with an experienced otolith laboratory. However, it was suggested that for those Members, the use of a single central otolith reading facility to carry out all otolith preparation and age reading would eliminate variability in age data that could arise if many different facilities were used. The Working Group recommended that finances could be made available in the short term, possibly through the General Science Capacity Special Fund, to ensure that sufficient age data were available from new and exploratory fisheries in order to facilitate the development of assessments in these areas.

8.24 It was recommended that the Secretariat assist Members with the selection of appropriate samples for age determination to ensure that the composition of aged fish reflects the composition of the fished stock. It was recommended that Members without otolith reading facilities could store otoliths collected from new and exploratory fisheries at the CCAMLR Secretariat.

## CONSIDERATION OF ECOSYSTEM MANAGEMENT

### Bottom fishing activities and VMEs

9.1 The Working Group agreed that the sections in the template for the ‘Report on Bottom Fisheries and Vulnerable Marine Ecosystems’ formed the plan for consolidating its work this year. The Subgroup on VMEs had progressed the template for the report (Annex 6, paragraph 3.1). The Working Group agreed with WG-EMM (Annex 6, paragraph 3.58) that a document on the status of knowledge on the ecology of VMEs in the CAMLR Convention Area should be developed separately to the bottom fisheries report.

### Glossary

9.2 In 2009, the Scientific Committee identified the need for a glossary of terms relevant to the consideration and management of VMEs in the CCAMLR area (SC-CAMLR-XXVIII, paragraph 4.251(iii)).

9.3 WG-FSA-10/28 proposed a VME glossary and a diagram illustrating the conceptual relationships between the various terms, consistent with terms agreed by WG-EMM in 2010 (Annex 6, paragraphs 3.2 and 3.3) and with previously agreed CCAMLR text, to facilitate clarity and ensure consistency in subsequent CCAMLR discourse regarding VMEs. In particular, to facilitate clarity regarding the quantitative assessment of impacts on VMEs, the paper disaggregated the agreed ‘vulnerability’ term to consider the physical susceptibility of a VME taxon to damage (‘fragility’) separate from other spatio-temporal and ecological factors affecting recovery (‘resilience’). The paper also proposed a definition of ‘risk’ following the advice of WG-EMM (Annex 6, paragraph 3.5).

9.4 The Working Group recommended the following VME-related terms for the glossary. These include slight modifications to the terms already agreed by WG-EMM, for purposes of clarity and to avoid redundancy with the new agreed terms. The proposed changes do not alter the intent or conceptual meaning of the terms agreed by WG-EMM.

**Fragility** – The susceptibility of a taxon or habitat to impact (physical damage or mortality) arising from a particular interaction with a particular type of threat, e.g. bottom trawls or longlines. Fragility refers to an intrinsic physical property of the organism and the nature of the threat, without reference to the actual presence or intensity of the threat.

Example: Tall, brittle organisms would be more fragile as a result of shearing forces exerted by lateral longline movement than low profile or flexible organisms.

**Resilience** – The ability of a species or habitat to recover from impact over time, incorporating longevity, productivity/growth rate, dispersal and colonisation, rarity, patch size and spatial distribution, and ecological succession.

**Vulnerability** – The susceptibility of a taxon or habitat to impact by a particular type of threat over time, without reference to the actual presence or intensity of the threat. Vulnerability incorporates fragility and resilience.

Example: A species with high fragility but, as a population, also high resilience (i.e. rapid growth, reliable and abundant recruitment) would have lower vulnerability than a species with comparable fragility and slower growth, or with comparable fragility and infrequent or lagged recruitment.

**Threat** – An anthropogenic activity (e.g. bottom fishing) that may exert an impact on vulnerable organisms or habitats. The level of threat reflects factors extrinsic to the organism or habitat (e.g. intensity of fishing effort).

**Instantaneous impact** – Change in status to a particular taxon, habitat or other component of an ecosystem, arising from a threat over a period within which recovery is unlikely to occur. Conceptually, instantaneous impact is the product of fragility and threat.

**Cumulative impact** – The accumulated impact over time, including recovery.

**Fishing footprint** – The area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km<sup>2</sup> seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint.

**Ecological consequence** – The magnitude of ecological effects likely to arise from a particular level of cumulative impact. For example, impacts to VMEs may affect benthic-pelagic coupling, the availability of three-dimensional structural habitat for associated species, reproductive output of benthic organisms, succession in the benthic assemblage or the viability of the affected population. Ecological consequence is a function of the level of cumulative impact and the ecological attributes of the benthic ecosystem.

**Risk** – The probability that an activity will have an unacceptable ecological consequence under a particular management strategy and in a specified timeframe, taking account of uncertainty. With specific reference to the management of bottom fishing impacts on VMEs, risk may be calculated as the probability that the ecological consequence associated with an impact will exceed the ‘significant adverse ecological consequence’ (SAEC) threshold as shown in Figure 3, consistent with the limits of acceptable impact expressed in the CAMLR Convention, Article II. Risk may be expressed with reference to activities to date, or in association with a future management strategy.

9.5 The Working Group agreed that the diagram in Figure 3 provides a useful illustration of the conceptual relationships between the terms, and recommended that the diagram should accompany the VME glossary.

9.6 The graph in the diagram illustrating the relationship between cumulative impact and ecological consequence is as recommended by WG-EMM (Annex 6, paragraphs 3.3 to 3.6 and Figure 5) and provides the conceptual link to the agreed definition of risk.

9.7 The Working Group considered a definition of ‘Vulnerable Marine Ecosystem’. It was agreed that it was important in the definition of VME to distinguish between a biological entity and a term used in the designation or management of those entities.

9.8 WG-FSA-10/28 proposed that the term VME refers to a biological entity, and that an alternate term, for example, ‘registered VME’ be used to denote particular areas that have been identified and, for example, added to the Registry of Vulnerable Areas (WG-EMM-10/7).

9.9 Some members felt that the definition of VME included in WG-FSA-10/28 was appropriate and broadly consistent with the intent of previous discussions within CCAMLR, and should be proposed as follows:

VME – A location on the seafloor where the benthic invertebrate community is of particular ecological importance, and vulnerable to impact by a threat (e.g. bottom fishing). Criteria contributing to ecological importance may include the provision of emergent biogenic habitats and/or anomalously high abundance, ecological significance, diversity, or rarity when assessed at an appropriate scale (see Annex 6, paragraphs 3.42 to 3.49). Criteria contributing to vulnerability include high fragility and/or low resilience, as defined above. A VME is a biological entity; it exists independent of whether or not it has been directly observed, and independent of the distribution of threats or fishery management boundaries.

9.10 Other members considered that the definition of a VME could naturally be constructed from the terms ‘vulnerability’ and ‘threat’ in the glossary (paragraph 9.4). They noted that WG-EMM had characterised a VME in this way, such that a VME could be identified by (i) anomalously high densities of VME taxa, (ii) rare or unique benthic communities, (iii) high diversity of VME taxa, (iv) benthic communities likely to be of particular importance for ecosystem function or species’ life cycles, or (v) benthic communities with other characteristics likely to be vulnerable to bottom fisheries activities (Annex 6, paragraph 3.48). In particular, they noted that the ecological connectivity of patches will be an important determinant as to whether a benthic ecosystem may be vulnerable to bottom fishing activities. Thus, a definition could be:

VME – The spatial mosaic of ecologically connected benthic areas, including benthic and related fauna, in which taxa or habitats are vulnerable to a threat.

9.11 Those Members also noted that the use of the term ‘registered VME’ for small areas where evidence of a VME was found may be confusing because the VMEs where such evidence is found were likely to be larger than the current designations.

#### Historical bottom fishing effort

9.12 Maps summarising historical fishing effort convey different information than the actual footprint of fishing gear interactions with the seafloor. ‘Fishing footprint’ (paragraph 9.4) refers to the actual area over which bottom fishing gear makes contact with the ocean floor (e.g. reflecting lateral movement for longlines or door-to-door swept area for trawls), the determination of which is not scale-dependent. In contrast, maps depicting

fishing effort distributions (as in Appendix E, Figures 7 and 8) are inherently scale-dependent and should not be used in isolation to calculate or infer areal estimates of footprint. The Working Group suggested that such maps be referred to as ‘fishing effort distributions’.

#### VME impact assessment methods

9.13 WG-FSA-10/31 provided an update of the impact assessment framework described in WG-SAM-10/20 and Sharp et al. (2009) to estimate the cumulative footprint and potential impact on VME taxa of bottom longline fisheries in the CCAMLR area. This method was recommended by WG-SAM (Annex 4, paragraph 4.16) and WG-EMM (Annex 6, paragraph 3.20) as a framework for use by Members notifying their intention to participate in new and exploratory fisheries (paragraphs 9.15 to 9.21), as well as the means by which WG-FSA could generate cumulative impact assessments for all bottom fishing methods at the scale of subareas or divisions (paragraphs 9.22 to 9.26). This method is presented in detail in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Appendix E).

9.14 The Working Group reviewed the appropriateness of the input parameters used in the autoline longline method assessment described in WG-SAM-10/20 for use in the cumulative assessment combined across all methods to characterise two different types of bottom contact by autoline longlines, i.e. the ‘standard footprint’ and the ‘lateral movement footprint’ (see WG-EMM-10/33). The Working Group discussed the relationship between lateral movement frequency  $f_l$  and depth and chose instead to apply  $f_l = 0.5$  to all sets independent of depth. Other input parameter functions used in WG-FSA-10/31 were retained for use in the combined assessment (paragraphs 9.22 to 9.26).

#### Review of preliminary impact assessments

9.15 Nine Members submitted notifications to participate in new and exploratory fisheries under CM 21-02 (CCAMLR-XXIX/20) and submitted preliminary benthic impact assessments as required under CM 22-06 (CCAMLR-XXIX/21). An additional notification from France was submitted but withdrawn and not considered further. Review of the benthic impact assessments followed the report card format endorsed by the Scientific Committee (SC-CAMLR-XXVIII, paragraph 4.244 and Annex 5, paragraphs 10.4 to 10.8 and Table 17).

9.16 Preliminary impact assessments submitted in 2010 were much more complete compared to those submitted in 2009, and most provided detailed information and diagrams of gear configuration, proposed effort and anticipated impacts, allowing a more meaningful review and estimation of cumulative proposed fishing footprint (Table 24).

9.17 Because of the variety of responses provided as part of each Member’s assessment, direct comparisons were not appropriate for each item in the pro forma. However, each notification did address each topic requested and the data required were sufficient to generate a composite impact assessment. All submitted assessments concluded that the potential impacts in each area due to the individual notifications of bottom fishing activities were low or negligible. However, all the assessments are currently based on a number of assumptions that require significant additional information, and therefore these assessments should be viewed as preliminary.

9.18 The report card review format is structured around the information requested in CM 22-06, Annex A. Review of the information requested in Annex 22-06/A generated recommendations to edit the pro forma to create a more succinct and streamlined assessment method so that Members only need to provide minimal new and updated information in each notification. The revised pro forma (Appendix D) requests summary data and six categories of information necessary to characterise the potential impacts to VMEs within the fishing footprint. In brief, the information requested consists of:

- (i) an estimate of the total proposed effort in each subarea for notified fishing activities, in the standard units described in the ‘gear configuration’ section;
- (ii) a description of the fishing gear configuration (or a reference to an appropriate description document adopted by CCAMLR), including a definition of standard gear unit (e.g. metre of mainline);
- (iii) a characterisation of the known or expected interaction of the gear with seafloor;
- (iv) an estimate of the footprint index of the gear (WG-SAM-10/20) in standard units of km<sup>2</sup> of seabed area per km of line;
- (v) an estimate of the impact index for the gear type as described in WG-SAM-10/20;
- (vi) a description of any fishing impacts not considered in the descriptions in (ii)–(v) and their frequency (e.g. trials of a new, non-assessed gear type or gear component that may have a different or additional impact on benthic communities).

9.19 Note that most of the information requested in the pro forma can be referenced to adopted documents describing the gear configuration, its behaviour in relation to the seafloor and the generation of footprint and impact indices. The Working Group encouraged Members to provide these documents for review and adoption as part of the development of CCAMLR’s gear library. These documents may then be cited by any Member as the method used in assessing the potential impacts of notified fishing activities on VMEs within each subarea/division. Documents describing the configuration (WG-FSA-08/60), performance (CCAMLR-XXVII/19, Annex I), and an impact assessment framework for autoline longline gear (WG-SAM-10/20) endorsed by WG-SAM (Annex 4, paragraphs 4.12 to 4.19) have been made publicly available for use by Members preparing these preliminary assessments.

9.20 Details of fishing gear configurations, and how each configuration may interact with benthic habitats, are required for all operations but are a particularly high priority for trotlines, trotlines with cachaloteras, Spanish longlines, fish pots and crab pots.

9.21 The Working Group recommended that the revised Annex 22-06/A pro forma be adopted and will provide the information necessary to estimate the spatial footprint and potential impact for the notified fishing activities for the coming season for each notification as tabulated in WG-FSA-09, Table 18 (SC-CAMLR-XXVIII, Annex 5).

## Combined impact assessments

9.22 The Working Group sought to generate combined cumulative fine-scale bottom fishing impact assessments for all bottom fishing methods in all subareas and divisions included under CMs 22-06 and 22-07, following the framework described in WG-SAM-10/20 and Sharp et al. (2009). A full description of the combined impact assessment is included in Appendix E.

9.23 Assumptions and corresponding input parameters within the autoline longline impact assessment have been the subject of considerable discussion within SC-CAMLR working groups (Annex 4, paragraphs 4.12 to 4.19, Annex 6, paragraphs 3.10 to 3.22). However, similar method assessments for other bottom fishing methods – i.e. Spanish longlines, trotlines, pots and bottom trawls – have not been completed. In the absence of detailed method assessments for all bottom fishing methods, the Working Group agreed, for purposes of completing the combined impact assessment, to treat Spanish longlines and trotlines as having impacts identical to the autoline longline method. The validity of this assumption is unknown, but it is thought that the parameter estimates are conservative.

9.24 The Working Group did not consider parameter values to characterise footprint and impact estimates for pots or trawls. Consequently, the combined impact assessment was completed with reference to longlines only. The outputs are displayed as frequency distributions of pixels within each subarea or division experiencing different levels of estimated longline impact, at a scale recommended by WG-EMM (Annex 6, paragraph 3.11) and are included in Appendix E. The corresponding fine-scale impact estimates are presented in map form in SC-CAMLR-XXIX/BG/13. Impact estimate maps in Appendix E are included at a coarser scale. Similarly, fine-scale spatial effort density distributions and corresponding coarse-scale maps are displayed separately for pots and trawls, without corresponding estimates of impact.

9.25 The combined assessment outputs demonstrate that within the fished areas of each subarea or division, fishing effort is distributed unevenly, with most fished pixels experiencing impacts less than 0.4%, and with higher impacts concentrated in a few pixels. Applying the mean impact index estimate, 41 of 10 155 fished pixels in all the subareas included within CM 22-06 are estimated to have experienced greater than 3% longline impact for the most fragile VME taxa. The single-highest fine-scale pixel-specific longline impact estimate is 10.07%.

9.26 The Working Group recommended that Members be requested to complete method assessments for Spanish longlines, trotlines, pots and trawls comparable to the format of WG-SAM-10/20 so that comprehensive combined impact assessments can be completed. Method assessments for the Spanish line and trotline methods will likely require estimates of the same five input parameters used in the autoline assessment above (i.e. characterising both the standard set without lateral movement and also the lateral movement scenario) and potentially of parameters characterising other non-standard scenarios particular to these methods. A method assessment for trawls will likely require parameters characterising distinct footprints for those portions of the seafloor affected by different gear components, e.g. trawl doors, sweeps, ground gear and the trawl net.

## Identification of VMEs using by-catch data

9.27 WG-EMM reviewed methods for identifying vulnerable habitats (Annex 6, paragraphs 3.23 to 3.41).

9.28 WG-FSA-10/30 provided further analysis since WG-EMM-10 of spatial patterns of benthic invertebrate habitats from fishery by-catch in the Ross Sea. Some taxa are relatively common as by-catch (e.g. Porifera, anemones, stylasterid hydrocorals) and the detectability of habitats containing these taxa with autoline longline gear is moderate to high (e.g. 70+%). The detectability of each taxon and any discernible relationship with density should be examined to the fullest extent possible in areas with sufficiently high fishing effort and also for non-autoline gear configurations, and ultimately should be confirmed with independent sampling to link actual densities on the seafloor with amounts of by-catch observed using different fishing methods.

## Risk Areas and VME Registry

9.29 WG-EMM summarised recent encounters with potential VMEs notified according to CM 22-06, as well as Risk Areas arising from the implementation of CM 22-07 (Annex 6, paragraphs 3.42 to 3.49).

9.30 WG-FSA-10/7 described a proposed work plan by the Secretariat for the development of a VME registry to manage, store, process and summarise data notified under CMs 22-06 and 22-07 (SC-CAMLR-XXVIII, paragraph 4.251(xvi)). The registry would include a secure database for holding notification details and related data for generating web-based lists of VMEs notified under CM 22-06 and VME Risk Areas and fine-scale rectangles notified under CM 22-07, and for holding documents outlining CCAMLR's management advice and information related to VMEs and Risk Areas and a selection of maps of VMEs, Risk Areas and associated features. These data are intended to be posted on the public section of the CCAMLR website. The development of the web-based lists, document archive and basic maps are expected to be completed by early 2011. Further work would be required in subsequent years to further develop the maps as well as to maintain the registry and implement transition to future software and system requirements.

9.31 The Working Group endorsed this proposal and work plan.

## Evaluation of management strategies

9.32 WG-FSA-10/29 further developed methods for evaluating the management of benthic impacts from longline fishing using spatially explicit production models, and includes model validation. A spatially explicit production model illustrated a range of scenarios for simulating the effect and management of benthic impacts from longline fishing effort. This paper updated previous work consistent with advice arising from WG-SAM (Annex 4, paragraphs 4.7 to 4.11) and WG-EMM (Annex 6, paragraphs 3.50 to 3.56) to present a set of simulations using a range of simple case studies to approximate biologically plausible scenarios and also extreme case studies to validate the underlying model and code. The results of the simulations in the paper suggest that management action in the form of areal



closures in the Ross Sea are likely to result in an improved outcome relative to scenarios where there was no management action, but that the magnitude of simulated impacts under the biologically plausible modelled scenarios was generally very small. While additional simulations to address a wider range of plausible scenarios may be required, the authors recommended that research be focused, at least in the short term, to provide the observational or experimental data necessary to constrain important model parameters, to reduce uncertainty and provide more plausible scenarios.

9.33 The Working Group agreed that spatially explicit production models could provide a useful tool for the investigation of impacts of fishing effort on benthic organisms, noting that plausible parameterisation will need to account for the relevant attributes of benthic species and assemblages, including life-history characteristics and succession (Annex 6, paragraphs 3.53 and 3.55).

9.34 The Working Group agreed that the model used in WG-FSA-10/29 has demonstrated, with simple case studies, that it operates consistent with expectations under extreme scenarios. It noted that a number of production scenarios could be explored using this model and encouraged Members to develop plausible scenarios for testing in the future.

#### Review of conservation measures

9.35 The Working Group agreed that the requirements for preliminary assessments in CM 22-06 could be improved and recommended that the draft annex be adopted for use next year (see paragraphs above and Appendix D).

#### Report on Bottom Fisheries and Vulnerable Marine Ecosystems

9.36 Following discussion at WG-EMM on the Report on Bottom Fisheries and Vulnerable Marine Ecosystems, the Working Group collated information into a report for review by the Scientific Committee (Appendix E).

#### Advice to the Scientific Committee

9.37 The Working Group noted the progress on the different elements of the work plan of the Scientific Committee on bottom fisheries (SC-CAMLR-XXVIII, paragraph 4.251):

(i) Definition of Risk Areas –

No further progress.

(ii) Review of existing Risk Areas, including the development of a review process –

WG-EMM has summarised data to consider in reviewing Risk Areas (Annex 6, paragraph 3.40).

- (iii) Development of a glossary of terms, including quantitative definitions as appropriate, to improve understanding and communication on these issues (SC-CAMLR-XXVIII, Annex 5, paragraphs 10.36 and 10.40) –

A glossary and accompanying diagram is included in Figure 3 and further discussed in paragraphs 9.2 to 9.11.

- (iv) Further consideration of criteria to assist the Scientific Committee in defining areas as VMEs under CM 22-06 (SC-CAMLR-XXVIII, Annex 10, paragraph 6.14) –

WG-EMM has summarised characteristics that might be considered as evidence of VMEs (Annex 6, paragraph 3.48).

- (v) Evaluation of the proportions of fishable areas that would comprise different benthic habitats and whether the frequency of observations of benthos in by-catch is consistent with the proportional coverage of these different habitats –

Some progress has been made on identifying habitat types using by-catch data (paragraph 9.28).

- (vi) Development of alternate trigger levels for a range of VME taxa, including distinction between ‘heavy’ and ‘light’ taxa, along with options to enable taxon-specific weights to be collected (SC-CAMLR-XXVIII, Annex 5, paragraph 10.44) –

No further progress.

- (vii) Consideration of whether the presence of high densities of rare taxonomic groups or unique community assemblages specific to the Southern Ocean will warrant additional attention, and perhaps an increased level of precaution (SC-CAMLR-XXVIII, Annex 4, paragraph 5.9) –

Some consideration has been given to this issue but no substantive progress has been made on methods of identifying locations of rare or unique assemblages (Appendix E, paragraphs 32 to 38).

- (viii) Further consideration of fishing footprint and its possible impacts on VMEs, taking account of the differences in the interactions of different gears with the bottom (SC-CAMLR-XXVIII, Annex 5, paragraphs 10.20 to 10.22) –

An impact assessment procedure has been used to assess impacts of longline fishing (paragraphs 9.13 and 9.14). Submissions are needed on Spanish longlines, trotlines, trawl and pot methods (paragraphs 9.19 and 9.20).

- (ix) Refinement of methods for creating cumulative fishery-scale footprint maps (SC-CAMLR-XXVIII, Annex 5, paragraphs 10.14 to 10.16), including resolving technical issues for their production, in order to update the calculations annually (SC-CAMLR-XXVIII, Annex 5, paragraphs 10.16 and 10.17) –

Software is now available in the Secretariat (paragraph 9.12).

- (x) Development of plausible scenarios of the types and dynamics of VMEs and the spatial and temporal interactions of the fishery with VMEs (SC-CAMLR-XXVIII, Annex 5, paragraph 10.45) –

Consideration of plausible scenarios by WG-EMM (Annex 6, paragraphs 3.52 to 3.55). The Working Group recommended that a focus topic be held on this issue at WG-FSA in 2012 when experts in benthic ecology could be invited to attend.

- (xi) Evaluation of management strategies within the conservation measures, along with other possible strategies for avoiding significant adverse impacts on VMEs –

Progress has been made on developing simulation tools to evaluate management strategies (see Report on Bottom Fisheries and Vulnerable Marine Ecosystems) (paragraphs 9.32 and 9.33; Annex 4, paragraphs 4.7 to 4.11).

- (xii) Further development of risk assessment frameworks (SC-CAMLR-XXVIII, Annex 4, paragraph 5.11; Annex 6, paragraphs 4.9 and 4.16; Annex 10, paragraphs 4.1 to 4.5) and simulation approaches, such as ‘Patch’ (SC-CAMLR-XXVIII, Annex 4, paragraphs 5.11 to 5.14; Annex 5, paragraphs 10.46 to 10.48; Annex 6, paragraphs 4.10 to 4.15, 4.17 to 4.19; Annex 10, paragraphs 4.6 to 4.10) –

The Report on Bottom Fisheries and Vulnerable Marine Ecosystems presents the impact assessment framework currently being used to assess cumulative impacts, as well as describing the simulation methods that have been developed.

- (xiii) Further assessment of benthic taxa against the seven criteria for assisting in evaluating their vulnerability (SC-CAMLR-XXVIII, Annex 10, paragraphs 3.1 to 3.10 and Table 1) –

No further progress has been made.

- (xiv) Consideration of different methods for identifying locations of VMEs (SC-CAMLR-XXVIII, Annex 10, paragraphs 5.1 to 5.37 and 6.10 to 6.13) –

Methods to use by-catch data for locating habitat types have been developed (paragraph 9.28).

- (xv) Consideration of how the footprint estimates for different gears might be used to assess whether proposed bottom fishing activities would contribute to having significant adverse impacts on VMEs (SC-CAMLR-XXVIII, Annex 5, paragraph 10.13) –

Work is yet to be undertaken to use the impact assessment methods on assessing the impacts of proposed bottom fishing activities in the future. The simulation methods might be used in this regard.

- (xvi) Further development of the Secretariat’s capability to manage, store, process and summarise data resulting from CMs 22-06 and 22-07 is necessary (SC-CAMLR-

XXVIII, Annex 5, paragraph 10.39), including the development of a work plan and budget, prioritising the capability to provide real-time data, and to provide data for use by the Scientific Committee and its working groups –

The Working Group endorsed the proposal of the Secretariat to further develop this capability (paragraphs 9.29 and 9.30).

(xvii) Further develop the procedural framework for managing bottom fisheries –

No further progress has been made on this. The current framework is contained in the Report on Bottom Fisheries and Vulnerable Marine Ecosystems (Appendix E, Figure 9; SC-CAMLR-XXVIII, Annex 5, paragraph 10.37).

## Depredation

9.38 Depredation of toothfish hooked in longline fisheries has been witnessed for marine mammal species, including killer whales and sperm whales (e.g. WG-FSA-10/P6). The Working Group agreed that the regular collection of data indicative of depredation would be useful, and considered whether marine mammal sightings during gear hauling, and/or directly observed behaviours indicative of depredation events, could be routinely included in the C2 data reporting requirements for longline fisheries. Depredation reporting should record which species is observed, and should be a vessel responsibility rather than an observer responsibility. Options for validation of the resulting data, e.g. using fishery observers, should be considered.

## Other interactions with WG-EMM

9.39 WG-FSA-10/15, 10/20, 10/22, 10/P3, 10/P4 and WG-SAM-10/21 have been considered separately under the Biology and Ecology agenda item. There was no further discussion under Item 9.3.

## SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

10.1 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. Information collected by scientific observers was summarised in WG-FSA-10/5 Rev. 2 and 10/8.

10.2 The Working Group urged technical coordinators to ensure that observers are aware of the need to accurately record all tag details and the full tag number (including any characters and addresses).

10.3 The Report of the Third Meeting of Ad Hoc TASO, held in Hobart, Australia, from 11 to 15 October 2010 (Annex 7), was presented by the Co-conveners. The Working Group welcomed the advances made by TASO towards developing a system of accreditation of observer programs.

10.4 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:

- (i) 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;
- (ii) noted that accreditation of observer programs will contribute to improved data quality from observers;
- (iii) noted that information in the *Scientific Observers Manual* to enable observers and crew to distinguish between *D. eleginoides* and *D. mawsoni* has been substantially improved in accordance with a recommendation made in 2009 (SC-CAMLR-XXVIII, Annex 5), and recommended that a list of the SSRUs where both toothfish species have been recorded be provided in the manual so that observers are sufficiently briefed as to which species are likely to be encountered;
- (iv) considered the template for outlining sampling requirements for the Ross Sea (WG-FSA-10/32, Table 3) and recommended investigation into summarising sampling requirements for other areas;
- (v) recommended that the following have the potential to contribute to continued improvement in the quality of observer data collected as part of the CCAMLR Scheme of International Scientific Observation –
  - (a) enhanced ‘within-trip’ error checking and feedback to observers from technical coordinators;
  - (b) providing the option for database entry of data by observers to allow enhanced data entry checking (e.g. logical and range checking);
  - (c) feedback to observers based on review of data performance metrics, including, inter alia, review of species identification, measurement, sex and maturity-stage determination and tagging.

10.5 It appears that a lack of clarity in the instructions for observers in new and exploratory fisheries exists because of contradictory instructions on sampling requirements in the observer logbook and CM 41-01, Annex B. Furthermore, the recommendation for sampling fish at a rate based on the number of hooks, rather than a fixed number per set, that was agreed by the Working Group in 2008 (SC-CAMLR-XXVII, Annex 5, paragraphs 11.4(ii)(c) and (e)) was incorporated into the observer logbook instructions but not into a revision of CM 41-01, Annex B.

10.6 The Working Group requested advice from the Scientific Committee and Commission on a process to clarify the sampling requirements for target and by-catch species as currently specified in conservation measures, the *Scientific Observers Manual* and the observer logbooks. The Working Group noted that the format described in Table 16 provided a possible means to facilitate this process.

10.7 It was recommended that technical coordinators consider training material, such as for maturity staging and species identification, that the Secretariat could distribute, including on the CCAMLR website, for use by coordinators in other areas. This should be limited to good-quality material with a high degree of transferability.

## FUTURE WORK

### Organisation of intersessional activities of subgroups

11.1 The Working Group thanked all subgroups for their contributions and encouraged each one to continue its work in the forthcoming intersessional period, focusing, where possible, on key issues identified below. Membership to the subgroups was open to all participants, and new participants are encouraged to contact the Secretariat for further information on the subgroups (see paragraph 2.5 for a list of subgroups and coordinators).

11.2 The Working Group agreed to establish a new subgroup to facilitate the development of assessments in data-poor fisheries, coordinated by Dr Taki.

11.3 The Subgroup on Biology and Ecology was tasked with the ongoing development and updating species profiles (paragraph 8.15).

11.4 Dr Jones agreed to contact subgroup coordinators two weeks prior to the next meeting of WG-FSA in order to review subgroup work plans for that meeting (including draft agendas) in light of the Working Group's priorities, meeting agenda and submitted papers. Subgroup coordinators were encouraged to submit a prioritised list of data requests and analyses to the Secretariat at that time, in order to facilitate the subgroups' preparatory work during the meeting.

11.5 The Working Group noted that it had covered a large in-depth range of topics during its meeting. It requested that the Scientific Committee review the Working Group's agenda, and advise on options and priorities for work at future meetings. Some aspects of WG-FSA's work (e.g. assessments) are conducted on a two-year cycle, and it may be feasible for the Working Group to consider other aspects of its work, such as by-catch or VME, on a two-year cycle.

11.6 The Working Group noted that holding its meeting concurrently with TASO in 2010 had provided opportunities for the exchange of expertise between these two groups. However, the concurrent meetings had also limited some of WG-FSA's activities during the first week of the meeting due to some WG-FSA participants attending the TASO meeting. This had impacted on the Working Group's workflow during the meeting.

### Intersessional meetings

11.7 During the course of its meeting, the Working Group identified a number of matters which it referred to WG-IMAF and WG-SAM:

WG-IMAF –

- consideration of the findings reported in WG-FSA-10/P1 (paragraph 3.9).

WG-SAM –

- development of the work plan for implementing research proposals for data-poor fisheries (paragraph 5.97);
- data collection and assessment methods for assessing *Macrourus* spp. (paragraph 6.37).

#### Notification of scientific research activities

11.8 Five notifications have been received in accordance with CM 24-01 for scientific research activities in 2010/11 (WG-FSA-10/9):

(i) Scientific research notifications (CM 24-01, paragraph 2) –

Germany: Subareas 48.1, 88.3 (November 2010–February 2011), krill research  
Subareas 48.1–48.3, 48.6 (February–April 2011), multi-disciplinary research.

(ii) Research fishing notifications (CM 24-01, paragraph 3) –

Japan: Divisions 58.4.4a and 58.4.4b (April–June 2011), toothfish  
Republic of Korea: Subarea 88.3 (March–May 2011), toothfish  
Russia: Subareas 88.2 and 88.3 (January–March 2011), toothfish.

11.9 The notifications involving research fishing were considered under Item 5.

11.10 The Working Group also noted that the UK and Australia will be conducting research surveys in 2011 in Subarea 48.3 and Division 58.5.2 respectively. Notifications for these surveys would be submitted in due course.

#### General matters

11.11 The Working Group identified the following general items of future work:

(i) Assessments –

- assessment of *Dissostichus* spp. in Subarea 48.4 (paragraphs 3.22, 4.5 and 4.6)
- assessment of *C. gunnari* in Subarea 48.3 (paragraphs 4.9 to 4.11)
- assessment of *C. gunnari* in Division 58.5.2 (paragraph 4.13)
- assessment of *D. eleginoides* in Division 58.5.1 (paragraphs 4.16, 4.17 and 5.142)
- assessment of *D. eleginoides* in Division 58.5.2 (paragraph 5.147)
- characterisation of the fishery for *Paralomis* spp. in Subarea 48.3 (paragraph 5.182)

- review of data collected in research hauls from exploratory fisheries in Subareas 48.6 and 58.4 (paragraphs 5.27 and 5.28)
  - assessment of *Dissostichus* spp. in Division 58.4.3b (paragraph 5.71)
  - validation of age readings (paragraph 8.20)
  - submission of detailed inventory of otolith data holdings (paragraph 8.21)
  - collection of validated age data (paragraph 8.22)
  - selection of appropriate samples for age determination (paragraph 8.24)
  - review of tag-specific parameters used in assessments (paragraph 3.32)
  - summary of data collection requirements in exploratory fisheries (paragraph 5.34)
  - research fishing in Division 58.4.4 (paragraph 5.118).
- (ii) IUU fishing –
- development of IUU catch estimates (paragraphs 3.11, 3.14 and 7.4).
- (iii) By-catch –
- future work program for skates (paragraphs 6.26 and 6.28)
  - analysis of data on macrourids in exploratory fisheries (paragraphs 6.35 and 6.36)
  - by-catch data inconsistencies (paragraph 6.12).
- (iv) VMEs –
- development of method assessments for fishing gear (paragraph 9.26)
  - development of the VME registry (paragraphs 9.30 and 9.31)
  - development of plausible scenarios for testing spatially explicit production models (paragraph 9.33).
- (v) Scientific observers –
- recording of tag details and numbers (paragraph 10.2)
  - training material for scientific observers (paragraph 10.7)
  - continued improvements in the quality of observer data (paragraph 10.4(v)).
- (vi) Other –
- development of species profiles (paragraph 8.15)
  - include a reference to CCAMLR statistical areas in geographic references provided in working group papers (paragraph 8.12)
  - translation of information about tagging programs (paragraph 3.31)
  - progressing scientific issues identified by the PRP (paragraphs 5.187 to 5.194)
  - consider a revision of statistical boundaries in the Ross Sea (paragraph 3.17).

11.12 Updates made to the Fishery Reports during the meeting had not been identified in track-change at the time of adoption, and the Working Group requested that the Secretariat highlight the substantive updates in the version of the reports which would be circulated during CCAMLR-XXIX. If inconsistencies were subsequently found between the information in the fishery reports and that reported in the report of the meeting, the Working Group agreed that the information in the report of the meeting would have primacy, and the relevant Fishery Report would be amended accordingly.



11.13 The Working Group agreed that, at future meetings, the version of the Fishery Reports prepared for adoption should retain the track-changes in order to facilitate the review and adoption procedure.

## OTHER BUSINESS

### Independent review of the Secretariat's Data Management Systems

12.1 The Secretariat outlined a proposal for an independent review of its data management systems (CCAMLR-XXIX/13). The goal of the proposed review is to provide assurance that CCAMLR's information assets are appropriately managed and protected, and that identified risks, including those which may arise from the Commission's growing needs, are managed and mitigated using an appropriate international standard as the benchmark. The Working Group also noted that the proposed review is part of the Secretariat's broad consideration of an information security policy.

12.2 The Working Group agreed that the current delivery of the Secretariat's data services is efficient and provides information essential to the work of WG-FSA. The proposed review was expected to assist in the further development of these services, including the implementation of data-quality metrics for fishery and observer data (Annex 4, paragraph 6.2). The proposed review was supported.

### *CCAMLR Science*

12.3 The Secretariat provided an update on the online availability of Volume 17 of *CCAMLR Science* and outlined the potential developments of the journal as it moves to an increasing emphasis on electronic publication (SC-CAMLR-XXIX/8). The Working Group agreed that while it was important for the journal to develop, it was also important that any changes did not undermine the specific role of *CCAMLR Science* in showing the breadth and quality of science that CCAMLR considered in providing its management advice.

### Rational use

12.4 The Working Group had insufficient time to consider SC-CAMLR-XXIX/BG/9 'Considering rational use in the context of designing CCAMLR's Representative System of Marine Protected Areas'.

## ADVICE TO THE SCIENTIFIC COMMITTEE

13.1 The Working Group's advice arising from the meeting is summarised below, and consideration of the surrounding issues is provided in Sections 2 to 12:

- (i) Development of assessments –
- short-term financial support for otolith preparation and age reading (paragraph 8.23)
  - selection of appropriate samples for age determination (paragraph 8.24)
  - implementation of a reward scheme for reporting tag recaptures (paragraphs 6.29 and 6.30)
  - tag-release program in exploratory fisheries (paragraphs 5.20, 5.21, 5.38, 5.45, 5.68 and 5.87)
  - data collection requirements in exploratory fisheries (paragraphs 5.34 and 5.95)
  - development of a research framework for data-poor fisheries (paragraphs 5.11 and 5.12)
  - research fishing in Division 58.4.4 (paragraph 5.116)
  - research plans notified under CM 24-01 (paragraph 5.126).
- (ii) IUU fishing –
- extent of IUU fishing (paragraphs 3.11, 3.14, 7.4 and 7.5).
- (iii) Fishery management advice –
- *D. eleginoides* in Subarea 48.3 (paragraphs 5.129 and 5.130)
  - *Dissostichus* spp. in Subarea 48.4 (paragraphs 5.135 to 5.137)
  - *D. eleginoides* in Division 58.5.1 (paragraphs 5.143 to 5.145)
  - *D. eleginoides* in Division 58.5.2 (paragraph 5.148)
  - *D. eleginoides* in Subarea 58.6, Crozet Islands (paragraphs 5.152 to 5.154)
  - *D. eleginoides* in Subareas 58.6 and 58.7, Prince Edward and Marion Islands (paragraphs 5.159 and 5.160)
  - *C. gunnari* in Subarea 48.3 (paragraph 5.166)
  - *C. gunnari* in Division 58.5.2 (paragraphs 5.172 and 5.173)
  - finfish in Subareas 48.1 and 48.2 (paragraph 5.177)
  - *Paralomis* spp. in Subarea 48.3 (paragraph 5.183)
  - *Paralomis* spp. in Subarea 48.2 (paragraph 5.185)
  - *Dissostichus* spp. in Subarea 48.6 (paragraphs 5.40 and 5.41)
  - *Dissostichus* spp. in Division 58.4.1 (paragraphs 5.47 to 5.49)
  - *Dissostichus* spp. in Division 58.4.2 (paragraphs 5.55 to 5.57)
  - *Dissostichus* spp. in Division 58.4.3a (paragraphs 5.62 and 5.63)
  - *Dissostichus* spp. in Division 58.4.3b (paragraphs 5.78 to 5.81)
  - *Dissostichus* spp. in Subareas 88.1 and 88.2 (paragraphs 5.95 and 5.96).
- (iv) By-catch –
- reporting of ‘discards’ south of 60°S (paragraphs 6.10 and 6.11)
  - outcomes from the Year-of-the-Skate (paragraphs 3.30, 3.31, 6.21 and 6.26 to 6.28)
  - focused data collection for macrourids (paragraph 6.35).

(v) VMEs –

- glossary of VME-related terms (paragraphs 9.4 and 9.5 and Figure 3)
- revision of Annex A of Conservation Measure 22-06 (paragraphs 9.21 and 9.35)
- fishing method assessments (paragraph 9.26)
- progress on the work plan of the Scientific Committee on bottom fisheries (paragraph 9.37).

(vi) Scientific observers –

- clarification of sampling requirements specified in conservation measures (paragraph 10.6)
- training material for scientific observers (paragraph 10.7)
- continued improvements in the quality of observer data (paragraph 10.4(v))
- collection of fish gonad staging information (paragraph 8.14).

(vii) Other –

- progressing scientific issues identified by the PRP (paragraphs 5.190 to 5.193)
- availability of species profiles (paragraph 8.17)
- proposed review of the Secretariat's data management systems (paragraph 12.2).

## ADOPTION OF THE REPORT

14.1 The report of the meeting was adopted.

## CLOSE OF MEETING

15.1 Dr Jones thanked the subgroup coordinators, rapporteurs, all participants and the Secretariat staff for their contributions and involvement in the work of WG-FSA, including the intersessional activities. The contributions were numerous and detailed, and had led to another productive meeting.

15.2 Dr Constable, on behalf of the Working Group, thanked Dr Jones for convening the Working Group. The Working Group had embraced a large body of work, and Dr Jones' thorough preparation and expertise had facilitated the meeting's achievements.

15.3 The meeting was closed.

## REFERENCES

Arana, P.M. and R. Vega. 1999. Exploratory fishing for *Dissostichus* spp. in the Antarctic region (Subareas 48.1, 48.2 and 88.3). *CCAMLR Science*, 6: 1–17.

- de la Mare, W.K., R. Williams and A.J. Constable. 1998. An assessment of the mackerel icefish (*Champscephalus gunnari*) off Heard Island. *CCAMLR Science*, 5: 79–101.
- Sharp, B.R., S.J. Parker and N. Smith. 2009. An impact assessment framework for bottom fishing methods in the CAMLR Convention Area. *CCAMLR Science*, 16: 195–210.

Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in 2009/10. **Bold**: fishery closed; CM: conservation measure. (Source: catch and effort reports to 24 September 2010 unless otherwise indicated.)

| Target species                  | Region                         | Fishery               | Fishing period |                        | CM    | Catch (tonnes) of target species |            | Reported catch (%limit) |
|---------------------------------|--------------------------------|-----------------------|----------------|------------------------|-------|----------------------------------|------------|-------------------------|
|                                 |                                |                       | Start          | End                    |       | Limit                            | Reported   |                         |
| <i>Champscephalus gunnari</i>   | 48.3                           | Trawl                 | 01-Dec-09      | 30-Nov-10              | 42-01 | 1 548                            | 12         | 1                       |
|                                 | 58.5.2                         | Trawl                 | 01-Dec-09      | 30-Nov-10              | 42-02 | 1 658                            | 365        | 22                      |
| <i>Dissostichus eleginoides</i> | 48.3                           | Longline, pot         | 01-Dec-09      | 30-Nov-10 <sup>a</sup> | 41-02 | 3 000                            | 2 522      | 84                      |
|                                 | 48.4 north                     | <b>Longline</b>       | 01-Dec-09      | 14-Apr-10              | 41-03 | 41                               | 40         | 98                      |
|                                 | 58.5.1 French EEZ <sup>b</sup> | Longline              | ns             | ns                     | ns    | ns                               | 2 977      | -                       |
|                                 | 58.5.2                         | Longline, trawl       | 01-Dec-09      | 30-Nov-10              | 41-08 | 2 550                            | 1 873      | 73                      |
|                                 | 58.6 French EEZ <sup>b</sup>   | Longline              | ns             | ns                     | ns    | ns                               | 512        | -                       |
|                                 | 58 South African EEZ           | Longline              | ns             | ns                     | ns    | ns                               | 21         | -                       |
| <i>Dissostichus spp.</i>        | 48.4 south                     | <b>Longline</b>       | 01-Dec-09      | 04-May-10              | 41-03 | 75                               | 74         | 99                      |
|                                 | 48.6                           | Longline              | 01-Dec-09      | 30-Nov-10              | 41-04 | 400                              | 295        | 74                      |
|                                 | 58.4.1                         | <b>Longline</b>       | 01-Dec-09      | 20-Feb-10              | 41-11 | 210                              | 196        | 93                      |
|                                 | 58.4.2                         | <b>Longline</b>       | 01-Dec-09      | 24-Feb-10              | 41-05 | 70                               | 93         | 133                     |
|                                 | 58.4.3a                        | Longline              | 01-May-10*     | 31-Aug-10              | 41-06 | 86                               | No fishing | -                       |
|                                 | 58.4.3b                        | Longline <sup>c</sup> | 01-Dec-09*     | 31-Mar-10              | 41-07 | 72                               | 14         | 19                      |
|                                 | 88.1                           | <b>Longline</b>       | 01-Dec-09      | 09-Feb-10              | 41-09 | 2 850                            | 2 870      | 101                     |
|                                 | 88.2                           | Longline              | 01-Dec-09      | 31-Aug-10              | 41-10 | 575                              | 314        | 55                      |
| <i>Euphausia superba</i>        | 48.1, 48.2, 48.3, 48.4         | Trawl                 | 01-Dec-09      | 30-Nov-10              | 51-01 | 620 000                          | 196 390    | 32                      |
|                                 | 48.6                           | Trawl                 | 01-Dec-09      | 30-Nov-10              | 51-05 | 15 000                           | No fishing | -                       |
|                                 | 58.4.1                         | Trawl                 | 01-Dec-09      | 30-Nov-10              | 51-02 | 440 000                          | No fishing | -                       |
|                                 | 58.4.2                         | Trawl                 | 01-Dec-09      | 30-Nov-10              | 51-03 | 452 000                          | No fishing | -                       |
| <i>Paralomis spp.</i>           | 48.2                           | Pot                   | 01-Dec-09      | 30-Nov-10              | 52-02 | 250                              | <1         | <1                      |
|                                 | 48.3                           | Pot                   | 01-Dec-09      | 30-Nov-10              | 52-01 | 1 600                            | 22         | 1                       |
|                                 | 48.4                           | Pot                   | 01-Dec-09      | 30-Nov-10              | 52-03 | 10                               | No fishing | -                       |

<sup>a</sup> Longline fishery is closed

<sup>b</sup> Reported in fine-scale data

<sup>c</sup> Research fishing only

ns Not specified by CCAMLR

\* Fishing may occur outside the prescribed season

Table 2: Total extrapolated incidental mortality of seabirds and observed mortality rates (birds/thousand hooks) in longline fisheries in Subareas 48.3, 48.4, 48.6, 58.6, 58.7, 88.1, 88.2, Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b, 58.5.1 and 58.5.2 from 1997 to 2010. - indicates no fishing occurred.

| Subarea   | Year    |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
|---|---------|---------|--------------------|---------|--------------------|---------------------|---------------------|--------------------|--------|--------|-------|-------|------------------|--------|
|   | 1997    | 1998    | 1999               | 2000    | 2001               | 2002                | 2003                | 2004               | 2005   | 2006   | 2007  | 2008  | 2009             | 2010   |
| <b>Subarea 48.3</b>                               |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | 5 755   | 640     | 210 <sup>1</sup>   | 21      | 30                 | 27                  | 8                   | 27                 | 13     | 0      | 0     | 0     | 8                | 7      |
| Observed mortality rate                           | 0.23    | 0.032   | 0.013 <sup>1</sup> | 0.002   | 0.002              | 0.0015              | 0.0003              | 0.0015             | 0.0011 | 0      | 0     | 0     | 0.0005           | 0.0005 |
| <b>Subarea 48.4</b>                               |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | -       | -       | -                  | -       | -                  | -                   | -                   | -                  | 0      | 0      | 0     | 0     | 0                | 0      |
| Observed mortality rate                           | -       | -       | -                  | -       | -                  | -                   | -                   | -                  | 0      | 0      | 0     | 0     | 0                | 0      |
| <b>Subarea 48.6</b>                               |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | -       | -       | -                  | -       | -                  | -                   | -                   | 0                  | 0      | 0      | 0     | -     | 0                | 0      |
| Observed mortality rate                           | -       | -       | -                  | -       | -                  | -                   | -                   | 0                  | 0      | 0      | 0     | -     | 0                | 0      |
| <b>Subareas 58.6, 58.7</b>                        |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | 834     | 528     | 156                | 516     | 199                | 0                   | 7                   | 39                 | 76     | 0      | 0     | 0     | 0                | 0      |
| Observed mortality rate                           | 0.52    | 0.194   | 0.034              | 0.046   | 0.018              | 0                   | 0.003               | 0.025              | 0.149  | 0      | 0     | 0     | 0                | 0      |
| <b>Subarea 58.6 French EEZ</b>                    |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality <sup>3</sup>               | no data | no data | no data            | no data | -                  | 1 243 <sup>2</sup>  | 720 <sup>2</sup>    | 343 <sup>2</sup>   | 242    | 235    | 314   | 131   | 94               |        |
| Observed mortality rate <sup>3</sup>              |         |         |                    |         | -                  | 0.1672              | 0.1092              | 0.0875             | 0.0490 | 0.0362 | 0.065 | 0.031 | 0.0119           |        |
| Extrapolated mortality                            |         |         |                    |         |                    |                     |                     |                    |        |        |       |       | 93               | 102    |
| Observed mortality rate                           |         |         |                    |         |                    |                     |                     |                    |        |        |       |       | 0.015            | 0.024  |
| <b>Subareas 88.1, 88.2</b>                        |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | -       | 0       | 0                  | 0       | 0                  | 0                   | 0                   | 1                  | 0      | 0      | 0     | 0     | 0                | 0      |
| Observed mortality rate                           | -       | 0       | 0                  | 0       | 0                  | 0                   | 0                   | 0.0001             | 0      | 0      | 0     | 0     | 0                | 0      |
| <b>Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b</b> |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | -       | -       | -                  | -       | -                  | -                   | -                   | 0                  | 8      | 2      | 0     | 0     | 0                | 0      |
| Observed mortality rate                           | -       | -       | -                  | -       | -                  | -                   | -                   | 0                  | <0.001 | 0.0002 | 0     | 0     | 0                | 0      |
| <b>Division 58.5.1 French EEZ</b>                 |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality <sup>3</sup>               | no data | no data | no data            | no data | 1 917 <sup>2</sup> | 10 814 <sup>2</sup> | 13 926 <sup>2</sup> | 3 666 <sup>2</sup> | 4 387  | 2 352  | 1 943 | 1 224 | 643              |        |
| Observed mortality rate <sup>3</sup>              |         |         |                    |         | 0.0920             | 0.9359              | 0.5180              | 0.2054             | 0.1640 | 0.0920 | 0.079 | 0.059 | 0.0316           |        |
| Extrapolated mortality                            |         |         |                    |         |                    |                     |                     |                    |        |        |       |       | 417              | 230    |
| Observed mortality rate                           |         |         |                    |         |                    |                     |                     |                    |        |        |       |       | 0.034            | 0.015  |
| <b>Division 58.5.2</b>                            |         |         |                    |         |                    |                     |                     |                    |        |        |       |       |                  |        |
| Extrapolated mortality                            | -       | -       | -                  | -       | -                  | -                   | 0                   | 0                  | 0      | 0      | 0     | 2     | 3                | 5      |
| Observed mortality rate                           | -       | -       | -                  | -       | -                  | -                   | 0                   | 0                  | 0      | 0      | 0     | 0.002 | 0.001            | 0.002  |
| Total seabird mortality                           | 6 589   | 1 168   | 366                | 537     | 2 146              | 12 084              | 14 661              | 4 076              | 4 726  | 2 589  | 2 257 | 1 357 | 521 <sup>4</sup> | 344    |

<sup>1</sup> Excluding *Argos Helena* line-weighting experiment cruise.

<sup>2</sup> The number of hooks has not been collected and the values given are from the total number of hooks set.

<sup>3</sup> Data provided by France for fishing season 1 September to 31 August, not CCAMLR season (1 December to 30 November).

<sup>4</sup> This total excludes the extrapolated totals provided by France for 2009.

Table 3: Seabird mortality totals and rates (BPT: birds/trawl) and species composition, recorded by observers in the CAMLR Convention Area trawl fishery during the 2009/10 season. \* – continuous trawl method; PRX – Procellariidae; PRO – *Procellaria aequinoctialis*; DAC – *Daption capense*; KRI – *Euphausia superba*; ANI – *Champtocephalus gunnari*; TOP – *Dissostichus eleginoides*.

| Season | Area   | Vessel<br>(target species)         | Fishing dates  | Trawls |                 | BPT   | Dead |       |     | Total<br>dead | Total<br>alive |
|--------|--------|------------------------------------|----------------|--------|-----------------|-------|------|-------|-----|---------------|----------------|
|        |        |                                    |                | Set    | Observed        |       | PRX  | PRO   | DAC |               |                |
| 2010   | 48     | <i>Saga Sea</i> (KRI)*             | 23/1–18/5/10   | 2192   | 28 <sup>1</sup> | 0.04  |      |       | 1   | 1             | 0              |
|        |        | <i>An Xing Hai</i> (KRI)           | 24/1–11/2/10   | 110    | 32              | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Kai Li</i> (KRI)                | 24/1–11/2/10   | 76     | 32              | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Juvel</i> (KRI)                 | 26/11–31/12/10 | 45     | 44              | 0.00  |      |       |     | 0             | 2              |
|        |        | <i>Fukuei Maru</i> (KRI)           | 14/2–15/4/10   | 680    | 414             | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Juvel</i> (KRI)                 | 11/2–18/3/10   | 114    | 95              | 0.00  |      |       |     | 0             | 2              |
|        |        | <i>Juvel</i> (KRI)                 | 13/4–19/5/10   | 97     | 67              | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Juvel</i> (KRI)                 | 13/6–19/7/10   | 149    | 109             | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Dalmor II</i> (KRI)             | 3/3–14/7/10    | 1174   | 743             | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Thorshøvdi</i> (KRI)*           | 29/1–24/3/10   | 74     | 51              | 0.04  |      |       | 2   | 2             | 2              |
|        |        | <i>Thorshøvdi</i> (KRI)*           | 25/4–4/5/10    | 36     | 4 <sup>1</sup>  | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Thorshøvdi</i> (KRI)*           | 17/6–22/7/10   | 198    | 14 <sup>1</sup> | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Maksim Starostin</i> (KRI)*     | 6/1–26/3/10    | 238    | 114             | 0.00  |      |       |     | 0             | 0              |
|        |        |                                    |                | Total  |                 | 5183  | 1747 | 0.002 |     |               | 3              |
|        | 48.3   | <i>Betanzos</i> (ANI)              | 26/3–8/4/10    | 14     | 14              | 0.07  | 1    | 1     |     | 2             | 16             |
|        |        | Total                              |                | 14     | 14              | 0.07  | 1    | 1     |     | 2             | 16             |
|        | 58.5.2 | <i>Southern Champion</i> (ANI/TOP) | 28/12–19/1/10  | 164    | 164             | 0.00  |      |       |     | 0             | 0              |
|        |        | <i>Southern Champion</i> (ANI/TOP) | 21/3–10/5/10   | 229    | 229             | 0.004 |      |       | 1   | 1             | 3              |
|        |        | Total                              |                | 393    | 393             | 0.003 |      |       | 1   | 1             | 3              |

<sup>1</sup> These low observed haul numbers are a result of continuous trawls, refer to WG-FSA-10/5 Rev. 2.

Table 4: Estimated effort, catch rates and total catches from IUU fishing for *Dissostichus* spp. in the Convention Area in 2009/10. The estimates are derived from information on gillnetters, using the deterministic method and information submitted by Members of sightings by surveillance operations and legal fishing vessels to 30 September 2010, and catch rates of licensed vessels. (Source: WG-FSA-10/6 Rev. 1)

| Division | Vessels sighted   | No. of vessels sighted | Estimated no. of days fished | Mean catch rate (tonnes per day) | Estimated IUU catch (tonnes) | IUU catch (tonnes) allocation |                   |
|----------|---|------------------------|------------------------------|----------------------------------|------------------------------|-------------------------------|-------------------|
|          |   |                        |                              |                                  |                              | <i>D. eleginoides</i>         | <i>D. mawsoni</i> |
| 58.4.1   | <i>Corvus, Trosky, Carmela, Chu Lim, Bigaro</i> (30 days) | 5                      | 350                          | 2.6                              | 910                          | 10                            | 900               |
| 58.4.2   | <i>Typhoon-1, Draco-1</i>                                 | 2                      | 160                          | 2.7                              | 432                          | 0                             | 432               |
| 58.4.3b  | <i>Typhoon-1, Draco-1, Bigaro</i> (30 days)               | 3                      | 190                          | 0.9                              | 171                          | 21                            | 150               |
| 58.4.4   | <i>Trosky</i>   | 1                      | 80                           | 1.0                              | 80                           | 80                            |                   |
| 58.5.1   | <i>Bigaro</i>   | 1                      | 6                            | 3.7                              | 22                           | 22                            | 0                 |
| Total    |   |                        |                              |                                  | 1615                         | 133                           | 1482              |



Table 5: Catch history of *Dissostichus* spp. taken by IUU fishing in the Convention Area. IUU fishing was first detected in 1988/89, and estimates are derived from longlining and gillnetting activities. Blank: no estimate; zero: no evidence of IUU fishing. (Source: WG-FSA-10/6 Rev. 1 and SC-CAMLR reports)

| Season      | Area/subarea/division |       |        |        |        |         |         |        |         |         |        |        |        |        |      |      | All areas |         |
|-------------|-----------------------|-------|--------|--------|--------|---------|---------|--------|---------|---------|--------|--------|--------|--------|------|------|-----------|---------|
|             | 48.3                  | 58    | 58.4.1 | 58.4.2 | 58.4.3 | 58.4.3a | 58.4.3b | 58.4.4 | 58.4.4a | 58.4.4b | 58.5.1 | 58.5.2 | 58.6   | 58.7   | 88.1 | 88.2 |           | Unknown |
| 1988/89     | 144                   |       |        |        |        |         |         |        |         |         | 0      |        | 0      |        |      |      |           | 144     |
| 1989/90     | 437                   |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 437     |
| 1990/91     | 1 775                 |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 1 775   |
| 1991/92     | 3 066                 |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 3 066   |
| 1992/93     | 4 019                 |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 4 019   |
| 1993/94     | 4 780                 |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 4 780   |
| 1994/95     | 1 674                 |       |        |        |        |         |         |        |         |         | 0      | 0      | 0      |        |      |      |           | 1 674   |
| 1995/96     | 0                     |       |        |        |        |         |         |        |         |         | 833    | 3 000  | 7 875  | 4 958  | 0    |      |           | 16 666  |
| 1996/97     | 0                     |       |        |        |        |         |         | 375    |         |         | 6 094  | 7 117  | 11 760 | 7 327  | 0    |      |           | 32 673  |
| 1997/98     | 146                   | 625   |        |        |        |         |         | 1 298  |         |         | 7 156  | 4 150  | 1 758  | 598    | 0    |      |           | 15 731  |
| 1998/99     | 667                   | 875   |        |        |        |         |         | 1 519  |         |         | 1 237  | 427    | 1 845  | 173    | 0    |      |           | 6 743   |
| 1999/00     | 1 015                 |       |        |        |        |         |         | 1 254  |         |         | 2 600  | 1 154  | 1 430  | 191    | 0    |      |           | 7 644   |
| 2000/01     | 196                   |       |        |        |        |         |         | 1 247  |         |         | 4 550  | 2 004  | 685    | 120    | 0    |      |           | 8 802   |
| 2001/02     | 3                     |       |        | 295    |        |         |         | 880    |         |         | 6 300  | 3 489  | 720    | 78     | 92   | 0    |           | 11 857  |
| 2002/03     | 0                     |       |        | 98     |        |         |         | 110    |         |         | 5 518  | 1 274  | 302    | 120    | 0    | 0    |           | 7 422   |
| 2003/04     | 0                     |       |        | 197    | 246    |         |         | 0      |         |         | 536    | 531    | 380    | 48     | 240  | 0    |           | 2 178   |
| 2004/05     | 23                    |       |        | 86     |        | 98      | 1 015   |        | 220     | 0       | 268    | 265    | 12     | 60     | 28   | 0    | 508       | 2 583   |
| 2005/06     | 0                     |       | 597    | 192    |        | 0       | 1 903   |        | 0       | 104     | 144    | 74     | 55     | 0      | 0    | 15   | 336       | 3 420   |
| 2006/07     | 0                     |       | 626    | 288    |        | 0       | 3 226   |        | 0       | 109     | 451    | 0      | 0      | 0      | 0    | 0    |           | 4 700   |
| 2007/08     | 0                     |       | 136    | 0      |        | 0       | 360     |        | 0       | 0       | 720    | 0      | 224    | 0      | 272  | 0    |           | 1 712   |
| 2008/09     | 0                     |       | 152    | 176    |        | 0       | 610     |        | 0       | 0       | 0      | 0      | 0      | 0      | 0    | 0    |           | 938     |
| 2009/10     | 0                     |       | 910    | 432    |        | 0       | 171     |        | 80      | 0       | 22     | 0      | 0      | 0      | 0    | 0    |           | 1 615   |
| All seasons | 17 945                | 1 500 | 2 421  | 1 764  | 246    | 98      | 7 285   | 6 683  | 300     | 213     | 36 429 | 23 485 | 27 046 | 13 673 | 632  | 15   | 844       | 140 579 |

Table 6: Estimated IUU catches (tonnes) of *Dissostichus eleginoides* and *D. mawsoni* taken from the Convention Area since IUU fishing was first detected in 1988/89. The allocation of the IUU catches between the two species is based on the catch ratio reported by licensed vessels. (Source: WG-FSA-10/6 Rev. 1 and SC-CAMLR reports)

| Season  | Estimated IUU catch (tonne) |                   |              |
|---------|-----------------------------|-------------------|--------------|
|         | <i>D. eleginoides</i>       | <i>D. mawsoni</i> | Both species |
| 1988/89 | 144                         | 0                 | 144          |
| 1989/90 | 437                         | 0                 | 437          |
| 1990/91 | 1 775                       | 0                 | 1 775        |
| 1991/92 | 3 066                       | 0                 | 3 066        |
| 1992/93 | 4 019                       | 0                 | 4 019        |
| 1993/94 | 4 780                       | 0                 | 4 780        |
| 1994/95 | 1 674                       | 0                 | 1 674        |
| 1995/96 | 16 666                      | 0                 | 16 666       |
| 1996/97 | 32 673                      | 0                 | 32 673       |
| 1997/98 | 15 731                      | 0                 | 15 731       |
| 1998/99 | 6 743                       | 0                 | 6 743        |
| 1999/00 | 7 644                       | 0                 | 7 644        |
| 2000/01 | 8 802                       | 0                 | 8 802        |
| 2001/02 | 11 766                      | 91                | 11 857       |
| 2002/03 | 7 324                       | 98                | 7 422        |
| 2003/04 | 1 744                       | 434               | 2 178        |
| 2004/05 | 1 448                       | 1 135             | 2 583        |
| 2005/06 | 714                         | 2 706             | 3 420        |
| 2006/07 | 1 609                       | 3 091             | 4 700        |
| 2007/08 | 1 303*                      | 409               | 1 712        |
| 2008/09 | 88                          | 850               | 938          |
| 2009/10 | 133                         | 1 482             | 1 615        |
| Total   | 130 283                     | 10 296            | 140 579      |

\* Adjusted to the catch ratio reported in SSRU 881A (see paragraph 3.11).

Table 7: Catch (tonnes) of *Dissostichus* spp. reported from licensed fishing and estimated from IUU fishing in the Convention Area, and reported in the CDS in areas outside the Convention Area in 2008/09 and 2009/10. (Source: data reported to 24 September 2010 and WG-FSA-10/6 Rev. 1)

2008/09 season

| Inside | Subarea/division | Reported catch | IUU catch | Total CCAMLR | Catch limit    |
|--------|------------------|----------------|-----------|--------------|----------------|
|        | 48.3             | 3 382          | 0         | 3 382        | 3 920          |
|        | 48.4             | 133            | -         | 133          | 150            |
|        | 48.6             | 282            | -         | 282          | 400            |
|        | 58.4.1           | 222            | 152       | 374          | 210            |
|        | 58.4.2           | 66             | 176       | 242          | 70             |
|        | 58.4.3*          | 135            | 610       | 745          | 206            |
|        | 58.4.4*          | 0              | 0         | 0            | 0              |
|        | 58.5.1           | 5 238          | 0         | 5 238        | 0 outside EEZ  |
|        | 58.5.2           | 2 464          | 0         | 2 464        | 2 500          |
|        | 58.6             | 908            | 0         | 908          | 0 outside EEZs |
|        | 58.7             | 20             | 0         | 20           | 0 outside EEZ  |
|        | 88.1             | 2 448          | 0         | 2 448        | 2700           |
|        | 88.2             | 484            | 0         | 484          | 567            |
|        | 88.3             | 0              | -         | 0            | 0              |
|        | Total inside     | 15 782         | 938       | 16 720       |                |

| Outside | Area          | CDS catch EEZ | CDS catch high seas | Total outside CCAMLR |
|---------|---------------|---------------|---------------------|----------------------|
|         | 41            | 4 487         | 2 521               | 7 008                |
|         | 47            | 88            | 74                  | 162                  |
|         | 51            | 18            | 106                 | 124                  |
|         | 57            | 0             | 0                   | 0                    |
|         | 81            | 503           | 0                   | 503                  |
|         | 87            | 4 947         | 62                  | 5 009                |
|         | Total outside | 10 043        | 2 763               | 12 806               |

Global total 29 526

\* Divisions 58.4.3a and 58.4.3b, and Divisions 58.4.4a and 58.4.4b were combined.

2009/10 season

| Inside | Subarea/division | Reported catch | IUU catch | Total CCAMLR | Catch limit      |
|--------|------------------|----------------|-----------|--------------|------------------|
|        | 48.3             | 2 522          | 0         | 2 522        | 3 000            |
|        | 48.4             | 114            | -         | 114          | 116              |
|        | 48.6             | 295            | -         | 295          | 400              |
|        | 58.4.1           | 196            | 910       | 1 106        | 210              |
|        | 58.4.2           | 93             | 432       | 525          | 70               |
|        | 58.4.3*          | 14             | 171       | 185          | 158              |
|        | 58.4.4*          | 59             | 80        | 139          | research fishing |
|        | 58.5.1           | 2 977          | 22        | 2 999        | 0 outside EEZ    |
|        | 58.5.2           | 1 873          | 0         | 1 873        | 2 550            |
|        | 58.6             | 518            | 0         | 518          | 0 outside EEZs   |
|        | 58.7             | 15             | 0         | 15           | 0 outside EEZ    |
|        | 88.1             | 2 870          | 0         | 2 870        | 2 850            |
|        | 88.2             | 314            | 0         | 314          | 575              |
|        | 88.3             | 0              | -         | 0            | 0                |
|        | Total inside     | 11 860         | 1 615     | 13 475       |                  |

(continued)

Table 7 (continued)

| Outside      | Area          | CDS catch EEZ | CDS catch high seas | Total outside CCAMLR |
|--------------|---------------|---------------|---------------------|----------------------|
|              | 41            | 2 822         | 2 029               | 4 851                |
|              | 47            | 13            | 27                  | 40                   |
|              | 51            | 104           | 51                  | 155                  |
|              | 57            | 0             | 0                   | 0                    |
|              | 81            | 276           | 0                   | 276                  |
|              | 87            | 4 603         | 27                  | 4 630                |
|              | Total outside | 7 818         | 2 134               | 9 952                |
| Global total |               |               |                     | 23 427               |

\* Divisions 58.4.3a and 58.4.3b, and Divisions 58.4.4a and 58.4.4b were combined.

Table 8: Number of vessels notified in exploratory longline fisheries for *Dissostichus* spp. in 2010/11 (a), and corresponding number of participating Members and vessels, and catch limits agreed in conservation measures in force in 2009/10 (b). (Source: CCAMLR-XXIX/20)

| Member notifications   | Number of vessels notified by subarea/division |        |        |         |         |      |      |
|--|--|--------|--------|---------|---------|------|------|
|  | 48.6   | 58.4.1 | 58.4.2 | 58.4.3a | 58.4.3b | 88.1 | 88.2 |
| (a) Exploratory longline fisheries for <i>Dissostichus</i> spp. in 2010/11 |  |        |        |         |         |      |      |
| Argentina  |  |        |        |         |         | 1    | 1    |
| Japan  | 1  | 1      | 1      | 1       | 1       | 1    |      |
| Republic of Korea  | 4  | 5      | 4      |         |         | 6    | 6    |
| New Zealand  |  | 3      | 1      |         |         | 4    | 4    |
| Russia   |  |        |        |         |         | 4    | 3    |
| South Africa   | 1  | 1      | 1      |         |         |      |      |
| Spain  |  | 1      | 1      |         |         | 1    | 1    |
| UK   |  |        |        |         |         | 2    | 2    |
| Uruguay  |  |        |        |         |         | 1    | 1    |
| Number of Members  | 3  | 5      | 5      | 1       | 1       | 8    | 7    |
| Number of vessels  | 6  | 11     | 8      | 1       | 1       | 20   | 18   |
| (b) Conservation measures in force in 2009/10                              |  |        |        |         |         |      |      |
| Number of Members  | 3  | 5      | 5      | 2       | 4       | 7    | 7    |
| Number of vessels  | 1*   | 10     | 8      | 3       | 1*      | 15   | 15   |
| Target species catch limit (tonnes)  | 400  | 210    | 70     | 86      | 0**     | 2850 | 575  |

\* Maximum number per Member at any one time

\*\* Excluding research fishing

Table 9: Unstandardised CPUE (kg/hook) of *Dissostichus* spp. in exploratory longline fisheries reported between 1996/97 and 2009/10. (Source: fine-scale data from commercial and fishery-based research hauls)

| Subarea/<br>division | SSRU | Season  |         |         |         |         |         |         |         |         |         |         |         |         |         |
|----------------------|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                      |      | 1996/97 | 1997/98 | 1998/99 | 1999/00 | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 |
| 48.6                 | A    |         |         |         |         |         |         |         | 0.04    | 0.07    | 0.11    | 0.15    |         |         | 0.05    |
|                      | D    |         |         |         |         |         |         |         |         |         |         | 0.05    |         |         | 0.61    |
|                      | E    |         |         |         |         |         |         |         |         | 0.08    |         | 0.13    |         | 0.46    | 0.51    |
|                      | G    |         |         |         |         |         |         |         | 0.02    | 0.07    | 0.16    | 0.07    | 0.12    | 0.23    | 0.06    |
| 58.4.1               | C    |         |         |         |         |         |         |         |         | 0.13    | 0.18    | 0.15    | 0.19    | 0.22    | 0.36    |
|                      | D    |         |         |         |         |         |         |         |         |         |         |         | 0.09    |         |         |
|                      | E    |         |         |         |         |         |         |         |         | 0.22    | 0.10    | 0.14    | 0.12    | 0.13    | 0.74    |
|                      | F    |         |         |         |         |         |         |         |         |         |         | 0.07    | 0.05    |         |         |
|                      | G    |         |         |         |         |         |         |         |         | 0.20    | 0.22    | 0.24    | 0.12    | 0.10    | 0.12    |
| 58.4.2               | H    |         |         |         |         |         |         |         |         |         |         |         | 0.15    |         |         |
|                      | A    |         |         |         |         |         |         |         |         | 0.08    | 0.08    | 0.13    | 0.20    | 0.20    | 1.22    |
|                      | C    |         |         |         |         |         |         | 0.10    |         | 0.07    | 0.17    |         | 0.42    |         |         |
|                      | D    |         |         |         |         |         |         | 0.19    | 0.06    |         |         |         |         |         |         |
|                      | E    |         |         |         |         |         |         | 0.21    | 0.11    | 0.14    | 0.22    | 0.15    | 0.21    | 0.23    | 0.14    |
| 58.4.3a              | A    |         |         |         |         |         |         |         |         | 0.05    | 0.05    | 0.02    | 0.08    | 0.08    |         |
| 58.4.3b              | A    |         |         |         |         |         |         |         |         | 0.04    | 0.08    |         | 0.15    | 0.17    | 0.22    |
|                      | B    |         |         |         |         |         |         |         |         | 0.14    | 0.23    | 0.17    | 0.12    |         |         |
|                      | C    |         |         |         |         |         |         |         |         |         | 0.07    |         | 0.04    | 0.12    | 0.10    |
|                      | D    |         |         |         |         |         |         |         |         |         | 0.08    | 0.18    | 0.03    | 0.12    | 0.18    |
|                      | E    |         |         |         |         |         |         |         |         |         | 0.10    | 0.08    | 0.05    |         | 0.21    |
| 88.1                 | A    | 0.01    |         |         |         | 0.02    |         | 0.16    |         |         |         | 0.08    | 0.05    |         |         |
|                      | B    | 0.05    | 0.03    |         |         | 0.17    | 0.25    | 0.26    | 0.11    | 0.55    | 0.07    | 0.33    | 0.15    | 0.39    | 0.02    |
|                      | C    |         |         |         |         | 0.44    | 0.87    | 0.59    | 0.31    | 0.53    | 1.06    | 0.71    | 0.36    | 0.46    | 0.91    |
|                      | E    |         | 0.07    | 0.06    |         | 0.03    |         | 0.05    | 0.08    | 0.28    |         | 0.02    |         |         |         |
|                      | F    |         | 0.00    |         |         |         |         | 0.03    |         |         |         | 0.16    |         |         |         |
|                      | G    |         | 0.06    | 0.02    |         | 0.13    | 0.12    | 0.12    | 0.12    | 0.15    |         |         |         |         |         |
|                      | H    |         | 0.17    | 0.26    | 0.38    | 0.41    | 0.74    | 0.46    | 0.22    | 0.77    | 0.59    | 0.37    | 0.40    | 0.33    | 0.31    |
|                      | I    |         | 0.37    | 0.23    | 0.29    | 0.29    | 0.43    | 0.19    | 0.15    | 0.43    | 0.40    | 0.34    | 0.43    | 0.52    | 0.36    |
|                      | J    |         |         | 0.12    | 0.18    | 0.04    |         |         | 0.11    | 0.19    | 0.21    | 0.32    | 0.18    | 0.25    | 0.20    |
|                      | K    |         | 0.32    | 0.15    | 0.40    |         | 0.45    |         | 0.01    | 0.34    | 0.51    |         | 0.28    | 0.49    | 0.79    |
|                      | L    |         |         |         |         | 0.12    |         |         | 0.10    | 0.14    | 0.19    |         | 0.17    | 0.10    | 0.19    |
|                      | M    |         |         | 0.08    |         | 0.08    |         |         |         |         | 0.00    | 0.58    | 0.39    | 0.31    |         |
|                      | 88.2 | A       |         |         |         |         |         |         |         |         | 0.14    | 0.06    |         |         |         |
| B                    |      |         |         |         |         |         | 0.82    |         | 0.11    | 0.47    | 0.54    |         |         |         |         |
| D                    |      |         |         |         |         |         |         |         | 0.06    |         |         |         |         |         |         |
| E                    |      |         |         |         |         |         |         |         |         |         | 0.43    | 0.31    | 0.19    | 0.14    | 0.26    |
| F                    |      |         |         |         |         |         |         | 0.35    | 0.42    | 0.70    | 0.33    | 0.22    | 0.49    | 0.20    | 0.29    |
| G                    |      |         |         |         |         |         |         |         |         |         | 0.26    | 0.02    | 0.39    | 0.16    | 0.23    |

Table 10: 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 2009/10 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<br>(required rate) | Flag State        | Vessel name                | <i>Dissostichus</i> spp. tagged and released |              |      |
|-------------------------------------|-------------------|----------------------------|--|--------------|------|
|                                     |                   |                            | Number of fish                               | Tagging rate |      |
| 48.4 (5)                            | New Zealand       | <i>San Aspiring</i>        | 310  | (162)        | 5.38 |
|                                     | UK                | <i>Argos Froyanes</i>      | 310  | (256)        | 5.52 |
|                                     | Total             |                            | 620  | (418)        |      |
| 48.6 (3)                            | Japan             | <i>Shinsei Maru No. 3</i>  | 295  | (0)          | 3.03 |
|                                     | Republic of Korea | <i>Insung No. 1</i>        | 310  | (310)        | 3.16 |
|                                     |                   | <i>Insung No. 2</i>        | 305  | (0)          | 3.06 |
|                                     | Total             |                            | 910  | (310)        |      |
| 58.4.1 (3)                          | Japan             | <i>Shinsei Maru No. 3</i>  | 275  | (12)         | 3.11 |
|                                     | Republic of Korea | <i>Insung No. 2</i>        | 352  | (0)          | 3.26 |
|                                     | Total             |                            | 627  | (12)         |      |
| 58.4.2 (3)                          | Republic of Korea | <i>Insung No. 2</i>        | 291  | (0)          | 3.14 |
|                                     | Total             |                            | 291  | (0)          |      |
| 58.4.3b (4)                         | Japan             | <i>Shinsei Maru No. 3</i>  | 60   | (8)          | 4.34 |
|                                     | Total             |                            | 60   | (8)          |      |
| 88.1 (1)                            | Argentina         | <i>Argenova XXI</i>        | 33   | (0)          | 1.08 |
|                                     | Republic of Korea | <i>Hong Jin No. 707</i>    | 368  | (0)          | 1.11 |
|                                     |                   | <i>Insung No. 1</i>        | 313  | (0)          | 1.10 |
|                                     |                   | <i>Jung Woo No. 2</i>      | 268  | (0)          | 1.17 |
|                                     |                   | <i>Jung Woo No. 3</i>      | 185  | (0)          | 1.05 |
|                                     |                   | <i>Antarctic Chieftain</i> | 164  | (0)          | 1.01 |
|                                     | New Zealand       | <i>Janas</i>               | 415  | (0)          | 1.02 |
|                                     |                   | <i>San Aotea II</i>        | 288  | (0)          | 1.12 |
|                                     |                   | <i>San Aspiring</i>        | 515  | (2)          | 1.06 |
|                                     |                   | <i>Tronio</i>              | 308  | (0)          | 1.00 |
|                                     | Spain             | <i>Argos Froyanes</i>      | 158  | (0)          | 1.04 |
|                                     | UK                | <i>Argos Georgia</i>       | 61   | (0)          | 1.27 |
|                                     | Total             |                            | 3076   | (0)          |      |
|                                     | 88.2 (1)          | Argentina                  | <i>Argenova XXI</i>                          | 8            | (0)  |
| Republic of Korea                   |                   | <i>Jung Woo No. 3</i>      | 6  | (0)          | 1.14 |
| Spain                               |                   | <i>Tronio</i>              | 52   | (0)          | 1.23 |
| UK                                  |                   | <i>Argos Froyanes</i>      | 250  | (0)          | 1.00 |
|                                     |                   | <i>Argos Georgia</i>       | 9  | (0)          | 1.06 |
| Total                               |                   |                            | 325  | (0)          |      |

Table 11: Overlap between the catch-weighted length frequencies of *Dissostichus* spp. reported by vessels in the exploratory fisheries in 2009/10, and the length frequencies of individuals tagged and released (length data aggregated by 10 cm length intervals). High  $\geq 60\%$  overlap, Medium  $\geq 30$  to  $< 60\%$ , Low  $< 30\%$ .

| Species               | Flag State            | Vessel name                | Subarea/division     |        |        |         |                     |        |
|-----------------------|-----------------------|----------------------------|----------------------|--------|--------|---------|---------------------|--------|
|                       |                       |                            | 48.6                 | 58.4.1 | 58.4.2 | 58.4.3b | 88.1                | 88.2   |
| <i>D. mawsoni</i>     | Argentina             | <i>Argenova XXI</i>        |                      |        |        |         | Medium              | Medium |
|                       | Japan                 | <i>Shinsei Maru No. 3</i>  | High                 | Medium |        | Medium  |                     |        |
|                       | Republic of Korea     | <i>Hong Jin No. 707</i>    |                      |        |        |         | Medium              |        |
|                       |                       | <i>Insung No. 1</i>        | <sup>a</sup>         |        |        |         | Low                 |        |
|                       |                       | <i>Insung No. 2</i>        | Medium               | Medium | High   |         |                     |        |
|                       | New Zealand           | <i>Jung Woo No. 2</i>      |                      |        |        |         | Low                 |        |
|                       |                       | <i>Jung Woo No. 3</i>      |                      |        |        |         | Medium              | Low    |
|                       |                       | <i>Antarctic Chieftain</i> |                      |        |        |         | Medium              |        |
|                       |                       | <i>Janas</i>               |                      |        |        |         | High                |        |
|                       |                       | <i>San Aotea II</i>        |                      |        |        |         | High                |        |
|                       |                       | <i>San Aspiring</i>        |                      |        |        |         | High                |        |
|                       | Spain                 | <i>Tronio</i>              |                      |        |        |         | High                | Medium |
|                       | UK                    | <i>Argos Froyanes</i>      |                      |        |        |         | Medium              | Medium |
|                       |                       |                            | <i>Argos Georgia</i> |        |        |         | Medium <sup>b</sup> | High   |
| <i>D. eleginoides</i> | Argentina             | <i>Argenova XXI</i>        |                      |        |        |         |                     |        |
|                       | Japan                 | <i>Shinsei Maru No. 3</i>  |                      | Medium |        | Medium  |                     |        |
|                       | Republic of Korea     | <i>Hong Jin No. 707</i>    |                      |        |        |         | b                   |        |
|                       |                       | <i>Insung No. 1</i>        | Medium               |        |        |         |                     |        |
|                       | New Zealand           | <i>San Aotea II</i>        |                      |        |        |         | b                   |        |
|                       |                       | <i>San Aspiring</i>        |                      |        |        |         | Medium <sup>b</sup> |        |
|                       | Spain                 | <i>Tronio</i>              |                      |        |        |         |                     | b      |
| UK                    | <i>Argos Froyanes</i> |                            |                      |        |        |         | b                   |        |

<sup>a</sup> 2 404 fish caught, 0 fish tagged and released.

<sup>b</sup> Less than 30 fish were caught.

Table 12: Time series (since 2006/07) of overlap between the catch-weighted length frequencies of *Dissostichus* spp. reported by vessels actively fishing in the exploratory fisheries in 2009/10, and the length frequencies of individuals tagged and released (length data aggregated by 10 cm length intervals). The overlap values where less than 30 fish were caught, and for *D. eleginoides* caught in Subareas 88.1 and 88.2, are not included. Shaded cells are those classified as low (<30%).

| Species               | Flag State            | Vessel name                | Subarea/<br>division | Season                |      |      |      |    |    |
|-----------------------|-----------------------|----------------------------|----------------------|-----------------------|------|------|------|----|----|
|                       |                       |                            |                      | 2007                  | 2008 | 2009 | 2010 |    |    |
| <i>D. mawsoni</i>     | Argentina             | <i>Argenova XXI</i>        | 88.1                 |                       |      |      | 52   |    |    |
|                       |                       |                            | 88.2                 |                       |      |      | 49   |    |    |
|                       | Japan                 | <i>Shinsei Maru No. 3</i>  | 48.6                 | 34                    | 31   | 65   | 64   |    |    |
|                       |                       |                            | 58.4.1               |                       |      |      | 56   |    |    |
|                       |                       |                            | 58.4.2               |                       |      | 36   |      |    |    |
|                       |                       |                            | 58.4.3a              |                       |      |      |      |    |    |
|                       | Republic of Korea     | <i>Hong Jin No. 707</i>    | 58.4.3b              | 31                    | 49   | 36   | 55   |    |    |
|                       |                       |                            | 88.1                 |                       | 20   | 26   | 47   |    |    |
|                       |                       |                            | 88.2                 |                       |      | 33   |      |    |    |
|                       |                       |                            | <i>Insung No. 1</i>  | 48.6                  |      |      |      |    |    |
|                       |                       |                            |                      | 58.4.1                | 13   | 15   | 15   |    |    |
|                       |                       |                            |                      | 58.4.2                | 24   | 12   |      |    |    |
|                       |                       |                            |                      | 88.1                  |      |      | 14   | 20 |    |
|                       |                       |                            | <i>Insung No. 2</i>  | 48.6                  |      |      |      | 41 |    |
|                       |                       |                            |                      | 58.4.1                |      | 29   |      | 42 |    |
|                       |                       |                            |                      | 58.4.2                |      |      |      | 69 |    |
|                       |                       |                            |                      | 88.1                  |      | 3    |      |    |    |
|                       |                       |                            |                      | <i>Jung Woo No. 2</i> | 48.6 | 13   |      |    |    |
|                       | 58.4.2                | 26                         |                      |                       |      |      |      |    |    |
|                       | New Zealand           | <i>Antarctic Chieftain</i> | 88.1                 | 32                    | 24   | 20   | 23   |    |    |
|                       |                       |                            | 88.2                 |                       |      | 21   | 38   |    |    |
|                       |                       |                            | 88.1                 |                       |      |      | 15   |    |    |
|                       |                       |                            | 88.2                 |                       |      | 57   | 59   |    |    |
|                       |                       |                            | 88.2                 |                       |      | 63   |      |    |    |
|                       |                       |                            | 88.1                 | 69                    | 76   | 40   | 75   |    |    |
|                       | Spain                 | <i>San Aotea II</i>        | 88.2                 |                       |      | 73   |      |    |    |
|                       |                       |                            | 88.1                 | 56                    | 67   | 77   | 79   |    |    |
|                       |                       |                            | 88.1                 | 80                    | 74   | 82   | 87   |    |    |
|                       |                       |                            | <i>Tronio</i>        | 58.4.1                | 28   | 21   |      |    |    |
|                       |                       |                            |                      | 58.4.3b               | 69   |      |      |    |    |
|                       |                       |                            | UK                   | <i>Argos Froyanes</i> | 88.1 |      | 24   | 20 | 62 |
|                       |                       |                            |                      |                       | 88.2 |      |      | 17 | 51 |
| 88.1                  |                       |                            |                      |                       |      | 43   | 43   | 55 |    |
| 88.2                  |                       | 31                         |                      |                       | 53   | 51   |      |    |    |
| <i>D. eleginoides</i> | Japan                 | <i>Shinsei Maru No. 3</i>  | 88.1                 | 57                    | 61   |      | 47   |    |    |
|                       |                       |                            | 88.2                 |                       |      | 56   | 67   |    |    |
|                       |                       |                            | 48.6                 | 33                    | 44   | 27   |      |    |    |
|                       |                       |                            | 58.4.1               |                       |      |      | 43   |    |    |
|                       |                       |                            | 58.4.2               |                       |      | 100  |      |    |    |
|                       |                       |                            | 58.4.3a              | 37                    |      | 45   |      |    |    |
|                       | Republic of Korea     | <i>Insung No. 1</i>        | 58.4.3b              | 36                    | 36   | 21   | 30   |    |    |
|                       |                       |                            | 48.6                 |                       |      |      | 33   |    |    |
|                       |                       |                            | 58.4.1               | 82                    |      |      |      |    |    |
|                       |                       |                            | 58.4.1               |                       | 70   |      |      |    |    |
| Spain                 | <i>Jung Woo No. 2</i> | 48.6                       | 43                   |                       |      |      |      |    |    |
|                       |                       | 58.4.2                     |                      |                       |      |      |      |    |    |
|                       |                       | 58.4.1                     | 39                   | 64                    |      |      |      |    |    |
| UK                    | <i>Tronio</i>         | 58.4.3a                    | 57                   |                       |      |      |      |    |    |
|                       |                       | 88.1                       | 100                  |                       |      |      |      |    |    |



Table 13: Number of *Dissostichus* spp. tagged and released in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR)

| Subarea/<br>division | Season  |         |         |         |         |         |         |         |         |         | Total  |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
|                      | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 |        |
| 48.6                 |         |         |         | 4       | 62      | 171     | 129     |         | 941     | 910     | 2 217  |
| 58.4.1               |         |         |         |         | 462     | 469     | 1 507   | 1 134   | 1 127   | 627     | 5 326  |
| 58.4.2               |         |         |         |         | 342     | 136     | 248     | 673     | 277     | 291     | 1 967  |
| 58.4.3a              |         |         |         |         | 199     | 104     | 9       | 41      | 113     |         | 466    |
| 58.4.3b              |         |         |         |         | 231     | 175     | 289     | 417     | 356     | 60      | 1 528  |
| 88.1                 | 326     | 960     | 1 068   | 2 250   | 3 223   | 2 972   | 3 608   | 2 574   | 2 954   | 3 076   | 23 011 |
| 88.2                 |         | 12      | 94      | 433     | 341     | 444     | 278     | 389     | 606     | 325     | 2 922  |
| Total                | 326     | 972     | 1 162   | 2 687   | 4 860   | 4 471   | 6 068   | 5 228   | 6 374   | 5 289   | 37 437 |

Table 14: Number of tagged *Dissostichus* spp. recaptured in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR)

| Subarea/<br>division | Season  |         |         |         |         |         |         |         |         |         | Total |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-------|
|                      | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2009/10 |       |
| 48.6                 |         |         |         |         |         | 3       | 2       |         | 2       | 5       | 12    |
| 58.4.1               |         |         |         |         |         |         | 4       | 6       | 8       | 4       | 22    |
| 58.4.2               |         |         |         |         |         |         |         |         | 1       | 1       | 2     |
| 58.4.3a              |         |         |         |         |         | 6       |         | 2       | 2       |         | 10    |
| 58.4.3b              |         |         |         |         | 1       | 6       | 1       | 1       | 1       | 1       | 11    |
| 88.1                 | 1       | 4       | 13      | 32      | 59      | 71      | 206     | 216     | 103     | 250     | 955   |
| 88.2                 |         |         |         | 18      | 17      | 28      | 33      | 36      | 56      | 44      | 232   |
| Total                | 1       | 4       | 13      | 50      | 77      | 114     | 246     | 261     | 173     | 305     | 1244  |



Table 16: Data collection requirements. Shaded requirements are part of the New Zealand National Data Collection Program. ‘Others’, includes the families Moridae, Muraenolepidae.

| <b>Data collected</b>   | <b>Frequency</b>  | <b>Rationale for frequency</b>   | <b>Change from current?</b>                                   |
|---|---|--|---|
| <b>Catch and effort data</b>  |   |  |   |
| C2 catch and effort data  | Every set as previously.  | Data required at that level of detail for numerous analyses.   | No  |
| <b>Ongoing yearly toothfish biological data</b>   |   |  |   |
| Length, sex, gonad state  | <b>TOA and TOP:</b> 4 per 1 000 hooks on the shelf and slope of the Ross Sea, 7 per 1 000 hooks everywhere else each species. | Retain current CV whilst reducing observer burden to allow by-catch sampling.                            | Yes: rate halved on the shelf and slope, identical elsewhere. |
| Otoliths  | <b>TOA and TOP:</b> 5–10 per set each species   | Ensure appropriate sampling for representative ageing.   | Yes: reduced to reflect industry practice and science needs.  |
| <b>Ongoing yearly tagging rate / other for stock assessment purposes</b>                |   |  |   |
| Toothfish tagging   | One per tonne, double-tagged  | Unchanged to avoid starting a new time series which might not be comparable with data collected to date. | No  |
| Skate tagging   | Optional this year but second wave in a future skate year.  | Might be required to increase numbers of tags recovered.   | Yes: skate tagging stopped for now, restart another year.     |
| Skate and toothfish tag recaptures  | Scan every fish for tags.   | To maximise returns.   | No  |
| Acoustic data (e.g. for macrourids)   | Record data within the CCAMLR region (e.g. on ES60 echosounder) if echosounder on board.                                      | Potential future use as biomass index of various species.  | Yes: addition   |
| <b>Ongoing yearly bottom fishing activities</b>   |   |  |   |
| Mid-point latitude and longitude of segment and weight of VME-indicator organism caught | Any segment where 5 kg or more is caught, whenever possible otherwise. A segment is 1 000 hooks or 1 200 m line.              | As required under CMs 22-06 and 22-07, unchanged until further data analysis.                            | No  |
| VME vs TOA  | Segment-level toothfish and VME catch   | To investigate potential interactions between fish and VME.  | No  |

(continued)

Table 16 (continued)

| Data collected  | Frequency   | Rationale for frequency  | Change from current?  |
|---|---|--|---|
| <b>Year-specific fish biological data – 2010/11 and 2013/14 skate and ‘other’ species</b> |   |  |   |
| Length, sex   | <b>Others:</b> 10 fish of combined cod species every set<br><b>Skates:</b> 10 of combined skate species every set   | Do focused data collection aiming at detecting any potential change through time.  | Yes: more prescriptive to better study less by-catch species each year. |
| Gonad state, gonad weight   | <b>Others:</b> 10 of combined cod species every set<br><b>Skates:</b> Only on those skates which will have thorns removed or which are not going to be released.  | Comprehensive dataset to allow future age frequency if needed, release as many healthy skates as possible.   | Yes: more prescriptive to better study less by-catch species each year. |
| Otoliths / thorns   | <b>Others:</b> 5 otolith pairs of combined cod species every set<br><b>Skates:</b> 5 thorns of combined skate species every set, choose skates that are least likely to survive.<br><b>Note:</b> maximum 200 fish per species per vessel.   | Comprehensive dataset to allow future age frequency if needed, release as many healthy skates as possible.   | Yes: more prescriptive to better study less by-catch species each year. |
| Isotope and stomach sampling  | <b>Others:</b> sample a 50 g fillet sample and freeze of a single fish every set in Subarea 88.1, 3 fish per set in Subarea 88.2, rotate species.<br><b>Skates:</b> sample a 50 g fillet sample and freeze of a single fish every set in Subarea 88.1, 3 fish per set in Subarea 88.2, rotate species.<br><b>Note:</b> Maximum 100 fish per species per vessel. | Do focussed data collection aiming at detecting any potential change in diet and trophic level, more data is needed in Subarea 88.2 as no data currently available from there. | Yes: more prescriptive to better study less by-catch species each year. |
| <b>Year-specific fish biological data – 2011/12 and 2014/15 macrourid species</b>         |   |  |   |
| Length, sex, gonad state, gonad weight  | <b>Macrourid:</b> 10 fish every other set on the shelf and slope of the Ross Sea, 10 fish every set elsewhere.  | Do focused data collection aiming at detecting any potential length frequency and reproductive change through time, acknowledging the numbers caught on the shelf and slope.   | Yes: more prescriptive to better study less by-catch species each year. |
| Otoliths  | <b>Macrourid:</b> 5 fish every other set on the shelf and slope of the Ross Sea, 5 fish every set elsewhere.<br><b>Note:</b> maximum 200 fish per species per vessel.   | Comprehensive dataset to allow future age frequency if needed, acknowledging the numbers caught on the shelf and slope.  | Yes: more prescriptive to better study less by-catch species each year. |
| Isotope and stomach sampling  | <b>Macrourid:</b> sample a 50 g fillet sample and freeze of a single fish every other set on the shelf and slope, every set in the north, and 3 fish per set in Subarea 88.2.<br><b>Note:</b> Maximum 100 fish per species per vessel.  | Do focused data collection aiming at detecting any potential change in diet and trophic level, more data is needed in Subarea 88.2 as no data currently available from there.  | Yes: more prescriptive to better study less by-catch species each year. |

(continued)

Table 16 (continued)

| Data collected  | Frequency   | Rationale for frequency   | Change from current?  |
|---|---|---|---|
| <b>Year specific fish biological data – 2012/13 and 2015/16 toothfish and icefish species</b> |   |   |   |
| Length, sex, gonad state  | <b>TOT:</b> not required<br><b>Icefish:</b> 10 of combined icefish species every set  | Do focused data collection aiming at detecting any potential length-frequency change through time, toothfish already carried out yearly.                                      | Yes: more prescriptive to better study less by-catch species each year. |
| Gonad weight  | <b>TOT:</b> 10 of combined toothfish species every other set in the slope and shelf of the Ross Sea, 10 every set elsewhere<br><b>Icefish:</b> 10 of combined icefish species every set   | Do focused data collection aiming at detecting any potential reproductive change through time, including toothfish species.   | Yes: more prescriptive to better study less by-catch species each year. |
| Otoliths  | <b>TOT:</b> not required<br><b>Icefish:</b> 5 otolith pairs of combined icefish species every set<br><b>Note:</b> maximum 200 fish per species per vessel.  | Comprehensive dataset to allow future age frequency if needed, toothfish already carried out yearly.  | Yes: more prescriptive to better study less by-catch species each year. |
| Isotope and stomach sampling  | <b>TOT:</b> sample a 50 g fillet sample, a 50 g liver sample and stomach of a single animal, preferably with full stomach and freeze; one fish every other set on the shelf and slope, one fish per set in the north and 3 fish per set in Subarea 88.2.<br><b>Icefish:</b> sample a 50 g fillet sample and freeze of a single fish every set in Subarea 88.1, 3 fish per set in Subarea 88.2, rotate species.<br><b>Note:</b> Maximum 100 fish per species per vessel. | Do focused data collection aiming at detecting any potential change in diet and trophic level, more data is needed in Subarea 88.2 as no data currently available from there. | Yes: more prescriptive to better study less by-catch species each year. |

Table 17: Catches of *Champscephalus gunnari* (ANI), *Macrourus* spp. (GRV), *Channichthys rhinoceratus* (LIC), *Lepidonotothen squamifrons* (NOS), Rajidae (SRX), *Dissostichus* spp. (TOT), and all other species from trawl fisheries in 2009/10, and reported in fine-scale (C1) data. Catches are given in tonnes.

| Subarea/<br>division | Target | ANI | GRV | LIC | NOS | SRX | TOT | Other species |
|----------------------|--------|-----|-----|-----|-----|-----|-----|---------------|
| 48.3                 | ANI    | 1   | 0   | 0   | 0   | 0   | 0   | 0             |
| 58.5.2               | ANI    | 365 | 1   | 51  | 0   | 12  | 22  | 3             |
| 58.5.2               | TOT    | 0   | 2   | 5   | 11  | 5   | 621 | 3             |

Table 18: Catches for macrourids, rajids and other species taken as by-catch from longline fisheries in 2009/10, and reported in fine-scale (C2) data. Catches are given in tonnes and as a percentage of the catch of *Dissostichus* spp. (TOT) reported in fine-scale data. (Rajids released from longlines are not included in these estimates.) na – not applicable.

| Subarea/division        | Toothfish<br>catch | Macrourids |       |                |                  | Rajids |       |                |                  | Other species |       |                |
|-------------------------|--------------------|------------|-------|----------------|------------------|--------|-------|----------------|------------------|---------------|-------|----------------|
|                         |                    | Catch      | % TOT | Catch<br>limit | % Catch<br>limit | Catch  | % TOT | Catch<br>limit | % Catch<br>limit | Catch         | % TOT | Catch<br>limit |
| 48.3                    | 2518               | 70         | 2.8   | 196            | 35.5             | 7      | 0.3   | 150            | 4.5              | 16            | 0.6   | 0              |
| 48.4 North <sup>1</sup> | 40                 | 4          | 10.6  | 12             | 35.1             | 1      | 3.3   | na             | -                | 0             | 0.6   | -              |
| 48.4 South              | 74                 | 12         | 15.7  | na             | -                | 1      | 1.3   | na             | -                | 1             | 1.1   | -              |
| 48.6                    | 295                | 7          | 2.3   | 64             | 10.8             | 0      | 0.0   | 100            | 0.0              | 0             | 0.2   | 140            |
| 58.4.1                  | 196                | 6          | 3.2   | 33             | 18.8             | 0      | 0.0   | 50             | 0.0              | 0             | 0.2   | 60             |
| 58.4.2                  | 93                 | 4          | 3.8   | 20             | 17.7             | 0      | 0.0   | 50             | 0.0              | 0             | 0.2   | 40             |
| 58.4.3a                 | 0                  | 0          | 0.0   | 26             | 0.0              | 0      | na    | 0              | -                | 0             | -     | 0              |
| 58.4.3b                 | 14                 | 2          | 13.6  | 80             | 2.3              | 0      | 1.0   | 50             | 0.3              | 0             | 0.5   | 20             |
| 58.5.1 French EEZ       | 2977               | 391        | 13.1  | na             | -                | 322    | 10.8  | na             | -                | 0             | 0.0   | -              |
| 58.5.2                  | 1237               | 100        | 8.1   | 360            | 27.7             | 11     | 0.9   | 120            | 9.3              | 6             | 0.5   | 50             |
| 58.6 French EEZ         | 512                | 86         | 16.9  | na             | -                | 52     | 10.2  | na             | -                | 0             | 0.0   | -              |
| 58 South African EEZ    | 21                 | 2          | 9.7   | na             | -                | 0      | 0.0   | na             | -                | 0             | 0.6   | -              |
| 88.1                    | 2869               | 119        | 4.2   | 430            | 27.8             | 8      | 0.3   | 142            | 5.7              | 15            | 0.5   | 160            |
| 88.2                    | 314                | 49         | 15.7  | 90             | 54.8             | 0      | 0.0   | 50             | 0.0              | 15            | 4.8   | 100            |

<sup>1</sup> By-catch limits for Subarea 48.4 North not included.

Table 19: Numbers of rajids retained, discarded and released as reported in fine-scale (C2) data in the 2009/10 season, calculated total numbers of rajids hauled on lines, numbers of rajids tagged and recaptured as reported in scientific observer data submitted to CCAMLR in the 2009/10 season, and calculated tag rates across subareas.

| Subarea/division     | Retained<br>( <i>n</i> ) | Discarded<br>( <i>n</i> ) | Released<br>( <i>n</i> ) | Total hauled<br>( <i>n</i> ) | Tagged<br>( <i>n</i> ) | Tags recaptured<br>( <i>n</i> ) | Tag rate |
|----------------------|--------------------------|---------------------------|--------------------------|------------------------------|------------------------|---------------------------------|----------|
| 48.3                 | 15                       | 902                       | 15 810                   | 16 727                       | 1 480                  | 43                              | 0.09     |
| 48.4 North           | 0                        | 254                       | 3 742                    | 3 996                        | 97                     | 0                               | 0.02     |
| 48.4 South           | 0                        | 183                       | 2 441                    | 2 624                        | 146                    | 3                               | 0.06     |
| 48.6                 | 0                        | 0                         | 0                        | 0                            | 0                      | 0                               |          |
| 58 South African EEZ | 0                        | 0                         | 5                        | 5                            | 5                      | 1                               | 1.00     |
| 58.4.1               | 0                        | 0                         | 0                        | 0                            | 0                      | 0                               |          |
| 58.4.2               | 0                        | 0                         | 7                        | 7                            | 7                      | 0                               | 1.00     |
| 58.4.3a              | -                        | -                         | -                        | 0                            | -                      | -                               | -        |
| 58.4.3b              | 0                        | 26**                      | 22                       | 48                           | 11                     | 0                               | 0.23     |
| 58.5.1 French EEZ    | 59 051                   | 10 936                    | 2                        | 69 989                       | 0                      | 0                               | 0.00     |
| 58.5.2*              | 1 345                    | 0                         | 7 456                    | 8 801                        | 819                    | 0                               | 0.09     |
| 58.6 French EEZ      | 5 302                    | 11 556                    | 5 543                    | 22 401                       | 0                      | 0                               | 0.00     |
| 88.1                 | 926                      | 66**                      | 6 796                    | 7 788                        | 2 256                  | 30                              | 0.29     |
| 88.2                 | 0                        | 0                         | 0                        | 0                            | 0                      | 0                               | 0.09     |

\* Tags released as part of a national tagging program, not reported in scientific observer data submitted to CCAMLR.

\*\* See paragraphs 6.8 to 6.11.

Table 20: Fate of rajid by-catch caught during scientific observation periods as reported in scientific observer data (L5) reported to CCAMLR for the 2009/10 season, given in (a) numbers and (b) as a percentage of all rajids observed.

(a)

| Subarea/division     | Lost/dropped at surface | Released with tags | Released in good health | Released in average health | Released in poor health | Discarded dead | Number predated | Retained without tags | Retained with tags <sup>+</sup> | Total caught |
|----------------------|-------------------------|--------------------|-------------------------|----------------------------|-------------------------|----------------|-----------------|-----------------------|---------------------------------|--------------|
| 48.3                 | 127                     | 1594               | 4111                    | 1035                       | 529                     | 231            | 3               | 52                    | 19                              | 7701         |
| 48.4                 | 20                      | 238                | 944                     | 451                        | 465                     | 68             | -               | -                     | -                               | 2186         |
| 48.6                 | -                       | 0                  | -                       | -                          | -                       | -              | -               | -                     | -                               | 0            |
| 58.4.1               | -                       | -                  | -                       | -                          | -                       | 1              | -               | -                     | -                               | 1            |
| 58.4.2               | -                       | 7                  | 3                       | 4                          | -                       | -              | -               | -                     | -                               | 14           |
| 58.4.3.a             | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               | 0            |
| 58.4.3.b             | 3                       | 8                  | 17                      | 7                          | -                       | 26**           | -               | -                     | -                               | 61           |
| 58.5.1 French EEZ    | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               | 0            |
| 58.5.2*              | -                       | 819                | 179                     | 230                        | 251                     | 6              | -               | 677                   | -                               | 2162         |
| 58.6 French EEZ      | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               | 0            |
| 58 South African EEZ | 13                      | 15                 | 29                      | 4                          | 8                       | 3              | -               | 30                    | -                               | 102          |
| 88.1                 | 104                     | 2208               | 2946                    | 499                        | 76                      | 143**          | -               | 424                   | 18                              | 6418         |
| 88.2                 | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               | 0            |

(b)

| Subarea/division     | Lost/dropped at surface | Released with tags | Released in good health | Released in average health | Released in poor health | Discarded dead | Number predated | Retained without tags | Retained with tags <sup>+</sup> |
|----------------------|-------------------------|--------------------|-------------------------|----------------------------|-------------------------|----------------|-----------------|-----------------------|---------------------------------|
| 48.3                 | 1.6                     | 20.7               | 53.4                    | 13.4                       | 6.9                     | 3.0            | 0.0             | 0.7                   | 0.2                             |
| 48.4                 | 0.9                     | 10.9               | 43.2                    | 20.6                       | 21.3                    | 3.1            | -               | -                     | -                               |
| 48.6                 | -                       | 0.0                | -                       | -                          | -                       | -              | -               | -                     | -                               |
| 58.4.1               | -                       | -                  | -                       | -                          | -                       | 100.0          | -               | -                     | -                               |
| 58.4.2               | -                       | 50.0               | 21.4                    | 28.6                       | -                       | -              | -               | -                     | -                               |
| 58.4.3.a             | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               |
| 58.4.3.b             | 4.9                     | 13.1               | 27.9                    | 11.5                       | -                       | 42.6           | -               | -                     | -                               |
| 58.5.1 French EEZ    | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               |
| 58.5.2*              | -                       | 37.9               | 8.3                     | 10.6                       | 11.6                    | 0.3            | -               | 31.3                  | -                               |
| 58.6 French EEZ      | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               |
| 58 South African EEZ | 12.7                    | 14.7               | 28.4                    | 3.9                        | 7.8                     | 2.9            | -               | 29.4                  | -                               |
| 88.1                 | 1.6                     | 34.4               | 45.9                    | 7.8                        | 1.2                     | 2.2            | -               | 6.6                   | 0.3                             |
| 88.2                 | -                       | -                  | -                       | -                          | -                       | -              | -               | -                     | -                               |

\* Tagging not reported to CCAMLR in L5 forms.

\*\* See paragraphs 6.8 to 6.11.

<sup>+</sup> Tag recaptures from observation periods only.



Table 21: Individual vessel rajid tagging rates calculated from total numbers of rajids tagged (source: scientific observer data submitted to CCAMLR) and total numbers of rajids caught (source: fine-scale (C2) data) for vessels in new and exploratory fisheries during the 2009/10 season. na – not applicable.

| Subarea/division | Nationality | Vessel                     | Total caught*         | Total tagged | Tagging rate |    |
|------------------|-------------|----------------------------|-----------------------|--------------|--------------|----|
| 48.6             | JPN         | <i>Shinsei Maru No. 3</i>  | 0                     | 0            | na           |    |
|                  | KOR         | <i>Insung No. 1</i>        | 0                     | 0            | na           |    |
|                  | KOR         | <i>Insung No. 2</i>        | 0                     | 0            | na           |    |
| 58.4.1           | JPN         | <i>Shinsei Maru No. 3</i>  | 0                     | 0            | na           |    |
|                  | KOR         | <i>Insung No. 2</i>        | 0                     | 0            | na           |    |
| 58.4.2           | KOR         | <i>Insung No. 2</i>        | 7                     | 7            | 1.00         |    |
| 58.4.3b          | JPN         | <i>Shinsei Maru No. 3</i>  | 48                    | 8            | 0.17         |    |
| 88.1             | ARG         | <i>Argenova XXI</i>        | 16                    | 5            | 0.31         |    |
|                  | KOR         | <i>Hong Jin No. 707</i>    | 246                   | 55           | 0.22         |    |
|                  | KOR         | <i>Insung No. 1</i>        | 477                   | 98           | 0.21         |    |
|                  | KOR         | <i>Jung Woo No. 2</i>      | 43                    | 13           | 0.30         |    |
|                  | KOR         | <i>Jung Woo No. 3</i>      | 59                    | 16           | 0.27         |    |
|                  | NZL         | <i>Antarctic Chieftain</i> | 1038                  | 292          | 0.28         |    |
|                  | NZL         | <i>Janas</i>               | 568                   | 269          | 0.47         |    |
|                  | NZL         | <i>San Aotea II</i>        | 1830                  | 521          | 0.28         |    |
|                  | NZL         | <i>San Aspiring</i>        | 2290                  | 607          | 0.27         |    |
|                  | ESP         | <i>Tronio</i>              | 140                   | 44           | 0.31         |    |
|                  | GBR         | <i>Argos Froyanes</i>      | 6                     | 4            | 0.67         |    |
|                  | GBR         | <i>Argos Georgia</i>       | 1332                  | 339          | 0.25         |    |
|                  | 88.2        | ARG                        | <i>Argenova XXI</i>   | 0            | 0            | na |
|                  |             | KOR                        | <i>Jung Woo No. 3</i> | 0            | 0            | na |
|                  |             | ESP                        | <i>Tronio</i>         | 0            | 0            | na |
| GBR              |             | <i>Argos Froyanes</i>      | 0                     | 0            | na           |    |
| GBR              |             | <i>Argos Georgia</i>       | 0                     | 0            | na           |    |

\* Total caught includes those fish tagged and released.

Table 22: Instances where the five-day/5 n miles move-on rule in CM 33-03, paragraph 5, was implemented by subarea, vessel and trigger level during 2009/10. GRV – *Macrourus* spp.

| Subarea/division | SSRU | Vessel                | By-catch weight (GRV) (kg) |
|------------------|------|-----------------------|----------------------------|
| 88.1             | 881I | <i>San Aotea II</i>   | 1095.9                     |
| 88.1             | 881I | <i>San Aotea II</i>   | 1695.4                     |
| 88.1             | 881I | <i>San Aotea II</i>   | 1272.8                     |
| 88.1             | 881I | <i>San Aspiring</i>   | 2460.0                     |
| 88.1             | 881I | <i>San Aspiring</i>   | 1649.2                     |
| 88.1             | 881I | <i>San Aspiring</i>   | 1078.4                     |
| 88.1             | 881I | <i>San Aspiring</i>   | 1589.2                     |
| 88.2             | 882E | <i>Argos Froyanes</i> | 1174.2                     |
| 88.2             | 882E | <i>Argos Froyanes</i> | 1193.5                     |
| 88.2             | 882E | <i>Argos Froyanes</i> | 1499.3                     |
| 88.2             | 882E | <i>Argos Froyanes</i> | 1365.1                     |
| 88.2             | 882G | <i>Tronio</i>         | 1666.0                     |

Table 23: Conservation Measure 33-03, paragraph 6, triggers by subarea, vessel and action during 2009/10.

| Subarea | Vessel                     | SSRU | Occurrences | First occurrence | Last occurrence | Advice  |
|---------|----------------------------|------|-------------|------------------|-----------------|---------|
| 88.1    | <i>Antarctic Chieftain</i> | 881I | 1           | 11-Jan-10        | 11-Jan-10       |         |
| 88.1    | <i>Argos Georgia</i>       | 881H | 1           | 01-Jan-10        | 01-Jan-10       |         |
| 88.1    | <i>Argos Georgia</i>       | 881I | 2           | 11-Jan-10        | 21-Jan-10       | Move-on |
| 88.1    | <i>Janas</i>               | 881I | 1           | 11-Jan-10        | 11-Jan-10       |         |
| 88.1    | <i>San Aotea II</i>        | 881I | 1           | 21-Jan-10        | 21-Jan-10       |         |
| 88.1    | <i>San Aspiring</i>        | 881I | 2           | 11-Jan-10        | 21-Jan-10       | Move-on |
| 88.2    | <i>Argos Froyanes</i>      | 882E | 2           | 01-Feb-10        | 11-Feb-10       | Move-on |
| 88.2    | <i>Tronio</i>              | 882G | 1           | 01-Mar-10        | 01-Mar-10       |         |

Table 24: Report card review of Members' preliminary assessments of the effects of bottom fishing on VMEs under CM 22-06. Individual assessments were not ranked relative to each other, but reviewed relative to compliance, completeness and level of detail provided.

| Member/gear   | Argentina | Japan | Korea,<br>Republic of | New Zealand | Russia | South Africa | Spain | UK  | Uruguay | Total |
|---|-----------|-------|-----------------------|-------------|--------|--------------|-------|-----|---------|-------|
| <b>1.1 Scope</b>  |           |       |                       |             |        |              |       |     |         |       |
| Number of vessels   | 1         | 1     | 7                     | 4           | 4      | 1            | 1     | 2   | 1       | 22    |
| Number of subareas/divisions  | 2         | 6     | 5                     | 4           | 2      | 3            | 4     | 2   | 2       | 30    |
| Notifications (vessel*fishery)  | 2         | 6     | 25                    | 12          | 7      | 3            | 4     | 4   | 2       | 65    |
| Assessment submitted  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>1.2 Proposed fishing activity</b>  |           |       |                       |             |        |              |       |     |         |       |
| 1.2.1 Detailed description of gear  | L         | M     | H                     | H           | H      | H            | H     | H   | M       |       |
| 1.2.2 Scale of proposed activity<br>(number of sets)  | 90        | 400   | 840                   | 550         | 875    | NA           | 125   | 250 | 64      |       |
| 1.2.3 Spatial distribution of activity  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>1.3 Mitigation measures to be used</b>   | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>Effectiveness</b>  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>2.1 Assessment of known/<br/>anticipated impacts on VMEs</b>   |           |       |                       |             |        |              |       |     |         |       |
| 2.1.1 Estimated spatial effort<br>footprint<br><i>Please provide details of %<br/>area covered by fishing effort.</i> | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.1.2 Summary of potential VMEs<br>present within areas of<br>activity  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.1.3 Probability of impacts  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.1.4 Magnitude/severity of the<br>interaction of the proposed<br>fishing gear with VMEs                              | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.1.5 Physical and<br>biological/ecological<br>consequences of impact   | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>2.2 Estimated cumulative footprint</b>   | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| <b>2.3 Research activities related to<br/>provision of new information on<br/>VMEs</b>                                |           |       |                       |             |        |              |       |     |         |       |
| 2.3.1 Previous research   | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.3.2 In-season research  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| 2.3.3 Follow-on research  | +         | +     | +                     | +           | +      | +            | +     | +   | +       |       |
| Cumulative assessment quality   | H         | H     | H                     | H           | H      | H            | H     | H   | H       |       |

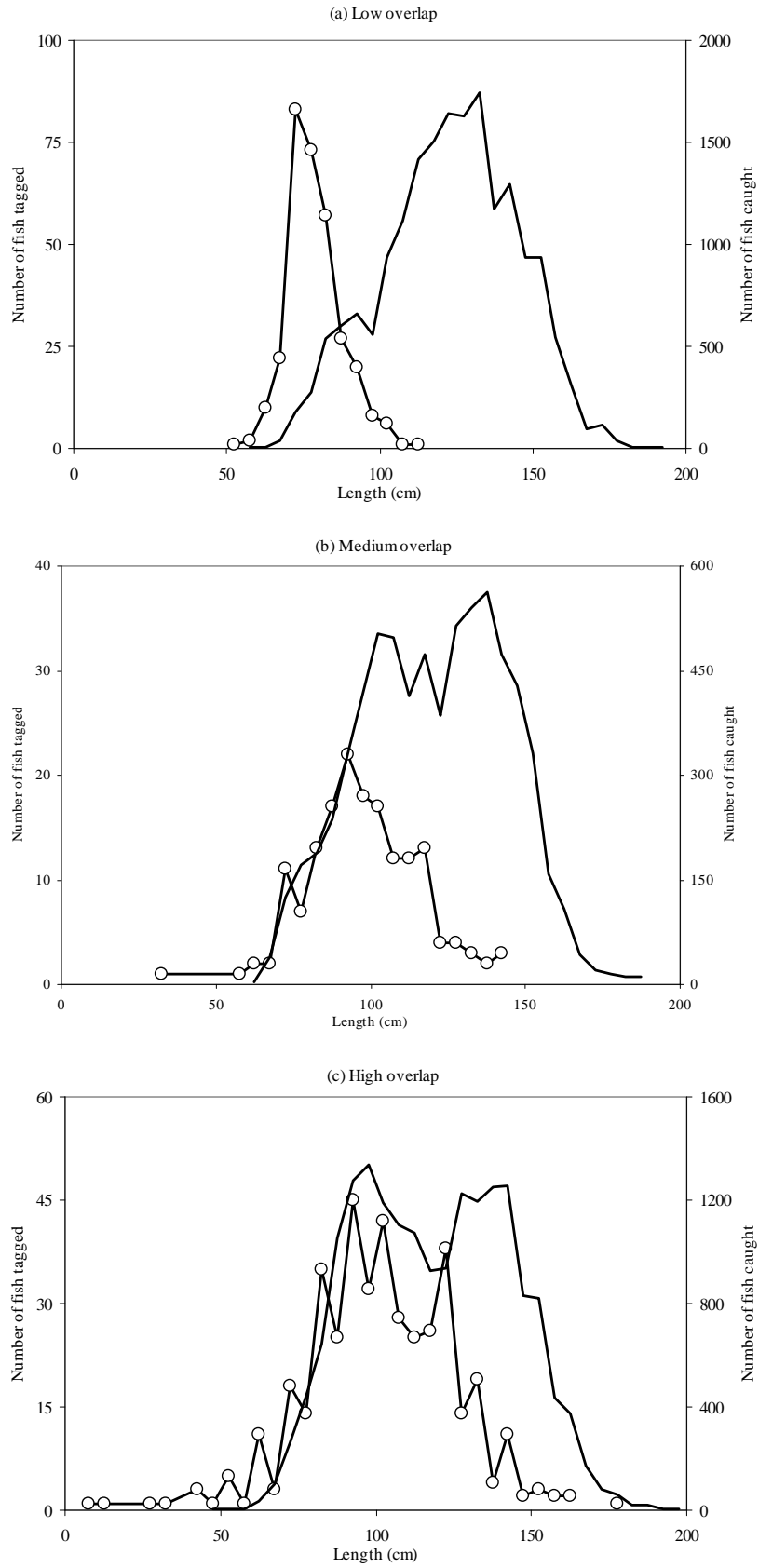


Figure 1: Example plots of the length frequencies of fish caught (solid lines) and tagged (circles) for vessels where the overlap data metric was (a) low (overlap of 20%), (b) medium (59%) and (c) high (75%).

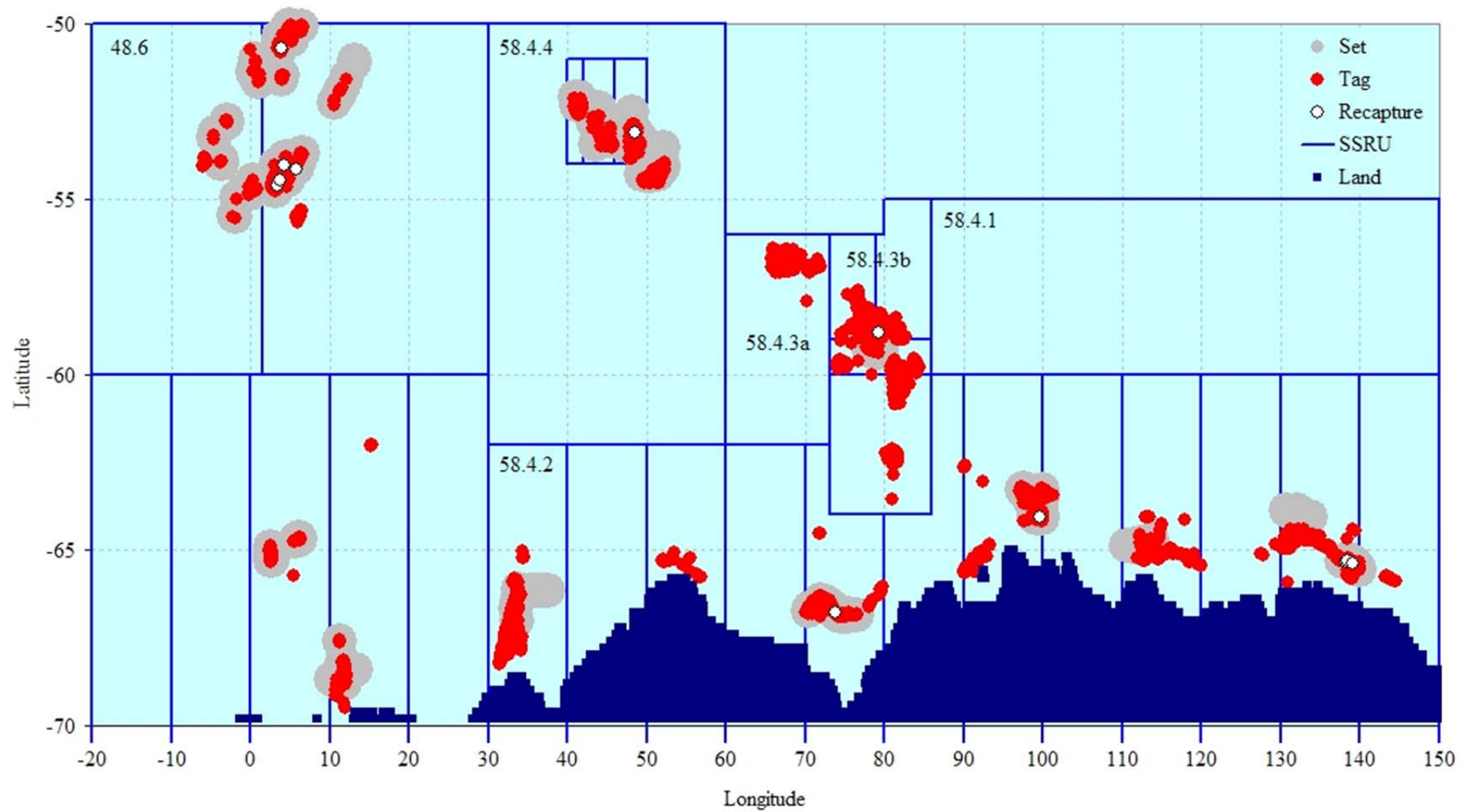


Figure 2: Distribution of fishing effort (including research fishing) and tag-recaptures in 2009/10, and tag-releases (all season) for *Dissostichus* spp. in Subareas 48.6 and 58.4.

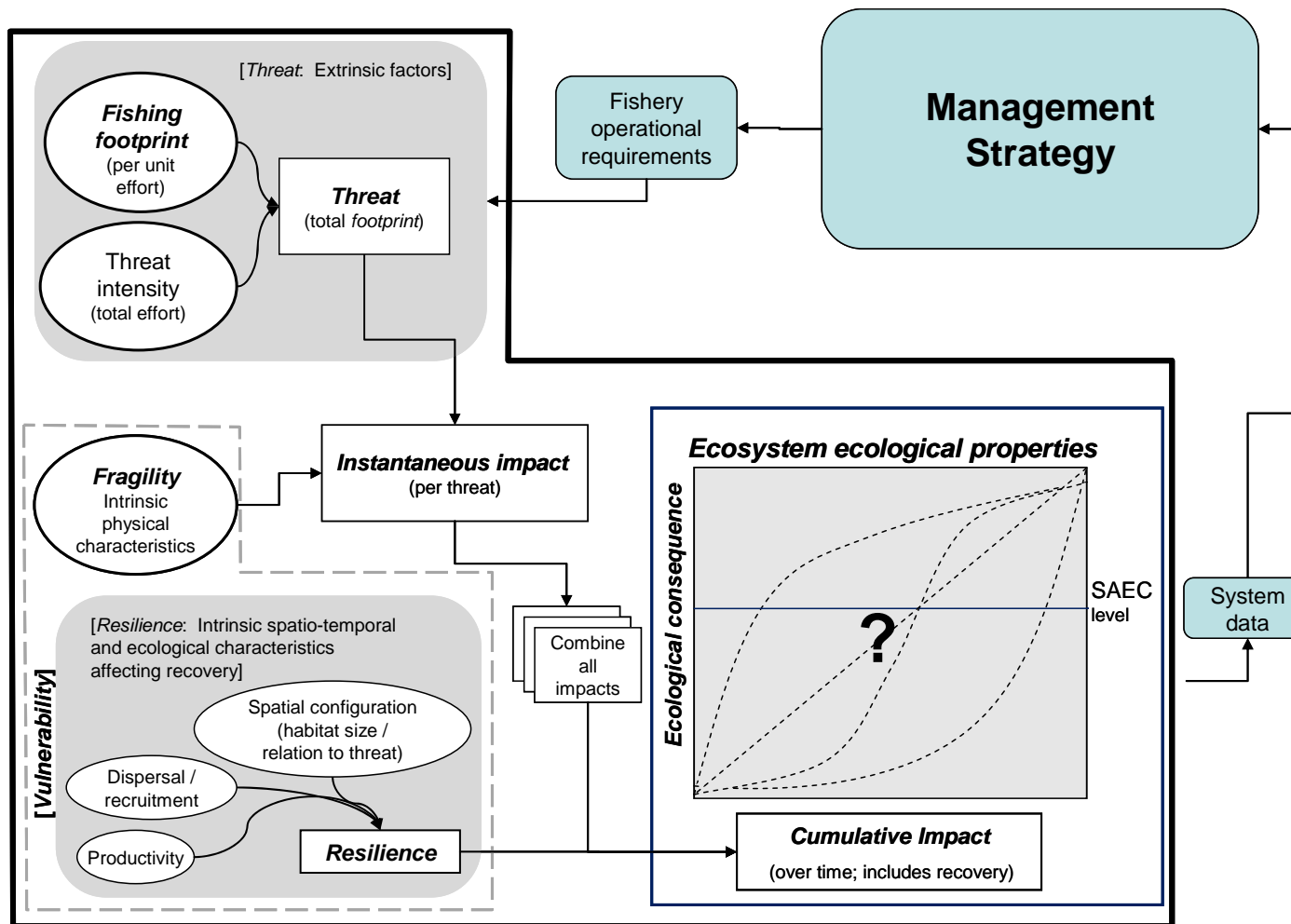


Figure 3: Conceptual diagram of the relationships among the terms used in the VME glossary. The thick black box indicates aspects of ecosystem dynamics and the relationship of the fishery to the ecosystem. Data are derived either from the fishery or as fishery-independent activities. These data are used in the management strategy, which determines the operational requirements of the fishery. A management strategy includes assessment method/s and decision rules or approaches by which the results of the assessment, which can include estimates of risk, can be used to adjust the operations of the fishery as needed.

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**AGENDA**

Working Group on Fish Stock Assessment  
(Hobart, Australia, 11 to 22 October 2010)

1. Opening of the meeting
2. Organisation of the meeting and adoption of the agenda
  - 2.1 Organisation of meeting
  - 2.2 Subgroup organisation and coordination
3. Review of available information
  - 3.1 Data requirements specified in 2009
  - 3.2 Fisheries information
  - 3.3 Inputs for stock assessment
4. Preparation for assessments and assessment timetable
  - 4.1 Report from the Working Group on Statistics, Assessments and Modelling (WG-SAM)
  - 4.2 Review of preliminary stock assessment papers
  - 4.3 Assessments to be carried out and assessment timetable
5. Assessments and management advice
  - 5.1 New and exploratory fisheries
    - 5.1.1 New and exploratory fisheries in 2009/10
    - 5.1.2 New and exploratory fisheries notified for 2010/11
    - 5.1.3 Update Fishery Reports for new and exploratory fisheries
    - 5.1.4 Research plans notified under Conservation Measure 24-01
  - 5.2 Development of methods to assess exploratory fisheries in the future
  - 5.3 Update Fishery Reports for assessed fisheries
  - 5.4 Assessment and management advice for other fisheries
  - 5.5 Progressing scientific issues identified in the Performance Review Panel (PRP) Report
6. Fish and invertebrate by-catch
7. Evaluation of the threats arising from IUU activities
8. Biology, ecology and demography of target and by-catch species

9. Considerations of ecosystem management
  - 9.1 Bottom fishing activities and vulnerable marine ecosystems (VMEs)
  - 9.2 Depredation
  - 9.3 Other interactions with WG-EMM
10. Scheme of International Scientific Observation
  - 10.1 Report from the ad hoc Technical Group for At-Sea Operations (TASO)
  - 10.2 Summary of information extracted from observer reports and/or provided by technical coordinators
  - 10.3 Implementation of the observer program
11. Future work
  - 11.1 Organisation of intersessional activities in subgroups
  - 11.2 Intersessional meetings
  - 11.3 Notification of scientific research
12. Other business
13. Advice to Scientific Committee
14. Adoption of the report
15. Close of the meeting.

**LIST OF DOCUMENTS**

Working Group on Fish Stock Assessment  
(Hobart, Australia, 11 to 22 October 2010)

|                    |   |
|--------------------|---|
| WG-FSA-10/1        | Provisional Agenda and Provisional Annotated Agenda for the 2010 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)   |
| WG-FSA-10/2        | List of participants  |
| WG-FSA-10/3        | List of documents   |
| WG-FSA-10/4 Rev. 1 | CCAMLR fishery information 2010<br>Secretariat  |
| WG-FSA-10/5 Rev. 2 | Summary of Scientific Observations in the CAMLR Convention Area for the 2009/10 season<br>Secretariat   |
| WG-FSA-10/6 Rev. 1 | Estimation of IUU catches of toothfish inside the Convention Area during the 2009/10 fishing season<br>Secretariat  |
| WG-FSA-10/7        | Development of the VME registry<br>Secretariat  |
| WG-FSA-10/8        | A summary of scientific observations related to Conservation Measures 25-02 (2009), 25-03 (2009) and 26-01 (2009)<br>Secretariat  |
| WG-FSA-10/9        | Scientific research notifications (Conservation Measure 24-01)<br>Collated by the Secretariat   |
| WG-FSA-10/10       | Results of trials undertaken around Crozet Island using pots to target Patagonian toothfish<br>N. Gasco, P. Tixier and C. Guinet (France)   |
| WG-FSA-10/11       | Short communication: Diet composition of deepwater icefish <i>Chionobathyscus dewitti</i> Andriashev et Neelov, 1978 ( <i>Chionobathyscus</i> , Channichthyidae) from the Ross Sea area<br>A.F. Petrov (Russia) |



- WG-FSA-10/12 Preliminary assessment of mackerel icefish (*Chamsocephalus gunnari*) in the vicinity of Heard Island and McDonald Islands (Division 58.5.2), based on a survey in March–April 2010, including a revised growth model  
D.C. Welsford (Australia)  
(CCAMLR Science, submitted)
- WG-FSA-10/13 Definition of age characteristics of Antarctic toothfish (*Dissostichus mawsoni*) from the Indian Ocean sector of the Antarctic region  
L. Pshenichnov, I. Slypko and K. Vyshniakova (Ukraine)
- WG-FSA-10/14 Brief information on Patagonian toothfish (*Dissostichus eleginoides*) fishery outside the zone of CCAMLR responsibility (Statistical Area 41)  
Delegation of Ukraine
- WG-FSA-10/15 Manual: estimating the age of Patagonian toothfish (*Dissostichus eleginoides*) using transverse cross-sections of otoliths  
K. Underkoffler, N. Ramanna and J. Ashford (USA)
- WG-FSA-10/16 Connectivity and population structure in *Pleuragramma antarcticum* along the west Antarctic Peninsula  
J. Ashford, J. Ferguson, A. Piñones, J. Torres and W. Fraser (USA)
- WG-FSA-10/17 Feasibility of lead-radium dating the otoliths of blackfin icefish (*Chaenocephalus aceratus*) and ocellated icefish (*Chionodraco rastrispinosus*)  
A.H. Andrews, M. La Mesa and J. Ashford (USA)
- WG-FSA-10/18 How much do icefish (Notothenioidei, Channichthyidae) eat in the southern Scotia Arc and the Antarctic Peninsula region?  
K.-H. Kock (Germany), C.D. Jones (USA), J. Gröger and S. Schöling (Germany)
- WG-FSA-10/19 A preliminary assessment of age and growth of eel cod (*Muraenolepis* sp.) and violet cod (*Antimora rostrata*) in the Ross Sea, Antarctica  
P.L. Horn and C.P. Sutton (New Zealand)
- WG-FSA-10/20 A preliminary assessment of age and growth of Antarctic silverfish (*Pleuragramma antarcticum*) in the Ross Sea, Antarctica  
C.P. Sutton and P.L. Horn (New Zealand)  
(CCAMLR Science, submitted)

- WG-FSA-10/21                      Manual for age determination of Antarctic toothfish  
(*Dissostichus mawsoni*)  
C.P. Sutton and P.L. Horn (New Zealand)
- WG-FSA-10/22                      Stomach contents of Antarctic toothfish (*Dissostichus  
mawsoni*) from the Ross Sea region in 2010 and a comparison  
with 2003  
D.W. Stevens, J. Forman and S. Hanchet (New Zealand)
- WG-FSA-10/23                      A characterisation of the toothfish fishery in Subareas 88.1  
and 88.2 from 1997/98 to 2009/10  
S.M. Hanchet, M.L. Stevenson and A. Dunn (New Zealand)
- WG-FSA-10/24                      Updated species profile for Antarctic toothfish (*Dissostichus  
mawsoni*)  
S.M. Hanchet (New Zealand)
- WG-FSA-10/25                      Characterisation of skate catches in the Ross Sea region  
S. Mormede and A. Dunn (New Zealand)
- WG-FSA-10/26                      Stability of trip selections for the assessment of Antarctic  
toothfish in the Ross Sea  
D.A.J. Middleton (New Zealand)
- WG-FSA-10/27                      Revised biological parameters for the Antarctic skates  
*Amblyraja georgiana* and *Bathyraja cf. eatonii* from the  
Ross Sea  
M.P. Francis (New Zealand)
- WG-FSA-10/28                      An updated glossary of terms relevant to the management of  
Vulnerable Marine Ecosystems (VMEs) in the CCAMLR Area  
B.R. Sharp and S.J. Parker (New Zealand)
- WG-FSA-10/29                      Development of methods for evaluating the management of  
benthic impacts from longline fishing using spatially explicit  
production models, including model validation  
A. Dunn, S.J. Parker and S. Mormede (New Zealand)
- WG-FSA-10/30                      Further analysis of spatial patterns of benthic invertebrate  
habitats from fishery bycatch in the Ross Sea region  
S.J. Parker, R.G. Cole and S.M. Hanchet (New Zealand)
- WG-FSA-10/31                      Updated impact assessment framework to estimate the  
cumulative footprint and impact on VME taxa of bottom  
longline fisheries in the CCAMLR Area  
B.R. Sharp (New Zealand)

- WG-FSA-10/32                      Developing a Ross Sea region medium-term data collection plan  
S. Mormede and S. Hanchet (New Zealand)
- WG-FSA-10/33                      DNA barcoding highlights a cryptic species of grenadier (genus *Macrourus*) in the Southern Ocean  
P.J. Smith (New Zealand), D. Steinke (Canada),  
P.J. McMillan, A.L. Stewart, S.M. McVeagh (New Zealand),  
J.M. Diaz De Astarloa (Argentina), D. Welsford and  
R.D Ward (Australia)  
(*J. Fish Biol.*, submitted)
- WG-FSA-10/34                      Non-target species in the Patagonian toothfish fishery inside the French EEZ  
N. Gasco (France)
- WG-FSA-10/35                      Results of the research fishing activities conducted by Chile in Management A of Subarea 48.3 from 2005–2008: the importance of conserving the big older fishes  
C.A. Moreno and P. Rubilar (Chile)
- WG-FSA-10/36                      On necessity of longline fishery and research of Antarctic toothfish in all SSRUs of Subareas and Divisions 88.1, 88.2, 58.4.1, 58.4.2  
K.V. Shust, A.F. Petrov, V.A. Tatarnikov and I.G. Istomin (Russia)
- WG-FSA-10/37                      Estimation of the 2011 catch limit for mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 using a length-based population dynamics model  
C.T.T. Edwards, R.E. Mitchell, J. Pearce and D.J. Agnew (UK)
- WG-FSA-10/38                      Results of the groundfish survey carried out in CCAMLR Subarea 48.3 in January 2010  
R.E. Mitchell, M. Belchier, S. Gregory, L. Kenny, J. Nelson, J. Brown and L. Feathersone (UK)
- WG-FSA-10/39                      Population assessment of Patagonian toothfish in the north of Subarea 48.4 – 2010 update  
J. Roberts and D. Agnew (UK)
- WG-FSA-10/40                      Proposal for an extension to the mark-recapture experiment to estimate toothfish population size in the South of Subarea 48.4  
J. Roberts and D. Agnew (UK)

- WG-FSA-10/41 Estimation of natural mortality for the Patagonian toothfish at Heard and McDonald Islands using catch-at-age and aged mark-recapture data from the main trawl ground  
S. Candy, D. Welsford, T. Lamb, J. Verdouw and J. Hutchins (Australia)  
(*CCAMLR Science*, submitted)
- WG-FSA-10/42 Rev. 1 Evaluating the impact of multi-year research catch limits on overfished toothfish populations  
D.C. Welsford (Australia)  
(*CCAMLR Science*, submitted)
- WG-FSA-10/43 Evaluating length-frequency data and length-based performance indicators in new and exploratory fisheries  
P.E. Ziegler, D.C. Welsford and A.J. Constable (Australia)  
(*CCAMLR Science*, submitted)
- WG-FSA-10/44 Brief report on results of experimental harvest regime for the exploratory fishery for crab in the area of the South Orkney Islands (CCAMLR Subarea 48.2) during the 2009/10 season  
Yu.V. Korzun and S.E. Anosov (Ukraine)
- WG-FSA-10/45 Reports on stock status and biological information on toothfish obtained from the scientific research survey by *Shinsei Maru No. 3* in 2009/10 in the SE sector of Division 58.4.3b  
K. Taki, M. Kiyota and T. Ichii (Japan)
- WG-FSA-10/46 Reports on abundance and biological information on toothfish in Divisions 58.4.4 a and 58.4.4b by the *Shinsei Maru No. 3* in the 2009/10 season  
K. Taki, M. Kiyota and T. Ichii (Japan)
- WG-FSA-10/47 Distribution and population structure of *Dissostichus eleginoides* and *D. mawsoni* on BANZARE Bank (CCAMLR Division 58.4.3b), Indian Ocean, Antarctic  
K. Taki, M. Kiyota, T. Ichii and T. Iwami (Japan)  
(*CCAMLR Science*, submitted)
- WG-FSA-10/48 Preliminary studies on age and growth of *Dissostichus eleginoides* in the Ob-Lena Bank  
K. Taki, M. Kiyota and T. Ichii (Japan)
- WG-FSA-10/49 Revised research plan for toothfish in Divisions 58.4.4a and 58.4.4b by the *Shinsei Maru No. 3* in 2010/11  
Delegation of Japan

- WG-FSA-10/50                      Analysis of maturity of Antarctic toothfish in the Amundsen Sea  
S.V. Piyanova and A.F. Petrov (Russia)  
(*CCAMLR Science*, submitted)
- WG-FSA-10/51                      Some aspects of the by-catch fish spawning and oogenesis  
V. Prutko (Ukraine) and D. Chmilevsky (Russia)
- Other Documents
- WG-FSA-10/P1                      At-sea distribution and diet of an endangered top predator: links of white-chinned petrels with commercial longline fisheries  
K. Delord, C. Cotté, C. Péron, C. Marteau, P. Pruvost, N. Gasco, G. Duhamel, Y. Cherel and H. Weimerskirch  
(*Endangered Species Research*, in press)
- WG-FSA-10/P2                      Testing early life connectivity using otolith chemistry and particle-tracking simulations  
J. Ashford, M. La Mesa, B.A. Fach, C. Jones and I. Everson  
(*Can. J. Fish. Aquat. Sci.*, 67 (2010): 1303–1315)
- WG-FSA-10/P3                      Latitudinal variation of demersal fish assemblages in the western Ross Sea  
M.R. Clark, M.R. Dunn, P.J. McMillan, M.H. Pinkerton, A. Stewart and S.M. Hanchet  
(*Ant. Sci.* (2010), doi:10.1017/S0954102010000441)
- WG-FSA-10/P4                      Distribution, abundance and acoustic properties of Antarctic silverfish (*Pleuragramma antarcticum*) in the Ross Sea  
R.L. O’Driscoll, G.J. Macaulay, S. Gauthier, M. Pinkerton and S. Hanchet  
(*Deep-Sea Res. II* (2010), doi:10.1016/j.dsr2.2010.05.018)
- WG-FSA-10/P5                      The Patagonian toothfish: biology, ecology and fishery  
M.A. Collins, P. Brickle, J. Brown and M. Belchier  
(*Advances in Marine Biology*, in press)
- WG-FSA-10/P6                      Estimating the impact of depredation by killer whales and sperm whales on longline fishing for toothfish (*Dissostichus eleginoides*) around South Georgia  
J. Moir Clark and D.J. Agnew  
(*CCAMLR Science*, 17 (2010): 163–178.)

## DRAFT REVISED CONSERVATION MEASURE 22-06, ANNEX A

**PRO FORMA FOR SUBMITTING PRELIMINARY ASSESSMENTS OF  
THE POTENTIAL FOR PROPOSED BOTTOM FISHING ACTIVITIES  
TO HAVE SIGNIFICANT ADVERSE IMPACTS ON  
VULNERABLE MARINE ECOSYSTEMS (VMEs)**

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**Preliminary assessment of bottom fishing activities – Required Information**

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**1. Scope**

- 1.1 Fishing method(s) notified  
*Longline type (e.g. Spanish, auto, trotline, pots etc.)*
- 1.2 Subarea/division where fishing has been notified  
*e.g. Subareas 88.1 and 88.2*
- 1.3 Period of notification  
*Fishing season*
- 1.4 Names of fishing vessels  
*Please provide the name of all vessels notifying to fish*

**2. Proposed fishing activity – please complete separately for each fishing gear method**

- 2.1 Fishing gear details  
*– refer to [CCAMLR fishing gear library](#) for examples noted below.*
- (i) Fishing gear configuration  
*Provide a detailed description of each fishing gear type and its deployment process including diagrams of the different components of the gear and their dimensions – include line type, weight, anchors, size, spacing, material properties (e.g. breaking strain), sink rates in water etc. – so that the fishing footprint can be estimated separately for each gear component. This description can simply cross-reference gear descriptions included in the CCAMLR fishing gear library (see examples or the diagrams available in the CCAMLR observer logbooks).*
- (ii) Expected behaviour of fishing gear  
*Provide a detailed description of the fishing process and the known or expected interaction of the gear with the seafloor, including gear movement (e.g. movement in contact with the seafloor etc.) during the setting, soaking and hauling processes. This description can reference other gear performance descriptions in documents previously adopted and available in the CCAMLR fishing gear library.*
- (iii) Estimated footprint associated with possible unusual fishing events  
*Provide a description of other fishing gear deployment events (e.g. line breakage, gear loss etc.) that can be expected to have a footprint size or impact level associated with fishing activity, with estimates of how frequently such events occur and their associated footprint as in (ii) above. This estimate may reference other gear performance description documents previously adopted and available in the CCAMLR fishing gear library.*
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- (iv) Estimated footprint index (km<sup>2</sup> per unit of fishing effort)  
*Using the description of fishing gear configuration (i) and the expected behaviour of the fishing gear (ii), provide an estimate of the footprint index – i.e. the estimated maximum area within which contact with the seafloor may occur per unit of fishing effort (e.g. km<sup>2</sup> impacted per km mainline deployed or other unit defined in the fishing gear configuration description, or see examples). Describe uncertainties used in estimating the fishing gear footprint (e.g. extent of gear movement in contact with the seafloor etc). This estimate may reference other footprint estimation documents previously adopted and available in the CCAMLR fishing gear library.*
- (v) Estimated ‘impact index’  
*Estimate the impact index per standard unit of fishing gear (i.e. the footprint index multiplied by the composite mortality rate expected within the footprint (see examples).*

2.2 Scale of proposed fishing activity

*Please provide proposed estimated effort within each subarea/division in which activities have been notified, including the expected depth range of fishing activities (e.g. expected effort in units used in (iv) – total km of mainline).*

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**3. Methods used to avoid significant impacts on VMEs**

*Please provide details of modifications (if any) to gear configuration or methods of deployment aimed at preventing or reducing significant impacts on VMEs during the course of fishing.*

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APPENDICES E TO T

**Appendices E to T are only available electronically at:**  
[www.ccamlr.org/pu/e/e\\_pubs/fr/drt.htm](http://www.ccamlr.org/pu/e/e_pubs/fr/drt.htm)



**CCAMLR SCIENTIFIC SCHOLARSHIP SCHEME**



## CCAMLR SCIENTIFIC SCHOLARSHIP SCHEME

### *Purpose*

CCAMLR recognises that to develop the best available science to support the work of the Scientific Committee and the Commission, from time to time active investment in science capacity will be required. The activities that contribute towards science capacity may include increasing participation and awareness of CCAMLR science, mechanisms to resource and deliver scientific activities, and improving information flow within the CCAMLR scientific community (SC-CAMLR-XXVIII, paragraph 10.23).

As part of this program of inter-related activities, the Scientific Committee has created the CCAMLR Scientific Scholarship Scheme. The scheme will be funded from the General Science Capacity Special Fund and the general Scientific Committee budget.

### *Objective*

CCAMLR awards scholarships to assist early career scientists to participate in the work of the Scientific Committee and its working groups. Scholarships may be awarded annually or only occasionally, dependent on the scientific priorities. CCAMLR may award more than one scholarship in any year.

The objective of the Scholarship Scheme is to contribute to capacity building within the CCAMLR scientific community, so as to generate a sound basis of scientific expertise able to support the requirements of CCAMLR in the long term. It will be expected to contribute to:

- (i) consistent and high attendance and participation by scientists from all Members, so that scientific advice has wide understanding and acceptance by Members;
- (ii) consistent and high-quality scientific advice being provided by the Scientific Committee;
- (iii) advice for robust decision-making being available to the Commission.

### *Scope*

Scholarships of up to A\$30 000 are available to cover travel, accommodation and subsistence at CCAMLR Scientific Committee workshops or working group meetings, and relevant preparatory meetings, and exceptionally, meetings of the Scientific Committee, over a period of two years. Applications for partial support for the above items are encouraged. Relevant preparatory meetings may include meetings and short periods of preparatory collaborative work with mentor scientists in their home institutions, or travel to/from mentor scientist research cruises.

Exceptionally, and on review of the activities of the scholarship recipient over the two-year period, the Scientific Committee may extend the scholarship for an additional one year.

### *Publicity*

Opportunities for scholarships will be advertised on the CCAMLR website on or about 1 June each year.

Additional publicity by individual Members, particularly in Member scientific institutions, and by CCAMLR Observers at international meetings, as well as Observers to CCAMLR, will be strongly encouraged.

### *Eligibility*

Scholarships are open to scientists from CCAMLR Members. Preference will be given to early career scientists (for example, but not limited to, PhD students or early post-Doctoral scientists) who have not previously, or routinely, participated in CCAMLR working groups and are actively seeking to participate in CCAMLR science.

Although candidates are sought from all Members, particular preference will be given to early career scientists from developing countries and those from countries having received low numbers of scholarships in past years.

Scholarships are not intended to cover salary or similar costs; candidates must have sources of additional funding to cover these aspects of their requirements.

### *Requirements*

Proposals for candidates must be made by the Scientific Committee Representative of the relevant Member giving the following:

- the name, address and affiliation of the candidate scientist;
- the language ability of the scientist. Ideally this will include proof of at least intermediate level proficiency in English, which is the working language of the working groups;
- the area of the Scientific Committee's work to which the scientist would contribute, considering particularly topics of special and current interest of the Scientific Committee;
- the scientific contribution that would be made by the scientist to CCAMLR arising from his/her intersessional work during the period of the scholarship;
- confirmation of participation from at least one established scientist with significant experience of attendance in relevant CCAMLR working groups, who may be from the applicant's country or from another CCAMLR Member, who has agreed to mentor the successful candidate;
- the working groups and workshops that the scientist would participate in;

- any additional travel to preparatory meetings, for instance with the mentoring scientist and his/her institution;
- justification of the need to apply for scholarship money;
- a preliminary budget, based on assumptions about the future disposition and length of Scientific Committee working group meetings;
- evidence that other funds are available to support the work of the scientist during the proposed period of tenure of the scholarship;
- a commitment that the Member will facilitate participation by the recipient in the work of the Scientific Committee for the duration of the scholarship;
- references from the scientist's home institution and the Member's Scientific Committee Representative.

### *Reporting*

Scholarship recipients will be required to provide the panel (see below) with a report of their associated activities each year, and will be expected to contribute to at least one paper for CCAMLR over a two-year period. They will further be required to publicise their activities, whilst a recipient of the scholarship, within the scientific community.

The Chair of the panel will report to the Scientific Committee each year on the disbursement of funds and the associated activities of the recipients.

### *Application procedure*

The Secretariat will annually publish widely a call for Scholarship proposals amongst all Members. This call shall include details of the Scientific Committee's priority topics and work plan.

The deadline for proposals shall be one month prior to the start of the annual Scientific Committee meeting.

Application shall be by application form, which should be developed by the Secretariat.

### *Evaluation*

A scientific review panel will be convened at each Scientific Committee meeting, chaired by the senior Vice-Chair of the Scientific Committee, and comprising the CCAMLR Science Officer, the Conveners of the Scientific Committee's working groups and the other Vice-Chair of the Scientific Committee. Two other senior members of the CCAMLR scientific community with expertise relevant to the applications will be appointed by the senior Vice-Chair. This panel will annually:

- Review existing scholarships, approve the annual expenditure and forecast expenditure.
- Review the scholarship proposals against the following set of criteria:
  - scientific and other qualifications of the candidate;
  - relevance to the work priorities and work plan of the Scientific Committee;
  - the extent to which it will strengthen the scientific capacity and engagement in the work of the Scientific Committee of the applying Member;
  - strength of the linkages made with mentor scientist(s) and the new scientist;
  - justification for the budget requested.
- Draw up a shortlist of candidates based on the review.
- Consider the funds available to the Scholarship Scheme, and propose any adjustments necessary to the budgets proposed by candidates.
- Report to the Scientific Committee on the progress of the Scholarship Scheme, and, if necessary, propose changes to it.
- Recommend to the Scientific Committee the scholarship recipient(s), and the budget requirements for the Scholarship Scheme, in the upcoming year.

#### *Funding and disbursement*

The Scientific Committee shall fund the Scholarship Scheme from the General Science Capacity Special Fund and from the Scientific Committee budget as appropriate.

The CCAMLR Secretariat will administer the Scholarship Scheme. The Secretariat will pay actual costs of all budgeted items on presentation of receipts.



**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  |
| 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                                     |
| 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  |
| 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<br>Convention | Convention on the Conservation of Antarctic Marine Living Resources          |
| CAML SSC            | CAML Scientific Steering Committee   |
| 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 <i>Dissostichus</i> 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   |
| 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      | <i>Dissostichus</i> 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 <i>Dissostichus</i> spp.  |
| ECOPATH  | Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see <a href="http://www.ecopath.org">www.ecopath.org</a> ) |
| ECOSIM   | Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see <a href="http://www.ecopath.org">www.ecopath.org</a> ) |

|         |  |
|---------|--|
| 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 <i>Polarstern</i> Study                                   |
| EPROM   | Erasable Programmable Read-Only Memory                             |
| eSB     | Electronic version of CCAMLR's <i>Statistical Bulletin</i>         |
| 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)   |
| GOSOE    | 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 WGFASST | 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)                                 |
| <i>M</i>             | Natural Mortality   |
| MARPOL<br>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                 | Monte Carlo Markov Chain  |
| 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                       |
| 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  |
| 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                                |
| RSMPA | Representative System of MPAs                             |
| 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-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<br>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                                       |
| 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                                |
| 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- <i>a</i> 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)                                 |
| 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 <i>D. eleginoides</i> (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)   |