SC-CAMLR-XXVI

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE TWENTY-SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
22–26 OCTOBER 2007

CCAMLR
PO Box 213
North Hobart 7002
Tasmania Australia

Telephone: 61 3 6210 1111
Facsimile: 61 3 6224 8766
Email: ccamlr@ccamlr.org
Website: www.ccamlr.org

Chair of the Scientific Committee
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Abstract

This document presents the adopted report of the Twenty-sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 22 to 26 October 2007. 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, are appended.

1031-2889

Sadly, Dr Edith Fanta (Brazil), Chair of the Scientific Committee, passed away in Curitiba on the evening of 7 May 2008 after bravely battling cancer. Edith was highly regarded by her Antarctic colleagues and served Brazil, CCAMLR, the Scientific Committee and SCAR with rare distinction. She will be sorely missed by all her friends and colleagues. The thoughts of Scientific Committee members are with her family – André, Pedro and Joana Feofiloff.

CONTENTS

REPORT OF THE TWENTY-SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 22 to 26 October 2007)

OPENING OF THE MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met from 22 to 26 October 2007 at the CCAMLR Headquarters in Hobart, Tasmania, Australia. The meeting was chaired by Dr E. Fanta (Brazil).

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

1.3 The Chair also welcomed to the meeting observers from the Cook Islands and Netherlands (Acceding States), Cambodia and Mozambique (non-Contracting Parties), along with observers from ACAP, ASOC, CEP, COLTO, FFA, IUCN, IWC, SCAR and SEAFO, and encouraged them to participate in the meeting to the extent possible.

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

1.5 The following rapporteurs were appointed to prepare the report of the Scientific Committee:

- Drs A. Constable (Australia) and C. Jones (USA) – Advances in statistics, assessments, modelling and survey methods (Advice from WG-SAM);
- Dr M. Collins (UK) – Advances in statistics, assessments, modelling and survey methods (Advice from SG-ASAM);
- Dr S. Nicol (Australia) – Ecosystem monitoring and management (Advice from WG-EMM) and Krill resources;
- Dr S. Grant (UK) – Ecosystem monitoring and management (Management of protected areas and bioregionalisation);
- Dr R. Holt (USA) – Interactions between WG-FSA and WG-EMM;
- Dr G. Parkes (UK) – Fish resources (except by-catch), Crab resources and Squid resources;
- Prof. G. Duhamel (France) – Fish and invertebrate by-catch;

- Dr D. Agnew (UK) – New and exploratory fisheries;
- Dr A. Constable (Australia) – Bottom fishing in CCAMLR high-seas areas;
- Ms K. Rivera (USA) – Incidental mortality;
- Ms N. LeBoeuf (USA) – Additional monitoring and management issues (marine debris);
- Dr P. Trathan (UK) – Additional monitoring and management issues (marine mammal and bird populations);
- Prof. C. Moreno (Chile) and Dr D. Welsford (Australia) – CCAMLR Scheme of International Scientific Observation;
- Dr K.-H. Kock (Germany) – Management under conditions of uncertainty about stock size and sustainable yield;
- Dr K. Sullivan (New Zealand) – Scientific research exemption;
- Prof. B. Fernholm (Sweden) – Cooperation with other organisations;
- Dr D. Ramm (Data Manager) – all other matters.

Adoption of Agenda

1.6 The Provisional Agenda had been circulated prior to the meeting (SC-CAMLR-XXVI/1). The Scientific Committee agreed to include a subitem on bottom fishing in CCAMLR high-seas areas (new Item 4(iv)). With this change, the Agenda was adopted (Annex 3).

Report of the Chair

Intersessional meetings of working groups and other groups of the Scientific Committee

1.7 The following meetings took place in 2007:

(i) The third meeting of SG-ASAM was held in Cambridge, UK, from 30 April to 2 May 2007, to consider models of krill target strength and classification of volume backscattering strength. Drs R. O'Driscoll (New Zealand) and Collins co-convened the meeting which was attended by 12 participants representing six Members. Two invited experts attended – Dr R. Korneliussen (Norway) and Dr G. Macaulay (New Zealand).

(ii) The CCAMLR-IPY Steering Committee held a planning meeting in Cambridge, UK, from 2 to 4 May 2007. The meeting was convened by Mr S. Iversen (Norway), and was held in association with the meeting of SG-ASAM, with a joint session on 2 May to discuss acoustic sampling protocols. The meeting was attended by 12 participants representing six Members, including Drs S. Hedley (IWC Observer) and G. Hosie (SCAR and CCAMLR Liaison).

(iii) Three meetings took place in Christchurch, New Zealand, in July 2007:

- The first meeting of the new WG-SAM took place from 9 to 13 July. It was co-convened by Drs Jones and Constable. Twenty-two participants from six Member countries attended.

- A Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA) was held on 16 July. It was co-convened by Drs K. Reid (UK, WG-EMM Convener) and S. Hanchet (New Zealand, WG-FSA Convener) and attended by 34 participants representing 10 Member countries.

- The thirteenth meeting of WG-EMM was held from 17 to 26 July. It was convened by Dr Reid and attended by 27 participants representing 10 Members. The Workshop to Review Estimates of B_0 and Precautionary Catch Limits for Krill was conducted during the course of the WG-EMM meeting. The workshop was convened by Dr Nicol.

(iv) The Workshop on Bioregionalisation of the Southern Ocean took place in Brussels, Belgium, from 13 to 17 August 2007. The workshop was co-convened by Drs Grant and P. Penhale (USA), and was attended by 30 participants representing 12 Members. Four invited experts also attended – Dr B. Danis (SCAR-MarBIN, Royal Belgian Institute of Natural Sciences), Dr Hosie (SCAR and Australian Government Antarctic Division), Dr M. Kahru (Scripps Institution of Oceanography, USA) and Dr M. Vierros (United Nations University, Institute of Advanced Studies, Japan). Dr B. Raymond (Australia) assisted the workshop by undertaking analysis remotely in Hobart.

(v) The meeting of WG-FSA was held from 8 to 19 October 2007 in Hobart prior to the Scientific Committee meeting. It was convened by Dr Hanchet.

(vi) Ad hoc WG-IMAF conducted its meeting as part of WG-FSA-07. It was co-convened by Ms Rivera and Mr N. Smith (New Zealand).

1.8 The Chair urged Members to support the intersessional activities of the Scientific Committee by facilitating the participation of their specialists at these meetings.

CCAMLR Scheme of International Scientific Observation

1.9 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. Scientific observers have participated in 56 cruises so far in 2006/07: 50 cruises on vessels targeting Patagonian toothfish (*Dissostichus eleginoides*), Antarctic toothfish (*Dissostichus mawsoni*) or mackerel icefish (*Champsocephalus gunnari*) (40 cruises on longliners; 9 cruises on trawlers and 1 cruise on a vessel using pots); and 6 cruises on vessels fishing for krill (*Euphausia superba*).

Fisheries

1.10 CCAMLR Member countries participated in 13 fisheries under conservation measures in force during the 2006/07 season (1 December 2006 to 30 November 2007). In addition, three other managed fisheries were conducted in national EEZs within the Convention Area in 2006/07.

1.11 Fifteen Members fished: Argentina, Australia, Chile, France, Japan, Republic of Korea, Namibia, New Zealand, Norway, Poland, Russia, South Africa, Spain, UK and Uruguay.

1.12 As of 5 October 2007, and subject to various conservation measures in force for 2006/07, Members had reported a total of 104 364 tonnes of krill, 14 023 tonnes of toothfish and 3 941 tonnes of icefish from the Convention Area. A number of other species were taken as by-catch, including rajids which were released alive where possible.

1.13 Fisheries and reported catches are detailed in SC-CAMLR-XXVI/BG/1, CCAMLR-XXVI/BG/17 and the 2007 report of WG-FSA (Annex 5).

Representation at meetings of other international organisations

1.14 The Scientific Committee was represented at a number of meetings of other international organisations during the intersessional period. Observers' reports from these meetings were considered under Agenda Item 10.

ADVANCES IN STATISTICS, ASSESSMENTS, MODELLING AND SURVEY METHODS

Report of the 2007 meeting of WG-SAM

2.1 The first meeting of WG-SAM was held in Christchurch, New Zealand, from 9 to 13 July 2007. The meeting was co-convened by Drs Jones and Constable. The report of WG-SAM is in Annex 7.

2.2 The Scientific Committee noted that WG-SAM addressed two broad technical areas during the 2007 meeting:

(i) those related to fish stock assessment methods (identified primarily during the course of last year's meeting of WG-FSA);

(ii) those associated with krill and predator–prey modelling – subdivision of krill catch into SSMUs.

2.3 With respect to refinements and new methods of parameter estimation, the Scientific Committee noted several recommendations by WG-SAM, including a call for more descriptive analyses of the tag–release and recapture data, further research in spatial patterns of tag recaptures and methods to describe movement, and the recommendation to consider the development of advice on how to manage the collection of non-toothfish tagging data (Annex 7, paragraphs 2.1 to 2.16).

2.4 The Scientific Committee noted WG-SAM's evaluation of a proposed depletion method for assessing toothfish on BANZARE Bank (Division 58.4.3b), and agreed that this approach could be useful for providing advice on potential yields in other exploratory fisheries.

2.5 WG-SAM's consideration of an alternative method for assessing toothfish in Subareas 88.1 and 88.2 (TSVPA) was noted by the Scientific Committee, along with the conclusion that WG-SAM was unable to appraise the method without the presence of the authors (Annex 7, paragraph 3.8).

2.6 The Scientific Committee was encouraged by advancements with respect to new methods for assessing by-catch species (Annex 7, paragraphs 3.14 to 3.20), such as those made for assessing rajid populations at South Georgia and in the Ross Sea (Subarea 88.1 and SSRUs 882A and 882B). The Scientific Committee endorsed the recommendations by WG-SAM for improving data necessary for an assessment, including those related to species identification, catch sampling, estimates of age and growth, tagging protocols and additional survivorship experiments.

2.7 The Scientific Committee agreed that improvements in data collection for by-catch species for assessment purposes is a high priority, and can potentially be advanced by focusing annually on a particular species group, for example, 2008/09 could be the year of the rajid, and 2009/10 could be the year of the macrourid.

2.8 The Scientific Committee noted the reviews of preliminary assessments undertaken by WG-SAM for finfish (Annex 7, paragraphs 4.1 to 4.19), and the recommendations made for this year's assessments of toothfish in Subarea 48.3, Division 58.5.2 and the Ross Sea. The Scientific Committee agreed that research priorities for the Ross Sea assessments in the medium term be those given in Annex 7, paragraphs 4.14 and 4.15.

2.9 The Scientific Committee agreed that it is a priority to identify factors responsible for the high variability of the data quality arising from different vessels in Subareas 88.1 and 88.2, and procedures should be explored by WG-FSA to ensure consistent high-quality data for assessments in multi-vessel, multi-nation fisheries (Annex 7, paragraph 4.16).

2.10 Developments toward evaluation of management strategies, as set out in Annex 7, paragraphs 5.1 to 5.6, were noted. The Scientific Committee continued to encourage the development of management strategy evaluations.

2.11 The Scientific Committee noted that WG-SAM examined the consequences of conducting assessments at multi-year intervals for toothfish stocks, and the resulting trade-off between the risk of errors in an assessment, and the considerable time saved in the meeting of WG-FSA and intersessionally. It was noted by the Scientific Committee that where a toothfish stock is at or above target levels, and where assessments have been stable, then assessments of toothfish could be performed on a biennial cycle without incurring significant additional risk (Annex 7, paragraphs 6.11 to 6.18). The discussion and recommendations by the Scientific Committee are taken up during discussions relative to Scientific Committee activities (section 14).

2.12 The Scientific Committee noted that WG-SAM did not provide advice on the estimation of B_0 and associated CV from survey data (SC-CAMLR-XXV, paragraph 3.27) but that the Working Group expected the issue would be considered by WG-EMM.

2.13 The Scientific Committee noted the advice from WG-SAM on the points to be considered in developing an integrated assessment of krill in Annex 7, paragraphs 3.12 and 3.13, and endorsed the need for:

- management strategy evaluation methods to help identify the best approaches for integrated assessments of krill;
- length-frequency data to be routinely provided from the fishery for several years in advance of a model being used for assessments;
- the collection of high-quality biological data from all commercial vessels.

2.14 In 2006, the Scientific Committee had requested further consideration and development of approaches to subdivide the catch limit for krill in Area 48 among SSMUs. It noted the outcomes of the discussion by WG-SAM on this issue in Annex 7, paragraphs 5.7 to 5.51 and 8.1 to 8.6. In particular, the Scientific Committee:

(i) agreed to a staged approach towards subdividing the krill catch among SSMUs (Annex 7, paragraph 5.10) and that such an approach would involve, at each stage:

  (a) an evaluation of the risks to krill, predators and the fisheries of the different options for subdividing the catch given the uncertainties in model structures, our understanding of the dynamics of the krill-based ecosystem and the future interactions of the fishery with the system;

  (b) risks would be evaluated for different levels of maximum aggregate catch across SSMUs;

  (c) advice at each stage would be on the strategy for subdividing catch along with the attendant risks at different aggregate catches;

(ii) noted that there would be value in exploring structured fishing in managing krill fisheries in SSMUs (Annex 7, paragraphs 5.13 and 5.14) as a form of Option 6, which is similar to the approach used for exploratory toothfish fisheries, provided that due account was given to the costs to the fisheries of different approaches;

(iii) noted that the maximum catch to be subdivided among SSMUs at present should only be the aggregate catches for Subareas 48.1, 48.2 and 48.3 (Annex 7, paragraph 5.15);

(iv) agreed that Stage 1 of a subdivision could be an initial subdivision based primarily on Options 2 to 4, and that Options 5 and 6 should be accorded a high priority starting in 2009 (Annex 7, paragraph 5.16);

(v) agreed that the empirical considerations by WG-SAM are appropriate for Stage 1 (Annex 7, paragraphs 5.17 to 5.27), including comments from WG-EMM (Annex 4, paragraphs 6.39 to 6.47), and noting that it is important that benchmarks be established to ensure that the models appropriately approximate reality in this process (Annex 7, paragraph 5.24);

(vi) welcomed the progress on the development of models for this task, noting that FOOSA (KPFM2) is well advanced for this task (Annex 7, paragraphs 5.28 to 5.36);

(vii) agreed that the scenarios for Stage 1 are appropriate (Annex 7, paragraphs 5.37 and 5.38);

(viii) endorsed the approach for developing performance measures (Annex 7, paragraphs 5.39 to 5.47) and the risk assessments for Stage 1 (Annex 7, paragraph 5.48);

(ix) endorsed the process for providing advice on Stage 1 to the Scientific Committee in 2008 (Annex 7, paragraph 5.49), noting that:

  (a) the models and approaches will be reviewed by WG-SAM and the results developed and reviewed by WG-EMM;

  (b) the development of advice may take longer than envisaged by WG-SAM and that the Scientific Committee needs to be kept informed during the intersessional period on progress in this process in case contingency plans need to be developed;

(x) encouraged Members to participate in the work of WG-SAM and WG-EMM in developing advice on the subdivision of krill catch amongst SSMUs.

2.15 The Scientific Committee noted that advice was provided to the working groups by WG-SAM:

(i) WG-EMM (Annex 7, paragraphs 8.1 to 8.6)
(ii) WG-FSA (Annex 7, paragraphs 8.7 to 8.15)
(iii) ad hoc WG-IMAF (Annex 7, paragraph 8.16).

2.16 The Scientific Committee endorsed the advice of WG-SAM in respect of:

(i) the role and terms of reference of WG-SAM (Annex 7, paragraphs 8.18 and 8.19);

(ii) the process for determining what is within the remit of WG-SAM (Annex 7, paragraph 6.3);

(iii) how the Working Group would approach the validation and verification of software and approaches (Annex 7, paragraph 6.5);

(iv) the approach for structuring the future work program for WG-SAM (Annex 7, paragraphs 6.6 to 6.10).

2.17 The Scientific Committee noted that models used in assessment and evaluation work need to be stable and verifiable. It asked WG-SAM to develop a format for reporting and archiving the work to validate and verify software and approaches, and for archiving assessment runs.

Subgroup on Acoustic Survey and Analysis Methods

2.18 Dr Collins (Co-convener) reported on the meeting of SG-ASAM, which was held in Cambridge, UK, in April 2007 (Annex 8). Two invited experts (Drs Macaulay and Korneliussen) attended the meeting. The meeting focused on the development of methodologies for acoustic surveys of icefish (*C. gunnari*) and the review of the acoustic sampling protocols for krill (*E. superba*) for use by CCAMLR-IPY projects.

2.19 The Scientific Committee noted that the principal recommendations from SG-ASAM with respect to krill and icefish were considered at the meetings of WG-EMM and WG-FSA respectively, and are dealt with under other agenda items.

2.20 The Scientific Committee noted the prevalence and ecological importance of myctophids in Antarctic waters and encouraged further work on this group.

Future meetings

2.21 The Scientific Committee recommended that the next meeting of SG-ASAM should be held in conjunction with the ICES WG-FAST meeting in 2009 to consider acoustic results from IPY surveys, developments in TS modelling, and other new observations.

2.22 The Scientific Committee recommended that the Data Manager should attend future meetings of SG-ASAM, and that the Secretariat cost associated with attending meetings away from Hobart should be included in the Scientific Committee's budget.

CCAMLR-IPY Planning Meeting

2.23 The CCAMLR-IPY Planning Meeting was held in Cambridge, UK, in May 2007 (SC-CAMLR-XXVI/BG/3), with one day held in conjunction with SG-ASAM to discuss data collection protocols.

2.24 The Planning Meeting noted that a coordinated survey of Antarctic krill would not be possible during IPY, but that various nations will be undertaking cruises in the Southern Ocean to collect acoustic data, including:

(i) a Norwegian survey in the northern part of Subarea 48.6 on *G.O. Sars* focusing on krill and the pelagic ecosystem, and a study of target strength of icefish and krill in Subareas 48.3 and 48.6;

(ii) a German survey on the *Polarstern* in the southern region of Subarea 48.6, which will collect acoustic data and RMT samples;

(iii) a New Zealand survey in the Ross Sea on the *Tangaroa*;

(iv) a Japanese survey on the *Umitaka Maru* in Divisions 58.4.1 and 58.4.2;

(v) UK surveys on the *James Clark Ross* in the Scotia Sea and western Antarctic Peninsula.

2.25 Dr Holt indicated that, as part of the US AMLR program, the USA will undertake a 30-day survey in the area of the South Orkney Islands that will include acoustic data collection.

2.26 Dr L. Pshenichnov stated that Ukraine was unable to participate in the IPY Survey, but will be sending scientists on board krill fishing vessels to collect data.

2.27 The Scientific Committee noted that some Members, who did not have vessels available for IPY surveys, will be participating on board vessels listed above.

2.28 The Scientific Committee noted that the CCAMLR-2000 Survey protocols and information on krill sex and maturity stages from CCAMLR's *Scientific Observers Manual* are now available in a public IPY-related area of the CCAMLR website.

2.29 The Scientific Committee recommended the following guidelines for archiving CCAMLR-related data from IPY surveys:

(i) store data in internationally recognised data repositories;

(ii) submit metadata records to CCAMLR and SCAR-MarBIN;

(iii) acoustic, trawl, CTD and net data will be stored and archived by CCAMLR under specified data access requirements;

(iv) data used for CCAMLR assessments must be held by CCAMLR – both in raw and processed form.

2.30 The Scientific Committee recommended that the Secretariat produce a summary of all IPY acoustic data and related metadata submitted to CCAMLR, and report to SG-ASAM by April 2009. The Scientific Committee further recommended that SG-ASAM should examine the available acoustic data and any analyses at its 2009 meeting and advise the Scientific Committee on their value for krill biomass estimation.

2.31 The Scientific Committee commended the Steering Group on its role in coordinating the CCAMLR-IPY initiative.

ECOSYSTEM MONITORING AND MANAGEMENT

Report of the 2007 meeting of WG-EMM

3.1 Dr Reid, WG-EMM Convener, reported on the results of the 13th meeting of WG-EMM which was held in Christchurch, New Zealand, from 17 to 26 July 2007 (Annex 4). In particular, the meeting included:

(i) a workshop to review estimates of B_0 and precautionary catch limits for krill (Annex 4, section 2 and Appendix D);

(ii) further development of management procedures to evaluate options for subdividing the krill catch limit among SSMUs in Area 48 and consideration of the advice from WG-SAM (Annex 7, paragraphs 6.3 to 6.5);

(iii) discussion of the core business of WG-EMM, which included:

- status and trends in the krill fishery
- status and trends in the krill-centric ecosystem
- status of management advice
- future work.

3.2 The Scientific Committee noted several key points in relation to the krill fishery which were highlighted in the report of WG-EMM:

(i) There were inconsistencies in the reporting of catches and notification of intention to fish by Members and non-Members (Annex 4, paragraph 4.17). There was also a substantial increase in the number of notifications of intention to participate in the krill fishery in 2008/09, suggesting a potential catch in excess of 700 000 tonnes (Annex 4, paragraph 4.14).

(ii) WG-EMM had adopted and implemented agreed protocols from SG-ASAM for the estimation of krill biomass based on acoustic surveys. The Working Group had used revised estimates of B_0, CV and γ to provide advice on the revision of the precautionary catch limits for krill in Area 48 and Division 58.4.2 (including an allocation of that yield into two subdivisions) (Annex 4, paragraphs 2.70 and 2.71).

(iii) WG-EMM had agreed to a proposal for a staged development of the krill fishery based on available information, such that the fishery does not develop at a pace greater than that at which it can be managed, in a way that achieves the objectives of the Commission. The first stage of this process will be to deliver advice next year on a risk-based expansion of the fishery to a level consistent with the current level of uncertainty (Annex 4, paragraphs 6.35 to 6.38).

(iv) The discussion of a number of suggestions for the collection of necessary data from the krill fishery, including options for the deployment of scientific observers. These discussions included consideration of the impact on data quality of the various options that might be adopted (Annex 4, paragraphs 4.85 to 4.88).

(v) The important scientific and operational requirements for the orderly development of krill fisheries and the need to consider the data requirements with respect to existing conservation measures this year (Annex 4, paragraph 6.50).

Scientific observer program

3.3 The Scientific Committee agreed that the instructions in the *Scientific Observers Manual* be revised (Annex 4, paragraph 4.34), and the interim fish larvae by-catch protocol (WG-EMM-07/25) be included in the manual, so that the various types of information urgently needed by the Scientific Committee could be systematically collected (Annex 4, paragraphs 4.64 to 4.72).

3.4 The Scientific Committee agreed to consider issues relating to observer coverage.

3.5 The Scientific Committee noted with interest WG-EMM's deliberations on the issue of data collection by scientific observers which focused on previously agreed priorities (SC-CAMLR-XXV, paragraph 2.15).

3.6 The Scientific Committee endorsed WG-SAM's advice which identified a need for high-quality length-frequency data from the fishery from several years in advance of implementing an integrated assessment, and recommended that the fishery start providing length-frequency data now, given that the coverage by research surveys is not likely to be sufficient for all regions (Annex 7, paragraph 3.13).

3.7 The Scientific Committee based its deliberations on the following two strategic objectives for scientific observations of the krill fishery:

(i) to understand the overall behaviour and impact of the fishery
(ii) to undertake routine monitoring of the fishery to inform population and ecosystem models.

3.8 The rationale behind this two-stage approach is that fisheries monitoring effort does not necessarily have to have indefinite maximum coverage if a reduced observation effort is sufficient to fulfil management requirements. There is, however, an expectation that there will be a long-term need for systematic data collection from the fishery.

3.9 The Scientific Committee agreed that it will only be possible to design the spatial and temporal level of observer coverage required for objective (ii) once objective (i) has been completed. A full investigation of (i) would require systematic spatial and temporal coverage by scientific observers across SSMUs, seasons, vessels and fishing methods.

3.10 The Scientific Committee agreed that there are a number of ways to collect the required scientific data from the krill fishery. For example, for both first and second stages the most comprehensive coverage, and the most rapid way to achieve objective (i), could be either of the following alternatives:

- 100% coverage by international scientific observers
- 100% coverage by international scientific and/or national observers.

3.11 The Scientific Committee noted that reduced levels of observational effort could delay the achievement of objective (i) in paragraph 3.7, and may also introduce bias into the data if the observational effort is not reduced appropriately. This reduced effort could include:

(i) systematic but <100% coverage by observers;

(ii) different levels of coverage for different fleets, for example, 100% coverage for new vessels with unknown characteristics and a lesser level of coverage on established vessels for which data are already available;

(iii) random systematic allocation of observers plus regular quality checks, and systematic coverage by scientific observers until the fishery is established to fulfil suitable data for management requirements.

3.12 It was clarified that:

(i) 'systematic coverage' means coverage that ensures data collection across all areas, seasons, vessels and fishing methods, which leads to the provision of consistent high-quality data for assessments in multi-vessel, multi-nation fisheries (Annex 7, paragraph 4.16);

(ii) to obtain the required information, either international or national scientific observers would be acceptable, provided the data and reports are consistent with the CCAMLR Scheme of International Scientific Observation and are of a sufficiently high quality to be of use for the proposed analyses;

(iii) levels of initial observation coverage to understand the overall behaviour and impact of the krill fishery might be higher than that of the eventual long-term observation coverage.

3.13 The Scientific Committee encouraged interested Parties to submit plans to achieve systematic and consistent collection of the required scientific data from the fishery to the next WG-EMM, WG-SAM and ad hoc WG-IMAF meetings for scrutiny. These plans would include those that proposed 100% observer coverage and those that could demonstrate adequate data collection using lower levels of coverage. This work is essential in order that Members can agree on the level of coverage that enables collection of the data necessary to achieve the stated objectives.

3.14 The Scientific Committee agreed that the working groups should carry out an assessment of the consequences to the data collection effort of the different approaches suggested, and recommend the required level of observer coverage to the Scientific Committee in 2008.

3.15 The Scientific Committee acknowledged that each of the options for obtaining the priority data required would have consequential issues of implementation and the timescale of delivery. Risks associated with reduced coverage need to be thoroughly addressed by relevant experts before agreeing on an observer coverage plan.

3.16 The Scientific Committee further urged Members and Contracting Parties fishing for krill to send their experts to WG-EMM and WG-SAM to be fully engaged in the process.

Orderly development of the krill fishery

3.17 The Scientific Committee agreed that a strategic approach to the orderly development of the krill fishery would allow the Commission to better control and mitigate the level of impact by the krill fishery on the krill stocks and on predator populations (Annex 4, paragraphs 4.73 to 4.76). This approach would also make the krill fishery consistent with other CCAMLR-managed fisheries.

Estimation of B_0 and precautionary catch limits for krill

3.18 The Scientific Committee noted the outcomes of the Workshop to Review Estimates of B_0 and Precautionary Catch Limits for Krill (Annex 4, paragraphs 2.1 to 2.80), and concurred with the advice that the most appropriate method for estimating B_0 from survey data was still the Jolly and Hampton (1990) method as has been used for all CCAMLR B_0 surveys to date (Annex 4, paragraphs 2.13 and 2.67).

3.19 The Scientific Committee agreed that current CCAMLR protocols for the acoustic estimation of krill biomass and its variance should follow those of the CCAMLR-2000 Survey (Trathan et al., 2001; Hewitt et al., 2004), except with regards to target strength and species identification; for these procedures, the recommendations of SG-ASAM should be followed (SC-CAMLR-XXIV, Annex 6). To assist this process, all CCAMLR-adopted acoustic protocols and guidelines for krill surveys should be collated into a single document (Annex 4, paragraphs 2.31 and 5.97).

3.20 The Scientific Committee noted that no new formulations of the key parameters for krill such as growth, recruitment variability and mortality were produced at the workshop. A work program has been initiated to incorporate the most recent information into the assessment process (Annex 4, paragraphs 2.33 to 2.36 and 2.52 to 2.54).

3.21 The Scientific Committee agreed that the B_0 estimate of 37.29 million tonnes and the CV estimate of 21.20%, presented in WG-EMM-07/30 Rev. 1, represents the best advice on the biomass estimate for krill in Area 48 during the CCAMLR-2000 Survey (Annex 4, paragraph 2.28) and that, using these values and the updated γ arising from the use of the GYM (0.093), compared to the KYM (0.091), the precautionary catch limit for Area 48 should be updated to 3.47 million tonnes (Annex 4, paragraphs 2.28, 2.39 and 2.41). The Scientific Committee recommended that Conservation Measure 51-01 be amended accordingly.

3.22 A new estimate of B_0 for Division 58.4.2, produced using the new simplified SDWBA model for target strength and species identification, of 28.75 million tonnes with a CV of 16.18% was presented in SC-CAMLR-XXVI/7. This biomass was subdivided as agreed by WG-EMM (Annex 4, paragraphs 6.22 and 6.50) and precautionary catch limits were calculated for the entire survey area and for the two subdivisions.

Stratum	B_0 (million tonnes)	CV	Precautionary catch limit (million tonnes)
Entire survey (30–80°E)	28.75	16.18	2.645
Western subdivision (30–55°E)	16.17	18.36	1.448
Eastern subdivision (55–80°E)	11.61	29.82	1.080

3.23 The Scientific Committee agreed that the subdivision was appropriate and that Conservation Measure 51-03 should be re-written to reflect these changes in the precautionary catch limit and its subdivision.

3.24 The Scientific Committee thanked Australia for completing this survey and congratulated it on the timely submission of the revised results.

3.25 The Scientific Committee agreed that any future surveys intended to produce estimates of B_0 should follow the agreed protocols and be first presented to WG-EMM for its consideration and approval (Annex 4, paragraph 2.30).

3.26 The Scientific Committee also noted that there are currently no SSMUs defined in areas other than Subareas 48.1, 48.2 and 48.3, and catch limits have not been set in Area 88 nor Subarea 48.6 (Annex 4, paragraph 2.55).

3.27 In noting that there is currently sufficient knowledge of where krill fishing might be possible, but insufficient knowledge about the impacts of such fisheries on krill and dependent predators for many areas, the Scientific Committee noted that as the krill fishery develops, it will be important to apply the ecosystem-based management principles developed in Area 48 to other areas (Annex 4, paragraph 2.79).

3.28 The Scientific Committee recommended that the development of krill fishing in Area 88 or Subarea 48.6 should be considered exploratory fisheries, since only limited information exists on the distribution and abundance of krill or predators.

3.29 WG-EMM should consider the information that would be required from exploratory krill fisheries. This could include consideration of stock sizes and definition, any subdivision of the statistical areas that might facilitate surveying or management, the requirement for SSMUs and trigger levels and the information available on krill, predators and the environment that could assist with management of exploratory fisheries (Annex 4, paragraph 2.79).

3.30 It was noted that some of the information required from an exploratory krill fishery might be provided from fishing vessels.

3.31 The Scientific Committee noted an aspect of uncertainty that is not currently incorporated in the assessment and decision rules – implementation uncertainty. Implementation uncertainty, caused by IUU fishing for krill or spatial/temporal misreporting, may also become important, and either minimised by putting appropriate control measures in place or explicitly represented in models (Annex 4, paragraph 2.64).

Status of predators, krill resource and environmental influences

3.32 The Scientific Committee noted WG-EMM's deliberations on the wider Antarctic ecosystem. It endorsed the comments on the importance of data collection to support CEMP indices (Annex 4, paragraph 5.6 and 5.73) and their analysis (Annex 4, paragraphs 5.75 and 5.76), encouraged regional studies in areas such as the Ross Sea (Annex 4, paragraphs 5.26 and 5.34) and the Scotia Sea (Annex 4, paragraph 5.58), encouraged participants in IPY and CAML surveys to follow standard protocols (Annex 4, paragraphs 2.31 and 5.84) and agreed on the need for future data requirements from the fishery (Annex 4, paragraphs 5.5 and 5.51).

3.33 The importance of the long time series of krill density and recruitment indices collected as part of the BAS, US AMLR and LTER programs for the work of CCAMLR was strongly emphasised. There will be a continuing need to collect and submit these data to the working groups into the future (Annex 4, paragraphs 2.75 and 5.43).

3.34 The Commission was urged to encourage Members to develop (and maintain) long-term scientific monitoring programs studying the krill-based ecosystem, as these will provide the data that will allow the Scientific Committee to investigate the effects of climate change as well as the effects of the fishery. This work will be facilitated by coordination of future long-term research to develop the best sites and data.

3.35 In noting the request from WG-EMM for advice from the Scientific Committee on the methods to use for subdividing large statistical areas in the absence of sufficient information, the Scientific Committee encouraged further work be undertaken by the Working Group to examine the consequences of not subdividing large statistical areas, or the consequences of subdividing these areas using limited data (Annex 4, paragraphs 6.23 and 6.24).

Small-scale management units

3.36 The Scientific Committee endorsed the results of WG-EMM's continuing deliberations on SSMUs (Annex 4, paragraphs 6.25 to 6.47), noting also its discussion in paragraph 2.14, in particular:

(i) its endorsement that 'structured fishing' is a useful elaboration of the meaning of Option 6 (Annex 4, paragraph 6.26);

(ii) its endorsement of the process recommended by WG-SAM that the implementation of a subdivision of the Area 48 catch limit amongst SSMUs could be undertaken in stages based on the best scientific evidence available at each stage (Annex 4, paragraph 6.35);

(iii) that Stage 1 advice can be delivered next year based on models and data currently available and would involve the provision of advice on a total catch limit in Area 48 combined with catch limits in each SSMU, and that the discussion surrounding this advice is provided in Annex 4, paragraphs 6.35 to 6.38;

(iv) its endorsement of the model scenarios for delivering Stage 1 advice and the need to consider the implications for the fishery of potential differences in catch rates in shelf versus oceanic SSMUs (Annex 4, paragraphs 6.39 to 6.44);

(v) the importance of using field and other data in the models to establish that the relative differences amongst SSMUs in the models reflect reality and its endorsement of the process of using data outlined by WG-SAM (Annex 4, paragraph 6.45), including consideration of the benchmark data suggested by WG-SAM for validating the models noting:

   (a) the strongest signals in empirical data are those for penguins and seals;

   (b) variability in krill abundance can be documented from the AMLR, BAS and LTER survey series;

   (c) changes in krill abundance prior to these survey series are less well supported by data, particularly when the errors in the estimates of abundance are considered;

   (d) trends in whale populations are unclear and very much dependent on which species is considered;

(vi) its endorsement of the approach of WG-SAM to the performance measures and risk assessments to be undertaken in Stage 1, noting that the 'benchmark levels' indicated by WG-SAM are really 'reference levels', which are quite distinct from the benchmark data used to validate the models (Annex 4, paragraph 6.46);

(vii) its endorsement of the further development of feedback management approaches (Option 5) and structured fishing (Option 6) after the work for Stage 1 is completed, noting that structured fishing could provide useful results to assist, during the development of the fishery, the elaboration of a feedback management in the longer term (Annex 4, paragraph 6.47).

3.37 Dr H. Shin (Republic of Korea) questioned if structured fishing is fishing as instructed by a pre-set plan overriding fishers' decisions with a view to generate artificial impacts. He doubted whether such fishing could detect any effects beyond natural variability when conducted at an ecologically safe level. He also observed it would be difficult to administer, particularly when applied in regular, assessed fisheries which have been in operation for a few decades.

3.38 The Scientific Committee acknowledged that the issue of variability in environmental parameters and in the krill population would have a major effect on the operation of SSMUs (Annex 4, paragraph 6.36) and noted that the models being developed incorporated such variability. There also needs to be an assessment of the various subdivision options on the krill fishery itself and how within-season reallocation of catches might be effected.

Lenfest Workshop

3.39 The Scientific Committee welcomed the discussion of the report of the Workshop on Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries organised at the request of the Lenfest Ocean Program in May 2007 in California, USA

(Annex 4, paragraphs 7.9 to 7.13). Such workshops provide an opportunity for people outside the CCAMLR community to contribute their experience, data and perspectives towards advancing the work of CCAMLR and to communicate that work to a wider audience.

Intersessional work

3.40 The Scientific Committee endorsed the priorities for the 2008 meeting of WG-EMM (Annex 4, paragraph 7.30):

(i) the development and provision of advice on Stage 1 of the subdivision of the Area 48 krill catch amongst SSMUs;

(ii) revision, as needed, of estimates of yield for krill;

(iii) considering the outcomes of the work of the Subgroup on Status and Trend Assessment of Predator Populations (WG-EMM-STAPP).

Conservation measures on krill fishing

3.41 The Scientific Committee discussed a number of issues arising from the advice of WG-EMM. The background to its discussions is given below.

Precautionary yield for krill in Area 48

3.42 The Scientific Committee noted that in 2000 the Commission agreed that krill catches in Area 48 should not exceed a trigger level until a procedure for division of the overall catch limit into smaller management units had been established (CCAMLR-XIX, paragraph 10.11), and that in 2002 the Commission had defined these smaller management units as small-scale management units (CCAMLR-XXI, paragraph 4.5). It further noted that WG-EMM had advised that the current drafting of Conservation Measure 51-01 would not allow the Secretariat to implement the trigger level as intended, and consequently recommended its revision (Annex 4, paragraphs 2.77 and 6.50).

3.43 The Scientific Committee further noted that following a reanalysis of the CCAMLR-2000 survey data, WG-EMM had provided advice on a revised precautionary catch limit for krill in Area 48 (3.47 million tonnes), but had not provided advice on a subarea division of this catch limit. The Scientific Committee noted that subarea divisions were not necessary given the decision of the Commission to define the spatial delineation of SSMUs.

3.44 The Scientific Committee recommended that Conservation Measure 51-01 be revised accordingly.

Notification of intent to participate in a krill fishery

3.45 The Scientific Committee endorsed the advice of WG-EMM of the need to clarify the notification procedure and include more detail in the notification form (Conservation Measure 21-03, Annex A). The large discrepancy between notifications for krill fishing and actual fishing effort creates a significant problem for the Scientific Committee in that it reduces its ability to plan its activities, particularly its work to determine appropriate catch limits for SSMUs.

3.46 The Scientific Committee agreed that one of the ways to reduce the number of notifications that were not followed by fishing would be to disallow future fishing for a number of years for those Contracting Parties which did not act on their notifications. It regretted the circumstance that might make this necessary.

3.47 The Scientific Committee recommended that Conservation Measure 21-03 be revised accordingly.

Data reporting from the krill fishery

3.48 The Scientific Committee noted the advice of WG-EMM that, under current reporting requirements, the Secretariat would have to forecast krill catches 120 days in advance to effect a closure of a krill fishery. It concluded that a shorter catch reporting system would be required as the fishery approached the trigger level. It recommended that moving to a 10-day reporting system would be necessary once 80% of the trigger level in any krill fishery had been reached.

3.49 Accordingly, the Scientific Committee recommended that Conservation Measure 23-06 be revised.

Biological reporting for the krill fishery

3.50 In noting that the conservation measure for the data reporting system for the krill fishery (Conservation Measure 23-06) is the only conservation measure that does not require collection of biological information, the Scientific Committee recommended the data reporting requirements from the krill fishery should be consistent with the data required to manage the orderly development of the fisheries (Annex 4, paragraph 4.70 to 4.72).

3.51 In order to deliver this consistency in reporting, the Scientific Committee requested that WG-EMM consider the biological data reporting requirements for the krill fishery and to deliver advice next year in order that the biological data reporting requirements included in Conservation Measure 23-06 may be reviewed.

Exploratory fisheries for krill

3.52 The Scientific Committee agreed that krill fisheries in areas without precautionary catch limits (e.g. Area 88 and Subarea 48.6) should be considered as exploratory fisheries and that the conditions applied to other exploratory fisheries (Conservation Measure 21-02) should apply.

3.53 The Scientific Committee requested that Members provide WG-EMM with details of appropriate approaches to determining the data requirements to evaluate the distribution, abundance and demography of krill to provide an estimate of precautionary catch limit and the potential yield of the fishery according to the CCAMLR decision rules.

Precautionary catch limitation on *Euphausia superba* in Division 58.4.2

3.54 The Scientific Committee agreed that the precautionary catch limit for krill in Division 58.4.2 be revised to 2.645 million tonnes per year based on the results of a scientific survey using approved methodology and the CCAMLR decision rules (Annex 4, paragraphs 2.29 and 5.39). Noting that WG-EMM had agreed that the subdivision of this area along the 55°E line of longitude was appropriate (Annex 4, paragraph 6.22) precautionary catch limits of 1.448 million tonnes and 1.080 million tonnes for the regions west and east of 55°E for these subdivisions were also agreed.

3.55 Noting that WG-EMM had agreed that trigger levels should be developed for each krill fishing area to manage the orderly development of the fishery (Annex 4, paragraph 2.79(iii)), the Scientific Committee agreed that trigger levels for this division should be calculated in a manner consistent with the proportion of B_0 used in Area 48, resulting in trigger levels of 260 000 and 192 000 tonnes west and east of 55°E in Division 58.4.2 respectively.

3.56 The Scientific Committee recognised that despite there being a recent assessment of krill biomass in Division 58.4.2, there is a relative paucity of ecological information in this division compared to Area 48. Furthermore, the krill fishery has not operated in Division 58.4.2 since the 1988/89 season and no observer reports have been submitted from the krill fishery in this division. Consequently, there is a need to collect scientific data from the fishery in this division to assist with management. Because of this lack of data, the Scientific Committee agreed it is prudent to apply some of the exploratory fisheries measures to Division 58.4.2 to ensure the orderly development of the fishery in this division, including the use of scientific observers to collect data on the fishing operations, by-catch and krill demographics.

3.57 The Scientific Committee recommended that Conservation Measure 51-03 be revised accordingly.

Other conservation measures

3.58 The Scientific Committee agreed with the Working Group's recommendation to remove the Seal Islands CEMP site from Conservation Measure 91-03 (paragraph 3.60; Annex 4, paragraphs 6.3 and 6.4).

Protected areas

3.59 Discussion of WG-EMM's deliberations on management of protected areas is reported in the next section.

Management of protected areas

3.60 The Scientific Committee endorsed the advice from WG-EMM that management plans for the Cape Shirreff and Seal Islands CEMP sites, and the two relevant measures (Conservation Measures 91-02 and 91-03 respectively) would not need to be reviewed until 2009. It further endorsed the recommendation that the Seal Islands CEMP site under Conservation Measure 91-03 should be discontinued, since research was no longer being undertaken at this site (Annex 4, paragraphs 6.2 to 6.4).

3.61 The Scientific Committee noted the advice from WG-EMM regarding the proposed management plan submitted by the USA for ASMA No. X: Southwest Anvers Island and Palmer Basin, which contains a marine component (SC-CAMLR-XXVI/BG/3). The Working Group had noted that the site contains an area of long-term ecosystem research, which occurs in an area without harvesting and thus provides information that can be compared to adjacent harvested areas. The proposed ASMA has a small marine component (3 275 km^2, representing approximately 0.5% of the total surface area in Subarea 48.1), and has not been subjected to sustained commercial harvesting (Annex 4, paragraph 6.13).

3.62 Dr Holt noted that this proposal was for a managed area, and not a protected area. He highlighted the reasons for the proposal of this area, and the need for the management of activities in order to protect long-term and future research interests. The proposed ASMA contains a small and shallow marine component, in an area that is considered very unlikely to support a krill fishery. The importance of providing scientific advice from the Scientific Committee to CEP was also emphasised, particularly in relation to the maintenance of a good working relationship between the Scientific Committee and CEP.

3.63 Dr N. Gilbert (CEP Observer) endorsed previous comments on the status of the proposed ASMA as a managed area. He noted that under the provisions of Annex V to the Protocol on Environmental Protection to the Antarctic Treaty, any area including any marine area may be designated as an ASMA. ASMAs are not prohibited-access areas, and are intended to coordinate the range of activities occurring in an area. For clarification, he noted that the draft management plan for Southwest Anvers Island had been submitted to CEP X (New Delhi, India, 2007), and that it has now entered a process of intersessional review under CEP. In this regard, CEP's expectation is that the Scientific Committee can provide input to this review, according to the procedure nominated by the Commission (CCAMLR-XX, paragraph 11.17).

3.64 Dr K. Shust (Russia) indicated that the marine boundary of the proposed area does not follow geographic features. Other Members noted that the management plan states that the boundaries of the ASMA have been designed to include areas of high ecological value while also maintaining a practical configuration for ease of use and navigation. It was further noted that the substance of the management plan, including the area boundaries, had already been reviewed by CEP.

3.65 The Scientific Committee noted that, for this ASMA proposal, it needs to address two questions in order to provide advice to the Commission:

(i) Could actual harvesting or the potential capability of harvesting of marine living resources be affected by site designation?

(ii) Are there provisions specified in a draft management plan which might prevent or restrict CCAMLR-related activities?

3.66 The Scientific Committee agreed the following response to the respective questions:

(i) the marine component contains a very small fraction of the krill population distributed throughout Area 48 (only comprising 0.5% of the total surface area of Subarea 48.1) and that, should fishing activities need to be undertaken, it would need to be carried out in such a way that it would not impact on research activities;

(ii) the research being undertaken in the area proposed to be included in the ASMA:

   (a) is important for considering ecosystem interactions related to krill and assists WG-EMM and, as such, enhances the work of CCAMLR;

   (b) contributes to the cooperative research being undertaken as a foundation to the work of CEP, CCAMLR and the Antarctic Treaty System as a whole;

   (c) could be compromised if activities occurring in the marine area are not appropriately managed to avoid interference with those programs.

3.67 The Scientific Committee agreed that there was a need for clarification in the management plan of whether fishing is permitted within the proposed ASMA. It was suggested that text could be inserted into the management plan to state that fishing activities are permitted within the ASMA, but that any fishing activities must be conducted in accordance with the provisions of the management plan, and in coordination with the research and other activities taking place in the area. This could include the development of a research plan for fishing in this area.

3.68 It was further noted that:

(i) there are no restrictions on the navigation of any vessels through the area, with the exception of seasonal buffer zones extending 50 m from the shore of a small number of islands, to protect sensitive bird colonies during the breeding season;

(ii) scientific research can be undertaken within the area by any CCAMLR Member or Party to the ATCM, in accordance with the general Code of Conduct and the Scientific and Environmental Guidelines contained within the management plan.

3.69 The Scientific Committee agreed that, in accordance with Annex V, Article 6.3 of the Protocol on Environmental Protection to the Antarctic Treaty, a review of this management plan would be initiated every five years, and the plan updated as necessary. This review would be conducted in full consultation with CCAMLR.

3.70 Taking into account the points agreed in paragraphs 3.67 to 3.69, the Scientific Committee expressed its support for the draft management plan, noting that the proposed ASMA would create an important coordination framework for activities such as scientific research and tourism. In particular, the area would enhance the ability of Members to undertake scientific research to further the objectives of CCAMLR and CEP. It was noted that the input provided by the Scientific Committee on this issue has provided a valuable example of the important cooperation between CCAMLR and CEP under the Antarctic Treaty System.

Workshop on Bioregionalisation

3.71 The Report of the Workshop on Bioregionalisation of the Southern Ocean (Annex 9) was introduced by the Workshop Co-convener, Dr Grant. The Workshop on Bioregionalisation was held from 13 to 17 August 2007 in Brussels, Belgium. The Workshop report contains technical details on data, methods and results, as well as an Executive Summary compiled by the Workshop Co-conveners. The Scientific Committee thanked Belgium for the opportunity to progress this work and for hosting such an excellent meeting.

3.72 The primary aim of the Workshop was to advise on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces (SC-CAMLR-XXV, paragraph 3.34) (Annex 9, paragraphs 10 and 11). The Workshop was organised around two subgroups considering the benthic and pelagic systems separately.

3.73 The Workshop considered available bathymetric, physical oceanographic and biological data for the pelagic bioregionalisation (Annex 9, paragraphs 39 to 64). Biological datasets considering spatial attributes of different areas were also considered, and it was determined that some of these datasets might be most appropriately used at the regional scale. Data from the Continuous Plankton Recorder (CPR) Survey, and SCAR-MarBIN were recognised as having particular value to bioregionalisation.

3.74 For the benthic bioregionalisation, the Workshop agreed that data on bathymetry, seafloor temperature and currents, geomorphology, sediments and sea-ice concentration are important. Regarding biological datasets available for the benthic bioregionalisation, the Workshop noted that for the most part, biological data are restricted to shelf areas. Data considered for inclusion in the analysis included data on benthic invertebrates from the SCAR-MarBIN network, as well as presence/absence data on demersal finfish from SCAR-MarBIN and the CCAMLR database (Annex 9, paragraphs 69 to 80).

3.75 The Workshop endorsed the general methodology used to provide a broad-scale pelagic regionalisation from the 2006 Hobart Workshop (SC-CAMLR-XXV, paragraphs 3.44 to 3.49). It was agreed that, at the broad scale, the primary bioregionalisation result from the 2006 Hobart Workshop was a good working product that could be used to inform spatial management of the Convention Area (Annex 9, paragraphs 94 and 95).

3.76 The Workshop agreed that the broad-scale pelagic regionalisation could potentially be enhanced (Annex 9, paragraph 96). Five methods of how biological data could be used to enhance the bioregionalisation were discussed (Annex 9, paragraphs 97 to 121). These included Species Habitat Modelling and the Boosted Regression Trees (BRT) method for modelling single-response variables using several environmental predictors.

3.77 The approach to a benthic bioregionalisation consisted of a three-step process, by which physical regions were first defined using the process employed by the 2006 Hobart Workshop. The biological data were then overlaid, and the classification evaluated. Further work on this classification was undertaken after the Workshop by workshop participants, using the methods described above, and incorporating additional data that was not available at the Workshop. The results of this work are described in SC-CAMLR-XXVI/BG/28.

3.78 The Workshop endorsed the broad-scale primary regionalisation result produced by the 2006 Hobart Workshop.

3.79 The Workshop was supportive of the potential for the BRT method to produce biological data layers for broad-scale and fine-scale bioregionalisation, and it was suggested that the method be submitted for technical review by WG-SAM. It was also suggested that WG-EMM and WG-FSA could be asked to review the appropriateness of the datasets to be included as response variables (biological data) and those for inclusion as environmental layers (Annex 9, paragraphs 140 to 144).

3.80 The results of the benthic bioregionalisation (Annex 9, paragraphs 145 and 146) were updated after the Workshop, to include additional physical data unavailable at the Workshop, and further evaluation of biological data layers (SC-CAMLR-XXVI/BG/28). These results show that there will be a greater heterogeneity in benthic biodiversity and ecosystem structure and function at finer scales.

3.81 A geomorphic map of the East Antarctic margin showed some key features relevant to benthic bioregionalisation, including shelf banks, depressions, steep slope areas, canyons, sediment mounds, seamounts, fracture zones and abyssal plain areas (Annex 9, paragraphs 149 to 156). Further work to extend this geomorphic classification to other areas is presented in SC-CAMLR-XXVI/BG/27.

3.82 The Workshop noted that in providing a framework for understanding spatial structure and function of ecosystems it is important to consider both biodiversity pattern information and spatially defined ecological processes (Annex 9, paragraphs 157 to 164). This can be of assistance to a spatial decision-making framework, which was used in developing the conservation plan for the Prince Edward Islands. The Workshop endorsed the approach to develop maps representing ecological processes and other features that cannot easily be incorporated into an analysis of spatial patterns.

3.83 It was noted that ecological processes can be mapped spatially in two ways:

(i) flexible processes can be mapped using spatial probability data (e.g. kernels)
(ii) fixed processes can be mapped using fixed features that define the process (e.g. geomorphic features).

3.84 The Scientific Committee endorsed the outcomes of the Workshop, as well as the follow-up work described in SC-CAMLR-XXVI/BG/27 and BG/28. It welcomed this work noting it can be used to inform spatial management, and is a primary foundation for understanding the biological and physical heterogeneity in the Southern Ocean.

3.85 The Scientific Committee endorsed the recommendations of the Workshop for further work on this topic (Annex 9, paragraphs 165 to 168):

(i) The primary regionalisation for the pelagic environment can be regarded as useful for application by CCAMLR and CEP. It was agreed that the initial regionalisation for the benthic environment should be reviewed and optimised for use by CCAMLR and CEP.

(ii) Refinements to this bioregionalisation could be made in the future as methods are improved and data acquired and analysed. Further finer-scale bioregionalisation work could be undertaken in a number of areas based on existing data.

(iii) Future work could include efforts to delineate fine-scale provinces, where possible. It was recommended that participants should submit papers to the Scientific Committee on approaches to fine-scale regionalisation, including on statistical methods and potential data sources. It was further recommended that WG-SAM should be requested to consider the statistical methods presented in Annex 9, paragraphs 140 and 141.

(iv) The inclusion of process and species information could also be considered further, particularly in the context of systematic conservation planning, and in developing a spatial decision-making framework (Annex 9, paragraph 157). This may be particularly applicable at finer scales.

3.86 It was also noted that the final term of reference agreed for the Workshop Steering Committee (to establish a procedure for identifying areas for protection to further the conservation objectives of CCAMLR) (Annex 9, Appendix A) had not been addressed in detail at the Workshop, and it was agreed that this should therefore be taken forward as an outstanding topic for consideration in further work.

3.87 The Scientific Committee agreed that the further work described in paragraphs 3.85 and 3.86 should be undertaken within the context of WG-EMM, given the existing focus within that Working Group on issues relating to Southern Ocean ecosystems and spatial management. It was recommended that Members should submit papers to WG-EMM on these topics listed in paragraphs 3.85 and 3.86, and that a new WG-EMM agenda item should be created to facilitate consideration of this work. This new agenda item should maintain flexibility in order to respond to future requests for work on this topic and other related issues.

3.88 Dr Gilbert warmly welcomed the achievements of the Workshop, and informed the Scientific Committee that he would circulate the full Workshop report to CEP Members. As a point of interest, he further noted that the Environmental Domains Analysis undertaken by CEP as a biogeographic classification system for terrestrial Antarctica had provided a useful framework for the development of a terrestrial protected area system, as well as having broader benefits for research, monitoring and reporting.

3.89 Prof. Fernholm noted the relevance of the Workshop outcomes to the recent CBD Experts Workshop on ecological criteria and biogeographic classification systems for marine areas in need of protection, and asked whether there had been any input from CCAMLR to this process. Dr Constable confirmed that some of the discussion points from both the 2007 Workshop on Bioregionalisation and the 2006 Hobart Workshop had been conveyed to the CBD meeting, and that the outcomes of this meeting, when available, may be of interest to the Scientific Committee.

Advice to the Commission

3.90 The Scientific Committee endorsed the advice from WG-EMM on management plans for the Cape Shirreff and Seal Islands CEMP sites as set out in paragraph 3.60 (Annex 4, paragraphs 6.2 to 6.4).

3.91 The Scientific Committee expressed its support for the draft management plan for ASMA No. X: Southwest Anvers Island and Palmer Basin, noting that the proposed ASMA would create an important coordination framework for activities such as scientific research and tourism.

3.92 The Scientific Committee endorsed the outcomes of the Workshop on Bioregionalisation of the Southern Ocean (Brussels, Belgium, 13 to 17 August 2007) (paragraph 3.84), and recommended that the Commission should endorse the further work outlined in paragraphs 3.85 and 3.86.

3.93 The Scientific Committee agreed that this further work should be undertaken within the context of WG-EMM, and that a new WG-EMM agenda item should be created to facilitate its consideration.

Interactions between WG-EMM and WG-FSA

3.94 In order to address some of the issues regarding interactions between WG-EMM and WG-FSA which had been identified by the working groups, the Scientific Committee, at its 2006 meeting, agreed that the conveners of those working groups would lead a one-day workshop in 2007 to address these issues. The aim of the workshop was to consider the development of ecosystem models to examine the effects of fisheries in fish-based ecosystems.

3.95 The workshop was held on 16 July 2007 in Christchurch, New Zealand. It was co-convened by Drs Reid and Hanchet. It was agreed to use an ecological risk assessment as a framework for considering an ecosystem approach to CCAMLR finfish fisheries.

3.96 The main focus of the workshop was to identify potential risks from some CCAMLR fisheries and to review progress on work being undertaken that might contribute to assessing those risks.

3.97 Presentations were made on approaches to developing ecosystem models for CCAMLR fisheries which target:

- *E. superba* in the South Atlantic
- *C. gunnari* at South Georgia
- *C. gunnari* and *D. eleginoides* at Heard Island
- *D. mawsoni* in the Ross Sea.

3.98 The Scientific Committee agreed with the conclusion reached by workshop participants that the one-day meeting provided a good opportunity to review progress on ecosystem modelling for some CCAMLR finfish fisheries. The Scientific Committee noted the need for further development of ecosystems models which could take into account the complex interactions between predators, target species, prey and other fisheries.

3.99 The Scientific Committee agreed that:

(i) the results of ecosystem/multi-species models would need to be evaluated by WG-SAM;

(ii) results of ecosystem/multi-species models could be discussed under the WG-FSA agenda item 'Considerations of ecosystem management';

(iii) interactions of the target fish species with top predators, and with krill and the krill fishery, may best be considered by WG-EMM under its agenda item 'Status and trends in the krill-centric ecosystem'.

3.100 The Scientific Committee agreed that further work on ecosystem modelling for finfish fisheries would benefit from holding another workshop. The Scientific Committee requested that during 2008, the WG-FSA and WG-EMM conveners develop terms of reference for a workshop to be held in 2009.

HARVESTED SPECIES

Krill resources

2006/07 season

4.1 The krill catch for the period from December 2006 to October 2007 in Area 48 was 104 364 tonnes. Norway reported the largest catch of krill with a total of 39 561 tonnes (Table 1). With the exception of the Republic of Korea and Poland, all Contracting Parties have submitted complete sets of fine-scale haul-by-haul data for 2005/06 in accordance with Conservation Measure 23-06 (Annex 4, paragraphs 4.1 and 4.2). The Republic of Korea and Poland were urged to submit the requested data and to send scientists to WG-EMM to assist with the analysis of fisheries data.

Notifications for the 2007/08 season

4.2 The total krill catch notified for the 2007/08 season was 764 000 tonnes, with 25 vessels notified from nine Contracting Parties (Table 2). Ten vessels from three Contracting Parties notified that they would be using a continuous fishing system (Cook Islands, Norway and Ukraine). The high level of notifications indicated that if all the projected catch was taken, the trigger level for Area 48 (620 000 tonnes) would be exceeded. There were notifications of large catches from Acceding States (Cook Islands, 175 000 tonnes and Vanuatu, 80 000 tonnes).

4.3 The Secretariat indicated that Vanuatu had withdrawn its notification to participate in the krill fishery. This reduced the total notified catch for 2007/08 to 684 000 tonnes, which was still in excess of the trigger level in Area 48.

4.4 There were a number of instances in the notifications where there was uncertainty concerning the presence of scientific observers on the fishing vessels. It is important to indicate in the notifications whether data will be collected from these vessels and will be submitted to the Secretariat.

4.5 Japan indicated that its fishing vessel may carry an international and/or national observer. Ukraine indicated that a national observer will conduct experimental work according to a special program. The main objectives of this work include determining the best way of sampling during continuous fishing in order to provide adequate data to the CCAMLR Secretariat in accordance with the conservation measures relating to data submission, as well as recording and determining the qualitative and quantitative composition of invertebrate and fish by-catch. Furthermore, at the end of each cruise, the national scientific observer will provide a report to the CCAMLR Secretariat using forms from the CCAMLR Scheme of International Scientific Observation. The second Ukrainian vessel will fish using conventional trawling for a short period of time and will carry two scientists who will provide a report to CCAMLR.

4.6 Updates on submitted notifications were provided by some Members. Norway will send three vessels in 2007/08 and two of the vessels will only start in April–May so they will catch less than projected in their notification. The Cook Islands indicated that there will be a staged entry of its vessels into the fishery: two vessels will commence fishing in January–February and once their methods are proven, then all seven vessels will enter the fishery.

4.7 The best information available to the Scientific Committee is that the krill fishery will increase markedly over the coming years and the Commission should be made aware that the Scientific Committee takes this predicted expansion very seriously.

4.8 Not only was there a record high level of notifications for the 2007/08 season, but also there was a significant number of new entrants and re-entrants and a wide range of fishing gears being proposed. This suggests that there are major changes occurring in the krill industry and these notifications will have to be taken more seriously than in the past.

4.9 New uses for krill appear to be driving interest in the krill fishery including the production of oil and pharmacological products (SC-CAMLR-XXVI/BG/26).

Fishing methods

4.10 Russia indicated that it would not employ a continuous fishing system, however, vessels may use pumps to clear the codends of conventional trawls. Ukraine indicated that it would be using conventional trawls as well as a continuous fishing system. One of the Norwegian vessels will use a continuous fishing system and two will use conventional trawls.

4.11 The Scientific Committee noted that there had been little progress on obtaining catch information from the continuous fishing system (Annex 4, paragraphs 4.11 to 4.13). Norway indicated that its operator was working on developing a system for real-time data collection of catch from the continuous fishing system and it would submit details to the next meeting of WG-EMM.

4.12 The Scientific Committee wished to draw to the attention of the Commission that one of the krill fishery notifications, from the Cook Islands, indicated the use of a fishing method not previously used in the Convention Area – pair trawling. The Scientific Committee noted that the Secretariat has no established data collection and analysis methods from pair trawling.

4.13 The Cook Islands has submitted detailed information on the vessels being used and it will deploy one national observer on one of the vessels. It will work with the Secretariat to resolve the data submission and analysis methods.

4.14 South Africa expressed serious concern over the potential by-catch of large pelagic organisms such as sharks, marine mammals and penguins associated with pair trawling.

4.15 The Scientific Committee noted that there were now several different fishing techniques being used in the krill fishery and that there were no standard measures of effort across the fishery. The inability to establish a measure of fishing effort in the krill fishery will severely impede the ability of the Scientific Committee to conduct an integrated assessment of the krill fishery. Additionally, the range of techniques, and the absence of biological data from these fishing methods, makes it impossible to assess the ecosystem impacts of the krill fishery. It is critical that information on the operation of the fishery be obtained in order to effectively manage the fishery. Failure to adequately manage the krill fishery would severely undermine CCAMLR's management of Antarctic marine living resources.

4.16 Australia pointed out that the development of the fishery should occur in an orderly and managed fashion (CCAMLR-XXVI/30). This would require an integrated package of measures to regulate the fishery and ensure that the ecosystem effects of the fishery are minimised. Not all measures will need to be implemented immediately but can occur in a staged and planned manner, but given the projected expansion of the fishery, it is a matter of urgency to obtain the most basic information on the fishery now and into the future.

4.17 The Scientific Committee requested that WG-EMM and WG-SAM examine how effort in the krill fishery can best be quantified. It also requested that Members send participants with appropriate expertise to these meetings so that information on fisheries operations can be thoroughly analysed.

Marine mammal by-catch

4.18 There was some concern that two fishing methods might increase the incidences of marine mammal interactions in the krill fishery. Uruguayan observers had noted that seals were attracted to the continuous fishing system. However, on the Norwegian vessel there has not been any by-catch of marine mammals because the vessel applies appropriate mitigation measures. There were observations from outside the Convention Area that pair trawling, because of the herding effect of the two vessels involved, could increase marine mammal by-catch. The Cook Islands, however, indicated that by-catch mitigation was possible in pair trawling. These concerns on by-catch indicated the importance of increased scientific observations from all types of krill fishing methods.

Advice to the Commission on krill

4.19 There had been a significant increase in the number and scale of notifications to enter the krill fishery from Members and Contracting Parties, including new entrants and re-entrants to the fishery. This increased interest appears genuine and it is likely that the krill catch will increase considerably over the next year (paragraphs 4.7 to 4.9).

4.20 The Commission's attention was drawn to the recommended changes to conservation measures in paragraph 3.41 to 3.57.

4.21 There needs to be an orderly development of the krill fishery and failure in this would undermine CCAMLR (paragraph 3.17).

4.22 There is agreement on stage-based development of allocation of krill catch limits to SSMUs in Area 48 (paragraph 3.36).

4.23 There is a scientific need for systematic observer coverage in the krill fishery (paragraph 3.13 to 3.16).

4.24 The Scientific Committee recommended that there should be an enhanced submission of information on a number of operational aspects of the krill fishery. These included (paragraphs 4.10 to 4.17 and 7.19):

- better information on catch rates and effort measures from all types of krill fisheries;
- specifications of net sizes and meshes used in the fishery;
- information on the processing capacity of the fishing vessels.

Fish resources

Fisheries information

Catch, effort, length and age data reported to CCAMLR

4.25 Fishing took place in 13 fisheries targeting icefish (*C. gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*E. superba*) under conservation measures in force in 2006/07 (CCAMLR-XXVI/BG/17).

4.26 Three other fisheries were conducted in the Convention Area in 2006/07:

- 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 and Area 51 outside the Convention Area.

4.27 Catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in 2006/07 are summarised in Table 1. Catches reported in 2005/06 are summarised in Table 3.

4.28 The Scientific Committee noted the work completed by the Secretariat on:

- monitoring and closure of fisheries when catch limits were reached
- review of the effectiveness of the macrourid 'move-on' rule
- updating of Fishery Reports
- investigating the geographic distribution of *D. eleginoides* and *D. mawsoni* in Subarea 48.6.

4.29 The Scientific Committee noted the estimates of catch and effort from IUU fishing (Annex 5, Table 2) and reported catches of toothfish in waters adjacent to the Convention Area (Annex 5, Table 4).

Input for stock assessment

4.30 The Scientific Committee noted that WG-FSA had reviewed all available research data which was subsequently used in updating stock assessments of fish in the Convention Area. This included catch-at-length/age data from fisheries, research surveys, CPUE analyses, tagging studies, biological parameters, stock structure and depredation.

Research surveys

4.31 The Scientific Committee noted that four research surveys were undertaken in 2006/07 (Annex 5, paragraphs 3.24 to 3.31):

- A bottom trawl survey in Division 58.5.2 carried out by Australia. The results of this survey were used to update assessments of toothfish and icefish in this division.

- A bottom trawl 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.

- A bottom trawl survey in the northern Antarctic Peninsula part of Subarea 48.1 was carried out by Germany. The Scientific Committee noted that the results from this survey indicated that finfish species in this region are currently below a level which would allow a reopening of bottom fisheries. The Scientific Committee was informed that the apparent lack of recruitment in several species was consistent with that found by Argentine scientists at Potter Cove.

- A bottom trawl survey of Division 58.5.1 was carried out by France which indicated that the total biomass in this area was approximately 245 000 tonnes with about half that (124 000 tonnes) being *D. eleginoides*. Some shelf and slope species (*C. gunnari* and *Notothenia rossii*) exhibited low levels of biomass compared to previous survey results (1987/88). Other species (*Channichthys rhinoceratus* and *Lepidonotothen squamifrons*) have increased in abundance.

4.32 The Scientific Committee congratulated Australia, France, Germany and the UK on completing very complex research surveys and for providing data and results in very short time periods, and for contributing to the long-term data series (Annex 5, paragraph 3.32).

4.33 In relation to the offshore survey conducted by Germany, Dr E. Barrera-Oro (Argentina) commented on the similarities between the survey results and those obtained in inshore waters of the same area (Argentine study).

4.34 Dr Barrera-Oro noted that a low but apparent constant increase in recruitment of *N. rossii* has been observed inshore since 2000. By contrast, juvenile *Gobionotothen gibberifrons* have virtually disappeared in inshore waters in the area. He further noted that although it has been 27 years since overfishing around the South Shetland Islands resulted in the closure in 1990 of Subarea 48.1 to commercial fishing, these fish species have not recovered. Therefore, the comparison between data collected in offshore and inshore parts of the shelf in the same area is very useful.

4.35 The Scientific Committee noted that these points further highlighted the importance of data from research surveys.

Tagging studies

4.36 The Scientific Committee noted the detailed discussion by WG-FSA on tagging of toothfish in both exploratory and assessed fisheries (Annex 5, paragraphs 3.33 to 3.52) and welcomed both the continuing progress in this area and the significant contribution of the results to the assessments carried out by the Working Group. In 2006/07, 5 530 toothfish were tagged in exploratory fisheries and 244 tagged fish were recaptured (Annex 5, Tables 9 and 10). In established fisheries, 4 653 toothfish were tagged in Subarea 48.3, 292 in Subarea 48.4, 1 199 in Division 58.5.2, 677 in Subarea 58.6 (Crozet) and 2 247 fish in Division 58.5.1. In total, about 14 600 fish were tagged in the Convention Area, which represents a huge commitment towards the development of datasets on which to carry out assessments and provide management advice.

4.37 The Scientific Committee specifically noted the discussion by WG-FSA with respect to:

(i) methods for tagging large toothfish (Annex 5, paragraph 3.33);

(ii) the recapture rates for tags released from some nations' vessels fishing in the Ross Sea toothfish fishery (Annex 5, paragraphs 3.34 to 3.36);

(iii) the failure of some vessels to achieve the required tagging rates in Divisions 58.4.1 and 58.4.2 and Subarea 88.2 (Annex 5, paragraphs 3.42 and 3.43);

(iv) the utility of a time-stamped photographic record of all recaptured tags together with a photograph tag template; the Secretariat estimated the cost of producing waterproof templates would be approximately A$1 500 (Annex 5, paragraphs 3.45 to 3.48);

(v) additional tagging activities planned for the 'Year of the Skate' that should be coordinated by the Secretariat (Annex 5, paragraphs 3.49 to 3.51);

(vi) the use of technological advances in tagging devices to improve understanding of fish behaviour and movement (Annex 5, paragraph 3.52).

4.38 The Scientific Committee expressed concern at the low level of recoveries of fish tagged by some vessels operating in the Ross Sea. This has created considerable doubt as to the completion of the tagging requirements by these vessels in Subareas 88.1 and 88.2. Consequently, a portion of the tag–recapture data from the Ross Sea fisheries could not be used in the assessment conducted by WG-FSA in 2007.

Management advice

4.39 The Scientific Committee recommended that the protocols for tagging very large toothfish, and plans for equipment to assist with handling such fish described in WG-FSA-07/36, be posted on the CCAMLR website, and technical coordinators be directed to this information by the Secretariat.

4.40 In all exploratory fisheries, observers should take a photographic record of all tags recovered and forward these photographs and tags to the Secretariat. Footnote 2 in Conservation Measure 41-01, Annex C, paragraph 2(v), which specifies a trial of photographing tags in 2007, should be removed.

4.41 The Scientific Committee requested that the Secretariat be asked to produce a waterproof template to assist observers with taking legible photographs of tag recaptures, to be distributed with tagging kits. The Secretariat should take responsibility for coordinating skate tagging programs in new and exploratory fisheries starting from the 2007/08 season, in preparation for the Year of the Skate in 2008/09.

4.42 The Scientific Committee requested that all skate tags used by Members in exploratory fisheries should be purchased from the Secretariat for use in the 2008/09 season onwards.

The Scientific Committee requested SCAF to identify funds required by the Secretariat, which will be recovered through the sale of tags and tagging kits to Members undertaking exploratory fisheries.

4.43 The Scientific Committee asked that the Secretariat write to Members providing data on recapture rates of their tags which could then be compared to the average for the Ross Sea, and requesting that they collect and report on information that would help in investigating the possible causes of the variable tag return rates from the tagging undertaken on their vessels. One possible explanation is differences in handling practices on board vessels when tagging the fish, which might give rise to differential post-tagging mortality rates. Information reported by Members should enable a comparison of handling practices on board.

4.44 The Scientific Committee noted that there would be significant merit in having all vessels operating in the fishery in a few areas to give the spatial and temporal overlap that would assist in an investigation of the causes of the differential tag return rates from the various vessels.

4.45 The Scientific Committee recommended that the tagging experiment in Subarea 48.4 be continued, so that further data can be collected that may allow estimates of abundance to be calculated in the future.

4.46 The Scientific Committee requested that SCIC review the information that it would like from WG-FSA, in future, to allow it to address the issue of reporting on vessels that have not met the required tagging rate in new and exploratory fisheries.

4.47 The Scientific Committee recommended that Conservation Measure 41-01, Annex C, be revised by amending the second sentence of paragraph 2(i) to read 'Vessels shall only discontinue tagging if they leave the fishery having tagged toothfish at the specified rate'.

Stock structure

4.48 The Scientific Committee noted information submitted to WG-FSA by New Zealand on the plausible life history of *D. mawsoni* in the Ross Sea region and noted that it would assist in the development of operating models for a future management strategy and evaluation of toothfish resources. The Scientific Committee further noted that, while the paper was highly speculative, it raised some important questions as well as developing a working hypothesis which could be used to focus future research and modelling.

General biology and ecology

4.49 The Scientific Committee noted the work of WG-FSA on biology and ecology and its main deliberations. In particular:

(i) consideration of papers on biology and ecology (Annex 5, paragraphs 9.1 to 9.9);

(ii) identification of three key areas of interest where papers would be requested for WG-FSA, including: (i) stock structure of *D. eleginoides*, (ii) reconstruction of the life history of *D. eleginoides* in different areas, and (iii) a field guide for skates in the Southern Ocean (Annex 5, paragraph 9.10);

(iii) the development and publication of species profiles noting that a species profile for *C. gunnari* had been completed in the intersessional period (Annex 5, paragraphs 9.12 and 9.13).

Preparation of assessment and assessment timetables

Review of preliminary stock assessment papers

4.50 The Scientific Committee noted that WG-FSA had reviewed six preliminary stock assessments that were developed during the intersessional period. These were *D. eleginoides* in Subarea 48.3, Division 58.5.2, Subarea 58.6/58.7 (Prince Edward Islands), *Dissostichus* spp. in Subarea 88.1/88.2 (Ross Sea), *Dissostichus* spp. in Division 58.4.3b and *C. gunnari* in Division 58.5.2. The resulting discussions and summaries are provided in Annex 5, paragraphs 4.13 to 4.33. In most cases, issues that had been raised at WG-SAM had been incorporated into the revised stock assessments.

Assessment carried out and assessment timetable

4.51 All assessment work was undertaken by primary authors of preliminary assessments, and reviewed independently at the WG-FSA meeting. 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 (Annex 5, Appendices D to Q).

Assessments and management advice

Dissostichus eleginoides South Georgia (Subarea 48.3)

4.52 In 2005, Subarea 48.3 was subdivided into management areas containing the South Georgia–Shag Rocks (SGSR) stock and other areas, to the north and west, that do not include the SGSR stock. Within the SGSR area, three management areas (A, B and C) were defined (Conservation Measure 41-02, Annex A). Catch limits for the areas to the north and west were set at zero for 2006/07.

4.53 The catch limits for *D. eleginoides* in the 2006/07 season for management areas A, B and C were 0 (excepting 10 tonnes for research fishing), 1 066 and 2 488 tonnes respectively, with an overall catch for SGSR of 3 535 tonnes. The total declared catch of *D. eleginoides* was 3 535 tonnes. There was no evidence of IUU fishing in the 2006/07 season. Catches in areas A, B and C were 7 tonnes, 976 tonnes and 2 552 tonnes respectively.

4.54 The Scientific Committee endorsed the assessment undertaken by WG-FSA, presented in Annex 5, paragraphs 5.107 to 5.115 and Appendix J (Fishery Report). In particular, the Scientific Committee noted that:

(i) the standardised GLMM CPUE analyses were updated (Annex 5, paragraph 5.110);

(ii) during 2006/07, a further 4 653 tagged *Dissostichus* spp. have been released in SGSR, bringing the total number of tagged fish released to around 17 800. In 2007, 530 recaptures of tagged fish were reported (Annex 5, paragraph 5.111);

(iii) WG-FSA agreed on a single CASAL assessment model, which was structurally similar to that presented at WG-FSA-06, updated with new data on catch, length frequency, CPUE and tagging data from 2007 (Annex 5, paragraph 5.112);

(iv) recent CPUE, length-frequency and tag data are consistent in their information on the level of B_0 (around 100 000 tonnes) (Annex 5, paragraph 5.113);

(v) stock status and the long-term yield were calculated using the MCMC samples for the updated assessment model, as was done last year, with the appropriate long-term yield being 3 920 tonnes (Annex 5, paragraph 5.114).

4.55 The Scientific Committee welcomed the procedure followed by WG-FSA. A preliminary assessment had been presented to the Working Group, independently reviewed during the meeting and a clear recommendation for a catch limit had resulted.

4.56 The Scientific Committee noted that the current model had produced a yield of 3 920 tonnes when updated with new data from 2007. It noted that some uncertainties with the assessment remain, such as the fits to the tag data. A significant revision of the model is under development which will allow direct estimation of present and future recruiting cohort strength which is not possible with the current model. The catch limit for 2008/09, if estimated with this new model, may be different from 3 920 tonnes.

Management advice

4.57 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Subarea 48.3 (SGSR stock) should be 3 920 tonnes for the 2007/08 fishing season.

4.58 If the Commission agrees, this catch limit can be carried over into the 2008/09 fishing season, subject to the conditions detailed in paragraph 14.6.

4.59 The catch limits for *D. eleginoides* in management areas A, B and C should be adjusted in a pro-rata manner to 0 (excepting 10 tonnes for research fishing), 1 176 and 2 744 tonnes respectively. By-catch limits for skates/rays and macrourids should be similarly revised to 196 and 196 tonnes respectively.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

4.60 The catch of *D. eleginoides* reported by France for this division in 2006/07 to 31 August 2007 was 3 438 tonnes. Only longlining is currently permitted in the fishery.

4.61 Prof. Duhamel reported that the catch of *D. eleginoides* in Division 58.5.1 was expected to be about 5 500 tonnes at the end of the 2006/07 season, similar to the catch level in 2005.

4.62 Analyses show a general decreasing trend in the standardised CPUE up until 2003 followed by a period up to the current year for which the CPUE estimates are relatively constant.

4.63 The Scientific Committee noted that 639 toothfish were tagged during the survey conducted on the FV *Austral* chartered at Kerguelen from September to October 2006 and further tagging had begun during the 2006/07 commercial fishing operations.

Management advice

4.64 The Scientific Committee encouraged the estimation of biological parameters for *D. eleginoides* in Division 58.5.1. It also encouraged the development of a stock assessment for this area, as well as cooperative work in the intersessional period between France and Australia on analysis of catch and effort data and other data that could be used to progress understanding of fish stock and fishery dynamics for Divisions 58.5.1 and 58.5.2 and Subarea 58.6. The Scientific Committee encouraged France to continue its tagging program in Division 58.5.1.

4.65 The Scientific Committee recommended avoidance of fishing in zones where there were high rates of by-catch of other species.

4.66 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* in Conservation Measure 32-13, remain in force.

4.67 The Scientific Committee noted that France had made significant progress in mitigating by-catch, including area/season closures (Annex 5, Appendix D, paragraph 23). It noted that the CPUE analysis would probably be robust to these changes so long as detailed haul-by-haul data continue to be available.

Dissostichus eleginoides Heard Island (Division 58.5.2)

4.68 The catch limit of *D. eleginoides* in Division 58.5.2 west of 79°20'E for the 2006/07 season was 2 427 tonnes (Conservation Measure 41-08) for the period from 1 December 2006 to 30 November 2007. The catch of *D. eleginoides* reported for this division as of 5 October 2007 was 1 956 tonnes. Of this, 1 338 tonnes (68%) was taken by trawl and the remainder by longline.

4.69 The Scientific Committee noted the work undertaken by WG-FSA, as summarised in Annex 5, paragraphs 5.128 to 5.135, and endorsed the refinements to the assessment based on the CASAL model introduced at WG-FSA-06. The Scientific Committee encouraged future work aimed at both improving the growth model and providing catch-at-age data to future assessments.

4.70 The Scientific Committee noted the differences between this assessment and those for toothfish in Subareas 48.3 and 88.1 that also use CASAL. These include the use of survey data as observations of young fish, the lack of useable tagging data, the modelling of recruitment without assuming a stock-recruitment relationship, and variability in recruitment estimated in the model from the vector of year-class strengths.

4.71 Dr Constable noted that these differences are not surprising and arise from the differences between the fisheries and the stocks themselves. The CASAL assessment used abundance-at-length estimated from a long-term survey series, catch-at-length from the fisheries and standardised CPUE time series to estimate current and initial population size and year-class strengths since 1981. These results were then used in projections to estimate the long-term annual yield that satisfies the CCAMLR decision rules for toothfish.

4.72 Long-term annual yield was estimated to be 2 500 tonnes giving 50.5% escapement with a probability of depletion of 0.08.

Management advice

4.73 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Division 58.5.2 west of 79°20'E should be 2 500 tonnes for the 2007/08 fishing season.

4.74 If the Commission agrees, this catch limit can be carried over into the 2008/09 fishing season, subject to the conditions detailed in paragraph 14.6.

Dissostichus eleginoides Crozet Islands (Subarea 58.6)

4.75 The catch of *D. eleginoides* reported by France for this subarea in 2006/07 to 31 August 2007 was 333 tonnes and will probably be at the level of the 2005/06 catches. Only longlining is currently permitted in the fishery.

4.76 The Scientific Committee noted that depredation on toothfish catches by killer whales has become a major problem for this longline fishery.

4.77 Analyses show a general decreasing trend in standardised CPUE to 2002/03 with a subsequent slight increase in 2003/04 and 2005/06 and a decrease for the 2006/07 season.

4.78 During 2006/07, 677 toothfish were tagged by observers on board commercial vessels.

Management advice

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

4.80 The Scientific Committee recommended avoidance of zones of where there was a high by-catch of other species.

4.81 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* in Conservation Measure 32-13, remain in force.

4.82 The Scientific Committee noted that France had made significant progress in mitigating by-catch, including area/season closures (Annex 5, Appendix D, paragraph 23). It noted that the CPUE analysis would probably be robust to these changes so long as detailed haul-by-haul data continued to be available.

Dissostichus eleginoides Prince Edward Islands (Subareas 58.6 and 58.7)

4.83 The catch limit of *D. eleginoides* in the South African EEZ for the 2006/07 season was 450 tonnes for the period from 1 December 2006 to 30 November 2007. The catch reported for Subareas 58.6 and 58.7 as of 5 October 2007 was 125 tonnes, all of which was taken by longlines.

4.84 As with the Crozet Islands, the Scientific Committee noted that depredation on toothfish catches by killer whales has become a major problem for this longline fishery.

4.85 The CPUE series was updated for the meeting and, as in previous years, the biological parameters from Subarea 48.3 were used.

4.86 The Scientific Committee noted the details of the assessment used to estimate a long-term annual yield undertaken by WG-FSA, including an augmented two-fleet ASPM that used catches, standardised CPUE and catch-at-length data. The results from the model were only slightly sensitive to whether or not cetacean depredation was included in the calculations and whether or not year-specific weights were used with the CPUE indices. The model estimated the spawning biomass of the resource to be between 37 and 40% of its average pre-exploitation level, although significant uncertainties remain in the assessment.

4.87 The Scientific Committee expressed concern 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) inside the EEZ

4.88 The Scientific Committee was unable to provide management advice for the fishery in the South African EEZ at the Prince Edward Islands. The Scientific Committee recommended that CCAMLR decision rules be used in estimating yields for this fishery.

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

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

Champsocephalus gunnari South Georgia (Subarea 48.3)

4.90 The catch limit set for *C. gunnari* in Subarea 48.3 in the 2006/07 season was 4 337 tonnes. A total catch of 3 940 tonnes of icefish was reported to October 2007. The fishery may remain open until 14 November 2007 by which time it is expected that the full catch limit will be taken.

4.91 The Scientific Committee noted that the UK undertook a random stratified trawl survey on the South Georgia and Shag Rocks shelves and the information was used to generate a standing stock estimate. Whilst the estimated mean value of the standing stock decreased by 8%, from 105 000 tonnes in January 2006 to 98 000 tonnes in September 2007, the lower one-sided CI decreased by 35% from 37 500 to 23 400 tonnes.

4.92 The Scientific Committee endorsed the short-term assessment undertaken by WG-FSA. The Scientific Committee noted the conclusion of WG-FSA that the spawning of *C. gunnari* has little spatial overlap with the fishery and that the requirement of vessels fishing between 1 March and 31 May to undertake 20 research trawls is likely to increase the risk of seabird mortality.

Management advice

4.93 The Scientific Committee agreed that the catch limit for C. *gunnari* should be set at 2 462 tonnes in 2007/08 and 1 569 tonnes in 2008/09.

4.94 The Scientific Committee also recommended that Conservation Measure 42-01 be amended to:

(i) remove the requirement that vessels fishing between 1 March and 31 May be required to undertake 20 research trawls (as detailed in Conservation Measure 42-01, Annex A);

(ii) not require that the catch during the 1 March to 31 May period be limited to 25% of the overall catch limit.

4.95 The Scientific Committee further recommended that the impact of changes to Conservation Measure 42-01 should be reviewed by WG-FSA at next year's meeting, particularly in respect to the maturity of fish caught through the year and the timing of fishing effort (particularly during the March–May period).

Champsocephalus gunnari Heard Island (Division 58.5.2)

4.96 The catch limit for *C. gunnari* in Division 58.5.2 in 2006/07 was 42 tonnes for the period 1 December 2006 to 30 November 2007. The catch reported for this division as of 5 October 2007 was 1 tonne.

4.97 A large 1+ 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 June–July 2007.

4.98 The Scientific Committee endorsed the short-term assessment undertaken by WG-FSA.

Management advice

4.99 The Scientific Committee recommended that the catch limit for *C. gunnari* in 2007/08 be set at 220 tonnes and that all other measures in Conservation Measure 42-02 should be retained.

4.100 The Scientific Committee also recommended that further work on developing a management procedure for *C. gunnari* is a high priority (SC-CAMLR-XXIV, Annex 5, Appendix M, paragraph 26).

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

4.101 Commercial finfishing in the Antarctic Peninsula and the South Shetland Islands (Subarea 48.1) and the South Orkney Islands (Subarea 48.2) was closed by CCAMLR after the 1989/90 season with the provision that these subareas should only be reopened to commercial fishing if surveys have demonstrated that the condition of fish stocks had improved to the extent which would allow commercial harvesting.

4.102 Germany conducted a bottom trawl in the Elephant Island–South Shetland Islands area (part of Subarea 48.1) from 19 December 2006 to 3 January 2007 (WG-FSA-07/22). The Scientific Committee agreed that biomass of most finfish stocks was found to be lower than during the last surveys in 2002 and 2003 and that this does not allow for a reopening of the fishery.

Management advice

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

South Sandwich Islands (Subarea 48.4)

4.104 The Scientific Committee noted the Fishery Report for *D. eleginoides* in Subarea 48.4, which is contained in Annex 5, Appendix Q. A mark–recapture experiment in Subarea 48.4 started in 2004/05 and is in its third year. It was noted that a New Zealand-flagged vessel and a UK-flagged vessel fished in the area in 2006/07 and continued the tagging program.

4.105 The Scientific Committee also noted that a total of 467 *D. eleginoides* and 11 *D. mawsoni* (total 478 fish) have been tagged and released and two *D. eleginoides* have been recaptured in the subarea. In addition, one fish tagged in Subarea 48.4 was recaptured in Subarea 48.3. It is expected that the mark–recapture experiment will continue in Subarea 48.4 over the 2007/08 season to inform the assessment of the toothfish population structure and size in accordance with Conservation Measure 41-03.

Management advice

4.106 The Scientific Committee noted that Conservation Measure 41-03 is in force until the end of the 2007/08 season and that the results of the tagging experiment would be reported at the 2008 meeting. This would provide an opportunity for WG-FSA to receive the results and develop the assessment of this fishery.

4.107 Based on the current low rates of tagging, the Scientific Committee recommended an extension of the current experiment for one or two further years.

4.108 The Scientific Committee agreed that further development of this fishery may include a similar tagging experiment for *D. mawsoni* in the southern region of Subarea 48.4 and the introduction of catch limits for by-catch species.

New and exploratory fisheries in 2006/07 and notifications for 2007/08

4.109 In 2006 the Commission agreed to seven exploratory longline fisheries for *Dissostichus* spp. in the 2006/07 season (Conservation Measures 41-04, 41-05, 41-06, 41-07, 41-09, 41-10 and 41-11). Activities in the exploratory fisheries are outlined below and summarised in Annex 5, Table 6. In most fisheries the number of vessels fishing was about half of the number notified.

4.110 Notifications for exploratory fisheries in 2007/08 are summarised in Annex 5, Table 7. Twelve Members submitted paid notifications 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. There were no notifications for new fishing areas, and no notifications were received for fisheries in closed areas. The number of vessels notified was substantially larger than for the 2006/07 fishing season, except in Division 58.4.3a and Subareas 88.1 and 88.2.

Progress towards assessments of new and exploratory fisheries

4.111 The Scientific Committee congratulated WG-FSA on making further progress this year in assessing stocks of *Dissostichus* spp. in the Ross Sea. It noted that, with the exception of Division 58.4.3b for which a Leslie depletion analysis had been undertaken by Australian scientists, the Working Group had been unable to progress the assessment of any other exploratory fisheries (Annex 5, paragraphs 5.6 to 5.9).

4.112 The Scientific Committee agreed that there was an urgent need for WG-FSA to develop assessments for all exploratory fisheries, and to ensure that appropriate data were collected to enable such assessments to be made as soon as practicable.

4.113 The Scientific Committee noted that WG-FSA had examined the power of current exploratory fishery research plans to deliver assessments of stock status. Results are preliminary, but one study suggested that for many areas, the research catch required for estimating CPUE in a single survey would need to be in excess of 40 tonnes. It also encouraged further development of an analysis which estimates the catch required to estimate stock size accurately given current tagging rates (Annex 5, paragraphs 5.10 to 5.22).

4.114 There is a need to investigate the design of research experiments that manipulate the distribution of fishing between SSRUs within exploratory fisheries (Annex 5, paragraphs 5.24 to 5.29). For instance, the catch limits for toothfish in Subareas 88.1 and 88.2 in the Ross Sea were changed in 2005 as part of a three-year experiment (SC-CAMLR-XXIV, paragraphs 4.163 to 4.166). The Scientific Committee noted WG-FSA's comment (Annex 5, paragraph 5.27) that if the concentrated sampling protocol was abandoned before or at the end of the experiment and fishing effort was dispersed, the tagging program would be diluted, which could adversely affect the assessments. The Scientific Committee endorsed the request of WG-FSA that WG-SAM undertake methodological work on designing research experiments and consider this and other issues at its meeting in 2008.

4.115 The Working Group also noted that research vessels which notify and fish specific areas are asked to provide a full report of the effort within 12 months (Conservation Measure 24-01, paragraph 4(c)), however, it was requested that a report be submitted in time for consideration of its 2008 meeting. This task could be aided by the development of pro formas for research proposals and research summaries.

General management advice for new and exploratory fisheries

4.116 The Scientific Committee noted that there are significant differences in the tag recovery rates deriving from tagging by different Members (Annex 5, paragraph 5.49). It is important to understand whether this is due to operational constraints which might suggest differences in mark–recapture model parameters, or to other reasons. The Secretariat is requested to investigate this matter intersessionally (paragraph 12.9).

4.117 A number of vessels failed to achieve the required tagging rates in exploratory fisheries. The Scientific Committee reiterated the importance of meeting these tagging targets. It recommended a change to Conservation Measure 41-01, Annex C, to emphasise that tagging should be carried out continuously while fishing, rather than sporadically, such as at the end of a fishing period.

4.118 The Scientific Committee noted that in the 2006/07 season, several vessels either did not conduct or did not report research sets in the exploratory fisheries in Subarea 48.6, Divisions 58.4.2, 58.4.3a and 58.4.3b as required under Conservation Measure 41-01, Annex C (Table 2 in Annex 5, Appendices D, F, G and H). The Scientific Committee encouraged Flag States to ensure that research sets are completed and reported as the data collected from these activities are essential for developing assessments.

4.119 Noting the advice of WG-FSA on efforts to increase survivorship of discarded rajids and the proposed Year of the Skate (Annex 5, paragraph 5.52; paragraph 4.184), the Scientific Committee recommended that Conservation Measure 33-03 be amended to include the following paragraph after paragraph 3: 'Unless otherwise requested by observers, vessels, where possible, should release rays from the line by cutting snoods and, when practical, removing the hooks'.

4.120 The Scientific Committee discussed appropriate levels for precautionary catch limits in new and exploratory longline fisheries in the case where the populations are severely depleted. It agreed that a balance needs to be struck between the levels of commercial catch that are necessary for scientific research, and the level of catch that is sustainable in severely depleted populations. Without the research, it will not be possible to determine appropriate long-term sustainable yields for these stocks or whether they have recovered to the point where fishing may be resumed, but in some cases the level of catch necessary for research may be greater than is sustainable from the population.

4.121 The Committee concluded that in the situation where research may require catches that are likely to be higher than is sustainable by a population, the Scientific Committee would recommend appropriate survey designs and catch levels required for the research, and the Commission should decide whether it required the research or whether those areas should remain closed.

4.122 Fishing by Members is only one source of mortality in such fisheries. However, the Scientific Committee was not able to conclude as to whether the presence of Members' vessels was likely to either increase or decrease the level of IUU fishing.

4.123 The Scientific Committee discussed the scientific value of the 10-tonne research exemptions that are allowed in some of the closed SSRUs in exploratory fisheries. Some of the analyses reported above suggest that such low catch limits may provide only limited information to assist stock assessments.

Dissostichus spp. (Subarea 48.6)

4.124 Three vessels (Japan, Republic of Korea and Norway) fished in the exploratory fishery in Subarea 48.6 in 2006/07. The precautionary catch limit for *Dissostichus* spp. was 910 tonnes and the total catch was 113 tonnes. The fishery operated primarily in SSRU A (the northern half of Subarea 48.6). There was no evidence of IUU fishing in 2006/07 (Annex 5, paragraphs 5.54 to 5.58).

4.125 Four Members (Japan, Republic of Korea, New Zealand and South Africa) and a total of eight vessels notified their intention to fish for toothfish in Subarea 48.6 in 2007/08. This is the same number of Members as 2006/07 but with an increased number of vessels (five last year, eight this year).

4.126 The Scientific Committee endorsed WG-FSA's recommendation that SSRU 486A be subdivided into two SSRUs along longitude 1.5°E (Annex 5, paragraph 5.59).

4.127 The Scientific Committee noted that the catch limit for Subarea 48.6 had originally been based on a pro-rata application of catch rates and seabed areas from Subarea 48.3. This method is no longer considered to be appropriate. Given the large variation in catch rates across the Convention Area, and the low catch rates in Subarea 48.6 (Annex 5, Table 8), the Scientific Committee no longer considered the catch limit of 910 tonnes to be precautionary, either north or south of 60°S.

4.128 The Scientific Committee recommended that Conservation Measure 41-04 be updated with the appropriate change to subdivide SSRU 486A and encouraged the Commission to reconsider the catch limit given that the Scientific Committee does not consider it to be appropriately precautionary.

Dissostichus spp. (Division 58.4.1)

4.129 Four Members (Republic of Korea, Namibia, Spain and Uruguay) and four vessels fished in the exploratory fishery in Division 58.4.1 in 2006/07. The precautionary catch limit for toothfish was 600 tonnes and the reported catch was 645 tonnes. The catch limit was slightly over-run in all three SSRUs open to fishing. The fishery targeted *D. mawsoni* and operated in SSRUs C, E and G. Information on IUU fishing activities indicated that 612 tonnes of toothfish were taken in 2006/07 (Annex 5, paragraphs 5.62 to 5.65).

4.130 Eight Members (Australia, Japan, Republic of Korea, Namibia, New Zealand, Spain, Ukraine and Uruguay) and a total of 15 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2007/08. This is higher than in 2006/07, when six Members notified nine vessels.

4.131 Spain has notified (COMM CIRC 07/114) its intention to conduct research fishing under the 10-tonne research exemption of Conservation Measure 24-01 in SSRUs 5841 D, F and H, which are currently closed to commercial fishing.

4.132 The Scientific Committee recommended that the tagging rate be maintained at at least three fish per tonne for this fishery (Annex 5, paragraph 5.83).

4.133 The Scientific Committee could not provide further advice on the management of this division. It strongly encouraged WG-FSA to undertake a preliminary assessment of catch and tagging data at its next meeting and endorsed the recommendation that a depletion analysis be conducted for Division 58.4.1 (Annex 5, paragraph 5.84).

Dissostichus spp. (Division 58.4.2)

4.134 Two Members (Republic of Korea and Namibia) and three vessels fished in the exploratory fishery in Division 58.4.2 in 2006/07. The precautionary catch limit for toothfish was 780 tonnes and the reported catch was 124 tonnes. The fishery targeted *D. mawsoni* and operated in SSRUs A and E. Information on IUU fishing activities indicated that 197 tonnes of toothfish were taken in 2006/07 (Annex 5, paragraphs 5.66 to 5.69).

4.135 Nine Members (Australia, Japan, Republic of Korea, Namibia, New Zealand, South Africa, Spain, Ukraine and Uruguay) and a total of 15 vessels notified their intention to fish for toothfish in Division 58.4.2 in 2007/08. This is higher than in 2006/07, when six Members notified nine vessels.

4.136 The Scientific Committee recommended that the tagging rate be maintained at at least three fish per tonne (Annex 5, paragraph 5.83).

4.137 The Scientific Committee could not provide further advice on the management of this division. It strongly encouraged WG-FSA to undertake a preliminary assessment of catch and tagging data at its next meeting and endorsed the recommendation that a depletion analysis be conducted for Division 58.4.2 (Annex 5, paragraph 5.84).

Dissostichus spp. (Division 58.4.3a)

4.138 Two Members (Japan and Spain) and two vessels fished in the exploratory fishery in Division 58.4.3a in 2006/07. The precautionary catch limit for toothfish was 250 tonnes and the reported catch was 4 tonnes. The fishery operated in SSRU A. There was no evidence of IUU fishing in 2006/07.

4.139 One Member (Uruguay) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2007/08. This is lower than the number of notifications in 2006/07.

4.140 The Scientific Committee could not provide further advice on the management of this division.

4.141 The Scientific Committee endorsed the recommendation of WG-FSA that the tagging rate in this division should be increased to three fish per tonne (Annex 5, paragraph 5.83).

Dissostichus spp. (Division 58.4.3b)

4.142 Four Members (Japan, Namibia, Spain and Uruguay) and four vessels fished in the exploratory fishery in Division 58.4.3b in 2006/07. The precautionary catch limit for toothfish was 300 tonnes and the reported catch was 253 tonnes. The fishery operated in SSRU A. Information on IUU fishing activities indicated that 2 293 tonnes of toothfish were taken in 2006/07.

4.143 Six Members (Australia, Japan, Republic of Korea, Namibia, Spain and Uruguay) and a total of 11 vessels notified their intention to fish for toothfish in Division 58.4.3b in 2007/08. This is more vessels than were notified for the 2006/07 fishing season.

4.144 The Scientific Committee noted that WG-FSA had made some progress in understanding the dynamics of toothfish in this area. In particular, a preliminary depletion analysis had been undertaken. However, it noted with concern the conclusion that the southern areas in particular had been subject to a rapid and severe depletion, and that significant numbers of juvenile animals have still not been found (Annex 5, paragraphs 5.74 to 5.80).

4.145 The Scientific Committee recommended that Division 58.4.3b be subdivided into two SSRUs at latitude of 60°S. The southern SSRU should be closed to fishing, given the rapid and unsustainable depletion seen in this area. The current catch limit of 300 tonnes is too high to be considered precautionary if applied to the northern SSRU alone and should be reviewed. The Scientific Committee recommended that Conservation Measure 41-07 be revised accordingly.

4.146 The Scientific Committee endorsed the recommendation of WG-FSA that the tagging rate in this division should be increased to three fish per tonne (Annex 5, paragraph 5.83).

4.147 Australia has notified its intention to conduct a research survey in Division 58.4.3b in the 2007/08 fishing season. The Scientific Committee agreed that in order for the survey to obtain the most scientifically useful data on the distribution of fish over BANZARE Bank, commercial fishing should not take place in Division 58.4.3b in the 2007/08 fishing season until the survey is completed, or until 1 June 2008, whichever is the sooner.

4.148 To enable Members to manage their fishing activity in Division 58.4.3b in the 2007/08 fishing season, and to provide for the best scientific outcome of the survey, Australia will notify the Secretariat at least three months before the start of the research survey of the date of that start, and will further notify the Secretariat of the date of completion of the survey.

Dissostichus spp. (Subareas 88.1 and 88.2)

4.149 In 2006/07, eight Members (Argentina, Republic of Korea, New Zealand, Norway, Russia, South Africa, UK and Uruguay) and 15 vessels fished in the exploratory fishery in Subarea 88.1. The fishery was closed on 2 February 2007 and the total reported catch of *Dissostichus* spp. (excluding research fishing) was 3 093 tonnes (101% of the limit) (CCAMLR-XXVI/BG/17, Table 3). The following SSRUs were closed during the course of fishing:

- SSRUs 881B, C and G closed on 28 December 2006, triggered by the catch of *Dissostichus* spp. (total catch 584 tonnes; 164% of the catch limit);

- SSRUs 881H, I and K closed on 2 February 2007, triggered by the catch of *Dissostichus* spp. (total catch 2 080 tonnes; 104% of the catch limit).

4.150 There was no evidence of IUU fishing in 2006/07.

4.151 Five Members (Argentina, Norway, Russia, UK and Uruguay) and seven vessels fished in the exploratory fishery in Subarea 88.2. The fishery closed on 31 August 2007 and the total reported catch of *Dissostichus* spp. was 347 tonnes (63% of the limit) (CCAMLR-XXVI/BG/17). SSRU 882E was closed on 4 March 2007, triggered by the catch of *Dissostichus* spp. (total catch 325 tonnes; 95% of the catch limit).

4.152 Nine Members (Argentina, Republic of Korea, Namibia, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and a total of 21 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.1 in 2007/08. Seven Members (Argentina, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and a total of 15 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2007/08. These are similar to the levels of notifications in 2006/07.

4.153 Spain has notified (COMM CIRC 07/114) its intention to conduct research fishing under the 10-tonne research exemption of Conservation Measure 24-01 in SSRU 881A which is currently closed to commercial fishing.

4.154 The Scientific Committee noted with approval the improvements in the assessment of this stock. It also noted the considerable progress by New Zealand in understanding the life cycle and distribution of toothfish in the Ross Sea (Subarea 88.1 and SSRUs 882A and B) (Annex 5, paragraphs 3.62 to 3.66).

4.155 The Scientific Committee noted with some concern that the release and recapture from parts of the fleet were not considered reliable enough to be used in the assessment. The assessment was based on only the tags released and recaptured by New Zealand vessels. This reflected a subset of the tagging data, some 50% (7 000) of the 13 700 tags released to date (Annex 5, paragraph 5.99). The Scientific Committee noted that the assessment selected to provide management advice was the most conservative of the alternative assessments presented.

4.156 The Scientific Committee endorsed the advice of WG-FSA that the experimental system of closed and open areas defined in 2005 for the Ross Sea should continue for the duration of the three-year experiment (from the 2005/06 fishing season to the end of the 2007/08 fishing season) (Annex 5, paragraphs 5.94, 5.95 and 5.102 to 5.104).

4.157 Noting the revised assessment by WG-FSA (Annex 5, paragraph 5.101), the Scientific Committee recommended that the allowable catch for the Ross Sea should be revised to 2 700 tonnes. The Scientific Committee had no new advice from which to revise the catch limits for SSRUs 882C, D, E, F and G, and therefore recommended that the levels set for the 2006/07 fishing season apply for the 2007/08 fishing season.

4.158 If the Commission agrees, this catch limit can be carried over into the 2008/09 fishing season, given the caveats detailed in paragraph 14.6.

Bottom fishing in CCAMLR high-seas areas

4.159 The Scientific Committee noted that it has been tasked to review the criteria for determining what constitutes significant harm to benthos and benthic communities (Conservation Measure 22-05; CCAMLR-XXV, paragraphs 11.25 to 11.38). It also noted that, in 2006, the United Nations General Assembly (UNGA) agreed the Sustainable Fisheries Resolution (61/105), which calls upon States and RFMOs or other arrangements to take immediate action to ensure fish stocks are managed sustainably and to protect vulnerable marine ecosystems (VMEs), including seamounts, hydrothermal vents and cold-water corals, from destructive fishing practices. More specifically, UNGA Resolution 61/105 calls upon States and RFMOs and other arrangements to regulate and manage all bottom fisheries in high-seas areas so as to prevent significant adverse impacts on VMEs by no later than 31 December 2008 (UNGA Resolution 61/105, OP80 – OP91).

4.160 Dr Constable introduced the report on bottom fishing in high-seas areas undertaken by WG-FSA (Annex 5, paragraphs 14.1 to 14.50) as well as papers on this topic:

(i) SC-CAMLR-XXVI/10 – Bottom fishing in high-seas areas of CCAMLR;

(ii) SC-CAMLR-XXVI/BG/27 – Antarctic seafloor geomorphology as a guide to benthic bioregionalisation;

(iii) SC-CAMLR-XXVI/BG/28 – CCAMLR Bioregionalisation Workshop: update on benthic bioregionalisation of the Southern Ocean;

(iv) SC-CAMLR-XXVI/BG/30 – Demersal fishing interactions with marine benthos in the Southern Ocean: an assessment of the vulnerability of benthic habitats to impact by demersal gears.

4.161 The Scientific Committee thanked Drs Constable and Holt for their detailed contribution in SC-CAMLR-XXVI/10 advancing many of the concepts, principles and actions that will need to be included in consideration of bottom fisheries by CCAMLR.

4.162 The Scientific Committee thanked WG-FSA for the development of practical guidelines for providing scientific advice to the Commission on the different components for managing bottom fisheries in high-seas areas of the Convention Area. It noted that these outcomes will usefully advance the work of the Commission to meet the requirements in the UNGA resolution by December 2008. It also noted that many of the components identified in the report of WG-FSA can draw on existing practices and procedures within the Scientific Committee and its working groups (Annex 5, paragraph 14.7), including:

(i) Article IX;

(ii) the exploratory fisheries conservation measure (Conservation Measure 21-02);

(iii) past new and exploratory fisheries measures that have been used to avoid benthic impacts (Conservation Measures 41-05 and 41-11) and undertake experimental work to investigate whether impacts might arise if fishing were to proceed (Conservation Measures 43-04 [186/XVIII], 212/XIX);

(iv) existing approaches to avoid and mitigate by-catch of finfish, birds and marine mammals, including approaches to acquiring information through research or fishery data collection activities and for using that information to advise on appropriate conservation measures;

(v) the regulatory framework considered by the Scientific Committee (SC-CAMLR-XVIII, paragraphs 7.11 to 7.23; SC-CAMLR-XIX, paragraphs 7.2 to 7.20) and the Commission (CCAMLR-XIX, paragraphs 10.2 to 10.8).

4.163 The Scientific Committee endorsed the report of WG-FSA, including the questions to be addressed and the tasks to be undertaken, taking special note of the following:

(i) the agreement of WG-FSA on practical definitions (Annex 5, paragraph 14.4) of destructive fishing practices, vulnerability of an ecosystem to fishing and what constitutes significant harm, equivalent to significant adverse impacts in the terms of the UNGA resolution, and the necessity to develop operational definitions based on them or procedures by which these could be identified during the conduct of bottom fisheries;

(ii) the work of UN FAO to develop approaches on these concepts;

(iii) some assemblages are easily classified as vulnerable when they are characterised by slow-growing, habitat-forming, sessile species (Annex 5, paragraph 14.5):

(a) significant interactions with these types of assemblages, including cold-water coral communities (also known as deep-water or deep-sea corals), sponge communities and other communities associated with seamounts, hydrothermal vent communities and methane cold seep communities, should be avoided as an important first step in mitigating significant adverse impacts;

(b) there was sufficient evidence globally that benthic habitats comprising slow-growing, habitat-forming, sessile species could take much longer than three decades to recover from significant fisheries disturbances (Annex 5, paragraph 14.6);

(iv) there will need to be specific requirements of fisheries to provide data to assist in identifying VMEs in need of protection (Annex 5, paragraph 14.11);

(v) the history of bottom fishing in the CCAMLR high-seas areas is summarised in Annex 5, paragraphs 14.12 and 14.13, with longline fishing being the primary method of fishing in high-seas areas of CCAMLR in recent years, the footprints of which are characterised in Annex 5, Figures 8 to 16 (summarised by statistical subareas, divisions and SSRUs for the last five years in Table 4);

(vi) the effective fishing footprint is also a useful concept for characterising where the fisheries may have had the greatest interactions with benthic ecosystems;

(vii) avoiding significant adverse impacts could be achieved using a number of mechanisms, including, *inter alia*, the development of mitigation methods, within-season avoidance (move-on) provisions or the designation of longer-term closed areas (Annex 5, paragraph 14.21);

(viii) research and data collection will be required from fishing vessels to support this process and some fishing activity may be required when evidence of VMEs has arisen to help document the nature and extent of VMEs along with developing mitigation measures to avoid significant adverse impacts. Such activities would need to be undertaken in such a way that they would not contribute to causing significant adverse impacts in the interim of establishing management approaches for an area (Annex 5, paragraph 14.22).

4.164 The Scientific Committee agreed that the proposed procedure provided by WG-FSA, which is based on existing practices and procedures, could be updated to that shown in Figure 1 and used as the framework for indicating what research and data collection activities might be required at different stages of the process of managing bottom fishing. It also clearly shows what is needed to develop scientific advice on (Annex 5, paragraphs 14.21 to 14.39):

(i) practical guidelines on identifying evidence of VMEs during fishing activities;

(ii) procedures that could be followed if evidence of VMEs is found;

(iii) research and data collection programs needed to:

(a) evaluate VMEs and the potential for significant adverse impacts;
(b) develop approaches to avoid and mitigate significant adverse impacts of fishing on benthic ecosystems.

The Scientific Committee endorsed the descriptions of the components of this procedure as described in Annex 5, paragraphs 14.26 to 14.39, noting that a different treatment between fished and non-fished areas might not be necessary once a clear process is established.

4.165 The Scientific Committee agreed that the full development of the process will require further work in both the Scientific Committee and the Commission and by Members during the intersessional period to meet the requirements of the UNGA resolution (Annex 5, paragraph 14.40). It noted that such work could include, *inter alia*:

(i) development of rules and data collection requirements needed to trigger actions for different gears and situations during a season with respect to avoidance of potentially vulnerable areas and the gathering of data to assist in identifying VMEs;

(ii) identifying the method for specifying areas in which evidence of VMEs is detected in order that interim within-season protection could be established either for the vessel concerned or the fishing fleet;

(iii) developing an approach, including data requirements, for annual assessments of benthic interactions of bottom fishing and identification of Vulnerable and Potentially Vulnerable Areas;

(iv) consideration of the requirements for observations and reporting;

(v) consideration of the available management approaches to avoid and mitigate significant adverse impacts on VMEs;

(vi) further consideration of the relationship between effective fishing footprint and geomorphological features;

(vii) a method for assessing the amount of seabed directly affected by the gears, such as through the use of cameras, where such methods could then be used to better evaluate the potential spatial extent of disturbance of VMEs at scales less than the resolution of the cell size used in evaluating the effective fishing footprint.

4.166 The Scientific Committee agreed that existing practices can be used to advance the requirements of the UNGA resolution with respect to avoiding significant adverse impacts on VMEs. The process described here is an elaboration of the by-catch procedures already in place and shows the advances in CCAMLR of the ecosystem approach to managing fisheries.

4.167 The Scientific Committee noted that this process makes it easier to understand what needs to be done and when and how this work contributes to CCAMLR achieving its objectives and complying with the UNGA resolution (Annex 5, paragraph 14.42). It also noted that additional resources will need to be brought to these tasks.

4.168 The Scientific Committee noted the work of Australia in developing camera gear that can be deployed on fishing gears by observers to be able to observe the interactions between fishing and benthic habitats (SC-CAMLR-XXVI/BG/30; see also Annex 5, paragraph 14.11). It welcomed these developments and encouraged Members to collaborate with Australia in its work.

Advice to the Commission

4.169 The Scientific Committee addressed issues surrounding Conservation Measure 22-05 (CCAMLR-XXV, paragraphs 11.25 to 11.38) and the implementation, from a scientific perspective, of the 2006 UNGA Sustainable Fisheries Resolution (61/105) in paragraphs 4.159 to 4.168.

4.170 The Scientific Committee agreed that the report of WG-FSA provided a useful foundation for this work, taking special note of the points in paragraph 4.163.

4.171 The Scientific Committee agreed that the procedure in Figure 1 can be used as the framework for indicating what research and data collection activities might be required at different stages of the process of managing bottom fishing (paragraph 4.164). It noted that the work to be undertaken to assist this process could include, *inter alia*, the points in paragraph 4.165 (paragraph 14.5), but that it can use existing practices to advance the requirements of the UNGA resolution with respect to avoiding significant adverse impacts on VMEs (paragraphs 4.166 and 4.167). The procedure is an elaboration of the by-catch procedures already in place and shows the advances in CCAMLR of the ecosystem approach to managing fisheries.

Crab resources (Subarea 48.3)

4.172 No target fishery for crabs was carried out in the last four seasons and no proposal for their harvest has been received by CCAMLR for the 2007/08 season.

Advice to the Commission

4.173 The Scientific Committee recommended that the existing Conservation Measures 52-01 and 52-02 on crabs should remain in force.

Squid resources

Martialia hyadesi (Subarea 48.3)

4.174 No target fishery for squid (*Martialia hyadesi*) was carried out in the last four seasons and no new request has been submitted to CCAMLR to continue exploratory fishing in the 2007/08 season.

Advice to the Commission

4.175 The Scientific Committee recommended that the existing Conservation Measure 61-01 on *M. hyadesi* should remain in force.

Fish and invertebrate by-catch

4.176 The Subgroup on By-catch met several times during the WG-FSA meeting, and a number of its conclusions are relevant to the Scientific Committee, particularly those involving scientific observers.

4.177 None of the limits on by-catch set in the conservation measures applying to the statistical areas managed by CCAMLR were exceeded during the 2006/07 season.

4.178 It was noted that a higher level of by-catch of macrourids was reported from longliners using autolines than for those using the Spanish longline system, although the total by-catch of macrourids has decreased considerably in the Ross Sea over the last two years.

4.179 The UK presented experimental trials aimed at limiting the by-catch of macrourids. It is hoped that further trials will be conducted in future.

4.180 Given that there are a number of inconsistencies and gaps in the recording of data in the formats for submission of data to CCAMLR, the Scientific Committee recommended that:

(i) the instructions for observers be amended to indicate that individual skates should be recorded on either L5 or L11 forms, but not on both;

(ii) the longline and pot tally forms used by observers be amended to reflect catch definitions in the C2 form;

(iii) the C2 form be modified to enable gear other than Spanish longlines and autoline systems to be recorded;

(iv) the form for the tally period for trawl fishing (T3) be amended to record the weight of subsamples and the number of individuals of each species retained or discarded.

4.181 The Scientific Committee recommended that 2008/09 be made the Year of the Skate. In preparation for this, the following priorities were identified:

(i) formation of a subgroup to communicate intersessionally and coordinate planning;

(ii) development of detailed region-specific identification guides for skates based on characters which could be easily determined on vessels by observers;

(iii) modification of the L11 form (for 2008/09) to enable adequate recording of detailed information about the fate of skates caught;

(iv) the skate tagging program in new and exploratory fisheries be revised and tested in 2007/08 prior to being adopted by all vessels in 2008/09;

(v) the Secretariat be asked to coordinate the skate tagging program in new and exploratory fisheries, and be the repository of skate tagging kits for new and exploratory fisheries.

4.182 The Scientific Committee recommended that the Year of the Skate incorporate all *Dissostichus* spp. fisheries in the Convention Area, with a tagging program focusing on new and exploratory fisheries.

4.183 In response to a question from Prof. Fernholm voicing concerns that the ‘cut-off’ system for skates was no longer a priority, but was being replaced by bringing skates on board before releasing them, the Convener of WG-FSA explained that it was preferable, for their survival, to bring skates on board (because of lower risk of damage to the body of the skate, especially in heavy seas) and that this procedure was, furthermore, extremely desirable for the observer who could then determine the species involved and detect any tags that may be present, which is difficult when skates were released in the water alongside the vessel (cut off).

4.184 The Scientific Committee therefore recommended that, for the 2007/08 season, where possible, skates be brought on board prior to release, and that this measure would become mandatory in the Year of the Skate.

4.185 No new data was presented which would allow new advice to be developed on by-catch limits.

4.186 However, preliminary trials were presented to WG-SAM by the UK for Subarea 48.3 and by New Zealand for the Ross Sea. Dr Hanchet specified that one of the aims of the New Zealand IPY/CAML survey in the Ross Sea, planned for summer 2008, would be to estimate the abundance of macrourids in that area.

4.187 The efficacy of the trigger level for the move-on rule in Conservation Measure 33-03, paragraph 5, was reviewed in response to a request from the Scientific Committee in 2006 (SC-CAMLR-XXV, paragraph 4.233), and as a result the Scientific Committee considered that a threshold level of macrourid catch is required by each vessel in each 10-day period in each SSRU to trigger the move-on rule.

4.188 The Scientific Committee recommended that paragraph 5 of Conservation Measure 33-03 be amended as follows:

> 'If the catch of *Macrourus* spp. taken by a single vessel in any two 10-day periods in a single SSRU exceeds 1 500 kg in each 10-day period and exceeds 16% of the catch of *Dissostichus* spp. by that vessel in that SSRU in those periods, the vessel shall cease fishing in that SSRU for the remainder of the season.' (A 10-day period is defined as day 1 to day 10, day 11 to day 20 or day 21 to the last day of the month.)

4.189 The Scientific Committee recommended that the amendment made to Conservation Measure 33-03 be reviewed by WG-FSA in 2008, particularly with respect to the effects of the change on macrourid catches and catch rates.

4.190 Finally, it is requested that guides be prepared for the identification of benthic organisms specific to areas in which observers carry out their activities to enable observers to identify benthic by-catch to the phylum level, and record their weights.

INCIDENTAL MORTALITY

5.1 The Scientific Committee reviewed the report of ad hoc WG-IMAF (Annex 6). It endorsed the report and its conclusions, and the plan of intersessional work (Annex 6, Table II.21) subject to the comments set out below.

5.2 The Scientific Committee invited Members to review the membership of ad hoc WG-IMAF and to facilitate the attendance of their representatives at its meetings, especially South American members. Further, where possible and appropriate, the attendance of technical coordinators would be beneficial to ad hoc WG-IMAF, WG-FSA and the general coordination of the observer program (Annex 6, paragraph I.1).

Incidental mortality of seabirds and marine mammals in fisheries in the Convention Area in 2006/07

5.3 The Scientific Committee noted that:

(i) the total number of observed seabird mortalities in longline fisheries in 2006/07, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, was zero.

This compared to two birds estimated killed, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, in 2005/06 (Annex 6, paragraph I.2). When seabird mortalities reported from the French EEZs in Subarea 58.6 and Division 58.5.1 are included, the total extrapolated seabird mortalities during longline fishing operations in 2006/07 were estimated to be 2 257. This estimate includes 313 birds in Subarea 58.6 and 1 944 birds in Division 58.5.1 (Annex 6, Table II.5) and represents a 13% decrease from the combined total estimated by-catch for Subarea 58.6 and Division 58.5.1 in the previous season (Annex 6, paragraph I.6 and Table II.6).

(ii) for the second consecutive year, no albatrosses were observed captured in longline fisheries in the Convention Area (Annex 6, paragraph I.2) and for the first year, zero birds were observed captured in longline fisheries in the Convention Area aside from the French EEZs (Annex 6, Table II.2);

(iii) in the Subarea 48.3 icefish trawl fishery, six seabirds, including both albatrosses and petrels, were observed killed and another three released alive and uninjured (Annex 6, paragraph I.11 and Table II.11). The rate of mortality in this subarea in 2007 was 0.07 birds per trawl compared to 0.07, 0.14, 0.37 and 0.20 in 2006, 2005, 2004 and 2003 respectively (Annex 6, paragraph I.11 and Table II.12);

(iv) there were two seabird mortalities observed in the Division 58.5.2 trawl fishery, an increase from the zero mortality in 2006 but below the level observed in 2005 (Annex 6, Table II.12);

(v) there were no seabird mortalities observed in the krill trawl fisheries in Area 48 (Annex 6, paragraph I.12) or any of the pot fisheries (Annex 6, paragraph I.13).

(vi) three marine mammal mortalities in longline fisheries were reported in longline gear in 2006/07 compared to no reports of incidental mortality in 2005/06 and no marine mammals were reported entangled and released alive in longline fisheries this year, down from two in 2005/06 (Annex 6, paragraph I.14);

(vii) no marine mammals were reported entangled or killed in the krill trawl fisheries in Area 48 in 2006/07 compared to 95 Antarctic fur seals (*Arctocephalus gazella*) in 2004/05 and one in 2005/06 (Annex 6, paragraph I.15);

(viii) no marine mammals were reported entangled or killed in the finfish trawl fisheries in 2006/07, down from one that was caught and killed in the Division 58.5.2 toothfish trawl fishery in 2005/06, and no reports of incidental mortality of marine mammals in pot fisheries (Annex 6, paragraphs I.16 and I.17).

5.4 The Scientific Committee noted that 100% of reported seabird captures in the Convention Area, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, were during longline hauling (Annex 6, paragraph I.3, Table II.1). Similar to the past two years, 32% of seabirds observed captured were caught alive in the French EEZs in Subarea 58.6 and Division 58.5.1 (Annex 6, paragraph II.15). This emphasises again this year a need to increase the focus on haul mitigation measures to reduce the remaining seabird by-catch in longline fisheries in the Convention Area (Annex 6, paragraph I.3).

5.5 The Scientific Committee noted the ongoing efforts to use and develop effective mitigation measures in the French EEZ fisheries and that France continues to reduce its total seabird by-catch (13% decrease from the previous season) (Annex 6, paragraphs I.4 to I.6). However, the seabird captures during longline fishing in the French EEZs are the only remaining substantial seabird by-catch in the Convention Area. The Scientific Committee recommended that France strive to eliminate the incidental mortality of seabirds in accordance with CCAMLR policies and practices (Annex 6, paragraph I.7).

5.6 With respect to the French EEZs in Subarea 58.6 and Division 58.5.1, the Scientific Committee recommended that France (Annex 6, paragraphs I.8 and I.9):

(i) consider using observers to collect additional data describing fishing activity and mitigation measures (Annex 6, paragraph II.19);

(ii) submit a detailed analysis of petrel population responses to fisheries and environmental factors for review to WG-SAM, and that WG-SAM report on the review to ad hoc WG-IMAF in 2008 (Annex 6, paragraph II.20);

(iii) submit all relevant raw by-catch data in the appropriate format, as is done for other Convention Area subareas and divisions, to allow reporting on the total seabird by-catch for the entire Convention Area (Annex 6, paragraph II.21);

(iv) conduct analyses to address high capture rates on a few vessels, specifically addressing operational problems in the fishery (Annex 6, paragraph II.22);

(v) consider broadening the set of mitigation measures used, particularly during the haul (Annex 6, paragraphs II.25 to II.26);

(vi) work closely with ad hoc WG-IMAF participants to facilitate further research into the nature of seabird captures and consider experimental trials (Annex 6, paragraph II.27);

(vii) utilise analyses of the factors that led to seabird by-catch within its EEZs to improve the direction of management actions intended to reduce seabird by-catch (Annex 6, paragraph II.29);

(viii) urgently submit a strategic plan to eliminate seabird mortality which includes details of implementation targets for recommended mitigation devices, establishment of by-catch targets reducing each year to near-zero levels in less than three years, and the implementation of additional seasonal and area closures if targets are not met (Annex 6, paragraph II.30);

(ix) submit a detailed paper describing the full set of regulatory instruments in place to reduce seabird mortality directly or indirectly (Annex 6, paragraph II.31).

5.7 Prof. Duhamel shared information about France's continuous efforts since 2001 to address reductions in seabird by-catch along with eliminating IUU fishing in the French EEZs which has resulted in an associated reduction of seabird by-catch. As in the rest of the Convention Area, albatross mortalities have been reduced to zero in the French EEZs. Based on an evaluation of fishery impacts on the petrel populations at Crozet and Kerguelen Islands (SC-CAMLR-XXVI/BG/22), the current incidental mortalities are not negatively impacting the petrel populations. France is not satisfied with these results and will pursue additional measures through an action plan it will implement. The action plan's objective is to reduce the current level of incidental mortality by a factor of two over the next three years. France will submit a report annually to ad hoc WG-IMAF on the progress and intermediate results of its action plan. The action plan items are as follows:

(i) all relevant by-catch data in the CCAMLR format will be submitted in 2008;

(ii) continue full implementation of CCAMLR conservation measures (sink rates of lines, streamer lines, setting at night, offal discharge);

(iii) continue analysis of the causal links between fishing and incidental mortality, including new data collections concerning offal discharge, streamer line characteristics, line sink rates, use of other mitigation devices or practices, experience of the vessel master and key crew members, and condition of baits at the point of setting;

(iv) consideration of new regulations based on new analyses;

(v) use of real-time data to monitor individual vessels and implement current regulations that allow for moving a high by-catch vessel out of a zone or suspending its fishing;

(vi) seasonal closure at Kerguelen Island during part of the breeding season;

(vii) consider using practices similar to those by New Zealand's large autoline vessels outside the Convention Area;

(viii) use of haul mitigation measures on all vessels;

(ix) identify areas with particularly high concentrations of seabirds;

(x) implement alternative gear types like pots that could contribute to reductions in seabird incidental mortality;

(xi) these efforts will involve cooperation between managers, scientists, shipowners and fishers.

5.8 Many Members thanked France for its commitment and continued efforts to reduce seabird by-catch and to work jointly with ad hoc WG-IMAF and other Members which have effectively addressed this problem. Dr Constable encouraged France to attend WG-SAM as it considers the French analysis of fishery impacts on petrel populations. He noted that CCAMLR's practices have aimed for avoidance or mitigation of seabird by-catch and always strive for zero by-catch.

5.9 The Scientific Committee was encouraged by France's action plan and its agreement to submit the full suite of data in CCAMLR format, and recognised that full avoidance of fishing during the petrel's breeding season could result in substantial reductions in the by-catch, noting however some concerns of IUU fishing that might then occur. It also recognised that France will have the ability to monitor the performance of individual vessels, given that the vast majority of the by-catch is coming from specific vessels. Prof. Duhamel assured the Scientific Committee that France will examine those vessels and the skippers, as well as consider the fishing zone and a whole range of factors to identify all causal links associated with the by-catch.

5.10 Dr J. Pierre (New Zealand) was supportive of France's indication of continued and enhanced data collection and reporting and offered New Zealand's assistance with France's efforts in by-catch reduction. Prof. Duhamel appreciated this offer and thanked Dr S. Waugh (New Zealand) in particular for her assistance to France during the ad hoc WG-IMAF meeting.

5.11 The Scientific Committee looked forward to detailed submissions of information from France in 2008 to address its recommendations in paragraph 5.6.

5.12 The Scientific Committee noted that the continuing decreases in incidental mortality in the Convention Area were positive and in particular noted the significance of having no albatross mortality observed in the Convention Area longline fisheries in 2006/07. The by-catch in most areas is zero or near-zero and substantial reductions have occurred in the French EEZs. This accomplishment has resulted from the pioneering work of Prof. Croxall, the hard work of ad hoc WG-IMAF, and by the Members and fishers which have implemented the advice of WG-IMAF. All involved should be commended. The Scientific Committee's job will be to maintain this efficacy and diligence and to not become complacent in matters of seabird by-catch reduction.

5.13 The Scientific Committee noted the positive result this year with the reduction in marine mammal mortalities. However, whilst this is good news, the need for continued vigilance and monitoring of incidental mortality in fisheries was emphasised, recollecting that three years ago seal by-catch in trawl fisheries was a new and difficult issue. The Scientific Committee further noted the need for improved reporting of the use of mitigation measures in all trawl fisheries so that the measures used successfully could be documented and made available more widely.

Information relating to the implementation of Conservation Measures 26-01, 25-02 and 25-03

5.14 The Scientific Committee noted that this year the level of reported performance was improved with 100% implementation for nearly all measures (Annex 6, paragraph I.18). The reported implementation of Conservation Measures 26-01, 25-02 and 25-03 is summarised as follows:

(i) With respect to Conservation Measure 26-01, observer reports indicated 100% implementation of this measure (Annex 6, paragraph I.23).

(ii) With respect to Conservation Measure 25-02 –

    (a) line weighting (Spanish system) – 100% reported implementation in all subareas and divisions (Annex 6, paragraph I.18(i) and Table II.16);

    (b) line weighting (autoline system) – all vessels in high-latitude areas fishing in daylight met the requirement to achieve a consistent minimum line sink rate as described in Conservation Measure 24-02. Only one vessel using a variation on the autoline method used clip-on weights to achieve its sink rate requirements. All autoline vessels are now using IWLs. The vessel using a trotline system met the sink rate requirements in Subarea 48.6 (Annex 6, paragraph I.18(ii));

(c) night setting and offal discharge – 100% reported implementation with night setting, and also for control of offal discharge in all areas where this was required (Subareas 48.3, 48.4, 58.6 and 58.7) (Annex 6, paragraph I.18(iii) and Table II.16). In areas where offal retention is required (Subareas 48.6, 88.1 and 88.2, Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b and 58.5.2), all but two vessels implemented fully (Table II.16). The *Tronio*, fishing in Divisions 58.4.1 and 58.4.3b, discharged offal on seven occasions due to mechanical problems. The *Ross Mar*, fishing in Subarea 88.1, was observed discarding offal during one haul (Annex 6, paragraph II.50);

(d) discard of hooks – hooks were present in discards on 3 of 39 longline cruises; on two of these this was reported as a rare event. However, the observer on board the *Insung No. 22* in Subarea 48.3 reported there was no system in place for removing hooks from discards and the discarding of offal with hooks present was a daily occurrence (Annex 6, paragraph I.18(iv); WG-FSA-07/8 Rev. 1, Table 1);

(e) streamer lines – the number of cruises complying with streamer line specifications has increased from 80 to 87% this year (Annex 6, paragraph I.18(v) and Table II.16). However, most of the non-compliant vessels had only minor deviations from the requirement. The cruises where streamer lines did not comply failed on streamer lengths (3 cruises), total streamer line length (1 cruise) and branched streamer spacing (1 cruise). One of these vessels, the *Viking Sur*, also failed on two specifications in 2005/06. There was 100% compliance with attachment height (Annex 6, paragraph I.18(v) and Table II.16);

(f) haul-scaring devices – one vessel in Subarea 48.3 (*Insung No. 22* (87%)), and one vessel in two cruises in Subareas 58.6 and 58.7 (*Ross Mar* (0%)) did not use haul-scaring devices on all hauls. In all other areas there was 100% compliance (Annex 6, paragraph I.18(vi) and Table II.16).

(iii) With respect to Conservation Measure 25-03 –

(a) a range of mitigation measures were used on board icefish vessels in Subarea 48.3 and Division 58.5.2 (Annex 6, paragraph I.24);

(b) compliance with Conservation Measure 25-03 was generally good with an exception that two vessels were reported as having used net sonde cables (Annex 6, paragraphs I.24 and I.25).

5.15 The Scientific Committee noted the low number of bottle tests for some vessels (Annex 6, paragraph I.20) and reported further increases in the discharge of gear debris, which occurred on five vessels and included the discharge of oil from the *Insung No. 1* (Republic of Korea) and *Ross Star* (Uruguay), the discharge of gear debris from the *Insung Ho* (Republic of Korea) and *Antartic II* (Argentina), and the discharge of inorganic garbage from the *Insung Ho* (Republic of Korea), *Ross Mar* (South Africa) and *Antartic II* (Argentina). This included fishing gear, small sections of line, snoods and plastics (Annex 6, paragraph I.21).

5.16 The Scientific Committee noted that although implementation of these conservation measures is improving, there are still some instances of non-implementation (streamer line design and use, discard of offal, discard of hooks, line-weighting bottle tests, discharge of gear debris and use of net sonde cables (Annex 6, paragraphs I.18 to I.21 and I.25). The Scientific Committee expressed concern as it did last year (SC-CAMLR-XXV, paragraph 5.16) at the reported discarding of hooks in offal, given the reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses (Annex 6, paragraph I.19). Dr Constable noted that non-implementation of measures poses the greatest challenge in maintenance of highly effective measures at reducing seabird by-catch. The loss of hooks, both inside and outside the Convention Area, is very important in terms of the potential impacts to Convention Area seabirds. The Scientific Committee recommended that at its meeting in 2008, ad hoc WG-IMAF consider the issue of hook loss and possible ways to reduce this loss, particularly if the problem is related to when the gear is being hauled and the fish retrieved.

Incidental mortalities of seabirds during fishing outside the Convention Area

5.17 The Scientific Committee noted a verbal report to ad hoc WG-IMAF on new information about documented high levels of mortality of Convention Area seabirds in pelagic longline fisheries in southern African waters (Annex 6, paragraph I.27). The Scientific Committee further noted that, when coupled with the levels of mortality reported in 2006 for the South African deep-water hake trawl fishery, it is of great concern that many thousands of albatrosses are estimated to be killed annually in these fisheries, including ca. 5 000 (95% CI 3 000–12 500) black-browed albatrosses, thought to predominantly be from the population breeding at South Georgia (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 68).

5.18 Given that considerably greater levels of mortality of Convention Area seabirds occur in areas north of the Convention Area, compared to levels within the Convention Area, the Scientific Committee reminded Members of the importance of the standing request to report on seabird mortality for Convention Area species arising from fisheries conducted outside the Convention Area (Annex 6, paragraph I.28; SC-CAMLR-XXV, Appendix D, Table 20, item 3.2).

Incidental mortality of seabirds during unregulated longline fishing in the Convention Area

5.19 The Scientific Committee noted that the overall estimated total for the whole Convention Area in 2006/07 indicates a potential seabird by-catch in the unregulated fishery of 8 212 (95% CI 6 730–21 926) seabirds (SC-CAMLR-XXVI/BG/32; Annex 6, paragraph I.29 and Table II.18).

5.20 In comparison with estimates for previous years, calculated in identical fashion, the value for 2006/07 is broadly similar to the values estimated for the last three years (SC-CAMLR-XXVI/BG/32). These are the lowest reported values since estimates started in 1996. This may appear paradoxical since IUU fishing has increased in the last three years (Annex 5, Table 3). However, the Scientific Committee noted that although IUU levels have increased, these catches have been taken in more southerly areas than previously, where the probability of encountering birds is reduced. This has resulted in an overall decrease in estimated seabird by-catch.

5.21 As in previous years, it was emphasised that these are very approximate estimates (with potentially large errors). The estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution. In particular, changes in gear type seen in the regulated fishery would undoubtedly have flowed through to IUU vessels. These gear changes, together with the use of gillnets by IUU vessels, will affect the levels of IUU fisheries-related by-catch, but are not reflected in the assumptions used to develop these estimates (Annex 6, paragraph I.32).

5.22 Nevertheless, the Scientific Committee reiterated its conclusions of recent years that even these levels of incidental mortality of seabirds arising from IUU fishing were of substantial concern and likely unsustainable for some of the populations concerned (Annex 6, paragraph I.33). The Commission was encouraged to continue to take action in respect of incidental mortality of seabirds caused by IUU fishing.

Research into and experience with mitigation measures

5.23 The Scientific Committee noted:

(i) the success to date within the Convention Area in reducing seabird by-catch, but that the mitigation measures used continue to require refinement to potentially allow for fishing at any time of day without seasonal closure of fishing grounds (Annex 6, paragraph I.34);

(ii) as CCAMLR mitigation measures and practices have been held up as a role model outside the Convention Area, and successfully exported to some of those fisheries, research into mitigation measure refinement remains a priority to support the export of best-practice mitigation (Annex 6, paragraph I.34);

(iii) a modification of the Spanish longline system (trotline/net system) being used extensively throughout South American fisheries that sinks gear quickly beyond the range of foraging seabirds and is reported to eliminate seabird by-catch and significantly reduce whale depredation with no loss in toothfish CPUE when compared to the Spanish longline system (Annex 6, paragraph I.35);

(iv) plans to conduct a trial inside the Convention Area to compare the effectiveness of the trotline/net system with the traditional Spanish system in reducing fish loss to toothed whales (Annex 6, paragraph I.36);

(v) that potential options for discharge management in trawl fisheries, such as underwater discharge and maceration, had not been tested to their full potential either inside or outside the Convention Area (Annex 6, paragraph I.42).

5.24 Based on the results of trials that examined the sink rate relationships between traditional Spanish system weights (netting bags of rocks) and elliptical, or torpedo-shaped, steel weights (Annex 6, paragraph I.37), the Scientific Committee recommended that Conservation Measure 25-02 be modified to provide Spanish longline-system vessel operators the option of using either traditional weights (netting bags of rocks) under the current two mass/spacing regimes or, steel weights (solid steel and not chain links) under a mass spacing regime of ≥5 kg mass spaced at intervals of no more than 40 m. The revision would also mean renumbering the existing footnotes 4 to 6 as 6 to 8. Paragraph 3 of Conservation Measure 25-02 would be revised to read as follows:

(i) Vessels using the Spanish method of longline fishing should release weights before line tension occurs; traditional weights[4] of at least 8.5 kg mass shall be used, spaced at intervals of no more than 40 m, or traditional weights[4] of at least 6 kg mass shall be used, spaced at intervals of no more than 20 m, or solid steel weights[5] of at least 5 kg mass shall be used, spaced at intervals of no more than 40 m.

(ii) Footnotes 4 and 5 would read: [4] Traditional weights are those made from rocks contained within a net bag; [5] Solid steel weights shall not be made from chain links. They should be made in a hydrodynamic shape designed to sink rapidly.

5.25 Dr Holt noted some concern for a new gear type, trotline/net, in that it was essential to collect information about its characteristics and fully understand its impacts on seabirds and other taxa. Mr Smith noted the ad hoc WG-IMAF advice in Annex 6, paragraph I.46. Prof. Moreno highlighted the extensive and rigorous testing that has already occurred for this new trotline/net system in areas of high albatross abundance (WG-FSA-07/14). Experiments with over 4 million hooks resulted in zero bird mortalities. This is not actually a new gear type but rather a modification of one already used in Chile. The gear exhibits sink rates that quickly sink the gear to depths where birds cannot reach the baited hooks. Several other South American countries began to use this gear in demersal fisheries in areas adjacent to the Convention Area during times when seabird abundance was high. It will be important to undertake a comparison between the traditional Spanish longline system and this trotline/net system. Mr Smith noted that these comparisons would need to include consideration of impacts on other taxa besides seabirds and cetaceans.

5.26 Prof. O. Pin (Uruguay) noted the use of this gear system by Uruguayan vessels and an analysis conducted to measure the sink rate of this gear and its impacts on seabirds (WG-FSA-07/23). The Scientific Committee appreciated these efforts and hoped to have South American colleagues join in the meetings of ad hoc WG-IMAF and WG-FSA.

5.27 Dr Constable concurred that information on use and impacts of new gear types is essential and hoped that the collection of vessel and technical gear information directly from the vessels would assist with future gear issues.

5.28 The Scientific Committee recommended that the Secretariat obtain data and details from Members on vessels, gear type, method of deployment and mitigation measures. Ideally this information could be archived at CCAMLR.

5.29 With respect to future improvements to Conservation Measures 24-02 and 25-02, the Scientific Committee recommended:

(i) testing the efficacy of the new trotline/net longline system line-weighting regime as a seabird deterrent and for operational characteristics (Annex 6, paragraph I.40);

(ii) expanding any trials inside the Convention Area to include as many Spanish longline vessels as possible to increase the data acquisition rate on the trotline/net method and enable CCAMLR to quickly understand the comparative effects of the two gear types (Annex 6, paragraph I.36);

(iii) that any use of the new trotline/net longline system in the Convention Area should comply with all requirements of Conservation Measure 25-02 (Annex 6, paragraph I.35);

(iv) testing the effectiveness of paired streamer lines in Southern Ocean conditions with common seabird assemblages (Annex 6, paragraph I.40);

(v) testing the utility of net binding as appropriate in Convention Area pelagic finfish trawl fisheries (Annex 6, paragraph I.44);

(vi) that CCAMLR produce a poster instructing crews to remove hooks from all landed fish and hauled baits. The estimated cost of the production of such posters is AU$5 000 (Annex 6, paragraph I.38).

5.30 Having expressed concern about UK reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses and embedded in wandering albatrosses (paragraph 5.16), the Scientific Committee strongly encouraged the UK and others to present papers to ad hoc WG-IMAF on survey work and, in particular, hook ingestion and hook body piercing, to its 2008 meeting (Annex 6, paragraph I.38).

5.31 The Scientific Committee, recognising the financial implications of producing a poster, recommended that (Annex 6, paragraph I.39):

(i) CCAMLR produces the A3 poster in colour, in all CCAMLR languages, as well as Indonesian, Korean and Japanese. It should be waterproof and on plastic for display in wet areas on vessels;

(ii) the Secretariat distributes the poster via technical coordinators to all longline vessels operating in the Convention Area early in the 2008 season as a priority;

(iii) the Secretariat, via technical coordinators, instructs vessel operators to display a poster in at least four strategic locations on vessels, including in fish processing factories, in line hauling bays in easy view of crews hauling gear, and in areas inboard of hauling areas where crews process hauled baits/hooks;

(iv) scientific observers be instructed to report on whether the poster is displayed on vessels and reminded of the need to monitor hook removal;

(v) Members operating the Spanish method of longlining (both traditional and trotline methods) outside the Convention Area adopt the use of the poster and provide posters to their longline vessels for on-board display (Annex 6, paragraphs II.94 and II.95).

5.32 Dr Agnew supported the poster proposal and noted its utility especially for Members fishing outside the Convention Area where Convention Area seabirds are being encountered. Given the reports of documented by-catch of sub-Antarctic seabirds from the Convention Area in fisheries in the Benguela Current and associated seabird population declines (Annex 6, paragraphs II.63 and II.64), South Africa and Namibia would be in a good position to share this poster with the Angolan longline fleet.

Observer data collection

5.33 The Scientific Committee supported the proposal of the Secretariat that Members (Annex 6, paragraph I.45):

(i) develop a standard set of training and educational standards to augment current domestic training programs;

(ii) consider the feasibility of developing a process whereby national observer programs are accredited to consistent international standards;

(iii) encourage and support national technical coordinators to attend WG-FSA and ad hoc WG-IMAF meetings and consider maximising such opportunities by convening training workshops for coordinators.

5.34 The Scientific Committee reviewed data collection needs relative to several areas of seabird and marine mammal interaction and mitigation and recommended additions or changes to logbooks and cruise reports, including:

(i) improved reporting on the use of net sonde cables (Annex 6, paragraph II.60);

(ii) net binding (Annex 6, paragraph II.117);

(iii) distinguishing which of the three longline fishing methods, or combination of, was in use on a vessel, either the Spanish system, autoline system or the trotline system (paragraph 13.12; Annex 6, paragraph II.11);

(iv) improved reporting on the warp-strike protocol (Annex 6, paragraphs II.120, II.123 and II.125);

(v) information on haul mitigation devices used in the Convention Area (Annex 6, paragraphs II.108 and II.109).

5.35 The Scientific Committee reiterated its 2006 recommendation that coverage of the krill fishery be increased to allow for adequate and representative sampling across all trawl fisheries for monitoring of by-catch and efficacy of mitigation measures (Annex 6, paragraph I.10).

5.36 The Scientific Committee noted concern that the reported percentage of hooks observed fell below the recommended minimum of 20% on several vessels in 2006/07 (as low as 0%) (Annex 6, paragraph I.47). The Scientific Committee also noted that vessels are capable of having 100% of hooks observed, as demonstrated by the *Antillas Reefer* (Annex 6, Table II.1).

5.37 The Scientific Committee recognised that a careful balance is needed when tasking observer duties; accordingly, priorities must be identified and established. In making the recommendations in paragraph 5.34, the Scientific Committee noted the general review of the implementation of the observer program (Annex 5, paragraph 11.11).

Assessment of risk in CCAMLR subareas and divisions

5.38 The assessment of potential risk of interactions between seabirds and fisheries for all statistical areas in the Convention Area was reviewed, revised and provided as advice to the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31). There were no changes to levels of risk this year (Annex 6, paragraph I.51).

5.39 The Scientific Committee noted a tabled description of the ad hoc WG-IMAF risk assessment (WG-FSA-07/P2) and recommended that the Secretariat assist in the dissemination of this paper, including to other RFMOs which could consider the experience of CCAMLR when developing approaches to minimising by-catch in their own fisheries (Annex 6, paragraph I.52).

5.40 The Scientific Committee noted the revised risk assessment, originally confined to longline fisheries, was extended to trawl fisheries this year following a request last year from the Commission (Annex 6, paragraph I.53; CCAMLR-XXV, paragraphs 5.21 to 5.24). The assessments now incorporate advice on operational measures that should be applied to pelagic trawling operations for all CCAMLR statistical subareas and divisions to minimise by-catch (Annex 6, paragraph I.54 and Table II.19; SC-CAMLR-XXVI/BG/31).

5.41 The Scientific Committee noted the advice of ad hoc WG-IMAF (Annex 6, paragraphs I.53 to I.55 and Table II.19) about a suite of best-practice mitigation measures known to assist in reducing seabird by-catch in pelagic finfish trawl fisheries to a best-practice outcome of zero. The Scientific Committee noted that the individual effect of each mitigation measure is not known and that existing fisheries have achieved zero or near-zero seabird by-catch by effectively using differing combinations of mitigation measures as contained in Annex 6, Table II.19. The Scientific Committee recognised that, by virtue of their current by-catch levels, those fisheries are already achieving a best-practice outcome and endorsed the advice of WG-IMAF that there was no need for additional mitigation for these fishing operations.

5.42 The Scientific Committee endorsed the view that best-practice for new entrants to existing fisheries and for new pelagic finfish trawl fisheries would be to apply the full suite of mitigation measures identified in Annex 6, Table II.19, unless it could be demonstrated that individual measures are not needed to achieve zero or near-zero seabird by-catch. It also noted the advice of ad hoc WG-IMAF that there may be operational and management considerations in different fisheries that preclude the use of one or more measures and others may need to be used in their place to achieve the same outcome.

5.43 The Scientific Committee noted that, with respect to pelagic trawling gear for krill and demersal trawling gear targeting finfish where offal retention occurs, no clear evidence is available to suggest that these methods pose a serious risk to seabirds in the Convention Area at this stage (Annex 6, paragraph I.56). For this reason, mitigation measures additional to those required by Conservation Measure 25-03 are not considered necessary at present for these gear types.

5.44 The Scientific Committee noted ad hoc WG-IMAF's advice that a proposed relaxation of the limitation of icefish catch that may be taken between 1 March and 31 May in Subarea 48.3 and the requirement to undertake research trawls in this period is unlikely to lead to an increased risk to seabirds from this fishery, provided that the best-practice mitigation measures are used year-round (Annex 6, paragraph I.57).

5.45 The Scientific Committee endorsed WG-IMAF's advice on a proposed season extension in Division 58.5.2 (season is currently 1 May to 31 August), with the following caveats (Annex 6, paragraph I.58):

(i) 1 to 14 September could be included in the core season and not subject to the three-seabird by-catch limit;

(ii) the three-seabird by-catch limit should continue to apply to fishing during the periods from 15 to 30 September and 15 to 30 April;

(iii) the season extension can extend from 1 to 31 October, subject to a three-seabird by-catch limit.

Incidental mortality of seabirds in relation to new and exploratory fisheries

5.46 The Scientific Committee noted that:

(i) of the 41 applications for exploratory longline fisheries for 2006/07, 28 were undertaken (Annex 6, paragraph I.59). No incidental seabird mortality was observed;

(ii) the 44 proposals by 12 Members for exploratory fisheries in seven subareas/divisions of the Convention Area in 2007/08 were addressed in relation to the advice in Annex 6, Figure II.2 and Table II.20 and SC-CAMLR-

XXVI/BG/31. The results, summarised in Annex 6, paragraphs II.158 to II.160, involve two categories: those that provide sufficient information and are assessed as conforming with advice relating to incidental mortality of seabirds (Annex 6, paragraph II.158), and those that contain insufficient information to be certain that they conform with advice relating to incidental mortality of seabirds (Annex 6, paragraph II.159). Applications by the Republic of Korea (CCAMLR-XXVI/16) and Uruguay (CCAMLR-XXVI/24) fall into the latter category. The Scientific Committee noted that as for last year (SC-CAMLR-XXV, paragraph 5.36(iii)) these inconsistencies should be able to be resolved easily, but suggested this was a task for SCIC (Annex 6, paragraph I.60).

5.47 The Scientific Committee welcomed improvements in notifications this year and requested that Members take greater care in future submissions to ensure the intent to comply with relevant seabird by-catch measures was clear (Annex 6, paragraph I.61).

5.48 The Scientific Committee was pleased with the number of Members that utilised the checklist and encouraged those that did not do so (Republic of Korea and South Africa), or altered the checklist without explanation (Uruguay), to use the pro forma and checklist in full in future notifications. The Scientific Committee noted that as the notification from Uruguay (CCAMLR-XXVI/24) had not been translated, it was uncertain whether the relevant information was contained within the document (Annex 6, paragraph I.62).

5.49 The Scientific Committee reiterated its recommendation that any vessel operating under the provisions of Conservation Measure 24-02, and which catches a total of three (3) seabirds, as defined in SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217, shall revert to night setting in accordance with Conservation Measure 25-02 (Annex 6, paragraph I.63).

5.50 The Scientific Committee noted CCAMLR-XXVI/27 proposing improvements to line sink rate monitoring and reporting and noted that, as the proposal had no technical implications for the work of ad hoc WG-IMAF, it was a matter for SCIC (Annex 6, paragraph I.64).

International and national initiatives relating to incidental mortality of seabirds in relation to longline fishing

5.51 The Scientific Committee noted reports on current international initiatives under the auspices of:

(i) ACAP – items of particular relevance to CCAMLR including ACAP's newly formed Seabird Bycatch Working Group (Annex 6, paragraphs II.166 to II.168);

(ii) FAO (IPOA-Seabirds) – noting COFI's agreement (pending cost considerations) to develop best-practice technical guidelines for NPOA-Seabirds and RFMOs, that the guidelines should extend to other relevant fishing gears, and that FAO could undertake this work through an expert consultation and in cooperation with CCAMLR, ACAP and BirdLife International (Annex 6, paragraph II.169);

(iii) Joint meeting of tuna RFMOs – Secretariat-provided information on CCAMLR's processes in developing its seabird by-catch mitigation measures (Annex 6, paragraphs II.171 to II.174);

(iv) RFMOs – no responses received to CCAMLR Resolution 22/XXV but updates on WCPFC, ICCAT, CCSBT, IOTC and IATTC (Annex 6, paragraphs II.175 to II.187).

5.52 The Scientific Committee encouraged Members to use and promote ACAP resources, as appropriate (species assessments and research plan for pelagic longline mitigation technologies). This technical information from ACAP is of utility as RFMOs consider seabird assessments and seabird by-catch mitigation measures (Annex 6, paragraph I.66).

5.53 The Scientific Committee reiterated its support for the development of FAO best-practice technical guidelines for the development of NPOA-Seabirds (SC-CAMLR-XXV, paragraph 5.44), to be used by countries and RFMOs and to include other relevant gear types. This effort is important where RFMOs manage fisheries in waters adjacent to the Convention Area, particularly where seabird species which breed and forage in the Convention Area may be distributed (Annex 6, paragraph I.67).

5.54 Consistent with CCAMLR Resolution 22/XXV, the Scientific Committee recommended the Commission extend an offer of technical assistance and/or information sharing on conducting seabird risk assessments to other RFMOs that may have fisheries that take CCAMLR Convention Area seabirds. The Scientific Committee stressed the need for assessing risk to seabird populations and for mitigating such risks via adaptive and precautionary decision-making, including the use of adequate levels of observer coverage and detailed reporting of implementation of conservation measures to truly achieve reductions in seabird by-catch (Annex 6, paragraph I.69).

5.55 With regard to the effectiveness of Resolution 22/XXV, the Scientific Committee:

(i) was encouraged by progress at WCPFC and ICCAT, but expressed concern at the general lack of progress in RFMOs (Annex 6, paragraphs I.68 and II.194);

(ii) encouraged the Secretariat and Contracting Parties to diligently implement all aspects of Resolution 22/XXV (Annex 6, paragraph II.195).

5.56 The Scientific Committee extended a standing invitation to ACAP and BirdLife International to participate in future meetings of ad hoc WG-IMAF as invited experts (Annex 6, paragraph I.71).

Streamlining the work of the Scientific Committee

5.57 The Scientific Committee noted that the process of updating fishery reports with information relating to the by-catch of seabirds and marine mammals contributed to streamlining the work of the Scientific Committee's working groups.

5.58 The Scientific Committee noted the continued very positive results again this year with respect to seabird and marine mammal by-catch throughout the Convention Area and highlighted an increasing need to focus on the by-catch of Convention Area seabirds outside the Convention Area given CCAMLR's responsibility for these Antarctic marine living resources (Convention Article I). Continued vigilance in the monitoring of by-catch and the implementation of conservation measures is needed to continue to strive to minimise seabird and marine mammal by-catch in all Convention Area fisheries and to avoid time delays in responding to changing fishery dynamics and by-catch rates which could have serious consequences for the conservation of seabirds and marine mammals. The Scientific Committee endorsed ad hoc WG-IMAF's recommendation that its annual meetings continue for the time being (Annex 6, paragraph I.75).

5.59 The Scientific Committee endorsed ad hoc WG-IMAF's recommendation for a one-day workshop immediately prior to WG-IMAF in 2008 and endorsed the following proposed terms of reference (Annex 6, paragraph I.76):

(i) review and recommend revisions to the terms of reference for ad hoc WG-IMAF;

(ii) develop short- and medium-term work plans for ad hoc WG-IMAF, particularly considering the work plan of WG-FSA for dealing with mitigation of the by-catch of fish and invertebrate by-catch, the work plan of the Scientific Committee and developments in other international bodies concerned with the interaction of fisheries and Convention Area birds or mammals;

(iii) review the frequency of meetings of ad hoc WG-IMAF. In particular:

  (a) consider the conditions under which a change in meeting frequency could take place and catalogue the advantages and disadvantages of such change;

  (b) examine in detail the consequences of decreasing the frequency of ad hoc WG-IMAF meetings on the work of WG-IMAF and the advice that it is able to provide WG-FSA, the Scientific Committee and the Commission;

  (c) consider mechanisms that could be put in place to minimise the risk of impacting significantly on the work of WG-FSA, the Scientific Committee and Commission were the ad hoc WG-IMAF meeting frequency to be reduced.

Other business

5.60 The Scientific Committee noted WG-IMAF's concern that its ability to adequately and effectively address some topics was hampered by the lack of translated working group documents, particularly its future efforts to assist with seabird by-catch reductions in the French EEZs, the last remaining area of substantial seabird by-catch in the Convention Area (Annex 6, paragraph I.77). Several Members highlighted the need for these translated documents and supported WG-IMAF's request for a case-by-case consideration. The Secretariat reminded the Scientific Committee that the agreed working language of the working groups was English.

5.61 Dr Agnew requested the Secretariat to provide cost details on paper translations, asking if there was a cost differential depending on how early a paper was submitted. Dr Constable suggested that resources permitting, consideration be given to papers of high priority or novel importance.

Advice to the Commission

5.62 This section attempts to distinguish between general advice (which the Commission may wish to note and/or endorse) and specific advice which includes requests to the Commission for action.

General advice

5.63 The Commission was requested to note:

(i) the continuing low levels of incidental mortality of seabirds in regulated longline fisheries in most parts of the Convention Area in 2007 and that, for the first time, no birds were reported taken in regulated longline fisheries except for the French EEZs and no albatross mortalities were observed in the Convention Area longline fisheries for a second consecutive year (paragraph 5.3);

(ii) that effort is required on mitigating incidental mortality of seabirds during the haul of longlines (paragraph 5.4);

(iii) the reduced levels of seabird and marine mammal incidental mortality in trawl fisheries in the Convention Area in 2007 (paragraph 5.3);

(iv) improved data collection and reporting by France and continued efforts to reduce seabird by-catch (paragraph 5.5);

(v) the assessment of implementation of relevant conservation measures, including improved performance with 100% implementation for nearly all measures (paragraph 5.14);

(vi) need for improved reporting of the use of mitigation measures in all trawl fisheries so that the successful measures used could be documented and made available more widely (paragraph 5.13);

(vii) the concern that discarding of hooks in offal may have adverse impacts on bird populations (paragraph 5.16);

(viii) a reminder to Members to report on seabird mortality for Convention Area seabirds arising from fisheries conducted outside the Convention Area (paragraph 5.18);

(ix) revisions to the assessment of risk of interactions between seabird and fisheries for all statistical areas in the Convention Area now includes a trawl gear assessment (paragraph 5.40);

(x) a proposed relaxation of the limitation of icefish catch in Subarea 48.3 is unlikely to lead to an increased risk to seabirds, provided that the best-practice mitigation measures are used year-round (paragraph 5.44);

(xi) the Scientific Committee will extend a standing invitation to ACAP and BirdLife International to attend WG-IMAF meetings as invited experts (paragraph 5.56).

5.64 The Commission was requested to endorse:

(i) a series of recommendations and requests to France to assist in the effort to further reduce seabird by-catch in the French EEZs to near-zero levels (paragraph 5.6);

(ii) a request to ad hoc WG-IMAF to consider the issue of hook loss and possible ways to reduce this loss (paragraph 5.16);

(iii) the research and items to further improve Conservation Measures 24-02 and 25-02 (paragraph 5.29);

(iv) recommended changes to logbooks and cruise reports (paragraph 5.34);

(v) the Secretariat's assistance in the dissemination of a paper describing the CCAMLR risk assessment of fisheries to bird by-catch (paragraph 5.39);

(vi) that best practice for new entrants to existing fisheries and for new pelagic finfish trawl fisheries would be to apply the full suite of mitigation measures identified in Annex 6, Table II.19 (paragraph 5.42);

(vii) the advice on a proposed season extension in Division 58.5.2 for longline vessels (paragraph 5.45);

(viii) its continued support for the development of FAO best-practice technical guidelines for seabird mitigation measures (paragraph 5.53);

(ix) an ad hoc WG-IMAF workshop in 2008 and its terms of reference to consider a future focus of work (paragraph 5.59).

Specific advice

5.65 The Commission was requested to consider taking action in respect of:

(i) production and distribution of a CCAMLR poster to instruct crews to remove hooks from all landed fish and hauled baits (paragraphs 5.29(vi) and 5.31);

(ii) suggested revisions to Conservation Measure 25-02 (paragraph 5.24);

(iii) continued action in respect of seabird mortality caused by IUU fishing (paragraph 5.22);

(iv) increasing observer coverage of the krill fishery (paragraph 5.35);

(v) translation of certain working group papers, on a case-by-case basis, for high-priority issues such as the further reduction of seabird by-catch in the French EEZs (paragraphs 5.60 and 5.61).

ADDITIONAL MONITORING AND MANAGEMENT ISSUES

Marine debris

6.1 The Scientific Committee noted that several papers had been provided regarding surveys of marine debris and its impact on marine mammals and seabirds conducted by Members in the Convention Area, including Annex 4, SC-CAMLR-XXVI/BG/10 and BG/16 to BG/20. The Scientific Committee noted that SC-CAMLR-XXVI/BG/10 provided a useful summary of the submitted papers and had been provided to ad hoc WG-IMAF.

6.2 The Scientific Committee indicated that this item would better be delegated to ad hoc WG-IMAF for its expert consideration and recommended that the issue of marine debris be removed from its agenda in the future.

6.3 Dr M. Naganobu (Japan) noted to the Scientific Committee that no marine debris had been released from any Japanese fishing vessels in the Convention Area in the 2006/07 fishing season.

Marine mammal and bird populations

6.4 During WG-EMM-07, progress towards a workshop on the estimation of land-based marine predator abundance in the southwest Atlantic was reviewed (Annex 4, paragraphs 7.1 to 7.5). WG-EMM discussed and endorsed the work plan and terms of reference for the workshop (Annex 4, paragraph 7.2) developed intersessionally by a correspondence group led by Dr C. Southwell (Australia).

6.5 In considering the work plan, WG-EMM also recognised that the estimation of predator abundance and predator demands for prey would require a considerable program of work and that this would extend beyond 2008. The Scientific Committee agreed that the correspondence group should be elevated to the status of a subgroup –WG-EMM-STAPP.

6.6 The Scientific Committee noted that the workshop to be held in 2008 need not be held in conjunction with WG-EMM-08. The Executive Secretary offered the CCAMLR offices in Hobart and it was agreed that the workshop should be held from16 to 20 June 2008.

6.7 The Scientific Committee endorsed the invitation and participation of appropriate SCAR experts at the workshop. Dr Hosie confirmed that Drs D. Patterson-Fraser and Danis would attend on behalf of SCAR.

6.8 The Scientific Committee also endorsed the invitation and participation of one independent expert who should be experienced in the statistical estimation of land-based predator populations. A budget of A$6 000 was agreed to support the attendance of an appropriate individual.

6.9 The Scientific Committee agreed that the report of the workshop should be delivered to both WG-SAM-08 and WG-EMM-08.

6.10 At the time of adoption of the report, the Scientific Committee agreed that in future this item should be considered by WG-EMM.

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

7.1 In accordance with CCAMLR's Scheme of International Scientific Observation, scientific observers were deployed on all vessels in all finfish fisheries in the Convention Area.

7.2 Information collected by scientific observers on board longline, finfish trawl, pot and krill trawl cruises were summarised by the Secretariat in SC-CAMLR-XXVI/BG/8 and outlined in paragraph 1.9.

7.3 The Scientific Committee also noted the discussions on the observer program by ad hoc WG-IMAF (Annex 6, paragraphs I.45 to I.48), and WG-FSA (Annex 5, paragraphs 11.1 to 11.10) and in paragraphs 4.21, 4.22 and 4.28 to 4.72 of the WG-EMM report (Annex 4).

7.4 The Scientific Committee noted WG-FSA's advice that an ad hoc technical group be established that reports to the Scientific Committee on discussion of issues in relation to the Scheme of International Scientific Observation identified as impacting on the work of the Scientific Committee, as well as an other technical issues related to at-sea implementation of management measures in the Convention Area (Annex 5, paragraphs 11.1 to 11.12).

7.5 The Scientific Committee further noted the advice from WG-FSA that:

(i) The ad hoc technical group should comprise experienced observers, regional technical coordinators, representatives of fishers and operators, science representatives, the Secretariat and any other expertise identified as necessary.

(ii) The following issues should be specifically addressed:

(a) ensure an equivalent level of training and accreditation for observers across the Convention Area, considering the results provided in SC-CAMLR-XXVI/BG/9 Rev. 1, which indicated that level of training across all Member States is variable;

(b) the context of the specific data types collected, and their use in developing management advice. This would further enable observers to focus on collecting important data, rather than data which are redundant, or would be better collected through remote sensing if required, e.g. estimates of sea-surface temperature or sea state;

(c) design or refinement of sampling and data collection protocols for recording by-catch of benthic invertebrate fauna to enable the identification and description of VMEs (Annex 5, paragraphs 6.31 to 6.33 and Agenda Item 14.1);

(d) time management and prioritisation of observer tasks, considering that any increase in workload for observers is likely to cause issues for the quality of data able to be collected by observers, as well as the range of target species, gear types and stage of development of fisheries and research priorities within the Convention Area;

(e) additional tasks that will be required by the proposed Year of the Skate and the impact that these additional tasks will have on the workload of observers and on the quality of other required tasks (Annex 5, paragraphs 6.34 to 6.39);

(f) consideration of technological improvements in data capture and management systems, and the potential for increased use of hardware and software to improve the quality and quantity of data collected by observers. This could include semi-automated methods of observing fisheries operations, measuring catch and by-catch and wildlife interactions using cameras and portable computers;

(g) exchange of expertise and experience between technical coordinators and experienced observers on methods of recruiting, training and managing observers, and systems of acquisition, quality assurance, securing and delivering observer data to the Secretariat;

(h) review the *Scientific Observers Manual* and the electronic logbooks to incorporate outcomes from the meeting;

(i) any other technical issues related to at-sea implementation of management measures in the Convention Area.

7.6 The Scientific Committee also noted that WG-FSA had developed a matrix to describe all data collected at sea by vessels and observers, identifying user groups and data types, a description of the data and how they are used by the working groups and the Scientific Committee, the optimal sampling scheme for each data type, and consideration of practical limitations on optimal data collection (Annex 5, Table 21).

7.7 Dr Constable thanked WG-FSA for its work, and supported the idea of setting up an ad hoc technical group as being very timely. Many issues could be usefully addressed by such a group, including what are appropriate measures of effort and ways of operationalising by-catch sampling in the krill fishery. It would represent a useful way of introducing new expertise into the discussion of the Scientific Committee, including industry representatives which would assist with understanding the implementation of conservation measures at sea.

7.8 The Scientific Committee supported the establishment of the ad hoc group and noted that provisions would need to be made for the group in the budget discussions by SCAF. The

Scientific Committee requested that a small group be convened to determine when the group could meet and for how long, and to develop points to be included in preliminary terms of reference and an agenda.

7.9 The Scientific Committee noted the small group's recommendation that the ad hoc Technical Group for At-Sea Operations (TASO) meet for two days in 2008, on the weekend between the meetings of WG-SAM and WG-EMM. This timing has the benefit of using an existing venue, Secretariat support would be available for the other meetings, and would make it more straightforward for all the necessary technical experts (scientists, observers, technical coordinators and industry representatives) to attend.

7.10 The Scientific Committee noted that TASO would not in the first instance need extra Secretariat support to produce a translated report, but rather the convener/s would present the outcome of its work in the form of a background paper to the Scientific Committee, which would also be produced so as to be available to assist the work of WG-EMM and WG-FSA in 2008. However, it would be useful for the Scientific Observer Data Analyst to attend, along with the Data Manager.

7.11 The Scientific Committee noted the small group's concern that there was limited time within this meeting to fully develop terms of reference or a work plan for TASO. The Scientific Committee also noted that the time limit of two days for the meeting would require a limit on the number of issues that could be addressed by TASO in its first meeting. The Scientific Committee therefore agreed that TASO would deal with only the highest priority issues which would assist the working groups. These were determined to be:

(i) description of the design and operation of krill fishing vessels and gear used in the Convention Area, including conventional trawling, continuous trawling and pair trawling;

(ii) description of the design and operation of the trotline longlining method;

(iii) consideration of observer priorities across different fisheries in the Convention Area, based on the framework provided by the at-sea data matrix developed by WG-FSA and ad hoc WG-IMAF;

(iv) development of terms of reference and a long-term work plan for TASO.

7.12 The Scientific Committee noted that there was a need for intersessional work to ensure that a streamlined agenda could be developed and requested that Members nominate participants to the Secretariat who would be involved in these consultations. The Scientific Committee also noted that the conveners of all working groups be included in intersessional consultations on the agenda. The Scientific Committee welcomed Dr Welsford and Mr C. Heinecken (South Africa) as Co-conveners for this group.

7.13 The Scientific Committee also noted the discussions by WG-EMM on observer issues from krill fisheries (Annex 4, paragraphs 4.57 to 4.60).

7.14 Five scientific observer (four international and one national) datasets were submitted for the 2005/06 season. These data were collected by CCAMLR scientific observers on board the vessels *Niitaka Maru* (Japan), *Konstruktor Koshkin* (Ukraine) and *Saga Sea* (Norway). At present, the CCAMLR database holds scientific observer data from 35 trips/deployments between 1999/2000 and 2005/06 in Subareas 48.1, 48.2 and 48.3, most of which were from Subarea 48.3 (WG-EMM-07/5, Appendix 1).

7.15 Two CCAMLR scientific observers had been deployed in the 2006/07 season at the time of the WG-EMM meeting, both of them on the *Saga Sea* which is employing the continuous fishing system (WG-EMM-07/5).

7.16 WG-EMM discussed the use of CCAMLR scientific observer cruise reports as potential means for assessing accuracy and completeness of data collected by observers (WG-EMM-07/22). It was agreed that the main purpose of observer cruise reports should remain the provision of summary information on observations conducted and data collected, including detailed descriptions of fishing gear and general comments of observers on the use of the *Scientific Observers Manual* and observer logbooks and any difficulties encountered during observation. Information contained in observer cruise reports has been used by the Secretariat, when required, as an additional source of information for the verification of data collected by observers and submitted in observer logbooks.

7.17 The Scientific Committee noted the recommendation from WG-EMM, that the Secretariat be requested to prepare a summary of the data collected by scientific observers on board krill fishing vessels during the 2006/07 season, similar to the summaries of information annually prepared by the Secretariat on observations conducted in finfish fisheries, in particular for toothfish (e.g. WG-FSA-06/37 and 07/38), and to submit it to the next meeting of WG-EMM for review and approval. The Scientific Committee agreed that this type of analysis would be particularly useful for WG-EMM in determining priority areas of observer coverage of the krill fishery in terms of vessels, gear types, timing during the fishing season and areas where data had not been collected before.

7.18 The Scientific Committee also noted that krill length-frequency data are accumulated through scientific observation and these allow some comparison in selectivity between vessels and between fishing methods, but that these observations were spatially and temporally limited. Coverage in time and space could be improved through systematically increasing observer coverage or through the collection of such data by fishing vessels.

7.19 WG-EMM requested the Secretariat to look into the issue of krill fishing gear descriptions in consultation with technical coordinators of national observer programs and gear experts, prepare the required illustrations and update the cruise report form. The Scientific Committee noted that this issue would be dealt with in part by the meeting of TASO in 2008.

7.20 The Scientific Committee thanked the Secretariat for completing the update of the *Scientific Observers Manual* as requested last year (SC-CAMLR-XXV, section 2). The Scientific Committee also thanked the Secretariat for completing the survey of observer training by Members presented in SC-CAMLR-XXVI/BG/9 Rev. 1.

7.21 Prof. Moreno emphasised that CCAMLR observers are highly skilled, having qualifications and expertise to observe the operations of fisheries and to collect biological information, as well as having qualifications in safety at sea and an understanding of the goals of CCAMLR.

7.22 Dr Welsford agreed that CCAMLR observers could be considered to be trained professionals, and drew the Scientific Committee's attention to SC-CAMLR-XXVI/BG/9 Rev. 1, describing the training and recruitment of Australian observers. The system Australia uses includes training in the specific tasks of CCAMLR observers, and also includes minimum standards of skills and experience with fishery operations and scientific data collection, as well as requiring first-aid and safety-at-sea training, police background checks and declaration of financial interests in the commercial fishing industry.

7.23 Dr Shust described the work of CCAMLR observers from VNIRO. Russia has had a long history of placing observers on krill and finfish vessels in the Convention Area, and Dr Shust invited Members to visit VNIRO to learn more about the methods Russia uses in training observers, and work together on the issue of training observers.

7.24 The Scientific Committee noted that its ability to conduct its work was contingent on the efforts of observers in collecting data, and requested that Members ensure that this gratitude be conveyed to all observers by Members after the meeting.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY

8.1 The Scientific Committee discussed information pertaining to fishing on *Dissostichus* spp. inside and outside the Convention Area. A summary of catch and effort data inside the Convention Area is contained in Annex 5, paragraphs 3.7 to 3.14 and Table 4. Catches of *Dissostichus* spp. outside the Convention Area originated mostly from Areas 41 and 87 (Annex 5, paragraphs 3.16 to 3.20 and Table 4).

8.2 Dr Barrera-Oro provided further information on the fishery for *D. eleginoides* inside the Patagonian sector of the Argentine EEZ (Area 41): the annual catch limit is 2 500 tonnes. Catches in 2006/07 were similar to the previous fishing season. In order to maintain a long-term sustainability of the fishery, conservation measures were introduced in 2002. It has been mandatory since 2006/07 to tag two fish per tonne of green weight caught. In 2006/07, 1 500 fish were tagged.

8.3 The Scientific Committee reiterated the serious concerns raised by WG-FSA on the increasing level of IUU catches in recent years and the shifting of the IUU fishery from 'traditional' grounds in Area 58, such as Division 58.5.1, to high-seas areas and oceanic banks, such as BANZARE Bank (Division 58.4.3b) closer to the continent.

8.4 The Scientific Committee drew the attention of the Commission to Annex 5, paragraphs 8.4 to 8.8 and Table 3, which provided a brief outline of the history of IUU fishing in the Convention Area. The level of IUU fishing in Division 58.4.3b and other CCAMLR subareas and divisions is undermining any CCAMLR attempt to provide the basis for fishing to be sustainable. Current levels of IUU fishing exceeded levels of sustainable catch several times in the last three years.

8.5 The Scientific Committee noted that longlines are currently likely to be replaced by gillnets in the IUU fishery. Gillnets require no bait, can be deployed at any time and are more powerful than longlines in their ability to catch fish. No information is currently available on the incidental mortality of birds, mammals and other marine biota in gillnets deployed by IUU fishing vessels in the Convention Area.

8.6 The Scientific Committee noted that gillnets have the potential to become lost and drift through the water column for an unknown amount of time while still fishing to a large extent (ghost nets).

8.7 Dr Welsford stated that *D. eleginoides* caught on BANZARE Bank are large adult fish while juvenile fish have never been taken. The relationship of these fish to fish in other areas is still unknown. BANZARE Bank might represent a spawning area for fish which live as juveniles in other adjacent areas. The excessive exploitation of these fish in recent years by IUU fishing vessels may have already caused substantial damage to the stock which is likely to be reversible in decades only.

SCIENTIFIC RESEARCH EXEMPTION

9.1 Scientific surveys using research vessels notified to the Secretariat at the time of the meeting of the Scientific Committee were:

(i) bottom trawl survey in Subarea 48.3 by the UK in 2008
(ii) bottom trawl survey in Division 58.5.2 by Australia in 2008
(iii) CCAMLR-related IPY surveys by Germany, Japan, New Zealand, Norway and the UK and related CAML activities.

9.2 The Scientific Committee commended all these countries for their commitment to the IPY and CAML, and recognised the importance of these surveys for the future work of CCAMLR.

9.3 In addition, the Scientific Committee discussed the two notifications of intent to conduct toothfish longline research using commercial vessels under the provisions of Conservation Measure 24-01. It is expected that the purpose of allowing research fishing under the terms of Conservation Measure 24-01 using commercial longliners would be to collect data which will eventually allow an assessment of fish stocks in the sampled area to be completed. However, there is a need to restrict initial effort, such as provided in Conservation Measure 41-09 (paragraph 12), to prevent over-harvesting before sufficient data are obtained to conduct an assessment.

9.4 Japan submitted a notification to conduct scientific research on the distribution and population structure of toothfish in Divisions 58.4.4a and 58.4.4b in 2007/08 (COMM CIRC 07/109 and SC-CAMLR-XXVI/9). The main objective outlined in the notification is to collect various biological and physical oceanographic data on toothfish required for assessing the status of the stocks. This information was considered important because it has been five years since the area has been open to fishing. In addition, tagging activities would be conducted to contribute to future investigations on the distribution and population structure of toothfish in these areas.

9.5 The Scientific Committee noted the concerns of WG-FSA (Annex 5, paragraph 5.32) that commercial harvesting of toothfish in Division 58.4.4 was prohibited in 2002 because of rapidly declining fish stocks attributed to intense IUU fishing activities, and that it was unlikely that toothfish stocks in Division 58.4.4 would have substantially recovered since 2002. For this reason many Members expressed concern over the size of the proposed catch from this area, noting that much of the information proposed to be collected can be obtained from relatively small catches. For example, information on stock structure (genetic samples) could be obtained from relatively few fish, or biological data, such as fish size, may be obtained from relatively few fishing lines.

9.6 At present, the amount of toothfish catch specified in Conservation Measure 24-01, Annex A, to support tagging studies is set at 10 tonnes, although larger catches may be needed to estimate CPUE, if there is large variability in catch rates. Catches required for such assessments may be greater than is sustainable. The Scientific Committee supported the view of WG-FSA that catch levels of no more than 10–20 tonnes in each SSRU were appropriate in the absence of further justification to show how the data will be used in an assessment and that the recovery of fish stocks will not be impeded (Annex 5, paragraph 5.34). Based on the likely variability in catch rates, 20 tonnes was considered to be the minimum catch required for robust CPUE estimation.

9.7 The Scientific Committee recommended an overall limit of 80 tonnes from Division 58.4.4 and that the maximum catch from any SSRU should be 20 tonnes. The research sets should involve a random element to increase the value of the survey information and detailed biological data should be collected from the target and all by-catch species (individual fish length, weight, sex, reproductive stage, otoliths for ageing studies and tissue samples for genetic studies) in addition to representative length frequencies from each haul. Additional information should be reported on the trotline fishing system and the design of the survey, and the depth of fishing recorded at each set. The Scientific Committee also agreed that tagging should be at a minimum rate of three fish per tonne. On this basis, the survey should increase knowledge of the current stock status in this area.

9.8 Australia submitted a notification to conduct scientific research in 2007/08 (COMM CIRC 07/117). The notification is to conduct research on the status of toothfish and major by-catch species in Division 58.4.3b. The survey vessel will use longlines and will take approximately 50 tonnes of finfish, but it is likely that the survey may catch in excess of 50 tonnes of finfish and more than 10 tonnes of toothfish. The specific research objectives for the survey are to: (i) quantify the relative abundance of toothfish and major by-catch species available to the longline method across BANZARE Bank; (ii) determine the demographic characteristics of the target and major by-catch species across BANZARE Bank (i.e. size distribution, sex ratios and reproductive status); and (iii) collect biological material which can be used to determine the relationships between toothfish stocks in the southwestern Indian Ocean sector.

9.9 The Scientific Committee noted that under Conservation Measure 24-01 (paragraph 1), catches taken in this area (where catch levels exist) will be considered as part of the catch limit for the season. Although fishery data exist in Division 58.4.3b, they are very patchy. Therefore, the present proposal is to conduct a standardised random survey across the entire area. This will be the first such effort and standardised CPUE data will greatly enhance the ability of WG-FSA to determine biomass of toothfish in this division and to better understand the relative importance of the existing fishing grounds to the stock in this division.

9.10 The Scientific Committee supported the research and data collection plan proposed for this survey and in particular the random stratified design of the survey intended to cover the entire BANZARE Bank (paragraph 4.147).

General comments relative to Conservation Measure 24-01

9.11 The Scientific Committee identified the dilemma that without surveys the status of stocks would remain unknown, while providing for the catch required to complete a survey may further deplete the stocks under investigation. It considered that this conservation measure should be reviewed to ensure it was consistent with its intended purpose. If surveys are to be approved under this measure, they must provide a reasonable certainty that the state of knowledge will be advanced. For this purpose, the Scientific Committee supported the WG-FSA suggestion that all notifications which proposed taking toothfish should be required to include research proposals for review by WG-FSA and it would be highly desirable for Members submitting research proposals using commercial vessels to ensure appropriate scientists attend the working group meetings.

COOPERATION WITH OTHER ORGANISATIONS

10.1 The Scientific Committee was chaired during this section by Dr Sullivan, Vice-Chair of the Scientific Committee.

Cooperation with the Antarctic Treaty System

CEP

10.2 Dr Gilbert referred to the Executive Secretary's report of his attendance at CEP X (New Delhi, India, April/May 2007) (CCAMLR-XXVI/BG/4), noting that there were increasing issues of mutual interest to both the Scientific Committee and CEP.

10.3 Dr Gilbert reminded the meeting that the Environmental Protocol provides for the designation of Antarctic species as specially protected species. At CEP X the Committee had considered the potential for designating southern giant petrels as specially protected species. However, in the absence of a scientifically defensible assessment of the status of the species, the Committee felt unable to do so. Ahead of its next meeting, CEP is working with SCAR and ACAP to prepare a more thorough assessment of the status of southern giant petrels. Dr Gilbert requested Members of the Scientific Committee with relevant data to provide it to SCAR so as to assist the assessment.

10.4 At CEP X, the Committee had decided to retain Ross seals on the list of specially protected species given the uncertainty over the status of the species.

10.5 Dr Gilbert noted that the specially protected species provisions of the Protocol were a management tool that provided an opportunity for ongoing cooperation between CEP and the Scientific Committee.

10.6 Dr Gilbert noted that CEP intended to focus attention on the issue of long-term monitoring at its next meeting and welcomed the CCAMLR Observer's offer of reporting on lessons learned in the development of CCAMLR's ecosystem monitoring program.

10.7 Dr Holt welcomed the CEP report and noted several areas of common interest between CEP and the Scientific Committee that needed to be fostered, not least the issue of protected and managed areas with a marine component.

10.8 Dr Constable agreed and recalled his suggestion from last year for a joint CEP-Scientific Committee workshop. To give greater impetus to that proposal, Dr Constable suggested that the Scientific Committee give consideration to holding such a workshop in 2009 and that representatives from WG-EMM in particular be encouraged to participate.

10.9 Dr Gilbert welcomed the proposal for a joint meeting in 2009 and offered that CEP would come forward to the next meeting of WG-EMM and the Scientific Committee with some firm suggestions for agenda items.

10.10 The Committee supported the proposal in CCAMLR-XXVI/BG/4 for the Secretariat's Science Officer to periodically attend meetings of CEP so as to provide continuity in the CEP–Scientific Committee relationship, particularly at times of changeover of the Scientific Committee Chair. However, the Committee also agreed that the formal observer role to CEP should remain with the Chair of the Scientific Committee. Dr Gilbert welcomed the Science Officer's attendance at future meetings of CEP.

SCAR

10.11 Dr Hosie presented a report (CCAMLR-XXVI/BG/36) on SCAR:

(i) It has been a busy year for SCAR in preparation for a number of IPY field projects. Many of these have involved direct collaboration with CCAMLR.

(ii) CAML participated in the CCAMLR-IPY planning meeting to help extend the range of CCAMLR's pelagic research during IPY. CAML has included the recommended CCAMLR survey protocols into the CAML pelagic protocols.

(iii) SCAR participated in the CCAMLR Bioregionalisation Workshop with representatives from SCAR-MarBIN and the SCAR Southern Ocean CPR Survey. CPR data were used extensively for the pelagic bioregionalisation analysis and much of the biological data for the benthic classification came from SCAR-MarBIN.

(iv) SCAR has invited the CCAMLR Data Manager onto the SCAR-MarBIN Scientific Steering Committee and his participation in the SCAR-MarBIN SSC meeting in Poland, in June 2007, was welcomed.

(v) The SO-CPR Survey continues to expand both its coverage of the Southern Ocean and the volume of data available for use by the Antarctic community. The SCAR Action Group on CPR Research functions as an advisory group to help develop the survey. SCAR has written to the CCAMLR Secretariat seeking a Member from CCAMLR, as CCAMLR is seen as a likely major user of the data.

(vi) SCAR has been working towards the merger of the birds and seals groups into a new Expert Group on Status and Trends of Top Predator Populations. SCAR should be able to advise CCAMLR of the full details, including the terms of reference, of the new expert group on top predators at CCAMLR-XXVII and how the new group can interact with CCAMLR and WG-EMM.

(vii) The SCAR/SCOR Oceanography Expert Group convened a meeting in Bremen, Germany, from 1 to 3 October 2007, to further develop the Southern Ocean Observing System (SOOS) initiative. The Chair of CCAMLR's Scientific Committee was invited to the meeting and the report is contained in SC-CAMLR-XXVI/BG/36. SOOS plans to observe key changes in oceanography and meteorology through time and relate these to the biota, and to use this information to predict future change. The research plan will be presented for further discussion at the SCAR Open Science Conference in St Petersburg, Russia (July 2008), and is scheduled for publication in September 2008.

(viii) SCAR commissioned a report on the State of the Antarctic and the Southern Ocean Climate System (SASOCS), submitted to CCAMLR for information as CCAMLR-XXVI/BG/37. The report highlighted unprecedented climate change in the last 50 years with ocean warming and sea-ice reduction west of the Antarctic Peninsula and in the Weddell Sea. Projections over the 21st Century indicate a doubling in CO_2 in the atmosphere, warming of the sea-ice zone and reduction of sea-ice extent.

(ix) The first circular of the XXX SCAR meeting and 3rd Open Science Conference in Russia, July 2008, has been posted on the public area of the CCAMLR website in the News section. Abstracts are to be submitted by 15 January 2008. There are numerous themes, including one on harvesting and exploitation of biological resources. CCAMLR's participation in the conference is welcomed.

(x) SCAR will again invite the Chair of the Scientific Committee to be an observer at the XXX SCAR meetings in St Petersburg and Moscow (Delegates Meeting).

(xi) The SCAR Executive has welcomed the closer interactions with CCAMLR. SCAR is keen to develop further collaborations with CCAMLR, particularly research projects of mutual interest.

10.12 Dr Constable, as Convener of WG-SAM, was nominated as the CCAMLR representative on the SCAR Action Group on CPR Research (paragraph 10.11(v)).

10.13 Dr Holt welcomed the development of the new expert group on top predators and looked forward to close and integrated cooperative efforts between CCAMLR and this new SCAR group.

10.14 Dr Naganobu noted that Norway seemed to be missing on Figure 1 of CCAMLR-XXVI/BG/36.

10.15 Dr Iversen replied that Norway will indeed perform a survey in Subareas 48.3 and 48.6.

SCAR-MarBIN

10.16 In 2006 the Scientific Committee endorsed SCAR's invitation for the Data Manager to join the International Steering Committee (ISC) of SCAR-MarBIN in order to improve the exchange of data and strengthen links between SCAR and CCAMLR. The Data Manager participated in the ISC meeting which was held in Bialowieza, Poland, 6 to 9 June 2007; travel costs were funded by SCAR (SC-CAMLR-XXVI/BG/12).

10.17 Outcomes of the ISC meeting of special interest to CCAMLR included:

(i) addition of aggregated data on the occurrence of krill provided by CCAMLR via Dr V. Siegel (European Community);

(ii) progress in establishing the Admiralty Bay Benthos Diversity Database as a sub-network of SCAR-MarBIN;

(iii) development of an interactive Antarctic Field Guide and identification keys, and improvements to the Register of Antarctic Marine Species;

(iv) SCAR-MarBIN's contribution to CCAMLR's workshop on bioregionalisation;

(v) request for CCAMLR to contribute metadata records to SCAR-MarBIN;

(vi) ISC will hold its next meeting in 2008.

10.18 ISC's request for CCAMLR to contribute metadata records to SCAR-MarBIN joins a growing interest among data users for the development of CCAMLR metadata. Metadata describe how, when and by whom a particular set of data was collected, and how the data are formatted (i.e. data about data). Metadata are essential for understanding information stored in large databases and have become increasingly important in web-based applications and the dissemination of information.

10.19 In light of this growing interest for metadata, the Secretariat proposed developing metadata records for fishery and scientific datasets held in the CCAMLR database. These metadata would be made available on a public-access section of the CCAMLR website, and relevant metadata would be submitted to SCAR-MarBIN and, where appropriate, other international collaborators (e.g. FIRMS).

10.20 The Scientific Committee endorsed the Secretariat's proposal to develop CCAMLR metadata.

Reports of observers from international organisations

ASOC

10.21 Dr R. Werner drew attention to the papers tabled by ASOC (CCAMLR-XXVI/BG/25 and BG/27).

10.22 With regard to the Antarctic krill fishery, ASOC welcomed the intersessional work of the Scientific Committee towards the development of management options for the krill fishery at SSMUs in the southwest Atlantic. It also welcomed the workshop hosted in May 2007 by the Lenfest Ocean Program to identify and resolve key uncertainties in management models for krill fisheries. This scientific work is crucial to making progress towards ecosystem-based management of krill fisheries.

10.23 ASOC welcomed the staged approach taken by the Scientific Committee towards the establishment of catch limits for krill for SSMUs and hopes that this staged approach will take appropriate account of remaining scientific uncertainties regarding krill and predator–prey interactions. In that context, achieving systematic scientific observer coverage in the krill fishery continues to be an urgent priority, and ASOC regretted deeply that the position of one Member, based on non-scientific considerations, is again hampering the Scientific Committee to deliver appropriate advice to the Commission on this issue. Insufficient scientific observer coverage across fishing areas and seasons and the resulting lack of consistent data should be taken into account when the Scientific Committee delivers advice on catch limits for specific SSMUs.

10.24 ASOC looked forward to further progress on management options for SSMUs in the southwest Atlantic and hoped that Stage 1 of the process will prioritise those options that minimise impacts on krill-dependent predators, as mandated by Article II of the Convention. In addition, CCAMLR should move as soon as possible towards an adaptive feedback management system that uses monitoring data to detect potential impacts of fishing on predator populations, and adopt management measures accordingly. ASOC was concerned that the number of CEMP monitoring sites has been reduced over the years, and that the expected expansion of the krill fishery is not matched by investments in the monitoring effort that is needed for appropriate management of the fishery. ASOC believed that the lack of predator monitoring data is a problem. There should be no expansion of the krill fishery, in scale or location, until a comprehensive monitoring program has been developed and implemented.

10.25 ASOC noted with concern the proposal to introduce pair trawling for krill in the Antarctic. This is a new method which has not been used in the Antarctic. Elsewhere this method has been controversial for catching marine mammals and seabirds. ASOC was concerned that if this method is allowed, it is essential that all vessels carry CCAMLR scientific observers to assess the impact on marine mammals, seabirds and finfish by-catch.

10.26 With regard to the bioregionalisation of the Southern Ocean, ASOC welcomed the intersessional work conducted by CCAMLR and the Scientific Committee, including the holding of the CCAMLR Workshop on Bioregionalisation of the Southern Ocean in August 2007 and the subsequent intersessional work on the benthic habitat classification of the Southern Ocean.

10.27 ASOC welcomed the Scientific Committee's endorsement of the outcomes of the CCAMLR Workshop, including its endorsement of the general methodology used to provide a broad-scale regionalisation of the Southern Ocean from the 2006 Hobart Workshop. ASOC also welcomed the endorsement of the additional intersessional work on benthic habitat classification – this additional work is a significant enhancement of the work of the 2006 Hobart Workshop. ASOC additionally welcomed the Scientific Committee's agreement that, at the broad scale, the primary bioregionalisation from the 2006 Hobart Workshop is a good working product that can be used to inform spatial management of the Convention Area. ASOC also welcomed the Scientific Committee's endorsement that States engage in further fine-scale planning at a regional level. ASOC encouraged States to act on this recommendation.

10.28 ASOC welcomed the strong interest on this issue expressed by the Chair of CEP and the Chair's proposed circulation of the report of the CCAMLR Workshop to CEP members. ASOC particularly welcomed the wish expressed by the Chair of CEP to participate in a partner relationship with CCAMLR.

10.29 ASOC noted the Scientific Committee's acknowledgement that not all the final terms of reference of the CCAMLR Bioregionalisation Workshop were addressed, namely the procedure for identifying areas for protection to further the conservation objectives of CCAMLR. ASOC also noted the referral of future work by the Scientific Committee to WG-EMM. However, ASOC had hoped that the Scientific Committee would have given strong advice on the establishment of a procedure for identifying areas for protection as well as strong direction on the application of the intersessional work to future spatial decision-making. ASOC also encouraged the Scientific Committee to use the bioregionalisation outcomes in other relevant decision-making including, for example, when assessing the impacts of fishing and other harvesting of species.

10.30 With regard to seabird by-catch, ASOC congratulated both governments and fishers in keeping seabird by-catch by licensed fishers to remarkably low levels. Particularly, ASOC was delighted by commitments by France to improve the by-catch performance of its licensed fishers and urged France to commit to achieving the same by-catch performance as other CCAMLR Members.

10.31 In relation to seabird by-catch occurring outside the CCAMLR Area, ASOC shared the concerns of Members of this committee that neither CCAMLR Members nor other RFMOs within the distribution range of Southern Ocean seabirds have responded to CCAMLR requests to address their seabird by-catch problems with a view to achieving by-catch reduction equivalent to that achieved by CCAMLR. ASOC urged delegates to ensure that their governments heed CCAMLR's calls and engage with relevant Flag States and RFMOs with a view to getting adequate by-catch reduction strategies in place.

10.32 With regard to scientific fishing, ASOC was deeply concerned to hear discussion of proposals to engage in research fishing at commercial levels in high seas in areas subject to distressingly high levels of IUU fishing. ASOC would note that the research exemption provided by Conservation Measure 24-01 is not designed to allow inappropriate commercial exploitation as has occurred in some other fora.

10.33 With regard to bottom fishing, ASOC applauded the work of WG-FSA with respect to its comprehensive consideration of UNGA Resolution 61/105 relating to bottom fishing. ASOC noted the importance of the fishing footprint in the implementation of the UNGA resolution and urged the Scientific Committee to find ways to address this.

IWC

10.34 The 59th Meeting of the Scientific Committee of the International Whaling Commission (SC-IWC) was held in Anchorage, Alaska, USA, from 7 to 18 May 2007. Catches of 1 847 large whales, mostly minke whales, were reported to the IWC in 2006. The Japanese scientific whaling in the Southern Ocean took 508 minke whales in 2006/07. In addition to direct takes, 258 large whales were reported being killed due to by-catch and vessel collision. A total of 2 105 whales were killed in 2006.

10.35 A progress report was provided on the preparations for the forthcoming CCAMLR-IWC Workshop to review data required for ecosystem models to be held in Hobart, Australia, in August 2008. It provided input to the subsequent discussions on the workshop in WG-EMM and WG-FSA. The IWC continued the in-depth assessment of southern hemisphere minke whales. It has still been impossible to reconcile the large differences in abundance estimates between Circum-Antarctic (CP) cruises I and II and CP cruise III. Changes in sea-ice distribution and abundance have been considered as one of the likely causes to explain at least part of the differences between CP I and II and CP III. New information was also presented on distribution, movements, stock structure and abundance of pygmy and true blue whales. The current abundance estimate was 2 400 true blue whales in the Southern Ocean. The JARPA program on scientific whaling in the Southern Ocean was reviewed by the SC-IWC in Tokyo, Japan, in December 2006 and a number of possible improvements of the program were discussed by the review group. The SC-IWC did not have time to consider the continuing research proposals from Japan. However, there were no substantial changes in this proposal since the previous review by the SC-IWC.

10.36 The IWC will be holding a Workshop on Cetaceans and Global Change in Italy in the second half of 2008. The IWC envisages a strong participation by CCAMLR Members to contribute to the success of the workshop.

Fourth International Zooplankton Production Symposium

10.37 Dr S. Kawaguchi (Australia) reported on the Fourth International Zooplankton Production Symposium: Human and Climate Forcing of Zooplankton Populations, that took place in Hiroshima, Japan, from 28 May to 1 June 2007, which was co-sponsored by PICES, ICES and GLOBEC. There were 10 theme sessions and three workshops covering a wide range of disciplines. More than 400 delegates from 54 countries attended.

10.38 There were many presentations related to the Southern Ocean, in particular in the workshop entitled 'Krill research: current status and its future', which was attended by most of the active scientists working with krill.

10.39 Two special volumes are to be published, one as a main volume for the overall symposium, and another on krill biology and ecology. The details are available through the PICES website (www.pices.int/meetings/international_symposia/2007_symposia/4th_Zooplankton/4th_Zoopl.aspx).

CWP

10.40 The Coordinating Working Party on Fisheries Statistics (CWP) provides a mechanism to coordinate fishery statistical programs of regional fishery bodies and other intergovernmental organisations with a remit for fishery statistics.

10.41 The Data Manager participated in the Twenty-Second Session of CWP which was held at FAO, Rome, 27 February to 2 March 2007 (SC-CAMLR-XXVI/BG/7). Outcomes of the meeting of special interest to CCAMLR are as follows:

(i) CWP will review members' criteria used for defining IUU fishing vessels and the methods used to estimate IUU catches, with a view to provide a basis for harmonising these criteria and methods.

(ii) CWP recommended that FAO establish a consolidated catch database based on publicly available data from RFBs (e.g. STATLANT data).

(iii) Changes in European legislation now require EUROSTAT and ICES to report catch data by national EEZs and the high seas. CWP considered this to be an important development, particularly in the light of the recommendations of UNGA to improve data for managing straddling and migratory stocks. CWP encouraged other members to implement measures for distinguishing between catches in national and international waters.

(iv) CWP agreed to move towards refining best-practice data standards for monitoring fisheries within their ecosystem context.

(v) Trade documentation systems are now commonly used among tuna RFBs and there is a general shift toward catch certification schemes. CWP had recommended that importing and exporting countries transmit full trade document information to RFBs, and only CCAMLR's scheme has achieved this completely.

(vi) CWP agreed to exchange information with the MCS-Network and invite the network as an observer for future sessions of CWP.

(vii) FAO is conducting a review of VMS systems which will provide input into the further development of the North Atlantic Format and the future role of CWP on this issue.

(viii) CWP agreed to hold an intersessional meeting at the NAFO Secretariat in mid-2008, and elected Dr Ramm as Vice-Chair for the intersessional period.

10.42 The Scientific Committee considered CWP's recommendation that catch statistics be reported separately from national EEZs and the high seas under Agenda Item 13.

5th International Fisheries Observer Conference

10.43 In 2006, the Scientific Committee approved participation of the Scientific Observer Data Analyst and the Science/Compliance Officer at the 5th International Fisheries Observer Conference which was held in Victoria, Canada, 14 to 18 May 2007.

10.44 The conference focused on observer safety and training standards, and included sessions on safety training, training programs and data collection methods. The conference also included a poster session, and the Secretariat submitted a poster on 'Using Observer Data in CCAMLR Management Decisions for Antarctic Fisheries'.

10.45 Information obtained during the conference helped guide the Secretariat's review of observer training (SC-CAMLR-XXVI/BG/9 Rev. 1).

10.46 The Scientific Committee recognised the benefits of the Secretariat's participation in the conference, and endorsed the participation of the Scientific Observer Data Analysis at the next International Fisheries Observer Conference which is scheduled to be held in the USA in May 2009.

Future cooperation

10.47 The Scientific Committee noted a number of international meetings of relevance to its work and agreed to the following representatives:

- 10th Session of the IOTC Scientific Committee, 5 to 7 November 2007, Seychelles – UK (see paragraph 10.48);
- FAO Workshop on Data and Knowledge on Deep-Sea Fisheries in the High Seas, 5 to 7 November 2007, Rome, Italy – Data Manager (participation funded by FAO);
- Fourth International Fishers' Forum (IFF4), 12 to 15 November 2007, Puntarenas, Costa Rica – USA (Mr E. Melvin);
- CoML – All Programmes Meeting, 12 to 18 November 2007, Auckland, New Zealand – New Zealand;
- First Open Science Climate Impacts on Oceanic Top Predators (CLIOTOP) Symposium, 3 to 7 December 2007, La Paz, Mexico – USA (Dr G. Watters);
- International Symposium on Advances in Fish Tagging and Marking Technology, 24 to 28 February 2008, Auckland, New Zealand – New Zealand (Mr Smith);
- 60th Annual Meeting of the SC-IWC, 1 to 13 June 2008, Santiago, Chile – Germany (Dr Kock);
- CEP XI, 2 to 6 June 2008, Kiev, Ukraine – Scientific Committee Chair (representative) and CCAMLR Science Officer;

- ICES 6th Symposium in Fisheries Acoustics: Ecosystem Approach with Fisheries Acoustics and Complementary Technologies (SEAFACTS), 16 to 20 June 2008, Bergen, Norway – UK;

- ICES WGFAST, 23 June 2008, Bergen, Norway – Norway;

- SCAR Meetings, St Petersburg, Russia:
  Southern Ocean Observing System (SOOS), 3 to 4 July 2008; XXX SCAR Science Week, 5 to 7 July 2008; and Joint SCAR-IASC Open Science Conference, 8 to 11 July 2008 – SCAR Liaison Officer (Dr Hosie)
  SCAR-MarBIN Steering Committee (dates to be confirmed) – Data Manager;

- XXX SCAR Delegates' Meeting, 14 to 16 July 2008, Moscow, Russia – SCAR Liaison Officer (Dr Hosie);

- Fourth Meeting of the ACAP Advisory Committee (AC4), 22 to 25 August 2008, Cape Town, South Africa – South Africa;

- Fourth International Conference on the Biology and Conservation of Albatrosses and Petrels, 11 to 15 August 2008, Cape Town, South Africa – South Africa;

- CCSBT meetings, New Zealand – New Zealand (see paragraph 10.48):
  13th Meeting of the Scientific Committee, 2 to 12 September, Rotorua
  15th Annual Meeting of the Commission, 14 to 17 October, Auckland;

- 4th Annual SEAFO Scientific Committee Meeting, 2 to 3 October 2008, Windhoek, Namibia – Norway (see paragraph 10.48);

- SCOR 50th Anniversary Symposium and General Meeting, 20 to 24 October 2008, Woods Hole, MA, USA – to be advised;

- 5th World Fisheries Congress – Symposium: Seamount Fisheries – from Unregulated Exploitation to Sustainable Use, 20 to 24 October 2008, Yokohama, Japan – Japan;

- World Conference on Marine Biodiversity, 11 to 15 November 2008, Valencia, Spain – to be advised;

- CWP Intersessional Meeting, NAFO Secretariat, Dartmouth, Canada (dates to be advised) – Data Manager;

- 4th Regular Session of the WCPFC Scientific Committee (date and venue to be advised) – to be advised (see paragraph 10.48).

10.48 The Scientific Committee tasked the Co-convenors of ad hoc WG-IMAF and the Secretariat to develop a briefing package for representatives at meetings of RFMOs, covering Resolution 22/XXV (International Actions to Reduce the Incidental Mortality of Seabirds Arising from Fishing) and WG-IMAF's risk assessments (WG-FSA-07/P2).

BUDGET FOR 2008 AND FORECAST BUDGET FOR 2009

11.1 The agreed budget of the Scientific Committee for 2008 and the forecast budget for 2009 are summarised in Table 5. The notes in Table 5 refer to the following budget items:

(1) Preparation and support for the annual meeting of WG-SAM, report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs (airfares and subsistence) for the Data Manager (full meeting) and secretarial support (2 days), based on the assumption that the meeting will be held immediately prior to the meeting of WG-EMM and at the same, or nearby, location.

(2) Preparation and support for the annual meeting of WG-EMM, report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs for four Secretariat staff.

(3) Preparation and support for the annual meeting of WG-FSA, including ad hoc WG-IMAF. Costs include computing facilities, report editing, translation and publication as annexes to the report of the Scientific Committee.

(4) Preparation and support for the meeting of SG-ASAM, report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs for the Data Manager; the next meeting is scheduled in 2009.

(5) 50% cost identified at SC-CAMLR-XXV, to be funded by the Scientific Committee for workshop organisation and invited experts for the CCAMLR-IWC Workshop.

(6) Secretariat support and participation costs associated with the CCAMLR-IWC Workshop.

(7) 50% cost identified at SC-CAMLR-XXV, to be funded by the Scientific Committee for CCAMLR-IWC Workshop report editing, translation and publication.

(8) Support costs for a two-day scoping workshop in 2008 (subject to the availability of funds), and preliminary estimate of costs of preparation and support for a meeting of the ad hoc technical group in 2009. Costs in 2009 may include report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs for Secretariat staff.

(9) Participation costs for an invited expert at WG-EMM's Predator Survey Workshop in 2008, and preliminary estimate for invited experts at working group meetings in 2009.

(10) Estimated cost of producing a waterproof colour poster instructing crews to remove hooks from all landed fish and hauled baits. The poster would be A3-size, and translated into all CCAMLR languages, as well as Indonesian, Korean and Japanese.

(11) Estimated cost of producing waterproof templates designed to provide a fixed area to focus on and provide a colour reference guide for photographs taken to aid in the identification of recaptured fish tags.

(12) Participation costs for the Scientific Observer Data Analyst at the Sixth International Fisheries Observer Conference in 2009.

(13) Participation costs for the Data Manager at the IPY data analysis workshop in 2009.

11.2 The Scientific Committee recalled that the cost of the CCAMLR-IWC Workshop would be shared equally between CCAMLR and the IWC (SC-CAMLR-XXV, paragraphs 10.3 and 10.4). The costs identified in the Scientific Committee's budget (paragraphs 11.1(5) and (6) and Table 5) represent 50% of the total cost of the workshop. The Scientific Committee noted that, to the extent possible, the workshop Steering Committee will strive to reduce the overall cost of the workshop. In addition, the Scientific Committee encouraged Members to investigate alternative options for funding in order to reduce the costs incurred by the Scientific Committee.

11.3 The Scientific Committee agreed that the one-day workshop by ad hoc WG-IMAF in 2008, immediately prior to its meeting, may not require additional funding.

11.4 The Scientific Committee noted that the Special Science Fund currently holds deferred amounts for the independent external review of the GYM and part of the review of the *Scientific Observers Manual*. The Scientific Committee agreed to carry these funds forward.

11.5 The Scientific Committee endorsed the following expenditures under the Commission's budget for 2008:

- level funding of A$12 000 for language support for *CCAMLR Science*;

- electronic dissemination of *CCAMLR Science* via the CCAMLR website;

- translation (from Russian to English) of the Russian key to early life stages of Antarctic fish, which was published by VNIRO (approximately 16 pages in A5 format). This translation will be used by working groups to develop a comprehensive identification guide;

- translation (from one language to English), on a case-by-case basis, of key paper(s) submitted by French, Russian or Spanish-speaking scientists to working groups. It is estimated that approximately 10 pages of text may require translation each year;

- participation cost for the Chair of the Scientific Committee and the Science Officer at the 2008 meeting of CEP;

- participation cost for the Data Manager at the 2008 meeting of CWP.

11.6 The Scientific Committee recommended that the Commission also fund the following items:

- The start-up costs for the Secretariat-based coordination of the tagging program for rajids. These costs will cover the initial cost of purchasing 50 000 tags and tagging equipment for vessels fishing in 2007/08 and in future seasons. Tags and tagging equipment will be sold to Members on a cost-recovery basis.

- A special issue of *CCAMLR Science* in 2009, covering the findings of the joint CCAMLR-IWC Workshop, and a special issue in 2010 of the CCAMLR Species Profiles.

11.7 The Scientific Committee sought the advice of the Commission on how the annual work that will arise from addressing the UNGA resolution on bottom fishing can be accommodated in the already large workload of the Scientific Committee and its working groups.

11.8 The Scientific Committee acknowledged that the growing scientific requirements of the Commission and new international initiatives have led to an expansion of the work of the Committee and its working groups. The advice of the Commission was sought on how the Scientific Committee may meet its expanding scientific requirements and manage its activities in the long term.

ADVICE TO SCIC AND SCAF

12.1 The Chair presented the Scientific Committee's advice to SCIC and SCAF during the meeting. The advice to SCAF is summarised in Section 11. The advice to SCIC is summarised below, and the primary advice is provided elsewhere in this report.

Mitigation measures

12.2 The Scientific Committee noted that information analysed by ad hoc WG-IMAF indicated that Members had achieved 100% implementation of all mitigation measures in 2006/07, except for streamer line design and use, discard of offal and the discard of hooks in offal (Annex 6, paragraph I.18). As a result, the total extrapolated seabird mortality due to interactions with fishing gear in longline fishing for *Dissostichus* spp. in the Convention Area in 2006/07, with the exception of the French EEZs in Subarea 58.6 and Division 58.5.1, was estimated to be zero (Annex 6, paragraph I.2).

12.3 The Scientific Committee advised SCIC that the maintenance of zero, or near-zero, levels of incidental mortality of seabirds and marine mammals in CCAMLR fisheries was closely linked to the successful and complete implementation of mitigation measures in Conservation Measures 25-02, 25-03 and 26-01. The Scientific Committee advised that any erosion of the level of implementation of these measures was likely to result in increased mortality. Members were urged to remain vigilant and ensure that all mitigation measures are fully implemented at all times.

12.4 The Scientific Committee advised SCIC that some vessels in 2006/07 had not met the requirements with regard to the discharge of offal and the discard of hooks (Annex 6, paragraph I.18), the conduct of bottle tests (Annex 6, paragraph I.20) and the use of net sonde cables (Annex 6, paragraph I.25).

12.5 The Scientific Committee also advised that some vessels had discharged oil, gear debris and inorganic garbage during the course of fishing in 2006/07 (Annex 6, paragraph I.21).

Exploratory fisheries

12.6 The Scientific Committee noted that WG-FSA had advised that some vessels operating in exploratory fisheries in 2006/07 had not achieved full compliance with the fishery-based research requirements for deploying research sets and the tagging program (Conservation Measure 41-01, Annexes B and C). This was particularly noted in relation to some vessels fishing in Divisions 58.4.1 and 58.4.2 and Subarea 88.2 (Annex 5, paragraphs 3.42, 5.49, 5.50 and 5.98). The Scientific Committee advised that non-compliance with the fishery-based research requirements compromised WG-FSA's capability to develop assessments for exploratory fisheries.

12.7 A further possibility of non-compliance had been identified by WG-FSA which had noted large differences between the rates of recapture of tagged toothfish reported by vessels, and had sought advice from the Scientific Committee and Commission (Annex 5, paragraphs 3.57 and 5.49). The Scientific Committee noted that such differences may arise due to factors such as differential survival rates of tagged fish, vessel- or region-specific factors, and variations in tagging rates, tag-detection rates and reporting.

12.8 The Scientific Committee sought advice from SCIC on the type of information required from WG-FSA to allow SCIC to address the compliance issues identified above (Annex 5, paragraph 3.59).

12.9 The Scientific Committee also requested that the Secretariat provide each Member with information on the tag–recapture rates reported by each of its vessel(s), together with the mean and range of the rates reported across all fleets. In addition, the Secretariat was tasked with tabling the tag–recapture rates of individual vessels at the next meeting of WG-FSA.

12.10 The Scientific Committee reviewed the tagging requirements in exploratory fisheries, and agreed to remove the tagging limit of 500 fish (Conservation Measure 41-01, Annex C, paragraph 2(i)). The Scientific Committee agreed that vessels should be required to continue tagging *Dissostichus* spp. at the specified rate until they leave the fishery (Annex 5, paragraph 3.60). In addition, Members were urged to tag fish during the course of fishing, and in proportion to the species and sizes of *Dissostichus* spp. present in the catches.

12.11 The Scientific Committee also considered WG-FSA's proposal to increase the tagging rate for *Dissostichus* spp. in exploratory fisheries in Subarea 58.4 (Annex 5, paragraph 5.83), and agreed to increase the tagging rate to a minimum of three fish per tonne of green weight caught in the exploratory fisheries in Divisions 58.4.3a and 58.4.3b. This was in line with the requirements in Divisions 58.4.3a and 58.4.3b, and would assist WG-FSA in developing assessments in Subarea 58.4.

12.12 The Scientific Committee endorsed WG-FSA's proposal that the Secretariat coordinate the tagging program for rajids in new and exploratory fisheries, initially purchasing 50 000 tags for use in 2007/08 and with full implementation in 2008/09 during the Year of the Skate (Annex 5, paragraphs 3.51 and 6.36). This matter was considered under Agenda Item 4.

Fishery notifications

12.13 The Scientific Committee, WG-FSA and ad hoc WG-IMAF considered the scientific aspects of the notifications for exploratory longline fisheries in 2007/08 (summarised in Annex 5, Table 7). This matter was considered under Agenda Item 4.

12.14 The Scientific Committee and WG-EMM had reviewed the notifications for krill fisheries in 2007/08. The Scientific Committee noted a number of issues regarding the notifications:

(i) the large number of notifications from the Cook Islands;

(ii) for the first time, the total notified catch (684 000 tonnes) was greater than the trigger level in Area 48 (620 000 tonnes);

(iii) the increasing numbers of notifications for fishing using new fishing methods (continuous fishing system and pair trawling);

(iv) some notifications were incomplete on submission and/or revised after the deadline for submission;

(v) the varying quality of the notifications.

12.15 WG-EMM had requested the Secretariat to obtain further information on the notifications, and this has been reported in CCAMLR-XXVI/11 (Table 3).

12.16 In addition, the Scientific Committee noted that the actual reported catches in recent seasons were less than the amounts notified (CCAMLR-XXVI/11, Table 4).

12.17 The Scientific Committee sought the advice of SCIC on these matters.

Scheme of International Scientific Observation

12.18 The Scientific Committee agreed to establish an ad hoc technical group to address priority scientific aspects of the Scheme of International Scientific Observation, as well as other technical issues related to the at-sea implementation of conservation measures (Annex 5, paragraph 11.11). This matter was considered under Agenda Item 7.

12.19 The Scientific Committee and its working groups noted that the quality of observer data which had been provided continued to improve and thanked technical coordinators and observers for their efforts in the last year. However, the Scientific Committee noted that improvements could still be made in the reporting of observer data and encouraged technical coordinators and observers to continue to fully implement the specifications of the various observer protocols and report all required data (Annex 6, paragraph I.48).

12.20 The Scientific Committee noted that ad hoc WG-IMAF had expressed concern that the reported percentage of hooks observed fell below the recommended minimum of 20% on several vessels in 2006/07 (as low as 0%) and had recommended that clarification be sought from the Members which designated the international observers for these cruises (Annex 6, paragraph I.47). The Scientific Committee sought advice from SCIC on this matter.

12.21 Following consultation with its working groups, the Scientific Committee recommended a small number of changes to the observer data forms in order to improve the accuracy of the observations (Annex 5, paragraphs 6.49 to 6.51).

12.22 The Scientific Committee reiterated the need to collect standard scientific observations on krill fishing vessels (SC-CAMLR-XXV, paragraphs 11.13 to 11.16). The requirements for scientific observers have also been reviewed by WG-EMM (Annex 4, paragraphs 4.85 to 4.88) and WG-IMAF (Annex 6, paragraph II.120). Systematic scientific observer coverage of the krill fishery is required across all fishing methods so as to allow the Scientific Committee to develop advice on the fishery, including evaluation of by-catch and the efficacy of mitigation measures. The strategic objectives for scientific observations of the krill fishery were:

- to understand the overall behaviour and impact of the fishery
- to undertake routine monitoring of the fishery to inform population and ecosystem models.

12.23 This matter was further discussed under Agenda Item 3, and referred to SCIC for further consideration.

Research exemptions

12.24 The Scientific Committee considered a proposal that a research survey be conducted in Division 58.4.3b, and the results analysed by WG-FSA, prior to further fishing in the exploratory fishery for *Dissostichus* spp. in that division. This matter was further discussed under Agenda Item 9.

Advice on sharks

12.25 The Scientific Committee was unable to provide new advice on the extent of shark stocks in the Convention Area.

Advice on gillnetting

12.26 The Scientific Committee was unable to provide new advice on the interim prohibition of deep-sea gillnetting in the Convention Area. However, the Scientific Committee agreed that deep-sea gillnetting has significant negative consequences with respect to resources in the Convention Area (see also paragraph 8.6).

Bottom fishing in CCAMLR high-seas areas

12.27 The Scientific Committee and WG-FSA had developed a method to estimate the effective footprint of bottom fishing in CCAMLR high-seas areas (Annex 5, paragraphs 14.1 to 14.43). This matter was further discussed under Agenda Item 4, and referred to the Commission for further consideration.

Estimation of levels of IUU Fishing

12.28 The Scientific Committee agreed that the method for estimating the extent of IUU fishing currently used by the Secretariat could be further improved by the addition of a measure of the local density of licensed vessels. Such a measure would reflect the ability of licensed vessels to detect (i.e. sight) IUU fishing. WG-FSA had discussed various measures, including the number of days in a season when legal vessels are present in an area (Annex 5, paragraphs 8.1 and 8.2).

12.29 The Scientific Committee agreed that such measures would provide an estimate of the probability of detecting an IUU fishing event, and may indicate areas where such a probability was low. The Scientific Committee requested that the Secretariat consider including a measure of the local density of licensed vessels in the tables it prepared on IUU fishing (e.g. WG-FSA-07/10 Rev. 5, Table 1).

12.30 The Scientific Committee noted the Secretariat's development of a trial matrix for estimating the uncertainty associated with IUU fishing events.

SECRETARIAT SUPPORTED ACTIVITIES

Data Management

13.1 The Secretariat's Data Management Team performs three main functions:

- management of CCAMLR data;
- data and scientific analyses and reporting in support of the work of the Commission, Scientific Committee and their subsidiary bodies;
- monitoring of CCAMLR fisheries.

13.2 Functional control of Data Management rests with the Data Manager, except when this relates to specific activities associated with other Secretariat functions (e.g. management of scientific observer data within the context of compliance and enforcement as well as management of CDS and VMS data by that entity).

13.3 The Scientific Committee noted the Data Manager's report which outlined the work undertaken by the Data Management Team in 2006/07, and measures taken to maintain the integrity of CCAMLR data (SC-CAMLR-XXVI/BG/13). The Scientific Committee noted that the volume and complexity of this work continued to increase (SC-CAMLR-XXVI/BG/13, Figure 1), and had involved:

(i) database administration and maintenance, processing and validation of data submitted in 2006/07, revision of data forms in accordance with the decisions of the Commission and Scientific Committee, and the further development of database structures and routines;

(ii) data and scientific support of the Scientific Committee and working groups and SG-ASAM, initial validation of assessments involving CASAL, estimation of γ for krill in Division 58.4.2, and routine analysis and reporting;

(iii) monitoring of 152 catch limits in CCAMLR fisheries and forecasting of fishery closures, reporting of catches, updating of Fishery Reports, preparation of the *Statistical Bulletin*, and support in the submission and administration of fishery notifications (new and exploratory fisheries and krill fisheries);

(iv) support of international collaborations, including contributions to the work of CWP, FIRMS and SCAR-MarBIN.

13.4 The Scientific Committee noted the great importance of this support in its work, and thanked the Data Management Team for its high level of professionalism.

STATLANT Data

13.5 The Scientific Committee recalled that STATLANT catch and effort data are designed to capture Members' official monthly catch and effort statistics. These data provide important information, and are routinely used by working groups to weight (i.e. scale or adjust pro-rata) the haul-by-haul catch data to the Members' official catch statistics. In addition, international organisations such as FAO and Eurostat use CCAMLR's STATLANT data to compile regional and global fishery statistics.

13.6 In his report (SC-CAMLR-XXVI/BG/13), the Data Manager noted that in recent years, Members' approaches to submitting STATLANT data have diverged to some degree, and three main approaches have become common practice:

(i) some Members submit STATLANT data directly to the Secretariat;

(ii) some Members request that the Secretariat generates STATLANT data from other available catch data. Generated STATLANT data are usually derived from data submitted in five-day, 10-day or monthly catch and effort reports (TAC data) and occasionally fine-scale data. The generated STATLANT data are forwarded to Members to check, amend and re-submit as required;

(iii) some Members may not submit STATLANT data in some years. If correspondence from the Secretariat fails to obtain STATLANT data, then the Secretariat generates the missing STATLANT data from TAC data or fine-scale data.

13.7 In addition, the Data Manager noted that the quality of the STATLANT data is variable, and some datasets are incomplete with respect to species caught (notably by-catch species), areas fished or fishing effort.

13.8 The Scientific Committee noted that the diversity of the methods of submitting STATLANT data to CCAMLR, and the variability in the quality of these data, may compromise the estimations of total removals, with consequential impact on assessments and the formulation of management advice.

13.9 In order to improve the quality of STATLANT data, the Data Manager indicated (SC-CAMLR-XXVI/BG/13) that the Scientific Committee may wish to consider revising the way in which STATLANT data are submitted to CCAMLR, and consider implementing a three-step approach to the submission of these data. The timing of this approach would need to be linked with the use of STATLANT data in the preparation of CCAMLR's *Statistical Bulletin*. The *Statistical Bulletin* is published in March–April each year, and the proposed three-step approach was as follows:

Step 1 (completed in December each year) – the Secretariat generates preliminary STATLANT data based on the TAC data submitted by Members fishing in the Convention Area. These preliminary data would cover all species caught, and areas fished, as reported in the catch and effort reporting system.

Step 2 (completed by January) – the preliminary STATLANT data are sent to Members for validation, and for adjustments which may take account of additional information on verified landed weights and other statistics, and corrections to data collected at sea.

Step 3 (some Members only, completed by January) – fisheries in the French and South African EEZs in the Convention Area are not subject to the catch and effort reporting system. In the case of France, TAC data are not available and it would be necessary for France to continue submitting original STATLANT data by the January deadline (*status quo*). In the case of South Africa, TAC data are submitted regularly and it would be possible to complete Steps 1 and 2 above.

13.10 The Scientific Committee noted that discrepancies do arise between TAC data, haul-by-haul data and STATLANT data, and noted that most of these discrepancies may be attributed to the varying levels of detail and type of data recorded. It was recognised that the STATLANT data generated using TAC data may contain discrepancies, and that Step 2 above provided an opportunity for Members to check and revise their catch statistics.

13.11 The Scientific Committee endorsed this new, three-step approach to the submission of STATLANT data, and referred this matter to the Commission.

Catch and effort data

13.12 The Scientific Committee endorsed WG-FSA's recommendation to modify the longline haul-by-haul catch and effort data form (C2 data) to allow the recording of:

- number of hooks that are lost attached to sections of longline during fishing (Annex 5, paragraph 7.5);
- gear types other than Spanish and autoline systems (Annex 5, paragraph 6.56);
- exclusion devices used on board longliners (Annex 5, paragraph 10.6).

13.13 The Scientific Committee recalled that fishing vessels are now required to record a unique haul identifier in their C2 data, and scientific observers are required to record this identifier in their data (SC-CAMLR-XXIV, Annex 5, paragraph 5.35). This procedure was introduced in 2005/06 and allows C2 data to be matched with observer data. However, the Scientific Committee noted that C2 and observer data cannot be matched for fishing prior to 2005/06, due to the complexity and size of the datasets.

13.14 In 2006, the Scientific Committee and Commission requested that the Secretariat conduct a feasibility study on the administration and resources required for the use of VMS data to validate positions reported in observer data, including tagging data and fine-scale data (CCAMLR-XXV, paragraphs 4.72 and 4.73).

13.15 In the interim, the Secretariat had developed a routine to check the vessel positions reported in haul-by-haul catch and effort and observer biological and tagging data (Annex 5, paragraphs 3.1 and 3.5). The Scientific Committee re-emphasised the importance of position checking in these data, and sought advice from the Commission on the outcome of the feasibility study and the further development of the position-checking routine.

Metadata

13.16 The Scientific Committee noted that SCAR-MarBIN had requested that CCAMLR consider contributing metadata records to the SCAR-MarBIN database (SC-CAMLR-XXVI/BG/12). The Scientific Committee also noted the growing interest among other data users for the development of CCAMLR metadata.

13.17 The Scientific Committee noted that metadata are used to describe how and when and by whom a particular set of data was collected, and how the data are formatted (i.e. data about data). Metadata are essential for understanding information stored in large databases and have become increasingly important in web-based applications and the dissemination of information.

13.18 The Scientific Committee endorsed the Secretariat's proposal to develop metadata records for fishery and scientific datasets held in the CCAMLR database, noting that these metadata may be made publicly available, and that relevant metadata would be submitted to SCAR-MarBIN and, where appropriate, other international collaborators (e.g. FIRMS).

13.19 The Scientific Committee sought the advice of the Commission on this matter.

Rules for Access and Use of CCAMLR Data

13.20 The Scientific Committee did not provided any new advice on this matter.

Publications

13.21 The Scientific Committee noted that the following documents had been published in 2007 in support of its work:

(i) Report of the Twenty-fifth Meeting of the Scientific Committee
(ii) *CCAMLR Science*, Volume 14
(iii) *CCAMLR Scientific Abstracts 2006*, available on the CCAMLR website
(iv) *Statistical Bulletin*, Volume 19
(v) Revisions to the *Scientific Observers Manual*.

CCAMLR Science

13.22 The Scientific Committee agreed to the electronic dissemination of *CCAMLR Science* via the CCAMLR website, and language support for *CCAMLR Science* in 2008, and sought level funding from the Commission's budget (see paragraph 11.5).

13.23 The Scientific Committee also agreed to consider at its next meeting proposals for special issues of *CCAMLR Science*, including the publication of the results of the CCAMLR-IWC Workshop and the CCAMLR Species Profiles (see also paragraph 11.6).

13.24 During the course of recent meetings of the Editorial Board of *CCAMLR Science*, the Board had identified various options for improving and developing the procedure for selecting papers for consideration by the journal (SC-CAMLR-XXVI/BG/37). The Board's consideration of these matters had focused on:

- improving the procedure for selecting papers, including consideration of short notes and review papers;

- assessing the relevance of papers to the work of the Scientific Committee and the contribution to CCAMLR-related science;

- developing special issues of the journal focusing on topics of relevance to CCAMLR-related science;

- creating an electronic reference library to deposit material which is of interest to the work of the Scientific Committee but was not published in the journal.

13.25 The Scientific Committee tasked the Scientific Editor, in consultation with the Chair of the Scientific Committee and the conveners of working groups, to prepare a revision of the journal's publication policy, including the procedure for selecting papers. The revision would be considered by the Scientific Committee at its next meeting.

INTERSESSIONAL WORK

Coordination of the work of the Scientific Committee and its working groups

14.1 Following the establishment of WG-SAM in 2006, the Scientific Committee had agreed to establish a long-term science plan to set the priorities of WG-SAM, WG-EMM, WG-FSA, ad hoc WG-IMAF and its other groups including SG-ASAM (SC-CAMLR-XXV, paragraph 13.13).

14.2 The Scientific Committee agreed that the development of a long-term science plan and the setting of priorities will require lengthy and detailed consideration of the future work of the working groups.

14.3 As a first step, the Scientific Committee reviewed and endorsed the intersessional work plans of WG-EMM, WG-FSA, ad hoc WG-IMAF and SG-ASAM, and future work on bioregionalisation.

14.4 The Scientific Committee also endorsed the intersessional work plan of WG-SAM, noting that:

(i) WG-EMM had identified the following priority task for WG-SAM (Annex 4, paragraph 7.30(i)):

   (a) the development and provision of advice on Stage 1 of the subdivision of the Area 48 krill catch limit among SSMUs;

(ii) WG-FSA had identified the following priority tasks for WG-SAM (Annex 5, paragraphs 12.1(i) to (iv)):

   (a) undertake methodological work to design research programs for exploratory fisheries;

   (b) undertake evaluations of assessment methods and management strategies for assessed fisheries, including, as a priority, evaluations of management strategies for *C. gunnari*;

   (c) development of methods for estimating abundance and productivity of key by-catch species, notably rajids and macrourids;

(d) developing approaches to minimise the effects of changing gears or implementing by-catch mitigation measures in toothfish fisheries on assessments of CPUE and stock status, including the potential confounding of mitigation measures and whether or not depredation is occurring;

(iii) WG-IMAF had identified the following task for WG-SAM (Annex 6, paragraph I.8(ii)):

(a) review French analysis of petrel population responses to fisheries and environmental factors;

(iv) the Bioregionalisation Workshop had referred the following task to WG-SAM (Annex 9, paragraphs 140 and 141):

(a) review of the Boosted Regression Tree method (BRT);

(v) FEMA had referred the following task to WG-SAM (SC-CAMLR-XXVI/BG/6, paragraph 51):

(a) evaluate ecosystem/multi-species models considered at FEMA.

14.5 In addition, the Scientific Committee reviewed the future work on bottom fishing in the CCAMLR high-seas areas, recognising that the full development of the process will require further work in 2007/08 to meet the requirements of the UNGA resolution. Such work could include, *inter alia* (Annex 5, paragraph 14.40):

(i) development of rules and data collection requirements needed to trigger actions for different gears and situations during a season with respect to avoidance of potentially vulnerable areas and the gathering of data to assist in identifying VMEs;

(ii) identifying the method for specifying areas in which evidence of VMEs is detected in order that interim within-season protection could be established either for the vessel concerned or the fishing fleet;

(iii) developing an approach, including data requirements, for annual assessments of benthic interactions of bottom fishing and identification of Vulnerable and Potentially Vulnerable Areas;

(iv) consideration of the requirements for observations and reporting;

(v) consideration of the available management approaches to avoid and mitigate interactions with VMEs;

(vi) further consideration of the relationship between effective fishing footprint and geomorphological features;

(vii) a method for assessing the amount of seabed directly affected by the gears, such as through the use of cameras, where such methods could then be used to better evaluate the potential spatial extent of disturbance of VMEs at scales less than the resolution of the cell size used in evaluating the effective fishing footprint.

14.6 The Scientific Committee noted the deliberations of WG-FSA with respect to biennial assessments (Annex 5, paragraphs 12.9 to 12.14), and endorsed the management advice that assessments of long-term precautionary yield for *Dissostichus* spp. in the Ross Sea, Subarea 48.3 and Division 58.5.2 had been moderately stable in the last few years, and stocks were at or above target levels. The Scientific Committee therefore recommended that biennial assessments for these *Dissostichus* spp. fisheries were appropriate, unless any of the following factors (Annex 5, paragraph 12.12) occur during the intersessional period:

(i) new or refined methods of assessment become available and recommended by WG-SAM for use in the assessment;

(ii) parameters used in the assessment are revised significantly; or

(iii) a large IUU catch (unless this was anticipated in the assessment).

14.7 Other tasks identified by the Scientific Committee included:

(i) further development of the procedural steps to enable multi-year assessments in fisheries for *D. eleginoides* (referred to WG-FSA and WG-SAM);

(ii) further development of the requirements for scientific observers in krill fisheries, including consideration of fishery-based research requirements in exploratory krill fisheries (referred to WG-EMM and the ad hoc technical group);

(iii) development of methods for quantifying effort in krill fisheries, including consideration of new fishing methods, such as the continuous fishing system and pair trawling, and associated data requirements (referred to WG-EMM);

(iv) evaluation of the risk of incidental mortality arising from the use of the pair trawling method proposed in the notification for krill fishing from the Cook Islands (referred to ad hoc WG-IMAF);

(v) further development of the work on bioregionalisation, and in particular establishing a procedure for identifying areas for protection to further the conservation objectives of CCAMLR (2007 Workshop Term of Reference 3(vi); SC-CAMLR-XXIV, paragraph 3.66) (referred to WG-EMM);

(vi) development of the terms of reference for the next meeting of FEMA (referred to WG-EMM, WG-FSA and WG-SAM).

14.8 The Scientific Committee tasked the Chair of the Scientific Committee, conveners of working groups and the Secretariat with developing a list of achievable priority tasks for each working group, in consultation with Members, including consideration of other tasks identified in the reports of the working groups.

14.9 The Scientific Committee recognised the urgency of work in relation to bottom fishing, and sought advice from the Commission on this matter. Pending the outcome of this advice, the Scientific Committee encouraged its working groups to begin the work in 2007/08, and requested that discussions and outcomes from WG-SAM be considered by WG-EMM, and the findings of these two working groups be considered by WG-FSA and ad hoc WG-IMAF.

14.10 The Scientific Committee urged all Members to participate fully in its work in 2007/08, and to send experts to the meetings of all working groups. The work of the Scientific Committee is expanding and can only be achieved through contributions and active participation of Members.

14.11 The Scientific Committee also sought the advice of the Commission on how the Scientific Committee may meet its expanding scientific requirements and manage its activities in the long term (paragraph 11.8).

Intersessional activities in 2007/08

14.12 The Scientific Committee noted that a number of Members had made provisional offers to host the meetings of WG-SAM and WG-EMM, including TASO, over a three-week period from 14 July to 1 August 2008, however, an exact venue could not be decided at this meeting and it was agreed that this would be decided by correspondence during the intersessional period[1]. In the event that Members could not host the meetings, they would take place at the CCAMLR Headquarters.

14.13 The Scientific Committee agreed to the following meetings in 2007/08:

- WG-EMM Predator Survey Workshop in Hobart, Australia, 16 to 20 June 2008 (Convener – Dr Southwell);
- meeting of WG-SAM (paragraph 14.12) (Convener – Dr Constable);
- two-day scoping workshop of TASO, held in association with the meetings of WG-SAM and WG-EMM, to begin the work of the ad hoc technical group and identify the terms of reference and long-term work plan (Co-conveners – Dr Welsford and Mr Heinecken);
- meeting of WG-EMM (paragraph 14.12) (Convener – Dr Watters);
- meetings of WG-FSA and ad hoc WG-IMAF in Hobart, Australia, from 13 to 24 October 2008 (Convener WG-FSA – Dr Jones; Co-conveners WG-IMAF – Ms Rivera and Mr Smith). WG-IMAF will also hold a one-day workshop.

14.14 The next meeting of SG-ASAM is scheduled in 2009 (see paragraphs 2.21 and 2.22).

CCAMLR-IPY projects

14.15 The report on the planning meeting of the CCAMLR-IPY Steering Committee was considered in paragraphs 2.23 to 2.31. The Scientific Committee noted the CCAMLR-related surveys which will be conducted during IPY, and thanked Members for undertaking extensive research on the marine ecosystems in the Southern Ocean.

[1] The Chair of the Scientific Committee, on behalf of the Scientific Committee, accepted with great pleasure the invitation by the Russian Federation, made during the Commission meeting, to host the next meetings of WG-EMM, the ad hoc Technical Group for At-Sea Operations (TASO) and WG-SAM in Moscow in July 2008 (CCAMLR-XXVI, paragraph 4.91).

Joint CCAMLR-IWC Workshop

14.16 The Scientific Committee noted the progress and arrangements made in preparation for the CCAMLR-IWC Workshop (Annex 4, paragraphs 7.25 to 7.28; SC-CAMLR-XXVI/BG/5).

14.17 The terms of reference for the workshop (SC-CAMLR-XXIV, paragraph 13.47) are to:

1. Consider the types of information needed for models on the Antarctic marine ecosystem that could be developed for providing management advice.

2. Consider how the information could be used in modelling the Antarctic marine ecosystem, the quality of the information, and key gaps needing to be resolved before such information might be used in the development of those models.

3. Consider metadata, rather than reviewing individual datasets and undertaking analyses to summarise the data, where the metadata would comprise information on the estimates of abundance, population trends and parameters, their data sources and methods used to estimate them.

14.18 The Scientific Committee discussed the budget for the workshop, and noted that the majority of the funds would be expended on invited experts who would provide expertise in ecological and environmental matters, including cetaceans, seals, flying birds, penguins, fish, squid, krill, plankton and sea-ice.

14.19 The partial cost of the joint workshop was approved in the Scientific Committee's budget for 2008 (paragraph 11.1). The Scientific Committee noted that, to the extent possible, the workshop Steering Committee will strive to reduce the overall cost of the workshop. In addition, the Scientific Committee encouraged Members to investigate alternative options for funding in order to reduce the costs incurred by the Scientific Committee.

14.20 The workshop is scheduled for August 2008 at the CCAMLR Headquarters, Hobart, Australia.

Preparation for the Year of the Skate

14.21 The Scientific Committee endorsed WG-FSA's proposal to hold the Year of the Stake in 2008/09. WG-FSA had established a coordination group to plan and develop the requirements for the Year of the Skate (Annex 5, paragraph 13.4), and the Scientific Committee encouraged Members to participate in the preparatory work.

Invitation of observers to the next meeting

14.22 The Scientific Committee agreed that all observers invited to the 2007 meeting would be invited to participate in SC-CAMLR-XXVII.

Invitation of experts to the meetings of working groups

14.23 The Scientific Committee agreed to invite one expert to the WG-EMM Predator Survey Workshop, and noted the terms of reference for this expert. The Scientific Committee re-endorsed SCAR's participation in the workshop, and invited SCAR experts on the subject matter (paragraph 6.7).

Next meeting

14.24 The next meeting of the Scientific Committee is scheduled at the CCAMLR Headquarters in Hobart, Australia, from 27 to 31 October 2008.

ELECTION OF VICE-CHAIR OF THE SCIENTIFIC COMMITTEE

15.1 Dr Pshenichnov's term as Vice-Chair ended with this meeting and the Scientific Committee sought nominations for a new Vice-Chair. Dr Pshenichnov nominated Mr Iversen. The Scientific Committee unanimously elected Mr Iversen to the position for a term of two regular meetings (2008 and 2009). A very warm welcome was extended to the incoming Vice-Chair.

15.2 The Scientific Committee thanked Dr Pshenichnov for his significant contribution to its work.

OTHER BUSINESS

16.1 The Scientific Committee thanked Dr Hanchet for convening WG-FSA over the past four meetings (2004–2007). Dr Hanchet had led WG-FSA through an important transition phase during which the Working Group introduced integrated assessments, developed assessments in exploratory fisheries and established the foundation for multi-year assessments. The Scientific Committee acknowledged Dr Hanchet's leadership in this work.

16.2 The Scientific Committee welcomed Dr Jones as new Convener of WG-FSA, and Dr Constable as Convener of WG-SAM. Both conveners had led the development of the work of WG-SAM (formerly WG-FSA-SAM) and co-convened that Working Group in 2007.

16.3 The Scientific Committee thanked Dr Reid for convening WG-EMM in 2006 and 2007. Dr Reid had led WG-EMM through the initial stages of developing a management procedure for the krill fishery in Area 48, and his leadership and expertise were instrumental in the Working Group's achievements. The Scientific Committee congratulated Dr Reid on his appointment to the post of Science Officer in the Secretariat, and looked forward to further close collaboration.

16.4 The Scientific Committee welcomed Dr Watters as new Convener of WG-EMM.

16.5 The Scientific Committee congratulated two prominent committee members for achieving geographic fame. The US Board on Geographic Names has named Holt Inlet (a western arm of Lapayrère Bay, Anvers Island, in Palmer Archipelago) and Hewitt Bay (a rectangular bay 1 mile long between Biscoe Point and Access Point, Anvers Island, in Palmer Archipelago) in recognition of Dr Holt's and Dr Hewitt's distinguished achievements in Antarctic research.

16.6 The Scientific Committee conveyed its best wishes to the Science and Compliance Officer, Dr Sabourenkov, who is retiring in early 2008, after serving in the Secretariat for 24 years. Dr Sabourenkov joined the Secretariat in 1984 and has been closely involved in the work of the Scientific Committee and its working groups. The Scientific Committee thanked Dr Sabourenkov for his dedicated service and expert contributions to the work of CCAMLR.

ADOPTION OF THE REPORT

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

CLOSE OF THE MEETING

18.1 In closing the meeting, Dr Fanta thanked the conveners of working groups, coordinators of other groups and all participants for their dedicated work during the meeting and intersessional period, all Secretariat staff for their high level of support, and the interpreters for facilitating the plenary discussions. These collective contributions had resulted in a very successful and friendly meeting.

18.2 Dr Fanta, on behalf of the Scientific Committee presented Dr Hanchet, outgoing Convener of WG-FSA and Dr Reid, outgoing Convener WG-EMM, with small gifts in appreciation of their service to those working groups and the Scientific Committee. The Scientific Committee welcomed Drs Jones and Watters as the new conveners of WG-FSA and WG-EMM respectively (see also paragraphs 16.1 to 16.4).

18.3 The Scientific Committee presented Dr Sabourenkov, who is retiring from his position as Science and Compliance Officer in early 2008, with a small gift in recognition of his long and dedicated service to CCAMLR (see also paragraph 16.6). In thanking the Scientific Committee, Dr Sabourenkov reflected on his 24 years at the Secretariat. He had been honoured to work for CCAMLR and with so many distinguished collaborators. Dr Sabourenkov had enjoyed the satisfaction and challenges of his work which had included nurturing the close ties between the Commission and Scientific Committee.

18.4 Dr Fanta and the Scientific Committee also acknowledged the scientific achievements of Prof. J. Beddington (UK) and thanked him for his outstanding contribution to the work of the Scientific Committee and Commission. Prof. Beddington was moving away from CCAMLR to take up his new appointment as Chief Scientific Adviser to the UK Government. Dr Miller, on behalf of the Secretariat, presented Prof. Beddington with a small gift.

18.5 Prof. Beddington thanked the Scientific Committee for its good wishes. He recalled participating in the first meeting of the Scientific Committee, when he was appointed rapporteur for the entire report! CCAMLR had made great progress over the past 25 years, and he wished the Scientific Committee every success in its future work.

18.6 Dr Constable, on behalf on the Scientific Committee, thanked Dr Fanta for her leadership, great patience and ability to provide guidance across all of the issues considered during the meeting. The Scientific Committee was also pleased and thankful that Dr Fanta was able to come to Hobart, and looked forward to the next meeting.

18.7 The meeting was closed.

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Table 1: Catches (tonnes) of target species reported in 2006/07 (December 2006 to October 2007) (source: catch and effort reports unless indicated otherwise).

	Species	Country	Subarea or division															Total
			48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Icefish	*Champsocephalus gunnari*	Australia											1					1
		Chile			1 106													1 106
		EC – UK			1 589													1 589
		Korea, Republic of			1 245													1 245
	Total (icefish)		0	0	3 940	0	0	0	0	0	0	0	1	0	0	0	0	3 941
Toothfish	*Dissostichus eleginoides*	Australia											1 956					1 956
		Chile			345													345
		EC – Spain			369													369
		France*										3 438		333				3 771
		Japan					75			2	35							112
		Korea, Republic of			200		2		0							11		213
		Namibia							0		4							4
		New Zealand			393	48										1		442
		Norway																<1
		South Africa			341									24	101			466
		UK			1 656	6										0		1 663
		Uruguay			232			94			36					0		361
	Dissostichus mawsoni	Argentina														157	42	199
		EC – Spain						233		2	81							316
		Japan					24			0	75							99
		Korea, Republic of					4	271	58							453		786
		Namibia						23	65		20							108
		New Zealand				0										1 160		1 160
		Norway					7									151	109	267
		Russia														434	152	586
		South Africa														51		51
		UK														440	34	474
		Uruguay						24			2					239	9	274
	Total (toothfish)		0	0	3 535	54	113	645	124	4	253	3 438	1 956	357	101	3 096	347	14 023
Krill	*Euphausia superba*	EC – Poland	2 307	3 171	1 936													7 414
		Japan	1 608	15 220	7 473													24 301
		Korea, Republic of	11 636	14 341	7 112													33 088
		Norway	2 866	32 640	4 055													39 561
	Total (krill)		18 417	65 372	20 576	0	0	0	0	0	0	0	0	0	0	0	0	104 364

* Data reported by France for fishing to August 2007

Table 2: Summary of notifications for the krill fishery in Area 48 in the 2007/08 season.

Country Date of notification Vessel name	Expected catch (tonnes)	Months during which fishing will proceed												Subarea/division where fishing will occur						Products to be derived from catch (%)										
		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	Raw	Frozen	Boiled	Meat	Meal	Oil	Peeled	Fat	Chitin	Hydro-lysate	Other
Chile																														
(28-Jun-07)																														
Betanzos	1 000		x	x	x	x	x	x	x	x	x	x	x			x					80			10		10				
Cook Islands*																														
(21-Jun-07)																														
Antares	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Antares II	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Keil	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Marlin II	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
San Liberatore	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Sunnuberg	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Weisbaden	25 000	x	x	x	x	x					x	x	x	x	x	x	x	x	x					99.5	0.5					
Japan																														
(31-May-07)																														
Niitaka Maru	30 000		x	x	x	x	x	x	x	x	x			x	x	x				30		10		40		20				
Korea, Republic of																														
(28-Jun-07)																														
Dongsan Ho	48 000			x	x	x	x	x	x	x				ns	ns	ns	ns			95				5						
Kwang Ja Ho				x	x	x	x	x	x	x				ns	ns	ns	ns			95				5						
Insung Ho				x	x	x	x	x	x	x				ns	ns	ns	ns			95				5						
Norway																														
(15-Jun-07)																														
Saga Sea	80 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x					99	1					
Thorshovdi +	60 000–80 000						x	x	x	x	x	x	x	x	x	x		x	x					ns	ns			ns		
Juvel +	50 000						x	x	x	x	x	x	x	x	x	x													ns	

(continued)

Table 2 (continued)

Country Date of notification Vessel name	Expected catch (tonnes)	Months during which fishing will proceed												Subarea/division where fishing will occur						Products to be derived from catch (%)										
		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	Raw	Frozen	Boiled	Meat	Meal	Oil	Peeled	Fat	Chitin	Hydro-lysate	Other
Poland																														
(29-Jun-07)																														
Dalmor II	20 000		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				35	7.5	12.5	27.5	17.5					
Russia																														
(14-May-07)																														
Maksim Starostin	60 000						x	x	x	x	x	x	x	x	x	x								95			5			
(11-Jul-07)																														
Marshal Vasilevskii	75 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25			45	50						5
Kapitan Sukhondyayevskii		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	25			45	50						5
Ukraine																														
(27-Jun-07)																														
Konstruktor Koshkin	65 000			x	x	x	x							x	x	x					30		40	30						
Kurshskaya Kosa		x	x	x	x	x	x	x	x	x	x	x		x	x	x					30			50	20					
Vanuatu**																														
Frey, Frigg, Odin, Thor	80 000			x	x	x	x	x	x					x	x	x	x							94	6					
25 vessels	764 000	11	14	22	22	22	18	17	17	13	17	16	15	24	24	25	17	11	11											

ns Not specified
* Krill notification withdrawn, see COMM CIRC 07/133
** Krill notification withdrawn during CCAMLR-XXVI
\+ Will commence fishing May 2008

Table 3: Catches (tonnes) of target species reported in 2005/06 (December 2005 to November 2006) (source: STATLANT data).

	Species	Country	Subarea or division															Total
			48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Icefish	*Champsocephalus gunnari*	Australia											660					660
		Chile			1 187													1 187
		Korea, Republic of			646													646
		UK			336													336
		Uruguay														0		0
	Total (icefish)		0	0	2 169	0	0	0	0	0	0	0	660	0	0	0	0	2 829
Toothfish	*Dissostichus eleginoides*	Australia											2 528					2 528
		Chile			440													440
		EC – Spain			373				0	88	0							461
		France										5 156		775				5 931
		Japan					100											100
		Korea, Republic of			225													225
		New Zealand			382	12										1		395
		Russia														0		0
		South Africa			304									27	124			454
		UK			1 562	6												1 569
		Uruguay			249						44							293
	Dissostichus mawsoni	Argentina														147	65	213
		Australia											0					0
		Chile						44	26		2							73
		EC – Spain						221	11	1	311							543
		Japan					63											63
		Korea, Republic of						153	126									280
		New Zealand				0										1 345	57	1 403
		Norway														121	264	385
		Russia														674	33	707
		UK														314	94	407
		Uruguay						2			3					367		373
	Total (toothfish)		0	0	3 535	19	163	421	164	89	361	5 156	2 528	801	124	2 969	514	16 843
Krill	*Euphausia superba*	EC – Poland	5 496	129	788													6 413
		Japan	19 756		12 955													32 711
		Korea, Republic of	42 386	645														43 031
		Norway	8 360		868													9 228
		UK			2													2
		Ukraine	12 878	2 329														15 206
	Total (krill)		88 876	3 103	14 613	0	0	0	0	0	0	0	0	0	0	0	0	106 591

Table 4: Indication of which gears have been used in statistical subareas, divisions and SSRUs in bottom fishing activities in high-seas areas over the last five years. No trawls or pots have been used in these areas. Longlining is indicated with an L. No fishing is indicated by '-'.

Subarea/division	SSRU	Fishing gears
48.1		-
48.2		-
48.5		-
48.6	A	L
	B	-
	C	-
	D	L
	E	L
	F	-
58.4.1	A	-
	B	-
	C	L
	D	-
	E	L
	F	-
	G	L
	H	-
58.4.2	A	L
	B	-
	C	L
	D	L
	E	L
58.4.3a		L
58.4.3b		L
58.4.4a		-
58.4.4b		-
88.1	A	-
	B	L
	C	L
	D	-
	E	L
	F	-
	G	L
	H	L
	I	L
	J	L
	K	L
	L	L
88.2	A	L
	B	L
	C	L
	D	L
	E	L
	F	L
	G	L
88.3		-

Table 5: Scientific Committee budget for 2008 and forecast budget for 2009.

2007 Budget A$	Item	2008 Budget A$	2009 Forecast A$	Notes*
	Working Group on Stock Assessment Methods (WG-SAM)			(1)
3 800	Secretariat support and participation costs	6 000	6 000	
20 000	Report completion and translation	20 000	22 400	
23 800		26 000	28 400	
	Working Group on Ecosystem Monitoring and Management (WG-EMM)			(2)
68 100	Secretariat support and participation costs	82 300	82 300	
38 500	Report completion and translation	40 000	44 800	
106 600		122 300	127 100	
	Working Group on Fish Stock Assessment (WG-FSA)			(3)
5 500	Computing facilities	5 700	6 000	
30 000	Secretarial support	31 000	32 900	
80 400	Report completion and translation	83 600	88 600	
115 900		120 300	127 500	
	SubGroup on Acoustic survey and Analysis Methods (SG-ASAM)			(4)
6 000	Secretariat support and participation costs	0	6 000	
7 500	Report completion and translation	0	8 400	
13 500		0	14 400	
	CCAMLR-IWC Workshop			
10 000	Workshop organisation and invited experts	88 500	0	(5)
	Secretariat support and participation costs	12 000	0	(6)
	Report completion and translation	20 000	0	(7)
10 000		120 500	0	
	Meeting of the ad hoc Technical Group			(8)
	Secretariat support and participation costs	(7 000)**	34 000	
	Report completion and translation	0	20 000	
26 000		(7 000)	54 000	
	Other Expenses for Scientific Committee Program			
12 500	External experts invited to meetings	6 000	13 000	(9)
	Seabird poster	5 000		(10)
	Photographic template	1 500		(11)
12 500	International Fishery Observer Conference	0	7 000	(12)
2 000	International Polar Year	0	6 000	(13)
1 200	**Contingency**	1 200	1 200	
311 500		402 800	378 600	

* The notes refer to the items described in paragraph 11.1.
** Subject to the availability of funds.

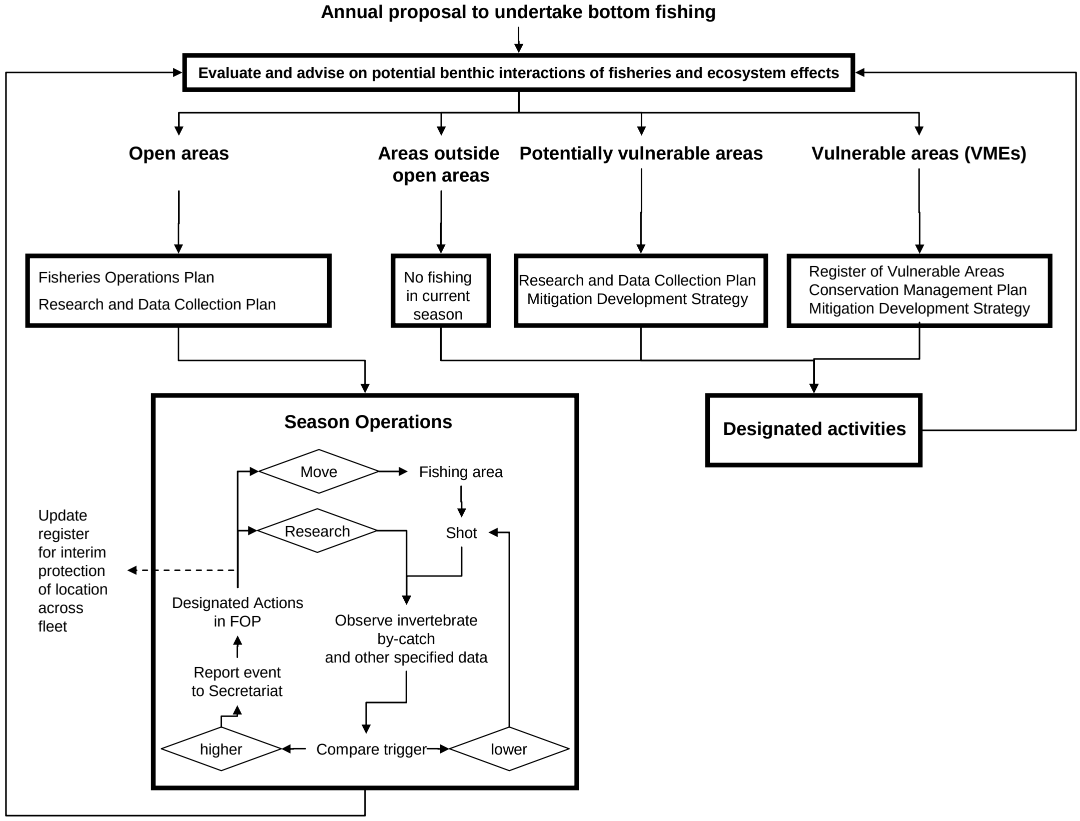

Figure 1: Framework, which is based on existing practices and procedures, for indicating what scientific and data collection activities might be required at different stages of the process of managing bottom fishing (elements described in Annex 5, paragraphs 14.26 to 14.39).

ANNEX 1

LIST OF PARTICIPANTS

LIST OF PARTICIPANTS

CHAIR,
SCIENTIFIC COMMITTEE

Dr Edith Fanta
Departamento de Biologia Celular
Universidade Federal do Paraná
Curitiba, PR Brazil
e.fanta@terra.com.br

ARGENTINA

Representative:

Dr. Enrique Marschoff
Instituto Antártico Argentino
Ministerio de Relaciones Exteriores,
Comercio Internacional y Culto
Buenos Aires
marschoff@dna.gov.ar

Alternate Representatives:

Dr. Esteban Barrera-Oro
Dirección Nacional del Antártico
Ministerio de Relaciones Exteriores,
Comercio Internacional y Culto
Buenos Aires
ebarreraoro@dna.gov.ar

Sr. Ariel R. Mansi
Director General de Asuntos Antárticos
Ministerio de Relaciones Exteriores,
Comercio Internacional y Culto
Buenos Aires
rpc@mrecic.gov.ar

Dra. Viviana Andrea Alder
Instituto Antártico Argentino
Ministerio de Relaciones Exteriores,
Comercio Internacional y Culto
Buenos Aires
viviana_alder@dna.gov.ar

Adviser:

Sra. Paola Gucioni
Dirección Nacional de Coordinación Pesquera
Ministerio de Economía y Producción
Buenos Aires
pgucio@mecon.gov.ar

AUSTRALIA

Representative: Dr Andrew Constable
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
andrew.constable@aad.gov.au

Alternate Representatives: Mr Ian Hay
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
ian.hay@aad.gov.au

Dr So Kawaguchi
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
so.kawaguchi@aad.gov.au

Dr Keith Martin-Smith
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
keith.martin-smith@aad.gov.au

Dr Stephen Nicol
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
steve.nicol@aad.gov.au

Dr Anthony Press
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
tony.press@aad.gov.au

Dr Dirk Welsford
Australian Antarctic Division
Department of the Environment
and Water Resources
Tasmania
dirk.welsford@aad.gov.au

Advisers: Mrs Rhonda Bartley
Australian Antarctic Division
Department of the Environment
and Water Resources
rhonda.bartley@aad.gov.au

Ms Deborah Bourke
Australian Antarctic Division
Department of the Environment
and Water Resources
Tasmania
deborah.bourke@aad.gov.au

Dr Susan Doust
Australian Antarctic Division
Department of the Environment
and Water Resources
Tasmania
susan.doust@aad.gov.au

Mr Alistair Graham
Representative of Conservation Organisations
Tasmania
alistairgraham1@bigpond.com

Dr Steve Kennelly
Representative of State and Territory Government
New South Wales
steve.kennelly@dpi.nsw.gov.au

Mr Peter Neave
Australian Fisheries Management Authority
Canberra
peter.neave@afma.gov.au

Dr Katrina Phillips
Bureau of Rural Sciences
Department of Agriculture, Fisheries and Forestry
Canberra
katrina.phillips@brs.gov.au

Dr Graham Robertson
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
graham.robertson@aad.gov.au

Mr Les Scott
Representative of Australian Fishing Industry
Tasmania
rls@petunasealord.com

Ms Gillian Slocum
Australian Antarctic Division
Department of the Environment and Water Resources
Tasmania
gill.slocum@aad.gov.au

BELGIUM

Representative:

Mr Daan Delbare
Institute for Agriculture and Fisheries Research
Oostende
daan.delbare@dvz.be

CHILE

Representative:

Prof. Carlos Moreno
Instituto de Ecología y Evolución
Universidad Austral de Chile
Valdivia
cmoreno@uach.cl

Advisers:

Ms Elsa Cabrera
Centro de Conservación Cetácea
Santiago
info@ccc-chile.org

Sra. Valeria Carvajal
Undersecretariat for Fisheries
Valparaíso
vco@subpesca.cl

Sr. Rubén Darío Rojas Todorovich
Armada de Chile
Dirección General del Territorio Marítimo
y de Marítima Mercante
Valparaíso
rrojast@directemar.cl

CHINA

Representative:	Mr Zongyu He Chinese Arctic and Antarctic Administration Beijing hezongyu@chinare.gov.cn
Advisers:	Dr Jiang Zhao Division of Distant Water Fisheries Bureau of Fisheries Ministry of Agriculture Beijing bofdwf@agri.gov.cn
	Ms Lei Zhao Department of Treaty and Law Ministry of Foreign Affairs Beijing zhao_lei@mfa.gov.cn
	Mr Xianyong Zhao Yellow Sea Fisheries Research Institute Chinese Academy of Fishery Sciences Qingdao zhaoxy@ysfri.ac.cn

EUROPEAN COMMUNITY

Representative:	Dr Volker Siegel Sea Fisheries Research Institute Hamburg, Germany volker.siegel@ish.bfa-fisch.de

FRANCE

Representative:	Prof. Guy Duhamel Muséum National d'Histoire Naturelle Paris duhamel@mnhn.fr
Alternate Representative:	M. Ludovic Schultz Ministère de l'Agriculture et de la Pêche Paris ludovic.schultz@agriculture.gouv.fr
Advisers:	Mme Caroline Krajka Ministère des Affaires étrangères et européennes Paris caroline.krajka@diplomatie.gouv.fr
	M. Eric Pilloton Administrateur des Terres australes et antarctiques françaises La Réunion eric.pilloton@taaf.fr
	M. Emmanuel Reuillard Chargé de mission auprès de l'administrateur supérieur des Terres Australes et Antarctiques Françaises Saint Pierre de la Réunion emmanuel.reuillard@taaf.fr

GERMANY

Representative:	Dr Karl-Hermann Kock Federal Research Centre for Fisheries Institute of Sea Fisheries Hamburg karl-hermann.kock@vti.bund.de
Alternate Representative:	Dr Hermann Pott Federal Ministry of Food, Agriculture and Consumer Protection Bonn hermann.pott@bmvel.bund.de

INDIA

Representative:	Mr Arun Kumar Rath Ministry of Earth Sciences New Delhi ak.rath@nic.in
Alternate Representative:	Dr V.N. Sanjeevan Centre for Marine Living Resources and Ecology Ministry of Earth Sciences Kochi sagarsampada@vsnl.net

ITALY

Representative:	Dr Marino Vacchi Museo Nazionale Antartide Università degli Studi di Genova Genoa m.vacchi@unige.it
Alternate Representative:	Dr Sandro Torcini Consorzio Antartide (ENEA) Rome sandro.torcini@casaccia.enea.it
Adviser:	Ms Francesca De Crescenzo Ministry of the Environment Rome decrescenzo.francesca@minambiente.it

JAPAN

Representative:	Dr Mikio Naganobu National Research Institute of Far Seas Fisheries Yokohama, Kanagawa naganobu@affrc.go.jp
Alternate Representative:	Mr Shuya Nakatsuka Fisheries Agency Ministry of Agriculture, Forestry and Fisheries Tokyo shuya_nakatsuka@nm.maff.go.jp

Advisers:	Mr Kiyoshi Katsuyama International Affairs Division Japan Fisheries Agency Tokyo
	Mr Naohisa Miyagawa Fishing Industry Representative Tokyo kani@tafco.maruha.co.jp
	Mr Noriaki Takagi Japan Deep Sea Trawlers Association Tokyo ntakagi@jdsta.or.jp
	Dr Kentaro Watanabe National Institute of Polar Research Tokyo kentaro@nipr.ac.jp

KOREA, REPUBLIC OF

Representative:	Dr Doonam Kim National Fisheries Research and Development Institute Busan dnkim@nfrdi.re.kr
Alternate Representative:	Dr Hyoung-Chul Shin Korea Polar Research Institute Seoul hcshin@kopri.re.kr
Adviser:	Mr Jong Sung Kim Ministry of Maritime Affairs and Fisheries Seoul kj0606@momaf.go.kr

NAMIBIA

Representative:	Mr Titus Iilende Ministry of Fisheries and Marine Resources Windhoek tiilende@mfmr.gov.na

Adviser:	Mr James Van Zyl Industry Representative Walvis Bay nmp@mweb.com.na

NEW ZEALAND

Representative:	Dr Kevin Sullivan Ministry of Fisheries Wellington kevin.sullivan@fish.govt.nz
Alternate Representatives:	Dr Stuart Hanchet National Institute of Water and Atmospheric Research (NIWA) Nelson s.hanchet@niwa.co.nz
	Mr Neville Smith Ministry of Fisheries Wellington neville.smith@fish.govt.nz
Advisers:	Mr Jack Fenaughty Silvifish Resources Ltd Wellington jmfenaughty@clear.net.nz
	Dr Neil Gilbert Antarctica New Zealand Christchurch n.gilbert@antarcticanz.govt.nz
	Ms Suzannah Jessep Ministry of Foreign Affairs and Trade Wellington suzannah.jessep@mfat.govt.nz
	Dr Johanna Pierre Department of Conservation Wellington jpierre@doc.govt.nz
	Ms Alice Revell Ministry of Foreign Affairs and Trade Wellington alice.revell@mfat.govt.nz

Mr Barry Weeber
EcoWatch
Wellington
ecowatch@paradise.net.nz

NORWAY

Representative:	Mr Svein Iversen Institute of Marine Research Bergen sveini@imr.no
Alternate Representative:	Dr Kit Kovacs Norwegian Polar Institute Tromsø kit@npolar.no
Adviser:	Mr Terje Løbach Directorate of Fisheries Bergen terje.lobach@fiskeridir.no

RUSSIAN FEDERATION

Representative:	Dr Konstantin Shust VNIRO Moscow antarctica@vniro.ru
Advisers:	Mr Nikolay Androsov JSC Murmansk Trawl Fleet Murmansk androsov@mtf.ru
	Dr Viacheslav A. Bizikov VNIRO Moscow bizikov@vniro.ru
	Mr Andrei Makavchik OOO Albatros Moscow makavchik@yahoo.com

SOUTH AFRICA

Representative:	Dr Robin Leslie Marine and Coastal Management Department of Environmental Affairs and Tourism Cape Town rwleslie@deat.gov.za
Alternate Representative:	Ms Theressa Frantz Marine and Coastal Management Department of Environmental Affairs and Tourism Cape Town takkers@deat.gov.za
Advisers:	Mr Daniel Bailey Fishing Industry Representative Cape Town dbailey@iafrica.com
	Mr Christopher Heinecken Capfish Cape Town chris@capfish.co.za
	Dr Deon Nel WWF–South Africa Stellenbosch dnel@wwwf.org.za
	Mr Barry Watkins BirdLife South Africa FitzPatrick Institute University of Cape Town seabirds@birdlife.org.za

SPAIN

Representative:	Mr Luis López Abellán Instituto Español de Oceanografía Centro Oceanográfico de Canarias Santa Cruz de Tenerife luis.lopez@ca.ieo.es
Adviser:	Ms Adriana Fabra Barcelona, Spain afabra@yahoo.es

SWEDEN

Representative:	Prof. Bo Fernholm Swedish Museum of Natural History Stockholm bo.fernholm@nrm.se
Alternate Representative:	Ambassador Greger Widgren Ministry for Foreign Affairs Stockholm gregor.widgren@foreign.ministry.se

UKRAINE

Representative:	Mr Leonid Pshenichnov YugNIRO Kerch lkp@bikent.net
Advisers:	Dr Volodymyr Herasymchuk Department for Fisheries of Ukraine Ministry of Agricultural Policy of Ukraine Kiev nauka@i.kiev.ua
	Mr Viktor Kazimirchuk Deputy Chair State Committee for Fisheries of Ukraine Kiev
	Dr Gennadi Milinevsky Head of Space Physics Department National Taras Shevchenko University of Kiev Kiev genmilinevsky@gmail.com

UNITED KINGDOM

Representative:	Dr David Agnew Renewable Resources Assessment Group Imperial College London d.agnew@imperial.ac.uk

Alternate Representatives: Prof. John Beddington
Department of Environmental Science
and Technology
Imperial College
London
j.beddington@ic.ac.uk

Dr Graeme Parkes
Marine Resources Assessment Group Ltd
London
g.parkes@mrag.co.uk

Dr Philip Trathan
British Antarctic Survey
Cambridge
p.trathan@bas.ac.uk

Advisers: Dr Martin Collins
British Antarctic Survey
Cambridge
macol@bas.ac.uk

Dr Susie Grant
British Antarctic Survey
Cambridge
suan@bas.ac.uk

Ms Harriet Hall
C/- Foreign and Commonwealth Office
London
harriet.hall@fco.gov.uk

Ms Indrani Lutchman
Institute for European Environmental Policy
London
ilutchman@ieeplondon.org.uk

Dr Keith Reid
British Antarctic Survey
Cambridge
k.reid@bas.ac.uk

UNITED STATES OF AMERICA

Representative:	Dr Rennie Holt Southwest Fisheries Science Center National Marine Fisheries Service La Jolla, California rennie.holt@noaa.gov
Alternate Representative:	Dr Christopher Jones Southwest Fisheries Science Centre National Marine Fisheries Service La Jolla, California chris.d.jones@noaa.gov
Advisers:	Dr Gustavo Bisbal Bureau of Oceans and International Environmental and Scientific Affairs US Department of State Washington, DC bisbalga@state.gov
	Mr Robert Gorrell National Marine Fisheries Service National Oceanic and Atmospheric Administration Silver Spring, Maryland robert.gorrell@noaa.gov
	Ms Nicole LeBoeuf Office of International Affairs NOAA Fisheries Silver Spring, Maryland nicole.leboeuf@noaa.gov
	Ms Kim Rivera Alaska Region National Marine Fisheries Service Juneau, Alaska kim.rivera@noaa.gov
	Mr Frank Sprtel Office of General Counsel for Fisheries National Oceanic and Atmospheric Administration Silver Spring, Maryland frank.sprtel@noaa.gov

Mr Mark Stevens
WWF-United States
Washington, DC
mark.stevens@wwfus.org

Ms Pamela Toschik
Department of Commerce
National Oceanic and Atmospheric Administration
Washington, DC
pamela.toschik@noaa.gov

URUGUAY

Representative:	Prof. Oscar Pin Dirección Nacional de Recursos Acuáticos Montevideo opin@dinara.gub.uy
Alternate Representative:	Sr. Alberto T. Lozano Comisión Interministerial CCRVMA – Uruguay Ministerio de Relaciones Exteriores Montevideo comcruma@mrree.gub.uy

OBSERVERS – ACCEDING STATES

COOK ISLANDS	Mr Garth Broadhead Maritime Cook Islands Ltd Rarotonga garth@maritimecookislands.com
NETHERLANDS	Mr Jan Groeneveld Special Adviser to the Director for Fisheries Ministry of Agriculture, Nature and Food Quality Remagen, Germany groeneveld1938@hotmail.com

OBSERVERS – INTERNATIONAL ORGANISATIONS

ACAP	Mr Barry Baker ACAP Interim Secretariat Tasmania, Australia barry.baker@latitude42.com.au

	Mr Warren Papworth ACAP Interim Secretariat Tasmania, Australia warren.papworth@acap.aq
CEP	Dr Neil Gilbert Antarctica New Zealand Christchurch n.gilbert@antarcticanz.govt.nz
FFA	Mr Steve Shanks Forum Fisheries Agency Honiara, Solomon Islands steve.shanks@ffa.int
IUCN	Ms Imèn Meliane IUCN Regional Office for Mesoamerica Moravia, Costa Rica imene.meliane@iucn.org
IWC	Prof. Bo Fernholm Swedish Museum of Natural History Stockholm, Sweden bo.fernholm@nrm.se
	Dr Karl-Hermann Kock Federal Research Centre for Fisheries Institute of Sea Fisheries Hamburg, Germany karl-hermann.kock@vti.bund.de
SCAR	Dr Graham Hosie Australian Antarctic Division Department of the Environment and Water Resources Tasmania, Australia graham.hosie@aad.gov.au

OBSERVERS – NON-GOVERNMENTAL ORGANISATIONS

ASOC	Ms Virginia Gascón Río Negro, Argentina virginia.antarctica@gmail.com
	Dr Lyn Goldsworthy Gordon, Australia lyn.goldsworthy@ozemail.com.au

Ms Nina Jensen
WWF-Norway
Oslo, Norway
njensen@wwf.no

Ms Constance Johnson
WWF–Australia
Brisbane, Australia
cjohnson@wwf.org.au

Mr Richard Page
Greenpeace
London, UK
richard.page@uk.greenpeace.org

Dr Rodolfo Werner
Antarctic and Southern Ocean Coalition
Bariloche, Argentina
rodolfo.antarctica@gmail.com

COLTO	Mr Martin Exel Austral Fisheries Pty Ltd Western Australia mexel@newfish.com.au
	Mr Andy Smith Talleys Fisheries Ltd Nelson, New Zealand andy@latsouth.co.nz

OBSERVERS – NON-CONTRACTING PARTIES

CAMBODIA	Mr Ear Se Royal Embassy of Cambodia Canberra, Australia cambodianembassy@ozemail.com.au
MOZAMBIQUE	Mr Augusto Nhampule Ministry of Fisheries Maputo anhampule@mozpesca.gov.mz

SECRETARIAT

Executive Secretary	Denzil Miller
General Office Administrator	Rita Mendelson
Conference Facilitator	Robyn Miller
Science/Compliance and Enforcement	
Science/Compliance Officer	Eugene Sabourenkov
Scientific Observer Data Analyst	Eric Appleyard
Compliance Administrator	Natasha Slicer
VMS-CDS Support Officer	Ingrid Karpinskyj
Analytical Support Officer	Jacquelyn Turner
AFMA Intern	Bella Burgess-Wilson
Data Management	
Data Manager	David Ramm
Data Administration Officer	Lydia Millar
Database Administrator/Programmer	Simon Morgan
Administration/Finance	
Administration/Finance Officer	Ed Kremzer
Finance Assistant	Christina Macha
Communications	
Communications Officer	Genevieve Tanner
Publications and Website Assistant	Doro Forck
French Translator/Team Coordinator	Gillian von Bertouch
French Translator	Bénédicte Graham
French Translator	Floride Pavlovic
French Translator	Michèle Roger
Russian Translator/Team Coordinator	Natalia Sokolova
Russian Translator	Ludmila Thornett
Russian Translator	Vasily Smirnov
Spanish Translator/Team Coordinator	Anamaría Merino
Spanish Translator	Margarita Fernández
Spanish Translator	Marcia Fernández
Website and Information Services	
Website and Information Services Officer	Rosalie Marazas
Information Services Assistant	Philippa McCulloch
Information Technology	
Information Technology Manager	Fernando Cariaga
Information Technology Support Specialist	Tim Byrne
Interpreters	
Ms Joëlle Coussaert	Dr Ludmila Stern
Mr Vadim Doubine	Mr Philippe Tanguy
Ms Roslyn Lacey	Ms Irene Ulman
Ms Isabel Lira	Dr Emy Watt
Mr J.C. Lloyd-Southwell	

ANNEX 2

LIST OF DOCUMENTS

LIST OF DOCUMENTS

SC-CAMLR-XXVI/1	Provisional Agenda for the Twenty-sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXVI/2	Provisional Annotated Agenda for the Twenty-sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXVI/3	Report of the Working Group on Ecosystem Monitoring and Management (Christchurch, New Zealand, 17 to 26 July 2007)
SC-CAMLR-XXVI/4	Report of the Working Group on Fish Stock Assessment (Hobart, Australia, 8 to 19 October 2007)
SC-CAMLR-XXVI/4 CORRIGENDUM	Report of WG-FSA, Appendix L Fishery Report: *Dissostichus eleginoides* Heard Island (Division 58.5.2)
SC-CAMLR-XXVI/5	Report of the Working Group on Statistics, Assessments and Modelling (Christchurch, New Zealand, 9 to 13 July 2007)
SC-CAMLR-XXVI/6	Comments on the Scientific Committee’s recommendations regarding bird mortality Delegation of France
SC-CAMLR-XXVI/7	Biomass of krill in Division 58.4.2 and an estimation of precautionary yield, including a subdivision of the precautionary catch limit along the 55ºE longitude Delegation of Australia
SC-CAMLR-XXVI/8	A proposal to revise the limitation of *Macrourus* by-catch in new and exploratory fisheries Delegation of Japan
SC-CAMLR-XXVI/9	Notification for research vessel activity in Divisions 58.4.4a and 58.4.4b Delegation of Japan
SC-CAMLR-XXVI/10	Bottom fishing in high-seas areas of CCAMLR Delegations of Australia and the USA
SC-CAMLR-XXVI/11	Workshop on Bioregionalisation of the Southern Ocean (Brussels, Belgium, 13 to 17 August 2007)

SC-CAMLR-XXVI/12	Ad hoc Working Group on Incidental Mortality Associated with Fishing (Hobart, Australia, 8 to 12 October 2007)

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SC-CAMLR-XXVI/BG/1	Catches in the Convention Area in the 2005/06 and 2006/07 seasons Secretariat
SC-CAMLR-XXVI/BG/2	Report of the Third Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Cambridge, UK, 30 April to 2 May 2007)
SC-CAMLR-XXVI/BG/3	Report of the Planning Meeting of the CCAMLR-IPY Steering Committee (Cambridge, UK, 2 to 4 May 2007)
SC-CAMLR-XXVI/BG/4	Observer's Report from the 59th Meeting of the Scientific Committee of the International Whaling Commission (Anchorage, Alaska, USA, 7 to 18 May 2007) CCAMLR Observer (K.-H. Kock, Germany)
SC-CAMLR-XXVI/BG/5	CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models: update on progress since 2006 Co-conveners, CCAMLR-IWC Workshop
SC-CAMLR-XXVI/BG/6	Report of the Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA) (Christchurch, New Zealand, 16 July 2007)
SC-CAMLR-XXVI/BG/7	Report on the twenty-second session of the Coordinating Working Party on Fisheries Statistics (CWP) Secretariat
SC-CAMLR-XXVI/BG/8	Summary of scientific observation programs undertaken during the 2006/07 season Secretariat
SC-CAMLR-XXVI/BG/9 Rev. 1	A review of national observer training and education programs (Scheme of International Scientific Observation) Secretariat
SC-CAMLR-XXVI/BG/10	Review of CCAMLR activities on monitoring marine debris in the Convention Area Secretariat

SC-CAMLR-XXVI/BG/11	Report on the 5th International Fisheries Observer Conference (Victoria, BC, Canada, 14 to 18 May 2007) Secretariat
SC-CAMLR-XXVI/BG/12	Report on the meeting of the International Steering Committee of the SCAR Marine Biodiversity Information Network (SCAR-MarBIN) Secretariat
SC-CAMLR-XXVI/BG/13	Data management report on activities 2006/07 Secretariat
SC-CAMLR-XXVI/BG/14	Synopses of papers submitted to WG-EMM-07 Secretariat
SC-CAMLR-XXVI/BG/15	Report of the Convener of WG-EMM-07 to SC-CAMLR-XXVI
SC-CAMLR-XXVI/BG/16	Beach debris survey – Main Bay, Bird Island, South Georgia, 2005/06 Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/17	Entanglement of Antarctic fur seals (*Arctocephalus gazella*) in man made debris at Bird Island, South Georgia, during the 2006 winter and 2006/07 breeding season Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/18	Fishing equipment, marine debris and hydrocarbon soiling associated with seabirds at Bird Island, South Georgia, 2006/07 Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/19	Beach debris survey, Signy Island, South Orkney Islands, 2006/07 Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/20	Entanglement of Antarctic fur seals (*Arctocephalus gazella*) in man-made debris at Signy Island, South Orkney Islands, 2006/07 Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/21	Note sur l'étude des effets environnementaux, spatiaux, temporels et opérationnels sur la mortalité accidentelle des oiseaux dans la pêcherie à la palangre dans les secteurs de Crozet et Kerguelen en 2003–2006 Délégation française

SC-CAMLR-XXVI/BG/22	Note sur l'étude d'évaluation de l'impact des pêcheries sur les populations de pétrels à menton blanc *Procellaria aequinoctialis* et de pétrels gris *Procellaria cinerea* aux îles Crozet et Kerguelen Délégation française
SC-CAMLR-XXVI/BG/23	Vacant
SC-CAMLR-XXVI/BG/24	Criteria for the Selection of Marine Protected Areas (MPAs) Delegation of the United Kingdom
SC-CAMLR-XXVI/BG/25 Rev. 1	Data on feeding and food objects of southern minke whales Delegation of Ukraine
SC-CAMLR-XXVI/BG/26	New page in the Antarctic krill fishing (Translation from *The Fishing Industry of Ukraine,* 1–2/2007: 11–14) Delegation of Ukraine
SC-CAMLR-XXVI/BG/27	Antarctic seafloor geomorphology as a guide to benthic bioregionalisation Delegation of Australia
SC-CAMLR-XXVI/BG/28	CCAMLR Bioregionalisation Workshop (Brussels, Belgium 13 to 17 August 2007) Update of benthic bioregionalisation of the Southern Ocean Co-conveners, CCAMLR Bioregionalisation Workshop
SC-CAMLR-XXVI/BG/29	Australian Antarctic Division and the Australian Fisheries Management Authority Observer Support and Training Delegation of Australia
SC-CAMLR-XXVI/BG/30	Demersal fishing interactions with marine benthos in the Southern Ocean: an assessment of the vulnerability of benthic habitats to impact by demersal gears Delegation of Australia
SC-CAMLR-XXVI/BG/31	IMAF risk assessment of fisheries by Statistical Area Ad Hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF)
SC-CAMLR-XXVI/BG/32	Incidental mortality of seabirds during unregulated longline fishing in the Convention Area Ad Hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF)

SC-CAMLR-XXVI/BG/33	Calendar of meetings of relevance to the Scientific Committee in 2007/08 Secretariat
SC-CAMLR-XXVI/BG/34	Intersessional work plan for Ad Hoc WG-IMAF for 2007/08 Ad Hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF)
SC-CAMLR-XXVI/BG/35	Guide to the Ad Hoc WG-IMAF Report for the Scientific Committee 2007
SC-CAMLR-XXVI/BG/36	Report on the Workshop on the Southern Ocean Observing System (SOOS) Dr Edith Fanta (SC-CAMLR Chair)
SC-CAMLR-XXVI/BG/37	Review of the *CCAMLR Science* publication policy and the procedure for selecting papers for publication (The Editor, *CCAMLR Science*)
SC-CAMLR-XXVI/BG/38	Report of the Convener of WG-FSA to SC-CAMLR-XXVI, October 2007

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CCAMLR-XXVI/1	Provisional Agenda for the Twenty-sixth Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXVI/2	Provisional Annotated Agenda for the Twenty-sixth Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXVI/3	Examination of the audited financial statements for 2006 Executive Secretary
CCAMLR-XXVI/4	Review of the 2007 budget, draft 2008 budget and forecast budget for 2009 Executive Secretary
CCAMLR-XXVI/5	Cost of providing interpreter services to the Standing Committee on Implementation and Compliance (SCIC) Secretariat
CCAMLR-XXVI/6	Executive Secretary’s Report to SCAF 2007 Executive Secretary
CCAMLR-XXVI/7	Implementation of Conservation Measures 10-06 and 10-07 Provisional Lists of IUU Vessels, 2007 Secretariat

CCAMLR-XXVI/8	Provision and installation of a stand-by generator at the CCAMLR Headquarters Secretariat
CCAMLR-XXVI/9	Professional development in the CCAMLR Secretariat Secretariat
CCAMLR-XXVI/10	Combined list of IUU vessels (Removal of ‘flagless’ vessels) Delegation of Uruguay
CCAMLR-XXVI/11	Summary of notifications for krill fisheries 2007/08 Secretariat
CCAMLR-XXVI/12	Summary of notifications for new and exploratory fisheries 2007/08 Secretariat
CCAMLR-XXVI/13	Notifications of Argentina’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Argentina
CCAMLR-XXVI/14	Notifications of Australia’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Australia
CCAMLR-XXVI/15	Notifications of Japan’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Japan
CCAMLR-XXVI/16	Notifications of the Republic of Korea’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of the Republic of Korea
CCAMLR-XXVI/17	Notifications of Namibia’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Namibia
CCAMLR-XXVI/18	Notifications of New Zealand’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of New Zealand
CCAMLR-XXVI/19	Notifications of Russia’s intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Russia

CCAMLR-XXVI/20	Notifications of South Africa's intention to conduct an exploratory longline fishery for *Dissostichus* spp. in 2007/08 Delegation of South Africa
CCAMLR-XXVI/21	Notifications of Spain's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Spain
CCAMLR-XXVI/22	Notifications of Ukraine's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Ukraine
CCAMLR-XXVI/23	Notifications of the United Kingdom's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of the United Kingdom
CCAMLR-XXVI/24	Notifications of Uruguay's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Uruguay
CCAMLR-XXVI/25	A proposal to amend the CCAMLR System of Inspection Delegations of the European Community, New Zealand and the USA
CCAMLR-XXVI/26	Proposed conservation measure for bottom fishing activities in the CCAMLR Area Delegation of the USA
CCAMLR-XXVI/27	Reporting and communicating of longline sink rates Delegation of Australia
CCAMLR-XXVI/28	A proposal to amend Conservation Measure 10-02 to improve safety standards for vessels licensed to fish in the CCAMLR Area Delegation of Australia
CCAMLR-XXVI/29 Rev. 1	A proposal to review and strengthen the CCAMLR System of Inspection Delegation of Australia
CCAMLR-XXVI/30	The orderly development of the krill fishery Delegation of Australia
CCAMLR-XXVI/31	Compliance requirements for an orderly development of the krill fishery Delegation of Australia

CCAMLR-XXVI/32	Proposal for a CCAMLR decision to undertake a performance review of the organisation Delegations of the European Community and the USA
CCAMLR-XXVI/33	Proposal for a conservation measure concerning the adoption of a trade measure to promote compliance Delegation of the European Community
CCAMLR-XXVI/34	Fishery management plans: the work of the ad hoc group Delegation of New Zealand
CCAMLR-XXVI/35 Rev. 1	Proposed conservation measure on the closure of CCAMLR fisheries Delegation of New Zealand
CCAMLR-XXVI/36	Proposed amendments to conservation measures dealing with catch limits for the krill fishery Delegation of Ukraine
CCAMLR-XXVI/37	Proposed amendments to conservation measures regulating new and exploratory fisheries Delegation of Ukraine
CCAMLR-XXVI/38	Illegal, unreported and unregulated (IUU) fishing. Proposal for amending CCAMLR Conservation Measure 10-06 (2006) and CCAMLR Conservation Measure 10-07 (2006) Delegation of Norway
CCAMLR-XXVI/39	Climate change on the agenda of CCAMLR Delegations of Norway and the United Kingdom
CCAMLR-XXVI/40	Report of the Standing Committee on Administration and Finance (SCAF)
CCAMLR-XXVI/41	Report of the Standing Committee on Implementation and Compliance (SCIC)

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CCAMLR-XXVI/BG/1 Rev. 1	List of documents
CCAMLR-XXVI/BG/2	List of participants
CCAMLR-XXVI/BG/3	Draft Management Plan for ASMA No. X: Southwest Anvers Island and Palmer Basin Delegation of the USA (as submitted to ATCM XXX (2007), WP 5)

CCAMLR-XXVI/BG/4	Report of the CCAMLR Observer to ATCM XXX and CEP X (New Delhi, India, 30 April to 11 May 2007) Executive Secretary
CCAMLR-XXVI/BG/5	Report of the Twenty-seventh Meeting of the FAO Committee on Fisheries (COFI-27) and the First Meeting of Regional Fisheries Bodies Secretariats Network (RSN-1) (5 to 13 March 2007, Rome, Italy) Executive Secretary
CCAMLR-XXVI/BG/6	Report of attendance at Chatham House IUU Workshop (21 to 23 November 2006, London) Executive Secretary
CCAMLR-XXVI/BG/7	Report of Second International Meeting on Establishment of a South Pacific Regional Fisheries Management Organisation (6 to 10 November 2006, Hobart, Australia) Executive Secretary
CCAMLR-XXVI/BG/8	Correspondence with Vanuatu Secretariat
CCAMLR-XXVI/BG/8 ADDENDUM	Correspondence with Vanuatu Secretariat
CCAMLR-XXVI/BG/9	Draft Memorandum of Understanding between CCAMLR and the Western Central Pacific Fisheries Commission (WCPFC) Secretariat
CCAMLR-XXVI/BG/10	Performance reviews for Regional Fisheries Management Organisations Secretariat
CCAMLR-XXVI/BG/11	On the scientific research of marine protected area within the bounds of the Argentina Islands Archipelago Delegation of Ukraine
CCAMLR-XXVI/BG/12	Report of the CCAMLR Observer to the 2007 Joint Meeting of the Tuna Regional Fisheries Management Organizations (RFMOs) (22 to 26 January 2007, Kobe, Japan) CCAMLR Observer (United States)
CCAMLR-XXVI/BG/13 Rev. 2	Implementation of the System of Inspection and other CCAMLR enforcement provisions in 2006/07 Secretariat

CCAMLR-XXVI/BG/14 Rev. 1	Implementation and operation of the Catch Documentation Scheme in 2006/07 Secretariat
CCAMLR-XXVI/BG/15	E-CDS trial and software improvements Secretariat
CCAMLR-XXVI/BG/16	Implementation and operation of the Centralised Vessel Monitoring System (C-VMS) in 2006/07 Secretariat
CCAMLR-XXVI/BG/17	Implementation of conservation measures in 2006/07 Secretariat
CCAMLR-XXVI/BG/18	Summary of current conservation measures and resolutions in force 2006/07 Secretariat
CCAMLR-XXVI/BG/19	Report on the Fourth Meeting of the FIRMS Steering Committee Secretariat
CCAMLR-XXVI/BG/20	Report of the CCAMLR Observer to the 59th Annual Meeting of the International Whaling Commission (IWC) (28 to 31 May 2007, Anchorage, Alaska, USA) CCAMLR Observer (United States)
CCAMLR-XXVI/BG/21	La réserve naturelle des Terres australes et antarctiques françaises : un exemple d'aires marines protégées Délégation française
CCAMLR-XXVI/BG/22	Global Earth Observation System of Systems and the Commission for the Conservation of Antarctic Marine Living Resources Delegation of the USA
CCAMLR-XXVI/BG/23	Assessment of IUU fishing in the French waters bordering Kerguelen and Crozet for season 2006/07 (1 July 2006 to 30 June 2007) Reports of sightings of fishing vessels in the Convention Area General information concerning CCAMLR Area 58 Delegation of France (available in French and English)
CCAMLR-XXVI/BG/24	Report from UNICPOLOS- 8: Marine genetic resources (New York, 25 to 29 June 2007) Delegation of Australia

CCAMLR-XXVI/BG/25	The need for a strategic plan for the management of the Antarctic krill fishery Submitted by ASOC
CCAMLR-XXVI/BG/26	The use of trade-related measures to deter IUU fishing: a step ahead for CCAMLR Submitted by ASOC
CCAMLR-XXVI/BG/27	A system of comprehensive marine protection – some policy considerations Submitted by ASOC
CCAMLR-XXVI/BG/28	Climate change and implementation of CCAMLR’s objectives Submitted by ASOC
CCAMLR-XXVI/BG/29	COLTO background information Submitted by COLTO
CCAMLR-XXVI/BG/30	Incidences of gillnet fishing in the Convention Area reported through the Scheme of International Scientific Observation Delegation of South Africa
CCAMLR-XXVI/BG/31	Recommended Best Practices for Regional Fisheries Management Organizations: Executive Summary Secretariat (available in English, French and Spanish)
CCAMLR-XXVI/BG/32	Convener’s report on the work of the intersessional group for the Development of a Compliance Evaluation Procedure (Convener, South Africa)
CCAMLR-XXVI/BG/33	A photographic record of the *Black Moon*, an IUU vessel fishing with gillnet gear, operating in the Southern Ocean October 2005 to May 2006 Delegation of South Africa
CCAMLR-XXVI/BG/34	Información complementaria sobre actuaciones inspectoras en puertos españoles contra buques ilegales listados por CCRVMA Delegación de España
CCAMLR-XXVI/BG/35	Report on the Third International Meeting for the Establishment of a South Pacific Regional Fisheries Management Organisation (Reñaca, Chile, 30 April to 4 May 2007) Delegation of Chile (available in English and Spanish)

CCAMLR-XXVI/BG/36	Report on the activities of the Scientific Committee on Antarctic Research (SCAR) 2006/07 SCAR Observer to CCAMLR (G. Hosie, Australia)
CCAMLR-XXVI/BG/37	State of the Antarctic and the Southern Ocean Climate System (SASOCS) (Originally submitted to the XXX Antarctic Consultative Treaty Meeting, New Delhi, India, 30 April to 11 May 2007, Information Paper 05) Submitted by SCAR
CCAMLR-XXVI/BG/38	Calendar of meetings of relevance to the Commission in 2007/08 Secretariat
CCAMLR-XXVI/BG/39	The failed inspection of *Dalmor II* within Subarea 48.1 of the Convention Area Delegation of Chile
CCAMLR-XXVI/BG/40	Vacant
CCAMLR-XXVI/BG/41 Rev. 1	Observer activities on Japanese krill fishing vessels in the CCAMLR Convention Area Delegation of Japan
CCAMLR-XXVI/BG/42	Report on the outcomes of 11th session of the Indian Ocean Tuna Commission Meeting, 2007 (Grand Baie, Mauritius, 13 to 18 May 2007) CCAMLR Observer (Australia)
CCAMLR-XXVI/BG/43	Report of the 2007 Annual Meeting of the South East Atlantic Fisheries Organisation (SEAFO) CCAMLR Observer (Norway)
CCAMLR-XXVI/BG/44	Report of the World Conservation Union (IUCN) to CCAMLR-XXVI Submitted by IUCN
CCAMLR-XXVI/BG/45	Report of the CCAMLR Observer (Brazil) to the 15th Special Meeting of the International Commission for the Conservation of Atlantic Tunas (ICCAT) (Dubrovnik, Croatia, 17 to 26 November 2006) CCAMLR Observer (Brazil)
CCAMLR-XXVI/BG/46	Report on the outcomes of 14th Meeting of the Commission for the Conservation of Southern Bluefin Tuna, 2007 CCAMLR Observer (Australia)

CCAMLR-XXVI/BG/47	New and revised conservation measures recommended by SCIC for adoption by the Commission
CCAMLR-XXVI/BG/48	Proposals for new and revised measures submitted by SCIC to the Commission for further consideration
CCAMLR-XXVI/BG/49	Data reporting system for krill fisheries Chair of the Conservation Measures Group
CCAMLR-XXVI/BG/50	Report of the Scientific Committee Chair to the Commission
CCAMLR-XXVI/BG/51	Summary advice of SCIC to the Commission CCAMLR-XXVI
CCAMLR-XXVI/BG/51 ADDENDUM	Report of the SCIC Chair to the Commission

ANNEX 3

AGENDA FOR THE TWENTY-SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE TWENTY-SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

1. Opening of the meeting
   - (i) Adoption of the agenda
   - (ii) Report of the Chair
   - (iii) Preparation of advice to SCAF and SCIC

2. Advances in statistics, assessments, modelling and survey methods
   - (i) Advice from WG-SAM
   - (ii) Advice from SG-ASAM
   - (iii) Advice to the Commission

3. Ecosystem monitoring and management
   - (i) Advice from WG-EMM
   - (ii) Management of protected areas
   - (iii) Interactions between WG-EMM and WG-FSA
   - (iv) Advice to the Commission

4. Harvested species

   - (i) Krill resources
     - (a) Status and trends
     - (b) Advice from WG-EMM
     - (c) Notifications for krill fisheries in the 2007/08 season
     - (d) Advice to the Commission

   - (ii) Fish resources
     - (a) Status and trends
     - (b) Target species
     - (c) Advice from WG-FSA
     - (d) Advice to the Commission

   - (iii) New and exploratory fisheries
     - (a) New and exploratory fisheries in the 2006/07 season
     - (b) Notifications for new and exploratory fisheries in the 2007/08 season
     - (c) Revision of boundaries
     - (d) Advice to the Commission

   - (iv) Bottom fishing in CCAMLR high-seas areas

(v) Crab resources
  (a) Status and trends
  (b) Advice from WG-FSA
  (c) Advice to the Commission

(vi) Squid resources
  (a) Status and trends
  (b) Advice from WG-FSA
  (c) Advice to the Commission

(vii) Fish and invertebrate by-catch
  (a) Status and trends
  (b) Advice from WG-FSA
  (c) Advice to the Commission

5. Incidental mortality
  (i) Incidental mortality of seabirds and marine mammals arising from fisheries
  (ii) Advice to the Commission

6. Additional monitoring and management issues
  (i) Marine debris
  (ii) Marine mammal and bird populations
  (iii) Advice to the Commission

7. CCAMLR Scheme of International Scientific Observation
  (i) Scientific observations 2006/07
  (ii) Advice to the Commission

8. Management under conditions of uncertainty about stock size and sustainable yield

9. Scientific research exemption

10. Cooperation with other organisations
  (i) Cooperation with the Antarctic Treaty System
  (ii) Reports of observers from other international organisations
  (iii) Reports of representatives at meetings of other international organisations
  (iv) Future cooperation

11. Budget for 2008 and forecast budget for 2009

12. Advice to SCIC and SCAF

13. Secretariat supported activities
  (i) Data management
  (ii) Publications

14. Scientific Committee activities
    (i) Coordination of the work of the Scientific Committee and its working groups
    (ii) Intersessional activities
    (iii) CCAMLR-IPY projects
    (iv) Joint CCAMLR-IWC workshop
    (v) Invitation of observers to the next meeting
    (vi) Invitation of experts to the meetings of working groups
    (vii) Next meeting

15. Election of Vice-Chair of the Scientific Committee

16. Other business

17. Adoption of the Report of the Twenty-sixth Meeting of the Scientific Committee

18. Close of the meeting.

ANNEX 4

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT
(Christchurch, New Zealand, 17 to 26 July 2007)

CONTENTS

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Christchurch, New Zealand, 17 to 26 July 2007)

INTRODUCTION

Opening of the meeting

1.1 The thirteenth meeting of WG-EMM was held at the Latimer Hotel, Christchurch, New Zealand, from 17 to 26 July 2007. The meeting was convened by Dr K. Reid (UK). In addition, a Workshop on Fisheries and Ecosystem Models in the Antarctic was held jointly by WG-EMM and WG-FSA on 16 July 2007 (SC-CAMLR-XXVI/BG/6; paragraphs 7.6 to 7.21).

1.2 Meeting participants (manuhiri, or visitors) were welcomed with a karakia (traditional Maori blessing) conducted by Apanui Skipper representing the tangata whenua (hosts). This was followed by a waiata (traditional song) performed by staff from the Christchurch office of the National Institute of Water and Atmospheric Research (NIWA).

1.3 The meeting was opened by the Rt Hon. Winston Peters, Minister of Foreign Affairs, who welcomed the participants and thanked them for their contribution to the conservation of Antarctic marine living resources. Dr Reid thanked the Rt Hon. Minister and the local organisers for their warm hospitality and for hosting the meeting.

1.4 Dr Reid extended his welcome to the participants, and outlined the program of work for the meeting. This work included:

- a Workshop to Review Estimates of B_0 and Precautionary Catch Limits for Krill (section 2 and Appendix D);
- further development of management procedures to evaluate options for subdividing the krill catch limit among SSMUs in Area 48 and consideration of the advice from WG-SAM (paragraphs 6.35 to 6.47; Annex 7);
- discussion of the core business of the Working Group.

Adoption of the agenda and organisation of the meeting

1.5 The provisional agenda was discussed by WG-EMM and adopted without change (Appendix A).

1.6 The meeting participants are listed in Appendix B. The documents submitted to the meeting are listed in Appendix C.

1.7 The report was prepared by Drs A. Constable (Australia), D. Demer (USA), M. Goebel (USA), Mr J. Hinke (USA), Drs R. Holt (USA), C. Jones (USA), S. Kawaguchi (Australia),

S. Nicol (Australia), M. Pinkerton (New Zealand), D. Ramm (Data Manager), C. Reiss (USA), E. Sabourenkov (Science and Compliance Officer), V. Siegel (Germany), C. Southwell (Australia) and W. Trivelpiece (USA).

WORKSHOP TO REVIEW ESTIMATES OF B_0 AND PRECAUTIONARY CATCH LIMITS FOR KRILL

2.1 The Working Group recalled that the Scientific Committee had agreed that a workshop to review estimates of B_0 and precautionary catch limits for krill should be held in conjunction with the 2007 Working Group meeting (SC-CAMLR-XXV, paragraphs 3.26 and 3.27).

2.2 The workshop would consider the following points:

(i) review of parameters used in the assessment of krill, including growth and recruitment variability;

(ii) examine whether integrated modelling approaches could be used to estimate recruitment variability and *M* from long-term datasets;

(iii) consider the level of krill escapement to provide for predators in the decision rule;

(iv) consider alternative methods for estimating catch limits for krill according to the CCAMLR decision rules and how the different methods might be compared and evaluated for providing advice;

(v) consider sources of uncertainty that may not be able to be included specifically in the estimation of B_0 or the assessment process generally.

2.3 The Scientific Committee had also requested SG-ASAM and WG-SAM to provide input to the workshop on what is the most appropriate method for estimating B_0 from survey data, considering design-based versus model-based estimation methods. It also requested SG-ASAM to review the method for estimating CV for the biomass estimate provided by Demer (2004) and consider whether this is sufficient to determine the uncertainty in B_0 more generally.

2.4 The Convener of the workshop (Dr Nicol) and the WG-EMM Convener (Dr Reid) had solicited contributions from Members on the three major themes of the workshop:

(i) Estimating B_0 –

  (a) spatial coverage and timing of surveys, acoustic protocols (e.g. target-strength model, target identification) and error estimation.

(ii) Key parameters used in assessment –

  (a) estimates of growth, recruitment, mortality as well as spatial and temporal variability in those parameters.

(iii) Desired escapement levels and approaches to estimation of precautionary catch limits for krill –

(a) Are there alternative methods for estimating catch limits for krill, according to the CCAMLR decision rules, and how might the different methods be compared and evaluated for providing advice?

(b) Are there sources of uncertainty that are not currently included in the estimation of B_0 or the assessment process generally?

2.5 Two papers (WG-EMM-07/30 Rev. 1 and 07/33) submitted for consideration at the workshop addressed the first theme, and one paper (WG-EMM-07/P6) addressed the second theme. The reports of SG-ASAM (Annex 8) and WG-SAM (Annex 7) were relevant to all three themes. The papers were discussed under the individual themes.

Background

2.6 The Working Group recalled that the need for the workshop arose out of discussions on the new target-strength formulations for krill, then incorporated strategic issues, such as the need to achieve consistency in approaches across time and between areas, and the general issues associated with the assessment of B_0 and the calculation of precautionary catch limits.

2.7 Consistency includes the setting of appropriate catch levels across the CCAMLR Convention Area using agreed protocols as well as common measures, such as trigger levels, in each area to be fished. The trigger level in Area 48 was set using historical fisheries data at what was perceived to be a low-risk catch level and was intended to be independent of the catch limit which was calculated from survey results.

2.8 The basic biological information required for the calculation of precautionary yield includes:

- estimate of biomass (B_0)
- estimates of natural mortality
- estimates of recruitment
- estimates of growth rates.

2.9 The current precautionary catch limits for krill are:

- Area 48: 4 million tonnes
- Division 58.4.1: 440 000 tonnes
- Division 58.4.2: 450 000 tonnes.

2.10 All precautionary catch limits have been set using the Greene et al. (1991) target-strength model which SG-ASAM has recommended be superseded by the SDWBA model (Annex 8, paragraph 8; SC-CAMLR-XXIV, Annex 6, paragraphs 27 and 28). The limits in Area 48 and Division 58.4.1 were set using similar survey designs and methodologies. The limit in Division 58.4.2 was set using data collected in the 1980s. This division was resurveyed in 2006 using a survey design compatible with that in Area 48 and Division 58.4.1

(WG-EMM-07/33), although the precautionary catch limit was not revised. No B_0 surveys have been conducted and no catch limits have been set in any other division/area including Subarea 48.6 and Area 88.

Theme 1 – Estimating B_0

2.11 This theme discussed progress in the estimation of B_0, especially regarding spatial coverage and timing of surveys, acoustic protocols (e.g. target-strength model, target identification) and error estimation.

2.12 Dr Demer provided further context to the discussions under this theme by summarising the previous activities of SG-ASAM related to acoustic surveys of krill biomass (SC-CAMLR-XXIV, Annex 6) and suggested that the work be organised to:

(i) review current protocols as they pertain to the acoustic estimation of krill biomass and its variance for CCAMLR management purposes;

(ii) summarise the major developments in data analysis since the CCAMLR-2000 Survey;

(iii) highlight and resolve any omissions and/or ambiguities in these protocols;

(iv) summarise the subgroup's findings for submission to WG-EMM, either directly or, if any issues of a technical nature remained to be resolved, via SG-ASAM;

(v) evaluate recently submitted biomass estimates (WG-EMM-07/30 Rev. 1, 07/33) for their applicability for CCAMLR management purposes.

2.13 The Working Group agreed that the best advice available for the purposes of the workshop was previous advice provided by SG-ASAM.

2.14 Two fundamental components of biomass estimation were discussed: estimation of transect biomass densities, and extrapolation of densities to the survey area. The first component is highly technical and falls within the remit of SG-ASAM; the second component is more general, and there was considerable general discussion on the merits of obtaining expert advice regarding survey design and the estimation of survey biomass from transect data. SG-ASAM had been asked by WG-EMM to consider this latter component at its 2007 meeting (SC-CAMLR-XXV, Annex 4, paragraph 6.57(xvii)), but had agreed there was insufficient expertise present at SG-ASAM-07 to make any progress (Annex 8).

2.15 The workshop focused on what has changed in terms of acoustic protocols since the CCAMLR-2000 Survey. The workshop addressed the current B_0 estimates and protocols, and considered future improvements that may arise.

2.16 The workshop produced a summary of the major points arising since the CCAMLR-2000 Survey. The aim of this summary was to clarify any potential confusion within the CCAMLR community about the results of subsequent reanalyses of the

CCAMLR-2000 dataset (Demer and Conti, 2005; WG-EMM-07/30 Rev. 1), and reiterate that there are likely to be further developments in this field into the future. This summary is presented in paragraphs 2.17 to 2.19.

Summary of changes in acoustic protocols since the CCAMLR-2000 Survey

2.17 The SDWBA model, which has been empirically validated, published in the peer-reviewed literature (Demer and Conti, 2005) and endorsed by SG-ASAM, WG-EMM and the Scientific Committee (Annex 8; SC-CAMLR-XXIV, paragraphs 3.10 to 3.13, Annex 4, paragraphs 4.55 to 4.60 and Annex 6; Demer and Conti, 2003), predicts krill target strengths that are generally lower than those of the Greene et al. (1991) model (WG-EMM-07/30 Rev. 1, Figure 1). Therefore, if all else is held equal, the use of the SDWBA will result in an increase in the original 44.3 million tonnes CCAMLR-2000 Survey biomass estimate. This was the finding of the first reanalysis of the CCAMLR-2000 dataset (Demer and Conti, 2005; Conti and Demer, 2006), which estimated between 108.0 million tonnes (CV = 10.4%) and 192.4 million tonnes (CV = 11.7%) depending on the krill orientation distribution used.

2.18 Taking the analyses further, the SDWBA also provides a method for more effective filtering out of non-krill targets (i.e. target classification). The effect of this additional filtering is to improve the acoustically estimated krill biomass. When using the SDWBA to both predict target strength and improve target classification, the combined effect is a reduction in the overall biomass estimate. This was the finding of the second reanalysis of the CCAMLR-2000 dataset (WG-EMM-07/30 Rev. 1), which estimated a krill biomass of 37.29 million tonnes (CV = 21.20%); this was 15.8% lower than the original estimate, but with a larger CV (WG-EMM-07/30 Rev. 1).

2.19 The results of the SDWBA target classification method are likely to be more accurate (i.e. less biased) owing to better rejection of non-krill species. In addition, the patchiness of krill is better elucidated, which results in a higher CV. That is, as non-krill are more effectively filtered, the remaining krill typically become more patchy. Holding sampling constant, higher patchiness and lower biomass results in a higher CV.

2.20 The Working Group emphasised the need to manage the implementation of incremental improvements to acoustic protocols, so that the B_0 and variance estimates in use by CCAMLR at any one time are consistent and comparable:

(i) A consistent set of protocols should be maintained for a period of five years. At the end of this period, any improvements to these protocols should be agreed on and implemented. This would include the reanalysis of existing datasets. However, it was also recognised that mid-period improvements in acoustic protocols will likely be published in the peer-reviewed literature where appropriate.

(ii) Clear guidelines were developed on which protocols currently apply in a CCAMLR context for new data collected (paragraphs 2.21 to 2.26 and Table 1).

(iii) For appropriate comparisons to be made across different surveys, it is implicit that the results need to have been calculated in a consistent way and that reanalyses are required across all datasets whenever protocols are amended (e.g. WG-EMM-07/31).

Current protocols for the acoustic estimation of krill biomass and its variance

2.21 The overall aim of producing agreed CCAMLR survey protocols should be to facilitate the decision-making process so that survey-specific issues can be accommodated and the resulting biomass estimates be as consistent as possible with currently agreed protocols.

2.22 The acoustic protocols of direct relevance to CCAMLR management activities have been extensively documented in the past and do not need to be reiterated in detail here. These are therefore summarised and referenced in the following paragraphs.

2.23 The CCAMLR-2000 Survey, which benefited from extensive planning and coordination across four CCAMLR Members, represented the benchmark for acoustics protocols at that time (e.g. SC-CAMLR-XXIV, Annex 4, paragraphs 4.55 to 4.60, 4.66 and 4.67; Hewitt et al., 2002, 2004).

2.24 Since the CCAMLR-2000 Survey, improvements have been made to the krill target-strength model and target-classification technique (Annex 8; SC-CAMLR-XXIV, Annex 6; Demer and Conti, 2003, 2005). SG-ASAM was established in 2005 to evaluate these improvements and to make recommendations to WG-EMM for possible changes to the CCAMLR-2000 Survey protocols (Annex 8; SC-CAMLR-XXIV, paragraphs 3.10 to 3.13, Annex 4, paragraphs 4.55 to 4.60 and Annex 6). These topics were discussed at the first and third meetings of SG-ASAM (Annex 8; SC-CAMLR-XXIV, Annex 6).

2.25 To date, SG-ASAM has recommended that:

(i) the simplified SDWBA target-strength model with constrained parameters be used to define krill target strength as a function of length, at a given acoustic frequency;

(ii) the range of target strengths from the subgroup's agreed run of the simplified SDWBA (SC-CAMLR-XXIV, Annex 6, Figure 4) be used as a first estimate of the error associated with krill target strength estimates;

(iii) the classification of S_v into krill and non-krill targets be undertaken using the ΔS_v technique, with the ΔS_v windows across three frequencies (38, 120 and 200 kHz) constrained according to SDWBA predictions for the appropriate size range of krill;

(iv) further work be carried out on understanding the orientation distribution, sound-speed contrast, density contrast and animal shape for krill under the surveying vessel;

(v) 70 kHz transducers be used in addition to the previously recommended frequencies (38, 120 and 200 kHz) whenever possible.

2.26 The Working Group agreed that current CCAMLR protocols for the acoustic estimation of krill biomass and its variance should follow those of the CCAMLR-2000 Survey (Trathan et al., 2001; Hewitt et al., 2004), except with regard to target strength and target classification; for these procedures, the recommendations of SG-ASAM should be followed (Annex 8; SC-CAMLR-XXIV, Annex 6).

Clarifying current acoustic protocols

2.27 The Working Group identified a number of potential omissions and/or ambiguities in the current acoustic protocols used to estimate krill biomass and its variance for CCAMLR purposes. To clarify, a table was produced listing these protocols and providing specific advice for each (Table 1). The protocol descriptions follow those suggested in Figure 1 of the SG-ASAM-07 report (Annex 8).

Estimates of B_0

2.28 The Working Group agreed that the methods described in WG-EMM-07/30 Rev. 1 were consistent with currently agreed acoustic protocols, as defined in paragraphs 2.21 to 2.26. Therefore, the B_0 estimate of 37.29 million tonnes and CV estimate of 21.20% represents the most current information for krill in Area 48 from the CCAMLR-2000 Survey.

2.29 The Working Group agreed that the methods in the Australian survey of Division 58.4.2 presented in WG-EMM-07/33 were consistent with those outlined for the CCAMLR-2000 Survey (Hewitt et al., 2004) and that the data could also be used to estimate a revised value of B_0 using the new simplified SDWBA target-strength model. The effects of any protocol deviations on the final B_0 and CV estimates from this survey should be quantified so that their importance can be better assessed by the CCAMLR community.

2.30 All future surveys intended to produce estimates of B_0 should first be presented to WG-EMM for its consideration and approval. The Working Group encouraged continuous and timely communication with CCAMLR regarding acoustic survey and analysis methods for all future CCAMLR surveys, to ensure that any deviations from the recommendations outlined here can be accounted for to the satisfaction of the CCAMLR community. This review task might be facilitated if the effect of any protocol deviations could be quantified with respect to the final estimates of B_0 and CV.

2.31 Dr T. Jarvis (Australia) agreed to produce a paper to be presented to WG-EMM next year that explicitly details data collection and analysis protocols for CCAMLR surveys.

2.32 The Working Group recommended that the following be considered when SG-ASAM meets next:

(i) all new measurements of krill density and sound-speed contrasts, shape and orientation beneath survey vessels relative to Table 1 in the SG-ASAM-05 report (SC-CAMLR-XXIV, Annex 6);

(ii) how krill density and sound-speed contrasts, shape and orientations beneath survey vessels should best be measured;

(iii) how krill length distributions should be considered to assure they are representative of the survey strata;

(iv) the efficacy of the three- versus two-frequency method for target identification; specifically, how the sensitivity of krill target strength at 200 kHz, due to changes in krill orientation and the stochastic nature of sound scatter, affects the three-frequency method for target identification and range limitations at 200 kHz;

(v) methods for integrating the information obtained from direct sampling (e.g. target trawls) into the acoustic species-identification procedure.

Theme 2 – Key parameters used in assessment

2.33 The Working Group recalled that in 2000 it was agreed that more work was still required before the recruitment more recent than 1994 could be used in the GYM (SC-CAMLR-XIX, Annex 4, paragraph 2.98). Currently for the estimation of γ, recruitment variability is assumed to be a stochastic event (SC-CAMLR-XIX, Annex 4, Table 1). Since reproduction and survival of krill is known to be closely linked to environmental factors in relation to the cycle of their life history (Siegel and Loeb, 1995; Quetin and Ross, 2001), the Working Group recommended exploration of ways of incorporating these features in the estimation of γ within the GYM.

2.34 Spatial variation in M will have to be investigated at appropriate scales to account for environmental variability and seasonal differences in predation pressure in Area 48. For example, Subarea 48.3 is thought to have a higher M (possibly resulting from high predation pressure) compared to Subareas 48.1 and 48.2, and therefore one option may be to set a different M for Subarea 48.3 from Subareas 48.1 and 48.2 and to have M vary with time associated with periods of peak predator demand.

2.35 The growth rate of krill is also known to vary in time and space in relation to environmental conditions (temperature, food availability). Recent findings further indicate that there is differential growth and mortality between sexes (WG-EMM-07/P6). It would also be desirable that the growth model to be used in the GYM be capable of taking into account environment variability and seasonal patterns.

2.36 The Working Group noted that the growth trajectory generated by the instantaneous growth rate (IGR) model (Candy and Kawaguchi, 2006) takes into account seasonal trends in temperatures based on direct field measurement.

2.37 The Working Group, however, acknowledged that the KYM and the GYM were not designed as spatially resolving models and used average values for the various parameters which were assumed to apply to the whole population in an area. The modelling work being conducted for the subdivision of the catch limit into SSMUs is the best way to capture regional differences in the key parameters. This would require an assessment of the parameter sets required for each SSMU. It is also uncertain how movement of krill would affect any regional differences in population parameters.

2.38 The currently used γ for Area 48 was estimated using the KYM (SC-CAMLR-XIX, Annex 4, paragraphs 2.96 to 2.101). As the Working Group had some revised parameters which were available at the 2007 meeting, two sets of runs of the GYM were conducted using these parameters. These included a re-run of the current parameter settings using the GYM (Table 2). The runs were:

Run 0 (re-run): Using the original parameters but using the GYM. This resulted with almost same γ as that estimated by the KYM.

Run 1: Using the original parameters but with an updated CV (21.20%) from WG-EMM-07/30 Rev. 1 in the GYM.

Although Run 1 resulted in a slightly lower γ for the recruitment criterion, according to the decision rules, γ was set at 0.093 which is the same as that from Run 0.

2.39 The Working Group noted the currently agreed γ based on the KYM is 0.091. Using the same data inputs as that calculation but using the GYM, the Working Group agreed that this could be updated to 0.093.

2.40 The Working Group agreed that because of the potential change in γ that could result from changes in the growth trajectory, further intersessional work was required to update parameter values for the next meeting.

2.41 The Working Group agreed that, using the revised B_0 and CV, and the updated γ, the precautionary catch limit for Area 48 could be updated to 3.47 million tonnes (Run 1).

2.42 The GYM runs during the meeting also indicated the impact (24% increase) that an alternative growth model has on the estimate of γ.

2.43 The Working Group agreed to the following plan for the intersessional period to be able to provide advice to the next meeting of WG-EMM:

(i) review the currently available growth models
(ii) investigate ways to handle recruitment indices and mortality
(iii) investigate implications of spatial and temporal scale variability on parameter settings in the estimate of γ.

Theme 3 – Approaches to estimation of precautionary catch limits for krill

Escapement levels

2.44 The Working Group recalled the history of the development of the 75% escapement rule for CCAMLR as being halfway between the escapement appropriate for a single-species decision rule (50%) and for a decision rule that preserved all krill for predators (100%), until further research could clarify the actual level of escapement required for predators (SC-CAMLR-XIII, paragraph 7.22; CCAMLR-XIII, paragraph 3.10).

2.45 One attempt has been made in the past to estimate an escapement level directly in a krill–predator model (Butterworth and Thomson, 1995; Thomson et al., 2000). Since then our ability to characterise predator responses to krill densities and the associated uncertainties has improved and has been incorporated into the ecosystem dynamic models currently being developed by CCAMLR (FOOSA, SMOM, EPOC).

2.46 Within the staged approach being considered for determining appropriate catch limits for SSMUs, Stage 1 (a risk-based approach), as specified by WG-SAM, should allow investigation of the likely impact on predator performance (Annex 7, paragraph 5.48(ii)) of using different levels of escapement in the decision rule, including the current level of 75%, through simulating different levels of harvest as proportions of γ (Annex 7, paragraph 5.37(v)).

2.47 The Working Group requested that in order to examine the effect of adopting escapement proportions lower than 75% of B_0, the range of harvest rates that should be examined in the models should include 1.25 times γ.

2.48 The Working Group noted that decreasing the escapement level may not lead to a change in γ, depending on whether krill population depletion ($\gamma 1$) or escapement ($\gamma 2$) becomes limiting with the decision rule.

2.49 The Working Group recognised that in Stage 1 above only three options for the relative distribution of krill catch between SSMUs will be examined. In Stage 2 other options (including feedback approaches) will be developed, and these could lead to a situation where the sum of the SSMU catch levels is greater than the total catch level for Area 48. Although counter-intuitive, this is not inconsistent with the decision rules: the total Area 48 catch limit would still be based on the decision rules accounting for area-wide krill and predator dynamics, but local SSMU catch limits would be allowed to vary from the relative distribution in Options 2–4 depending on the local situation with predators. In the event that the Area 48 catch limit was reached, the Area 48 fishery would be closed whether or not all the SSMU catch limits had been reached.

2.50 In Stage 2 there may be some possibility of investigating whether different levels of escapement should be used in response to locally observed conditions as part of the development of feedback management. In the interim, a range of specific studies might be conducted to address escapement.

2.51 A feedback management scheme, such as regular reassessments, should also be able to deal with long-term shifts in the Antarctic ecosystem and climate change. It will be important to continue monitoring of both krill and predators to detect such changes. At the moment, the only long-term surveys monitoring the krill population in Area 48 are the surveys conducted by BAS, US AMLR and LTER. Structured fishing provides another potential way that the effect of climate change on appropriate SSMU limits and krill escapement might be investigated (Annex 7, paragraphs 5.13 and 5.14).

Alternative assessment methods

2.52 The Working Group welcomed the consideration of integrated krill assessments by WG-SAM. It noted that such methods may allow estimation of recruitment variability, relative abundance by area and movement between areas. The assessments would, however, remain restricted to the target species (krill) and would not be developed to explicitly include ecosystem dynamics. The latter would remain the role of the ecosystem dynamic models.

2.53 Integrated assessments may also allow more frequent and less costly estimates of krill population status than the current reliance on occasional synoptic surveys. Regular surveys will be increasingly important as the krill fishery develops and the krill population departs from B_0. It is not anticipated that the CCAMLR decision rule would change, but its method of application would become closer to that used currently for toothfish. This would mean that rather than estimating a γ to be applied to B_0, a long-term yield consistent with the decision rules would be directly calculated whenever a new assessment was undertaken. MSE work can be used to identify the most cost-effective methods for collecting data to help in this process (Annex 7, paragraph 6.16)

2.54 The Working Group encouraged participants to continue investigations into integrated assessments for krill and to provide advice to WG-SAM in its work on developing feedback management procedures for krill.

Consistency of approaches to management in the Convention Area

2.55 The Working Group noted that there are currently no SSMUs defined in areas other than Subareas 48.1, 48.2 and 48.3, although there has been some consideration of this matter (SC-CAMLR-XX/BG/24). Furthermore, catch limits have not been set in Area 88 nor Subarea 48.6.

2.56 In considering the existing trigger levels, the Working Group recalled the advice of the Scientific Committee and response by the Commission in 2000:

- As a precautionary step, the Commission agreed that krill catches should not exceed a set (i.e. ‘trigger’) level in Area 48 until a procedure for division of the overall catch limit into smaller management units has been established. This is consistent with the current Conservation Measure 51-01 which sets such a trigger level at 620 000 tonnes – slightly above the historical maximum annual catch in Area 48 to date (CCAMLR-XIX, paragraph 10.11).

- The Commission noted that the Scientific Committee had proposed two options for setting a trigger level in Area 48 (CCAMLR-XIX, paragraph 10.12):

  - retain the level of 620 000 tonnes, which approximates the historical maximum annual catch; or

  - set the level at 1 million tonnes, which approximates the harvest level suggested for each of the subareas in Area 48 and derived from the CCAMLR-2000 Survey results.

2.57 The Secretariat advised that, for consistency with other fisheries, Conservation Measure 51-01 may not result in it implementing the trigger level as intended by the Commission (CCAMLR-XIX, paragraph 10.11).

2.58 With respect to data reporting and the management of catch limits, the Secretariat routinely forecasts closures in fisheries, management areas and SSMUs using a regression model and data submitted in accordance with the Catch and Effort Reporting System (Conservation Measures 23-01 to 23-03). The regression is based on data from a minimum of three reporting periods, and most forecasts are based on data from four reporting periods.

2.59 In most finfish fisheries, Contracting Parties are required to submit five-day catch and effort reports and the deadline for the submission of these reports is two working days following the end of the reporting period (Conservation Measure 23-01). Given these time intervals, the earliest a forecast can be made is approximately 17 days after the start of fishing (three five-day periods and a deadline of two working days), and closures are forecast up to five days in advance.

2.60 In krill fisheries, Contracting Parties are required to submit monthly catch and effort reports and the deadline for the submission of these reports is the end of the following reporting period (Conservation Measure 23-03). Given these time intervals, the earliest a forecast can be made in a krill fishery is 120 days after the start of fishing (three 30-day periods and a 30-day deadline), and closures are forecast up to one month in advance. In some subareas the fishing seasons are relatively short (four months during the winter in Subarea 48.3, five months during the summer in Subarea 48.2) and the Secretariat would not have sufficient data to close the fishery before the catch limit is exceeded.

2.61 Given the above, the Working Group recommended that the Scientific Committee:

(i) recall its advice on the trigger level in 2000 (SC-CAMLR-XIX, paragraphs 7.21 to 7.24), noting that the Secretariat may not be able to administer its intent with the current conservation measures;

(ii) note and comment on the possibility that the current monthly reporting periods may not be sufficient to ensure that the catch limits for a subarea are not significantly exceeded in the situation where the krill fishery is capable of taking more than 1 million tonnes per season.

Uncertainty

2.62 It was recognised that the current assessment process incorporates parameter (fishery and ecosystem) uncertainty, and structural (model) uncertainty to the extent that there are multiple models being developed. The Working Group felt that known current uncertainties are incorporated reasonably well in the risk-based Stage 1 approach to setting SSMU catch limits. Stage 2 should further investigate the robustness of the management system, both the γB_0 method of setting catch limits and the distribution of catches between SSMUs, to uncertainties.

2.63 Uncertainties, such as long-term changes to parameters, particularly those caused by changes in krill/predator distribution and climate/environmental/exogenous change are difficult to accommodate in decision-making frameworks at present. Continued monitoring is required, and will probably be required in areas currently not being monitored, to identify and update harvest strategies in the future.

2.64 Another aspect of uncertainty that is not currently incorporated in the assessment and decision rules is implementation uncertainty. The Commission has previously requested that the Scientific Committee assume perfect implementation of catch limits. Implementation uncertainty, caused by IUU fishing for krill or spatial/temporal misreporting, may also be important, and may be either minimised by putting appropriate control measures in place or explicitly represented in models.

Conclusion of the workshop

2.65 The Convener of the workshop, Dr Nicol, thanked all participants for their assistance in producing valuable advice to the Scientific Committee in all three themes. In particular, he thanked Drs D. Agnew (UK), Demer and Kawaguchi who coordinated discussions under the three themes and contributed substantially to the writing of the report.

2.66 The Working Group thanked Dr Nicol for achieving an ambitious work program in the short time available.

Advice to the Scientific Committee

2.67 The Working Group advised the Scientific Committee that the most appropriate method for estimating B_0 from survey data was still the Jolly and Hampton (1990) method as has been used for all CCAMLR B_0 surveys to date (paragraph 2.13).

2.68 The Working Group recommended that current CCAMLR protocols for the acoustic estimation of krill biomass and its variance should follow those of the CCAMLR-2000 Survey (Trathan et al., 2001; Hewitt et al., 2004), except with regard to target strength and species identification; for these procedures, the recommendations of SG-ASAM should be followed (paragraph 2.26 and Annex 8; SC-CAMLR-XXIV, Annex 6).

2.69 The B_0 estimate of 37.29 million tonnes and CV estimate of 21.20% presented in WG-EMM-07/30 Rev. 1 represent the best advice on the biomass estimate for krill in Area 48 from the CCAMLR-2000 Survey (paragraph 2.28).

2.70 The Working Group agreed that, using the revised B_0 and CV, and the updated γ, the precautionary catch limit for Area 48 could be updated to 3.47 million tonnes (paragraph 2.41).

2.71 The Working Group agreed that the methods in the Australian acoustic survey for krill in Division 58.4.2 presented in WG-EMM-07/33 were consistent with those outlined for the CCAMLR-2000 Survey (Hewitt et al., 2004). A new estimate of B_0 using the new simplified SDWBA model for target strength and species identification should be produced in time for the next meeting of the Scientific Committee (paragraphs 2.29 and 5.39).

2.72 All future surveys intended to produce estimates of B_0 for krill should follow agreed protocols and be first presented to WG-EMM for its consideration and approval (paragraph 2.30).

2.73 The Working Group reviewed the parameters used in the assessment, including growth and recruitment variability, and examined whether integrated modelling approaches could be used to estimate recruitment variability and M from long-term datasets, but was unable to produce new formulations of the key parameters. A work program has been initiated to incorporate the most recent information into the assessment process (paragraphs 2.33 to 2.36 and 2.52 to 2.54).

2.74 The Working Group noted that in order to examine the effect of adopting escapement proportions lower than 75% of B_0, the range of harvest rates that should be examined in the models should include 1.25 times γ (paragraph 2.47).

2.75 The Working Group strongly emphasised the importance of the long time series of krill data collected as part of the BAS, US AMLR and LTER programs for the work of CCAMLR and the continuing need to collect and submit these data to the Working Group into the future (paragraph 2.51).

2.76 The Working Group drew the Scientific Committee's attention to the fact that there are currently no SSMUs defined in areas other than Subareas 48.1, 48.2 and 48.3. Although there has been some consideration of this matter (SC-CAMLR-XX/BG/24), catch limits have not been set in Area 88 nor Subarea 48.6 (paragraph 2.55).

2.77 The Secretariat advised that, in being consistent with other fisheries, Conservation Measure 51-01 may not result in it implementing the trigger level as intended by the Commission (CCAMLR-XIX, paragraph 10.11; paragraph 2.57).

2.78 The Working Group drew the Scientific Committee's attention to the possibility that, with the current monthly reporting periods, the Secretariat may not be able to close the fishery before the catch limit is significantly exceeded, should the krill fishery be capable of taking more than 1 million tonnes of krill (paragraphs 2.60 and 2.61).

2.79 As the krill fishery develops, it will be important to apply the ecosystem-based management principles developed in Area 48 to other areas. It was noted that like toothfish, krill fisheries are likely to be possible wherever krill is found. There is currently sufficient knowledge of where krill fishing might be possible, but insufficient knowledge about the impacts of such fisheries on krill and dependent predators for many areas. An orderly development would mean that:

(i) the development of fishing in Area 88 or Subarea 48.6 should be considered exploratory fisheries, since only limited information exists on the distribution and abundance of krill or predators;

(ii) the requirements for developing an exploratory fishery should be to undertake a B_0 survey prior to the fishery developing and that:

  (a) notification of the survey should be in sufficient time for the Scientific Committee and WG-EMM to consider the research plan and the likely stock definition for an effective B_0 survey;

  (b) the large size of these statistical areas may require some consideration by the Scientific Committee of their subdivision prior to any survey taking place;

  (c) the survey is undertaken according to the standard protocols developed in paragraphs 2.21 to 2.26, and an assessment includes application of CCAMLR decision rules. This would not preclude such surveys being undertaken by commercial vessels;

(iii) based on a consideration of the risk of krill fishing to predators and the possible requirements for SSMUs, trigger levels should be developed for each krill fishing area to manage the orderly development of the fishery (see also paragraph 6.35).

2.80 The Working Group drew the Scientific Committee's attention to an aspect of uncertainty that is not currently incorporated in the assessment and decision rules – implementation uncertainty. Implementation uncertainty, caused by IUU fishing for krill or spatial/temporal misreporting, may also become important, and may be either minimised by putting appropriate control measures in place or explicitly represented in models (paragraph 2.64).

FEEDBACK FROM THE 2006 MEETINGS OF THE SCIENTIFIC COMMITTEE AND THE COMMISSION

3.1 At the 2006 meetings of the Scientific Committee, SCIC and/or the Commission, the following items were identified for consideration by the Working Group. They were addressed under the appropriate agenda item indicated below.

Agenda Item 4.3 (key points in paragraphs 4.84 to 4.89) –

(i) The need to review the priorities of the observer program to ensure that the expectations and workloads of observers remain achievable (SC-CAMLR-XXV, paragraph 2.21; CCAMLR-XXV, paragraph 10.11).

(ii) The need to collect standard scientific observations on krill fishing and the provision of information from krill fishing nations on fishing methodologies, technology and fishing operations. In particular, operational data were needed on fishing selectivity, total mortality and vessel observer coverage (SC-CAMLR-XXV, paragraphs 4.18 and 11.13; CCAMLR-XXV, paragraphs 4.30 and 10.1 to 10.11).

Agenda Item 4.4 (key points in paragraphs 4.80 to 4.83) –

(iii) To obtain early notification of all fishing activity for krill, the Commission agreed to implement a notification procedure for krill fisheries (Conservation Measure 21-03) which requires Contracting Parties intending to participate in a krill fishery to notify the Secretariat of their intent not less than four months in advance of the Commission's regular annual meeting. The deadline of four months was chosen to allow sufficient time for notifications to be considered by the Scientific Committee and WG-EMM during their regular annual meetings (CCAMLR-XXII, paragraphs 4.37 to 4.39).

Agenda Item 5 (key points in paragraphs 5.87 to 5.94) –

(iv) Members to provide to the next meeting of WG-EMM submissions on what the potential effects of climate change on the Antarctic marine ecosystems might be, and how this knowledge could be used to advise the Commission on management of the krill fishery. The Scientific Committee also requested that Members consider how the effects of fishing might be distinguished from the effects of climate change. For example, could a program of experimental fishing be used to help quantify these effects and/or how might simulation studies using ecosystem models be used to understand what the potential effects might be (SC-CAMLR-XXV, paragraph 3.7).

Agenda Item 6.1 (key points in paragraph 6.51) –

(v) The status of review for CEMP site protection under Conservation Measure 91-01 (2004) in respect of Conservation Measures 91-02 and 91-03 (protection of Cape Shirreff and Seal Islands respectively) should be clarified and, if appropriate, reviewed at the earliest opportunity (SC-CAMLR-XXV, paragraph 3.17).

Agenda Items 2 and 6.2 (key points in paragraphs 2.71 and 6.55 to 6.57) –

(vi) To provide an update of the precautionary catch limit for krill in Division 58.4.2, and other elements of the conservation measure including subdivision of the catch, the placement of scientific observers and the utilisation of VMS in order to facilitate the orderly and precautionary development of the fishery (SC-CAMLR-XXV, paragraph 3.18; CCAMLR-XXV, paragraphs 12.65 to 12.69).

Agenda Item 7.3 (key points in paragraph 7.29) –

(vii) To review the use of bottom trawling gear in high-seas areas of the Convention Area, including with respect to relevant criteria for determining what constitutes significant harm to benthos and benthic communities in the Convention Area; and to begin developing a policy on destructive fishing practices by identifying vulnerable deep-sea habitats, including deep-sea corals, which may require protection from fishing (CCAMLR-XXV, paragraphs 11.27 to 11.33 and 12.28).

STATUS AND TRENDS IN THE KRILL FISHERY

Fishing activity

Season 2005/06

4.1 The total catch of krill reported from the fishery in Area 48 in the 2005/06 season, based on STATLANT data, was 106 589 tonnes. The Republic of Korea reported the largest catch of krill with a total of 43 031 tonnes. Japan also reported a large catch (32 711 tonnes). Ukraine, Norway and Poland reported catches of 15 206, 9 228 and 6 413 tonnes respectively.

4.2 The Working Group noted that, with the exception of the Republic of Korea and Poland, all Contracting Parties had submitted complete sets of fine-scale haul-by-haul data for 2005/06 in accordance with Conservation Measure 23-06.

4.3 The Secretariat advised that it had been in contact with the relevant authorities in the Republic of Korea and Poland, and it was hoped that the overdue data would be submitted to CCAMLR as soon as possible.

4.4 Most vessels fished in Bransfield Strait and the catch reported from the two Bransfield Strait SSMUs within this area showed the highest value compared to the historical catches from these SSMUs. This coincided with the low krill abundance which was recorded by the scientific survey conducted by the US AMLR Program in the South Shetland Islands area (WG-EMM-07/31).

4.5 It was unclear whether this distribution of fishing effort is a result of low krill density in the established fishing ground north of the South Shetland Islands, or is simply part of historically observed variations of catch distribution within Area 48.

Current season (2006/07)

4.6 Five vessels from three Contracting Parties (Japan, Republic of Korea and Norway) are fishing for krill in Area 48. Norway is employing the continuous fishing system. There was no information available on whether Vanuatu, which had notified its intent to fish in 2006/07, had been fishing this season.

4.7 A total catch of 70 832 tonnes of krill was reported by the time of WG-EMM-07. Based on the monthly catch and effort reports, 15 762 and 55 070 tonnes were reported from Subareas 48.1 and 48.2 respectively.

4.8 The preliminary projected estimate of the total krill catch for the 2006/07 fishing season is approximately 111 700 tonnes (WG-EMM-07/5). This compares with 106 589 tonnes of krill reported in the STATLANT data for the previous season (2005/06).

Time series

4.9 The total catch of krill has remained relatively constant since the 1999/2000 season (between 104 425 and 127 035 tonnes), however, there were marked changes in the balance of catches between Contracting Parties, including recent new entrants (Norway and Vanuatu).

4.10 During the past 10 seasons, the maximum catch in any SSMU occurred in one of three SSMUs (SGE, SOW and APDPW).

Fine-scale data arising from the continuous fishing system

4.11 In 2006, problems with the reporting of data on appropriate spatial and temporal scales from the continuous fishing system were identified. Norway had advised that a 'flow scale' instrument would be fitted to the vessel in 2007 to improve the collection of accurate catch data (SC-CAMLR-XXV, paragraph 4.16).

4.12 Analysis of the latest fine-scale data suggest that catches reported from the Norwegian-flagged vessel and taken from both conventional trawling and continuous fishing systems are still being estimated only once per day, and then divided into two-hour intervals. This approach fails to capture the variability in catch rates and precludes the accurate estimation of catch taken in each SSMU when more than one SSMU is traversed during a single continuous tow (WG-EMM-07/5).

4.13 The Working Group urged Norway to implement the proposed 'flow scale' instrumentation in 2007 and to report measured catches at two-hour time intervals (SC-CAMLR-XXV, paragraph 4.16).

Notifications for 2007/08
(table from WG-EMM-07/6 Rev. 2)

4.14 The total krill catch notified for the 2007/08 season was 764 000 tonnes, and was expected to be taken by 25 vessels from nine notifying countries. Ten vessels from three countries notified that they would be using a pumping system (Cook Islands, Russia and Ukraine) (WG-EMM-07/6 Rev. 2). However, at WG-EMM it was clarified that the pumping method notified by Russian vessels did not refer to continuous fishing, but rather to a method used to clear the codends of conventional trawls without hauling the net onto the deck.

4.15 It remained unclear whether the other notifications proposing the pumping method (Cook Islands and Ukraine) will be using the continuous fishing system, and the Working

Group asked the Secretariat to contact the relevant authorities to clarify the fishing method. It was also noted that although Norway has not specified its fishing method, the *Saga Sea* is known to be employing the continuous fishing system.

4.16 WG-EMM noted that the Secretariat has been seeking further information from Vanuatu authorities on the activities of vessels notified at the Scientific Committee meeting in 2006 but has not yet received an answer. No catch from Vanuatu has been reported so far in 2006/07.

4.17 The Working Group listed a number of issues regarding the notifications:

(i) the large number of notifications by non-Members;

(ii) for the first time, the total notified catch (764 000 tonnes) was greater than the trigger level in Area 48 (620 000 tonnes);

(iii) the increasing numbers of notifications for fishing using the continuous fishing system;

(iv) some notifications were incomplete on submission and/or revised after the deadline for submission;

(v) the varying quality of the notifications.

4.18 Regarding paragraph 4.17(iii), WG-EMM still does not have an adequate method to describe catch and effort data in the continuous fishing system. The Working Group urged Norway to undertake the studies proposed by the Scientific Committee in 2006 (SC-CAMLR-XXV, paragraph 4.16) to address this problem (paragraphs 4.11 to 4.13).

4.19 Regarding paragraph 4.17(iv), it was noted that it is essential to have all information submitted prior to the meeting of WG-EMM because notifications and revisions received after the meeting of WG-EMM would preclude management advice from WG-EMM on those notifications.

4.20 Regarding paragraph 4.17(v), suggestions were made to modify the notification form in Conservation Measure 21-03 (Annex 21-03/A) to provide information that would better assist WG-EMM in evaluating the notifications (paragraphs 4.77 and 4.78).

Deployment of observers

4.21 Five scientific observer (four international and one national) datasets were submitted for the 2005/06 season. These data were collected by CCAMLR scientific observers on board the vessels *Niitaka Maru* (Japan), *Konstruktor Koshkin* (Ukraine) and *Saga Sea* (Norway). At present, the CCAMLR database holds scientific observer data from 35 trips/deployments between 1999/2000 and 2005/06 in Subareas 48.1, 48.2 and 48.3, most of which were from Subarea 48.3 (WG-EMM-07/5, Appendix 1).

4.22 Two CCAMLR scientific observers have been deployed in the current season (2006/07) by the time of the WG-EMM meeting, both of them on the *Saga Sea* which is employing the continuous fishing system (WG-EMM-07/5).

By-catch

4.23 The incidental mortality of one Antarctic fur seal was observed in the krill fishery in Area 48 in the 2005/06 season.

4.24 Only 12.8% (7 234 hauls) of the total hauls in the krill fishery were observed for by-catch between 1999/2000 and 2005/06. The dominant by-catch species differed between SSMU groups, showing *Pleuragramma antarcticum* dominant in the Antarctic Peninsula region, *Champsocephalus gunnari* at South Georgia, and *Lycodapus* spp. at the South Orkney Islands. *Electrona* spp. were abundant in catches in both the South Georgia and South Orkney Island regions (WG-EMM-07/5).

Description of the fishery

4.25 The status of the krill fishing ground in Subarea 48.2, as determined from information collected by a Ukrainian national observer in the 2005/06 fishing season, was characterised by very low recruitment and density, and was not profitable for the fishing vessel involved (WG-EMM-07/9). On the other hand, Subarea 48.1 formed good fishing grounds, especially near Elephant Island and in Bransfield Strait. WG-EMM-07/9 further suggested that krill density of 280–300 g m^{-2} was the threshold density required for the Ukrainian fleet.

4.26 WG-EMM-07/27 used haul-by-haul data to identify whether there are simple signals in CPUE patterns that indicate when vessels move between SSMUs in different subareas. The mean CPUEs showed decreasing trends about 1–2 days before the vessels moved from an SSMU, suggesting that the captains were allowing over one day to determine if the factory supply can be maintained before moving. The authors suggested that vessel-specific information, e.g. capacity and rates of processing, determines the captains' decisions and searching time. The best way of achieving uniform reporting of high-quality data on such movements would be through the deployment of international CCAMLR observers trained in reporting these types of data.

4.27 The Working Group also drew attention to the questionnaire (SC CIRC 06/39) on fishery dynamics. It was noted that there has been no reply so far from fishing nations. WG-EMM urged Members to reply to this questionnaire to help gather fishery information to make progress in a fleet dynamics model.

Scientific observation

4.28 WG-EMM-07/P5 examined how current data collection through the fishing operation can contribute to a greater understanding of krill biology. It pointed out that the type of information available from the fishery is different from that usually available from research surveys, including complete seasonal coverage and high sampling frequencies from a single population. It pointed out future priorities for fishery-related research, including the effective use of the CCAMLR Scheme of International Scientific Observation to collect scientific information.

4.29 WG-EMM-07/16 provided an updated analysis of the *Saga Sea* catch data using both the continuous fishing system and conventional trawls, extending the initial analysis (WG-FSA-06/57) to include data collected up to May 2007. International observers covered 100% of the days fished in the current season.

4.30 A total of 1 721 hauls were conducted by the *Saga Sea* during the fishing period. Of these, 469 trawls (27% of the total) were sampled for krill and 146 trawls (8% of the total) were sampled for by-catch. By-catch was observed by using the newly developed interim protocol (WG-EMM-07/25).

4.31 The Working Group noted that comparison of krill length frequencies showed no differences between the size of krill caught by conventional and continuous trawls deployed by the *Saga Sea*.

4.32 Although the new protocol for the collection of data on fish larvae by-catch worked well, sampling coverage of larval fish was still not sufficiently comprehensive to allow a robust analysis of larval fish by-catch data. The results to date suggest that catch rates of larval fish from continuous trawls conducted by the *Saga Sea* are similar to those reported for conventional trawls.

4.33 WG-EMM-07/25 presented an interim protocol developed in response to the recent requests by the Scientific Committee to develop a standardised protocol for the quantitative assessment of fish in krill catches for use by observers on board krill fishing vessels (SC-CAMLR-XXV, paragraph 4.10). This manual was distributed to all krill fishing nations for use in the 2006/07 fishing season.

4.34 WG-EMM-07/26 assessed the workload of the tasks required in the *Scientific Observers Manual*. The total time needed for the minimum amount of daily routine tasks was above the capacity of a single observer if all the tasks listed in the manual were pursued as required. It was recommended that the instructions in the manual be revised so that the observer can systematically collect the various types of information across vessels and fishing methods by following the instructions (paragraphs 4.61 to 4.72). In order to accomplish the task, the Secretariat should consult with Dr Kawaguchi (Convener of the Subgroup on Fisheries) and technical coordinators.

4.35 WG-EMM-07/32 presented a field key to early life stages of Antarctic fish caught in the krill fishery. The key includes eight families and 28 species mainly from the Atlantic sector of the Southern Ocean and uses distinguishing characteristics which permit rapid field identification. This key has been used by national observers in the Japanese krill fishery for a number of years.

4.36 The Working Group thanked Japan for developing such a useful key to species identification, and suggested that it be submitted to WG-FSA for advice on its use as a guide for CCAMLR scientific observation.

4.37 WG-EMM encouraged all identification guides of the early life stages of fish currently used by Members be reviewed by WG-FSA to make a common identification guide for use by scientific observers on krill fishing vessels.

Scientific observer coverage

4.38 At the 2006 meeting of the Scientific Committee, three questions of priority in the krill fishery were highlighted (SC-CAMLR-XXV, paragraph 2.15):

(i) understanding the differences in selectivity between different krill fishing gear configurations;

(ii) determining the level of by-catch of fish larvae in the krill fishery;

(iii) determining the level of warp strikes by seabirds and incidental mortality of seals.

4.39 WG-SAM further identified a need for high-quality length-frequency data from the fishery from several years in advance of implementing an integrated assessment, and recommended that the fishery start providing length-frequency data now, given the coverage by the research surveys is not likely to be sufficient for all regions (Annex 7, paragraph 3.13).

4.40 The Working Group recognised that the requirements (precision, resolution etc.) for observer data collection may vary depending on the purpose, objectives or the questions that are being addressed.

4.41 It was suggested by the Working Group that, at some stage, a CCAMLR accreditation system for scientific observers may need to be introduced to ensure the quality and standard of the data when the number of observers increases (see also SC-CAMLR-XXV, paragraph 2.11).

4.42 The Working Group discussed the kinds of data needed from the fishery, the data available from other sources, and the spatial and temporal coverage required.

4.43 The Working Group noted that the size selectivity of commercial nets is subject to gear types and fishing method (WG-EMM-07/28) and advised that it is important that the length-frequency data are accompanied by this information.

Options for observer coverage

4.44 The Working Group focused on the question: 'What data are required to provide reliable answers to each of the Scientific Committee's priorities in respect of the krill fishery?' (SC-CAMLR-XXV, paragraph 2.15).

4.45 The Working Group endorsed two strategic objectives for scientific observations in the krill fishery:

(i) to understand the overall behaviour and impact of the fishery
(ii) to undertake routine monitoring of the fishery to inform population and ecosystem models.

4.46 The Working Group noted that it will only be possible to design the spatial and temporal level of coverage required for (ii) once (i) has been completed. A full investigation of (i) would require a systematic coverage by scientific observers across SSMUs, seasons, vessels and fishing methods.

4.47 The rationale behind this two-stage approach is that fisheries monitoring effort does not necessarily have to have indefinite maximum coverage if a reduced observation effort is sufficient to fulfil management requirements. There is, however, an expectation that there will be a long-term need for systematic data collection from the fishery.

4.48 The Working Group agreed that there are a number of ways to collect the required scientific data from the krill fishery. For example, the most comprehensive coverage, and the most rapid way to achieve objective (i), could be either of the following alternatives:

- 100% coverage by international observers
- 100% coverage by international and/or national observers.

4.49 The Working Group noted that reduced levels of observational effort would significantly delay the achievement of objective (i) but this reduced effort could include:

(i) systematic but <100% coverage by observers;

(ii) different levels of coverage for different fleets, for example, 100% coverage for new vessels with unknown characteristics and a lesser level of coverage on established vessels for which data are already available;

(iii) random systematic allocation of observers plus regular quality checks, and systematic coverage by international observers until the fishery is established for vessels from which data suitable for the purposes described in paragraph 4.47 are not available.

4.50 The Working Group noted that not only would these approaches delay the data collection effort, they could also introduce bias into the data.

4.51 The Working Group further clarified that:

(i) 'systematic coverage' means coverage that ensures data collection across all areas, seasons, vessels and fishing methods, which leads to the provision of consistent high-quality data for assessment in multi-vessel multi-nation fisheries (Annex 7, paragraph 4.16);

(ii) to obtain the required information, either international or national observers would be acceptable, provided the data and reports are consistent with the CCAMLR scheme and are of a sufficiently high quality to be of use for the proposed analyses.

4.52 The Working Group acknowledged that each of the options for obtaining the priority data required by the Scientific Committee would have consequential issues of implementation and time scale of delivery.

4.53 Dr M. Naganobu (Japan) expressed his disagreement to the compulsory 100% deployment of international scientific observers and/or national observers on krill fishing vessels since he understands that: (i) deployment of scientific observers through bilateral agreement is sufficiently effective and has provided scientific data, (ii) compulsory 100% observer deployment has significant financial implications, and (iii) in relation to larval by-catch, Japan and Norway have already observed the level of by-catch in the krill fishery, and there are no recent reports on incidental mortality of seabirds and seals.

4.54 The Working Group noted, however, that answering the questions posed by the Scientific Committee would require systematic observation and it welcomed any proposals for the alternative methods to achieving systematic and consistent collection of the required scientific data without 100% observer coverage.

4.55 In noting that arguments against 100% coverage have in the past been made in relation to the level of depletion of the krill resource (CCAMLR-XXV, Annex 5, paragraph 5.4), the Working Group emphasised that the requirement for observer coverage is in no way related to the level of depletion of the krill resource, but results from requirements for scientific information on the ecosystem effects of the krill fishery.

4.56 Members of the Working Group expressed their frustration that the collection of these data, which have been granted a high priority by the Scientific Committee, is being impeded by non-scientific arguments.

Scientific observer data

4.57 The Working Group discussed the use of CCAMLR scientific observer cruise reports as potential means for assessing accuracy and completeness of data collected by observers (WG-EMM-07/22). It was agreed that the main purpose of observer cruise reports should remain the provision of summary information on observations conducted and data collected, including detailed description of fishing gear and general comments of observers on the use of the *Scientific Observers Manual* and observer logbooks and any difficulties encountered during observation. Information contained in observer cruise reports has been used by the Secretariat, when required, as an additional source of information for the verification of data collected by observers and submitted in observer logbooks.

4.58 The Working Group recommended that the Secretariat be requested to prepare a summary of the data collected by scientific observers on board krill fishing vessels during the 2006/07 season, similar to the summaries of information annually prepared by the Secretariat on observations conducted in finfish fisheries, in particular, for toothfish (e.g. WG-FSA-06/37 Rev. 1 and 06/38), and to submit it to the next meeting of WG-EMM for review and approval.

4.59 The Working Group noted that the analyses of available cruise reports, presented in WG-EMM-07/22, indicated that the quality of summary information recorded by observers in these reports could be improved, in particular, in terms of increasing consistency of completion of all sections of the cruise report by all observers. In addition, the section with gear description could be improved by adding schematic layouts of various types of trawl gear, in particular, for krill fishing to assist observers in recording details of fishing gear used. At present, the cruise report form contains only a schematic layout of longline gear.

4.60 The Working Group requested the Secretariat to look into the issue with technical coordinators of national observer programs and gear experts, prepare the required illustrations and update the cruise report form. Consultations on the issue with experts present at the forthcoming meeting of WG-FSA would also be useful.

Scientific Observers Manual

4.61 The Working Group revisited the observers' priority tasks identified by the Scientific Committee.

4.62 The Working Group recommended that the collection of data to meet the three priorities (SC-CAMLR-XXV, paragraph 2.15) must be undertaken and listed as the highest priorities in the observer tasks. In doing so, the Working Group recognised that this may result in a high workload for the observer to ensure collecting comprehensive information on fish larvae by-catch using the interim fish larvae by-catch protocol (WG-EMM-07/25).

4.63 The Working Group recommended that the way forward was to have some of the biological information (maturity stage, feeding intensity) as lower priority items, but to provide the observers with thorough guidance on how data can be collected without compromising systematic observation coverage in time and space.

4.64 One option is to have the required scientific observation from krill fisheries (SC-CAMLR-XXV, paragraph 2.12) listed by the Scientific Committee as mandatory items, and the other tasks listed as optional. However, this may result in inconsistent coverage in time and space.

4.65 The interim fish larvae by-catch protocol was adopted as the standard protocol for fish larvae by-catch observation after some technical revisions.

4.66 The interim fish larvae protocol instructs the observers to randomly preserve remainders of sorted samples for later analysis by Members. Scientists from the Designating Member of the observers are encouraged to undertake the analysis. A minor technical difficulty was pointed out regarding the large amount of samples that would need to be stored on board the fishing vessels.

4.67 WG-EMM also requested data on the frequency of infected krill with black spots to be included in the *Scientific Observers Manual* (WG-EMM-07/29).

4.68 The Working Group agreed that all suggested revisions of the *Scientific Observers Manual* should be done through close correspondence between the CCAMLR Scientific Observer Data Analyst and relevant experts.

4.69 The Working Group also noted that krill length-frequency data are accumulated through scientific observation and these allow some comparison in selectivity between vessels and between fishing methods, but that these observations were spatially and temporally limited. Coverage in time and space could be improved through systematically increasing observer coverage or through the collection of such data by the fishing vessels.

4.70 The Working Group noted that the conservation measure for the data reporting system for krill fisheries (Conservation Measure 23-06) is the only conservation measure for a CCAMLR fishery that does not have an obligation to collect biological information.

4.71 The Working Group recommended that the requirements for the collection of biological information from the krill fishery should be consistent with the finfish fisheries, which require mandatory reporting of length composition measurements of target species (Conservation Measure 23-05) (paragraph 5.51).

4.72 It was also noted that in finfish fisheries the presence of compulsory scientific observers on vessels takes the reporting burden off the vessel's crew. However, without observers on the fishing vessels, the crew would be required to collect and report these data.

Regulatory issues

Orderly development of the krill fishery

4.73 WG-EMM-07/23 described Australia's position regarding the scientific requirements related to the orderly development of the krill fishery as foreshadowed in the Commission meeting in 2006 (CCAMLR-XXV, paragraph 12.66). It recommended that in keeping with the precautionary approach, steps need to be taken to establish when, relative to the scale of the fishery, different arrangements need to be set in place.

4.74 WG-EMM-07/23 recommended the following for ensuring the orderly development of the krill fishery (as described more fully in the paper):

(i) Undertake krill stock surveys in areas with no precautionary catch limits to set a catch limit before fishing is prosecuted.

(ii) Establish SSMUs to minimise localised impacts on krill predators prior to a threshold being reached, to avoid impacts on the predators dependent on that location for food, and allow for the reasonable development of the fishery.

(iii) Establish a threshold capacity for the fishery relative to the catch limits until the system for managing the catch limits is in place.

(iv) Develop a program to monitor and observe krill catch and by-catch, with methods for minimising by-catch in krill fisheries developed early to achieve low levels of by-catch from the outset.

4.75 The paper concluded that CCAMLR will not be able to meet its objective, including an orderly development of the krill fishery, unless the outlined processes are adopted as integral components of managing the krill fishery.

4.76 The Working Group agreed that a strategic approach to the orderly development of the krill fishery, such as that suggested by Australia, would allow the Commission to better control and mitigate the level of impact by the krill fishery on the krill stocks and on predator populations (see paragraph 2.79).

Notification form

4.77 The Working Group recalled the purpose of the conservation measure on the notification of intent to participate in a krill fishery (Conservation Measure 21-03, Annex 21-03/A). This was to provide, *inter alia*, WG-EMM with projections of the expected catch, and where, when and how those catches may occur, for discussion during the annual Working Group meeting. This allows an improved assessment of interest in the krill fisheries and an examination of potential trends in the fishery.

4.78 WG-EMM noted the usefulness of these notifications and suggested some additions to the notification form (Conservation Measure 21-03, Annex 21-03/A) to improve its utility (Appendix D).

Key points for consideration by the Scientific Committee

4.79 The krill catch for the 2006/07 season in Area 48 was 106 589 tonnes. The Republic of Korea reported the largest catch of krill with a total of 43 031 tonnes. Japan also reported a large catch (32 711 tonnes). Ukraine, Norway and Poland reported catches of 15 206, 9 228 and 6 413 tonnes respectively (paragraph 4.1), and the Working Group noted that with the exception of the Republic of Korea and Poland, all Contracting Parties had submitted complete sets of fine-scale haul-by-haul data for 2005/06 in accordance with Conservation Measure 23-06 (paragraph 4.2).

4.80 The total krill catch notified for the 2007/08 season was 764 000 tonnes, and was expected to be taken by 25 vessels from nine notifying countries. Ten vessels from three countries notified that they would be using a pumping system (Cook Islands, Russia and Ukraine) (WG-EMM-07/6 Rev. 2) (paragraph 4.14).

4.81 The high level of notifications indicated that, if all the projected catches were taken, the trigger level for Area 48 (620 000 tonnes) would be exceeded (paragraph 4.17).

4.82 There were notifications of large catches from non-Member States (Cook Islands, 175 000 tonnes and Vanuatu, 80 000 tonnes) (paragraph 4.17).

4.83 The Working Group suggested some modifications to the notification form (Conservation Measure 21-03, Annex 21-03/A) to provide information for improved assessment of interest in the krill fisheries and an examination of potential trends in the fishery (paragraphs 4.20, 4.77 and 4.78) and to take note of the issues in paragraphs 4.17 to 4.20.

4.84 WG-EMM recommended that the instructions in the *Scientific Observers Manual* be revised (paragraph 4.34), and the interim fish larvae by-catch protocol (WG-EMM-07/25) be included, so that the various types of information urgently needed by the Scientific Committee could be systematically collected (paragraphs 4.64 to 4.72).

4.85 The Working Group agreed on two strategic objectives for scientific observations in the krill fishery (paragraphs 4.45 and 4.46):

(i) to understand the overall behaviour and impact of the fishery
(ii) to undertake routine monitoring of the fishery to inform population and ecosystem models.

4.86 The Working Group considered a number of options and approaches and made recommendations on the deployment of observers in the krill fishery to achieve the objectives in paragraphs 4.44 to 4.56.

4.87 To assess the accuracy and completeness of the data collected by scientific observers in the krill fishery, the Working Group requested the Secretariat to prepare a summary of the data collected by scientific observers on board krill fishing vessels during the 2006/07 season and to submit it to the next meeting of WG-EMM for review and approval (paragraph 4.58).

4.88 The Working Group noted that the conservation measure for the data reporting system for the krill fishery (Conservation Measure 23-06) is the only conservation measure that does not require the collection of biological information, and recommended that the requirements from the krill fishery should be consistent with the finfish fisheries (Conservation Measure 23-05) (paragraphs 4.70 and 4.71).

4.89 The Working Group agreed that a strategic approach to the orderly development of the krill fishery would allow the Commission to better control and mitigate the level of impact by the krill fishery on krill stocks and on predator populations (paragraphs 4.73 to 4.76).

STATUS AND TRENDS IN THE KRILL-CENTRIC ECOSYSTEM

Status of predators, krill resource and environmental influences

Predators

CEMP indices

5.1 Dr Ramm summarised recent submissions of CEMP data, data validation and trends in CEMP indices (WG-EMM-07/4). Data for 2006/07 were submitted by eight Members for 10 sites and 13 different CEMP parameters. The Italian CEMP researchers had reported that their study season at Edmonson Point in 2006/07 had been short and only breeding population and breeding success counts had been undertaken. In addition, CEMP data from Esperanza (Hope Bay) were collected in 2006/07 but were lost in a fire on board the Argentine icebreaker *Irizar*.

5.2 Dr Ramm also reported that routine validation and logic testing of CEMP is now complete for data submitted to June 2007. In general, the quality of the CEMP submissions remains high; however, in recent years there have been some recurring issues which had the potential to reduce the quality of these data. These issues were examined by the Subgroup on Methods (paragraphs 5.69 to 5.76).

5.3 Dr P. Wilson (New Zealand) confirmed that aerial photographs for determining breeding population counts for Adélie penguins (*Pygoscelis adeliae*) at Ross Island had been taken in 2003/04, 2004/05, 2005/06 and 2006/07, and population counts derived from these photographs are currently being undertaken and should be available in 2008.

5.4 The Working Group thanked Dr Ramm for his summary of the CEMP data and noted that, while the number of CEMP parameters and Members submitting data had remained relatively constant, the number of sites from which data had been submitted had declined over the past five years. It was noted that this change may not simply be related to funding, but to a combination of issues including shifting scientific priorities.

5.5 The Working Group noted evidence that the krill fishery may be entering a period of expansion (WG-EMM-07/5) which implies that there may be an increased need for monitoring. It further noted that the ability to effectively manage the fishery in areas with no monitoring data may be restricted compared to those areas with more data. The Working Group felt that data collection now is an investment in the future management of the fishery.

5.6 The Working Group also noted that there are countries doing research of interest to CCAMLR and its work which do not currently contribute to the CEMP database. The Working Group encouraged CCAMLR Members with active research programs to join ongoing and future efforts of importance to the work of CCAMLR.

Predator summary

Winter data from the Antarctic Peninsula region

5.7 WG-EMM-07/10 analysed data from archival temperature tags to investigate the daily time and energy budgets of gentoo penguins (*P. papua*) for the full winter periods of 2005 and 2006 in the South Shetland Islands. In general, the time budget of gentoo penguins tracked the cycle of day length and exhibited diurnal foraging patterns. Foraging trip durations tracked light availability throughout the winter; however, lower variation in trip duration among individuals in early winter suggested that gentoo penguins use all available daylight to maximise time spent foraging prior to the mid-winter period. Increased variability in early spring trips may be related to increased activities associated with courtship. Among environmental parameters that affected the winter time budget, air temperature was consistently identified by statistical models, with warmer days associated with longer foraging trips, and colder days associated with reduced trip frequencies. Future work during winter will benefit from increased sample sizes, geolocation of sample birds and complementary data on the diets to refine estimates of consumption during winter.

5.8 The Working Group welcomed this contribution, noting that little is known about the natural history of any penguin species during the winter period in this region. However, increasingly, it appears to be the major time period affecting adult survival and juvenile recruitment in penguins. Initial estimates of winter energy budgets presented in the paper are also useful but will benefit from concurrent work on diets and local movement patterns of individuals over the winter period.

5.9 The Working Group noted that gentoo penguins, unlike their more numerous congeners, the Adélie and chinstrap (*P. antarctica*) penguins are non-migratory and would therefore serve as year-round samplers of the marine system within discrete SSMUs. The Working Group further noted that while the small population sizes of gentoo penguins in Area 48 may suggest they have relatively little impact on krill resources in the region, their life history characteristics make them particularly good indicators of local prey abundance.

Predator foraging parameters from the Antarctic Peninsula region

5.10 WG-EMM-07/P2 compared the size and sex of Antarctic krill (*Euphausia superba*), taken from chinstrap and gentoo penguin diet samples, to those from scientific net surveys in the adjacent region of the South Shetland Islands from 1998 to 2006. Both penguin diet and net samples revealed a four- to five-year cycle in krill recruitment with one or two strong cohorts sustaining the population during each cycle. Penguin diet samples contained adult krill of similar lengths to those caught in nets; however, penguins rarely took juvenile krill. Penguin diet samples contained proportionately more females when the krill population was dominated by large adults at the end of the cycles; net samples showed greater proportions of males in these years. The authors suggest that these patterns are likely driven by the availability of different sizes and sexes of krill in relation to the colony.

5.11 WG-EMM-07/11 examined the diet of chinstrap penguins at Livingston Island, South Shetland Islands, in relation to their diving and foraging behaviour using time-depth recorders over five seasons from 2002 to 2006. Results revealed that when krill were smaller, chinstrap penguins often exhibited a shift to deep dives after sundown, and then resumed their shallower pattern at sunrise. These night-time dives were unexpectedly deep (up to 110 m) and mean night-time depths sometimes exceeded those from the daytime. The average annual size of krill was negatively correlated to the number of penguins foraging on fish, mean night-time dive depths, and the proportion of foraging trips occurring overnight. Based on these patterns, the authors suggested that when krill were small, penguins foraged more on myctophid fish. In addition, the average krill size was negatively correlated to the time chinstrap penguins spent foraging, which suggests that penguins incurred a cost associated with this switch to fish by spending more time at sea foraging.

5.12 WG-EMM-07/P1 summarised results from penguin studies at Cape Shirreff in the South Shetland Islands undertaken by US AMLR researchers in the 2006/07 season. Both gentoo and chinstrap penguin populations experienced average years with breeding success and chick fledging weights slightly below the 10-year mean for gentoo penguins, while both of these parameters were slightly above the mean for chinstrap penguins. Diet samples contained the highest proportion of fish in the 10 years of study and both species had significant amounts of juvenile krill (<35 mm in length) in their diet samples. The small krill and increased percentage of fish in the penguins' diets in 2006/07 were very similar to diet data from the 1997/98 and 2002/03 seasons. In addition, the mean foraging trip durations during chick rearing were significantly longer than in the previous season.

5.13 The Working Group discussed the female bias in krill found in penguin diets reported in the latter years of each krill recruitment cycle. It noted that this bias may be related to spatial segregation of non-breeding females inshore with males located offshore; however, several other explanations were suggested, including:

(i) local effects could be influencing the krill population at Cape Shirreff as krill distributions are very dynamic, particularly in poor years;

(ii) vertical stratification in krill could account for the female bias;

(iii) older krill are female-biased due to differences in growth and survival between males and females (WG-EMM-07/P6);

(iv) penguins may be selecting large female krill for their higher energy value.

5.14 The Working Group noted the high incidence of fish in the penguin diets in years dominated by small juvenile krill and the concurrent increase reported in foraging trip duration in those years. The authors added that in addition to longer foraging trips, years with a high proportion of fish included foraging trips 30 to 40 km offshore, to the shelf break and beyond. Years where large krill dominated the penguin diets were characterised by short foraging trips within 10 km of the colony.

Indian Ocean sector

5.15 WG-EMM-07/21 investigated the relationship between sea-ice and Adélie penguin reproductive performance at Béchervaise Island. Sea-ice influences penguin populations through a variety of processes operating at different spatial and temporal scales. To further understanding of the relationship between sea-ice and penguin biology, the authors examined annual breeding success in relation to three sea-ice attributes: (i) winter sea-ice cover; (ii) offshore summer sea-ice cover; (iii) near-shore summer ice cover. Results indicated that the relative importance of sea-ice cover on reproductive performance differs according to the spatial scale and timing of sea-ice presence and magnitude. In particular, the analyses presented here highlight the importance of the influence of near-shore January ice cover on reproductive performance for Béchervaise Island Adélie penguins.

5.16 The Working Group noted that there is mounting evidence of the effects of climate change in the Antarctic ecosystem and that it is therefore important to continue the assessment of the linkage between penguins and their ice environment. Such understanding will aid in interpreting results from the CEMP monitoring program and in predicting changes in krill-dependent predator populations.

5.17 The Working Group cautioned that the Antarctic ecosystem should not be regarded as a single system operating in a uniform manner; rather it is increasingly evident that the Antarctic Peninsula, East Antarctica and the Ross Sea regions are responding to environmental change in differing ways and at different rates. The linkages between sea-ice, krill and predators that have been reported in the Antarctic Peninsula region may not hold for other regions.

5.18 The Working Group further noted that, given the different responses in the system to environmental change, it will be important to have monitoring sites in regions that have different ice regimes. The design of future monitoring studies should include not only what is measured, but also include a consideration of where measurements are made, so that fishery–predator interactions will be assessed over a broad range of environmental conditions.

Ross Sea region

5.19 WG-EMM-07/7 reported on a joint survey of the RV *Kaiyo Maru* and the Japanese Whale Research Program that examined the interactions between oceanographic conditions, the distribution of krill and baleen whales in the Ross Sea region during the austral summer of 2004/05. Results indicated close interactions between the thermal conditions, krill and baleen whale distributions. Humpback whales (*Megaptera novaeangliae*) were mainly distributed in ACC waters with high density around 0°C near the southern boundary of that current. Antarctic minke whales (*Balaenoptera bonaerensis*) were mainly distributed in Antarctic surface water and shelf water with a high density around –1°C in the continental shelf slope frontal zone. The interaction between distributions and abundance of krill and baleen whales and oceanography, relating water mass and circulation pattern of the oceanic surface layer, was summarised in a conceptual model.

5.20 WG-EMM-07/P4 summarised observations of Weddell seals (*Leptonychotes weddellii*) feeding on Antarctic toothfish (*Dissostichus mawsoni*) in McMurdo Sound from the 2001 to 2003 austral summers. In addition to past reports of isolated toothfish captures, the frequency of these observations, and the quantity of toothfish captured, suggest that this species is a significant prey item for Weddell seals, and that the recent development of a toothfish fishery in the Ross Sea may have broad ecosystem impacts.

5.21 The Working Group noted the importance of behavioural data in predator studies, as identifiable hard-part remains (otoliths) of toothfish seldom appear in Weddell seal scats, yet toothfish may be important to this species' foraging ecology. It further noted that new innovative techniques, such as critter-cams, might be very helpful in improving our knowledge of the potential overlap between predators and the toothfish fishery.

5.22 Dr Nicol suggested that new molecular techniques may allow prey items to be identified when hard parts are missing, and may also be useful to investigate prey consumed by predators at times of the year when access to them is difficult. Improved data on diets of predators are of great importance for models to be used in calculations of predator demand.

5.23 Dr Wilson noted that the Ross Sea region has several sites where monitoring-type data have been collected for 20+ years, and suggested it would be important to determine how WG-EMM might encourage the submission of these data to CCAMLR. Data from the Italian program were of particular interest, given a recent finding suggesting that the program is monitoring in an important transition area in the Ross Sea (WG-EMM-07/7).

5.24 The Working Group further noted the proposal for a new monitoring parameter on Weddell seals (WG-EMM-07/13).

5.25 The Working Group discussed the need for, and development of, a monitoring program for the Ross Sea region. Some participants felt there was an urgency to proceed along this path, given the rapid development of the toothfish fishery in recent years and the lack of any monitoring data of relevance to this fishery in the region. However, there were several concerns, including that:

(i) it would be counter productive to begin collecting data without first developing a monitoring design that was both theoretically sound and pragmatic;

(ii) it will be important to distinguish between what must be collected to have a viable monitoring program and what would be additional information to assist in better understanding the ecosystem;

(iii) to be helpful, a monitoring program would have to have a long-term funding commitment.

5.26 The Working Group expressed its appreciation for the work presented from the Ross Sea region and encouraged future contributions that would assist in providing advice to CCAMLR regarding the toothfish fisheries in Subareas 88.1 and 88.2.

Krill resources

Survey results

5.27 WG-EMM-07/8 reported on a krill net sampling survey along three transects in the southern part of Subarea 48.6 during winter 2006. During this period the survey area was completely covered by seasonal pack-ice. Antarctic krill was caught in most of the 54 RMT samples. Krill abundance estimates for the current winter survey in the Lazarev Sea resulted in 13.9 krill 1 000 m^{-3}. This was a significant increase compared to the mean numerical density observed during an early summer survey carried out in the same season, which resulted in a density estimate of 3.15 krill 1 000 m^{-3}. Size composition in winter was dominated by 1- and 2-year-old krill; however, the proportion of the juvenile group was relatively low, indicating only a moderate abundance of the 2005 year class.

5.28 It was argued in the paper that a quantitative evaluation of the other Euphausiacea species seems to be essential, because they not only overlap with Antarctic krill in the same area, but they can also occur in similar numerical densities and, depending on the area, in similar size classes. This may cause problems in species delineation during the acoustic surveys for krill biomass estimates. Therefore, the study also covered the distribution of other euphausiids and their abundance.

5.29 Ice krill (*E. crystallorophias*) was found exclusively on the narrow shelf and along the slope stations of the continent. Numbers were relatively low and densities did not exceed 2 krill 1 000 m^{-3}. *Thysanoessa macrura* was distributed across all stations of the survey grid. Densities were one order of magnitude lower in winter than in the preceding summer when *T. macrura* outnumbered the density of *E. superba* five times. However, samples from the multiple RMT in winter indicated substantially higher densities of *T. macrura* in deeper depth strata down to 400 m. This would point to a seasonal vertical migration of the species to deeper waters in winter.

5.30 The analysis of *E. superba* larvae resulted in an average density of 6.8 furcilia m^{-2}. Compared to historic data of the FIBEX 1982 survey or the CCAMLR-2000 Survey, the density of larvae in the Lazarev Sea was relatively low. However, due to the lack of time-series data from Subarea 48.6 it is impossible to identify whether 2006 was an unusually poor year for krill larvae in that area or whether the situation reflects the common situation in the Lazarev Sea.

5.31 WG-EMM-07/7 presented results of a survey to the Ross Sea in 2004/05 to study the interactions between oceanographic conditions, and the distribution of krill as prey and baleen whales as predators in the Ross Sea. The oceanography of the surface layer was summarised as an oceanographic environmental index that integrated the mean temperature from 0 to 200 m in depth (ITEM-200). Distribution of ITEM-200 was used as background information to compare distribution patterns of species. *Euphausia superba* was mainly distributed in the Antarctic surface water area (ITEM-200 between 0° and –1°C). *Euphausia crystallorophias* did not occur in the Antarctic surface water, but was distributed in the colder shelf water on the continental shelf south of the –1°C isopleth of ITEM-200 which approximately coincides with depths shallower than 1 000 m.

5.32 The survey area was divided into two strata to estimate the biomasses of the two krill species based on their distribution patterns. Biomass densities of *E. superba* and *E. crystallorophias* were estimated to be 5.36 g m^{-2} and 3.44 g m^{-2} respectively. The total biomass of *E. superba* and *E. crystallorophias* in the study presented here were estimated to be 2.04 and 1.26 million tonnes respectively.

5.33 The Working Group noted that the ITEM-200 index might be a helpful tool to delineate areas of different krill distribution patterns or for bioregionalisation purposes. It was suggested that the general appropriateness of the index should be tested for other areas, because the temperature range described for krill distribution in the Ross Sea is obviously different in areas such as the Antarctic Peninsula or the Scotia Sea.

5.34 The Working Group encouraged further oceanographic and sighting studies in the Ross Sea and other high-latitude areas around the continent, such as the one presented in WG-EMM-07/7 (see discussion in paragraphs 6.28 to 6.30). It was noted that the segregation between *E. superba* and *E. crystallorophias* has also been observed in other high-latitude areas, such as the southern Weddell Sea and the Prydz Bay region, but not in the Lazarev Sea and the Bellingshausen Sea, where the two species co-occur on the shelf. This can be important for subdividing subareas and the setting of future precautionary catch limits.

5.35 WG-EMM-07/30 Rev.1 reviewed the estimation of krill biomass of the international acoustic CCAMLR-2000 Survey across the Scotia Sea (Subareas 48.1 to 48.4) (see paragraphs 2.17 to 2.19). A detailed discussion of the new methods and the recommendations can be found in the report of SG-ASAM (Annex 8) and the discussion of the krill acoustic subgroup during the WG-EMM workshop (paragraphs 2.11 to 2.32).

5.36 WG-EMM-07/33 updated the survey estimate for Division 58.4.2, which was first presented to WG-EMM in 2006 (WG-EMM-06/16). A reanalysis of the data has resulted in amendments to the acoustic estimates of krill mean biomass density, biomass and variance. The methods are clearly described in the paper. The volume-backscattering bins at 120 kHz were classified into krill and non-krill, where krill are defined by the algorithm S_v 120–38 kHz = 2–16 dB and S_v >–80 dB. The analysis also applied the Greene et al. (1991)

TS:length model at 120 kHz to convert the krill areal-backscattering values to an areal measure of biomass density. In general it can be realised that the post-processing of the raw echosounder data was consistent with the acoustic protocol applied for the original CCAMLR-2000 Survey analysis (see paragraph 2.29 and Hewitt et al., 2004).

5.37 Krill were widely distributed at relatively low densities throughout the survey area; only 13% of the 2-km-alongtrack echo-integration intervals were devoid of krill, 50% of intervals registered densities of 1 g m^{-2} of krill or less. The mean acoustic biomass density of krill, integrated to 250 m depth across the entire survey stratum of Division 58.4.2 (1.31 million km^2), was 9.48 g m^{-2}. B_0 was estimated to be 12.46 million tonnes with a CV of 15.15%.

5.38 The krill distribution was considered in the context of the physical oceanography, from which a case is presented for the subdivision of Division 58.4.2 into smaller, more biologically homogeneous, areas. The paper suggested that Division 58.4.2 be divided into four ecologically distinct harvesting units. The simplest subdivision is longitudinally at 55°E, which acknowledges the dominant influence of the Weddell Gyre and the Prydz Bay Gyre. A further latitudinal subdivision at 65°S would take into account both the krill demography and the southern boundary of the ACC, and would also reflect the influence of the Antarctic Slope Current (see also paragraphs 6.18 to 6.24).

5.39 Drs Nicol and Jarvis informed the Working Group that they will provide the biomass estimate results as well as the revised potential yield estimates for the subdivided harvesting units of Division 58.4.2 to the Scientific Committee using the newly agreed acoustic protocols (Annex 8; see also paragraph 3.1(vi)). They further indicated that the biomass estimate of the 1996 survey of Division 58.4.1 will be revised according to the agreed protocols for the next meeting of WG-EMM, so that a consistent set of biomass estimates will be available to revise the existing precautionary catch limits.

5.40 WG-EMM-07/31 presented krill biomass trends in the South Shetland Island region of Subarea 48.1. Only daytime data were used in the analysis due to possible bias from diurnal vertical migration. All previous data from 1996 to the present were reanalysed using the simplified SDWBA target-strength model and a dynamic ΔS_v krill delineation model. Krill are delineated from other scatters by use of a three-frequency ΔS_v method instead of using a constant range of ΔS_v (i.e. $2 \leq S_v120$ kHz – S_v38 kHz ≤ 16 dB). This is in conformity with the agreed protocol currently accepted by SG-ASAM (Annex 8).

5.41 In 2007 krill was distributed in dense layers all across the survey area. The biomass was 294, 129 and 43 g m^{-2} for the Elephant Island, the South Shetland Islands and Bransfield Strait areas respectively. The total biomass exceeded 19 million tonnes. This increase from <500 000 tonnes in 2006 represents the largest biomass recorded in nearly 20 years. One-year-old krill were poorly represented in the net samples in 2006, but more than 60% of the biomass of krill collected in 2007 was composed of two- and three-year-old krill. This suggests that either a large recruitment event was not captured in surveys conducted in 2006 or 2005, or that in 2007 advection from elsewhere is responsible for the recent increase. The paper discussed the observation that anomalously high temperatures and high chl-*a* conditions in 2006 may have affected distribution of krill in that year.

5.42 The Working Group observed that the biomass time series shows that the biomass during the year of the CCAMLR-2000 Survey was in the lower range of the biomass estimates. It further noted that in 2007 krill biomass around Elephant Island and north of the South Shetland Islands was substantially higher than in Bransfield Strait. This is in contrast with the observer report from the *Saga Sea*, which indicated that in the 2006/07 season major krill fishing activities in Subarea 48.1 have moved from outside to inside Bransfield Strait (WG-EMM-07/16). However, final conclusions about the behaviour of the fishing fleets can only be made after the complete catch and effort data for 2006/07 will have been submitted to the CCAMLR Secretariat.

5.43 The Working Group further noted that the biomass estimates in Subarea 48.1 from acoustic and net sampling data show very similar trends across the long-term time series, which was very encouraging. It stressed the importance of continuation of collecting krill density and recruitment indices for this area, since these are important input parameters for the GYM to calculate precautionary catch limits.

Biological information

5.44 WG-EMM-07/P6 consisted of two parts: (i) krill sex ratio across length classes was examined using field survey data; and (ii) model simulation was performed to explore the model structure and parameter settings that best explain the trends observed from the field. The field data show that the proportion of males was consistently high in the smallest adult size class (30–35 mm). The proportion of males was always low in medium-sized krill (38–42 mm), but showed higher values in larger krill (45–50 mm), and the values again decreased in the largest animals.

5.45 The outcome of the simulation model indicated that the trend of male proportions with length is a result of the combined effects of differential growth rates and mortality rates between the sexes, the age composition of the population, the life span and the degree of mortality acceleration at the end of the life span.

5.46 Results suggested that a higher proportion of males tends to be associated with good recruitment. The authors argue that, as the population ages with little recruitment, and thus little input of new males, the population becomes dominated by the longer living females. With a high recruitment in some years, combined with higher proportion of males than females at birth, the ratio becomes skewed towards males. Overall, it appears that the pattern of proportion of males across size is mainly dictated by the life span of males (3–4 years) in relation to females (7 years). An assumed 3–4 year male life span, or accelerated mortality above age 3, compared to the female 7 years' lifespan, seemed to best reproduce the pattern observed from the field data. This may explain interannual differences in male:female ratios. The discussion mentioned that the consequences would be obvious, accelerated mortality in above age 3 in males means that if the number of years with poor recruitment increases, then there would be a major reduction in surviving productive males, and restoring the population would become more difficult than it would be in a population with males and females of the same age structure.

5.47 The Scientific Committee and WG-EMM have commented extensively on the implications of new technologies in the krill fishery (SC-CAMLR-XXIV, paragraphs 4.4 to 4.10; SC-CAMLR-XXV, Annex 4, paragraphs 3.28 to 3.31 and 3.48 to 3.61; WG-EMM-06/27). In particular, concerns have been expressed that the new continuous fishing system may capture different components of the krill population and may have a higher ecosystem impact than conventional trawls. However, even for the conventional trawl, very limited information is available on catchability or selectivity. WG-EMM-07/28 presented information on selectivity and vulnerability of krill in conventional trawling, by comparing length-frequency data of krill from RMT1, RMT8 and a pelagic trawl.

5.48 WG-EMM-07/28 reported that krill smaller than 20 mm were underestimated by roughly 60% in the catches from the RMT8. Depending on the surveys, the RMT8 selection curve showed a selectivity inflection point (L_{50}) between 16 and 19 mm. It was discussed that length classes below this inflection point are usually below the size range of krill present in summer when surveys usually take place and when krill reach a mean length well above 20 mm. From this it can be concluded that mesh-size selection for the RMT8 has little effect on the estimation of the density of the 1+ age group.

5.49 The comparison of length-frequency data from the RMT8 and commercial trawl samples showed a shift to larger size classes in the commercial trawl by 3 mm on average. The turning point of the net selection curve was calculated as L_{50} = 42.2 mm. However, data from a year with a much higher proportion of small krill present in the stock resulted in an L_{50} selection point of 32 mm. It is hypothesised that, due to clogging effects, length-frequency distributions and the location of selection curves obtained from the commercial trawl are highly dependent on the actual stock composition in a given year and area. This makes the estimation of recruitment indices less reliable.

5.50 A preliminary study on krill damaged during commercial trawling operations indicated an effect of trawling duration and total catch per haul. It is interesting to note in this regard that the damage rate of krill in the commercial trawl was not size dependant or related to sex of krill. This can be important, because it can be assumed that at least 5 to 25% or even more of those krill passing through the meshes are also lethally damaged after long trawling times or high catches.

5.51 The Working Group noted that krill length-frequency data from the fishery are important for the interpretation of the stock composition, because the fishery covers larger areas over a longer time and can collect data which are not available from surveys. Consequently, a standardisation of data will be essential. It was therefore recommended that information on gear type and mesh size shall be reported by scientific observers together with biological data.

5.52 WG-EMM-07/29 described a black-spot disease found on *E. superba*, sampled by a scientific observer on board a krill fishing vessel in the South Shetland and the South Georgia regions during winter 2003 and 2006. Approximately 2–5% of sampled krill showed this infection. The black spots were most often found on the cephalothorax. Three bacteria were isolated from these black spots. Histological observations showed that the black spots were melanised nodules and that these nodules often contained more than one type of bacteria. The melanised nodules were almost always accompanied by tumour-like cells, which seemed to be derived from a gonad tissue. These results suggest that the bacterial infections of krill were likely to be secondary and that the development of the tumour-like cell mass in the gonad may be the primary cause for the disease.

5.53 The Working Group recognised the importance of the results and noted that a similar kind of shell disease is well known from shrimp species in the North Atlantic, where pollution, effects of fishing gear, predator interaction and level of organic enrichment are discussed as potential reasons, although the reasons for infections in Antarctic waters are probably different.

5.54 Dr Siegel noted that, despite the authors' observation that krill specimens were recovering at least from the bacterial infections, an unknown proportion of the infested population may have already been subject to mortality. Even if the disease does not directly cause mortality in the krill, the development of such a tumour-like cell mass in the gonad can affect reproduction of the organism. This has been observed in shrimp populations in the North Sea where, over a period of several years, the reproductive rate of female shrimp had decreased by 50 to 90% leading to an overall decline in the shrimp stock biomass.

5.55 Predation is usually the primary mortality component in food-web models. This study provided insights into other potential sources of mortality. In order to consider the potential consequences of this condition on krill reproductive performance and mortality, the Working Group requested that observations on the frequency of occurrence of such black spots be recorded by scientific observers on krill fishing vessels. The analysis of intra-annual and interannual time series of occurrence of this condition might provide insights into its impacts on the dynamics of krill populations.

5.56 No other diseases are currently reported for krill in the published literature which would require further monitoring.

Environment

5.57 WG-EMM-07/P8 presented an exhaustive summary and review of the Scotia Sea ecosystem. It summarised how the influence of the eastward-flowing ACC and waters from the Weddell–Scotia Confluence dominates the physics of the Scotia Sea, leading to a strong advective flow, intense eddy activity and mixing. The paper reviewed the impact of the strong seasonality, including irradiance and sea-ice cover, which leads to shorter summers in the south and impacts the strength and timing of summer phytoplankton blooms, probably as a result from the mixing of micronutrients into surface waters through the flow of the ACC over the Scotia Arc. It also reviewed the importance and influence of interannual variability in winter sea-ice distribution and SST that is linked to southern hemisphere-scale climate processes such as ENSO. The paper summarised the importance of this climate link in relation to regional primary and secondary production and biogeochemical cycles and importantly to krill population dynamics and dispersal. It also reviewed how this ecosystem has been perturbed by resource harvesting over the last two centuries and significant ecological changes owing to climate change. The authors concluded that these changes suggest that the Scotia Sea ecosystem is likely to show significant change over the next two to three decades, which may result in major ecological shifts.

5.58 The Working Group noted the extensive amount of work summarised in WG-EMM-07/P8. Discussion revolved around the different mechanisms that could result in coherences in age structure of krill between the South Shetland Islands and the South Georgia area of Area 48. The Working Group also noted that the summary section of the review article provided a series of ideas from which to formalise hypotheses for testing in the future.

5.59 WG-EMM-07/P10 presented the results of a circumpolar lagrangian modelling study that includes interactions with sea-ice to examine the importance to krill distribution. The paper used outputs from the OCCAM project together with satellite-derived sea-ice motion vectors to examine the potential roles of the ocean and sea-ice in maintaining the observed circumpolar krill distribution. It showed that the ACC is likely to be important in generating the large-scale distribution of krill and that sea-ice motion can substantially modify the ocean transport pathways, enhancing retention or dispersal depending on location. Within the Scotia Sea, the authors showed that variability in sea-ice motion increases variability of influx to South Georgia, at times concentrating the influx into pulses of arrival. This variability has implications for the ecosystem around the island. The inclusion of sea-ice motion leads to the identification of source regions for the South Georgia krill populations additional to those identified when only ocean motion is considered. This study indicated that the circumpolar oceanic circulation and interaction with sea-ice are important in determining the large-scale distribution of krill and its associated variability.

5.60 The Working Group noted that considerable variability in particle arrival and particle distribution was found in the model outputs and such data indicate the utility of these modelling approaches to provide information regarding the transport and retention in the Southern Ocean.

5.61 WG-EMM-07/14 extended the time series of the DPOI (the sea-level pressure difference between Rio Gallegos, Argentina, and the Esperanza Base) to 2006. It further correlated the annual DPOI and the integrated temperature of the water column over the upper 200 m in the South Shetland Islands region. The data are likely to be useful in examining the relationship between atmospheric changes and krill abundance and recruitment (Naganobu et al., 1999).

5.62 There was considerable discussion regarding the broader use of the DPOI to infer transport variability of the ACC. The Working Group noted that the DPOI has now been linked with the integrated temperature of the upper water column and that this index may provide a stronger link to atmospheric forcing. It was also noted that, as the DPOI extends into the past more than 50 years, it should provide an important link to other atmospheric and oceanographic time series. The authors were encouraged to continue development and exploration of this index.

5.63 WG-EMM-07/15 proposed a method to forecast the fishing conditions across Area 48 through examination of the relationship between solar activity (indexed by the mean annual Wolf sunspot number), the variability in the rotation of the earth (the index was not described) and net-based catch rates across Area 48. The proposed mechanism is increased eddy activity, and increased zonal atmospheric interactions that may aggregate animals in the nearshore environments. The paper also proposed that this relationship could be used to forecast catch rates over the next three years.

5.64 The Working Group noted that the development of environmental indices to forecast fishing should be pursued.

5.65 WG-EMM-07/12 presented a first-order analysis of 18 years of hydrographic data from the Elephant Island region of the South Shetland Islands and examined their relationship to atmospheric tele-connections (principally El Niño) and both water column properties and phytoplankton biomass. The authors developed an index of the influence of upper circumpolar deepwater (UCDW) and found a negative correlation between their index and the strength of the El Niño 3.4 (EN34) index. No linear secular trend was observed in the temperature at 27.6 σ*t*, however, a significant unimodal pattern was found suggesting that long-term decadal scale variability was also captured in the study. Phytoplankton biomass (inferred from chl-*a*) was not correlated to the influence of the UCDW, although a high EN34 index was related to low phytoplankton biomass. Chlorophyll *a* was positively correlated with both upper mixed layer (UML) temperature and the UML depth, and a further stepwise regression showed that UML temperature, not UML depth, was more important in explaining the variability in mean phytoplankton biomass over the 18-year time series. The authors concluded that both ENSO event scale forcing and long-term trends in atmospheric forcing influence UCDW in the vicinity of the Elephant Island region of the South Shetland Islands and show that the collapse of the UML shoaling (associated with low SST) leads to the lack of a bloom during El Niño.

5.66 The discussion around the importance of this paper centred around the chl-*a* data, and the high values observed in 2006. The Working Group discussed the relationship between the warm water column temperature and the chl-*a* concentration as it related to the lack of krill observed in 2006.

Other prey species

5.67 The Working Group welcomed work on epipelagic macrozooplankton distribution in the Ross Sea conducted on board the RV *Kaiyo Maru* (Japan) (WG-EMM-07/10).

5.68 The Working Group noted that different groups of zooplankton may be affected to different extents by climate change (e.g. ocean acidification is likely to particularly affect pteropods).

Methods

5.69 The Subgroup on Methods met to review issues relating to CEMP methods. There were five issues that were discussed and brought to the attention of the Working Group.

5.70 The first issue regarded the CEMP Standard Method A7, fledging weights of penguins. At WG-EMM-06 it was agreed that the standard method be modified for gentoo penguins to reflect the difference in fledging behaviour noted at Admiralty Bay (SC-CAMLR-XXV, Annex 4, paragraph 4.52) compared to other pygoscelid penguins. However, no proposed modification was tabled at WG-EMM-07 and it was agreed that progress on this issue would be made intersessionally and presented at the next meeting of WG-EMM. Dr Trivelpiece agreed to coordinate this work.

5.71 The second issue was a suggestion that CCAMLR species codes used in CEMP be reviewed. It was pointed out that the scientific name of the black-browed albatross had been changed from *Diomedea melanophrys* to *Thalassarche melanophrys*. The species code used by CEMP, DIM, was based on the former name and was no longer intuitive for some data submitters.

5.72 It was noted, however, that the three-letter species codes are FAO species codes. Consistency in the use of data codes was essential in maintaining the integrity of the CCAMLR databases. However, the Secretariat agreed to look into the utility of an alternate CEMP code that could be cross-referenced to the FAO species codes.

5.73 The third issue, raised by the Secretariat, concerned CEMP data forms. It was noted that some Members were using old data forms to submit data and that there were some inconsistencies in reporting. The Working Group made the following recommendations:

(i) Members should be encouraged to use the most current data forms available, which are found on the CCAMLR website;

(ii) Members should be encouraged to use comment sections of data forms and to send extra information that they believe may be useful in data validation or interpretation of the data.

5.74 WG-EMM noted that the Secretariat sends an annual circular to Members, with email copy to regular submitters of CEMP data, advising on the deadline for the submission of CEMP data and any changes to data forms.

5.75 The fourth issue, related to CEMP data, was a request from the Secretariat for guidance from WG-EMM on the implementation of the ordination method for presenting trends in CEMP indices, specifically:

(i) which CEMP indices should be used, as not all have complete series or have been collected annually;

(ii) how to address missing values in the time series;

(iii) what sort of ordination method to use;

(iv) what approach should be taken when dimensions are limited for a particular region.

5.76 It was suggested that a 'scoping' paper that outlined the issues above, and further defined what is needed, be tabled with WG-SAM for consideration. Further it was noted that a combined approach with WG-SAM and data providers working together might prove more fruitful. It was suggested that the report of the Subgroup on Statistics (SC-CAMLR-XVI, Annex 4, Appendix D) and subsequent commentary of this Working Group be used as a basis for such a scoping paper.

5.77 WG-EMM-07/13 contained a proposal to monitor Weddell seal population numbers in the Ross Sea along the Victoria Land coast using aerial census techniques and aerial photography. It noted that Weddell seals are potentially important predators of Antarctic toothfish and may be impacted by the longline fishery, though the level of predation is not yet clear.

5.78 The Working Group noted that it would be premature to approve the Weddell seal as a CEMP species because it was not clear how monitoring of these seals would be used in the context of CEMP to signal the impacts of fishing on dependent and related species. An important prerequisite is that CEMP species are responsive to changes in targeted species and therefore signal potentially wider ecosystem effects of fishing. Nevertheless, the Working Group agreed that establishing time-series monitoring of important species in different areas will help document the variability in the system as baseline data and, in particular, will help identify when the system is changing. It was also noted that species need to be chosen carefully to achieve these aims.

5.79 The Working Group encouraged further work on determining the role of the Weddell seal in the Ross Sea ecosystem and whether it was a sufficiently sensitive species to monitor for ecosystem variability and change and whether it could be a suitable indicator species in CEMP. It agreed that large-area surveys of Weddell seals would be useful in this baseline task, as they would complement existing long-term localised biological monitoring of Weddell seal populations at Ross Island. It encouraged submission of results of this work in the future.

Future surveys

5.80 Plans for proposed krill and krill predator surveys, and associated surveys in parts of the Convention Area, were reviewed.

Methods and protocols for future acoustic surveys

5.81 The report of the third meeting of SG-ASAM was considered (Annex 8). The meeting focused on the development of methods for acoustic surveys of mackerel icefish and reviewed the acoustic sampling protocols for Antarctic krill for use by CCAMLR-IPY projects.

5.82 Regarding future CCAMLR acoustic surveys to estimate krill B_0, SG-ASAM recommended that:

(i) the SDWBA model with constrained parameters be used to define krill target strength as a function of length at a given frequency;

(ii) the minimum and maximum TS values from the subgroup’s agreed run of the simplified SDWBA (SC-CAMLR-XXIV, Annex 6, Figure 4) be used as a first estimate of the error associated with krill target strength;

(iii) the classification of S_v to filter out non-krill targets should be undertaken using the ΔS_v technique, with the ΔS_v windows constrained for the appropriate size range of krill;

(iv) further research be conducted during future surveys on the distributions of orientation and shape, and sound-speed and density contrasts for krill under the surveying vessel;

(v) 70 kHz echosounders be used in addition to 38, 120 and 200 kHz to improve krill detection, classification and estimation of B_0, whenever possible.

5.83 Regarding future CCAMLR surveys of icefish, SG-ASAM recommended that:

(i) multiple frequencies, including 38, 70 and 120 kHz, be used in acoustic surveys of icefish and krill whenever possible to improve echo classification. The utility of higher and lower frequencies should also be investigated;

(ii) the efficacy of the current Δ120–38 kHz S_v dB difference method of target identification be further evaluated in relation to discrimination of icefish from associated species;

(iii) the target strength of icefish and associated species continues to be studied using a variety of methods including *in situ* measurements, *ex situ* experiments on individuals and aggregations, and physics-based and empirical models;

(iv) data be collected on icefish orientation, including changes in orientation due to vertical migration or in response to survey vessels;

(v) icefish behaviour should be further investigated, including vertical distribution and response to survey vessels, as they impact on survey design, fish orientation, target strength determination and species delineation;

(vi) a library of echograms with associated target strength, catch and biological data for icefish and associated species should be archived with, and made available from, the CCAMLR Secretariat. This library should be incorporated into the existing CCAMLR acoustic database;

(vii) the Secretariat investigate the feasibility of archiving data in the HAC[1] (or other suitable) format, and that other types of data, such as calibration parameters, should be archived by the Secretariat.

Planned IPY surveys

5.84 The CCAMLR-IPY Steering Committee met in May 2007, and held a joint session with SG-ASAM on 2 May 2007 to discuss acoustic sampling protocols for CCAMLR-IPY surveys. The meeting was convened by Mr S. Iversen (Norway). The report of the meeting (SC-CAMLR-XXVI/BG/3) was circulated in SC CIRC 07/26 in order that appropriate acoustic and sampling protocols can be implemented in the coming Antarctic field season. Further reference to the use of acoustic protocols by Members carrying out IPY surveys may be found in paragraph 5.98.

5.85 The following surveys are planned during IPY (SC-CAMLR-XXVI/BG/3):

(i) Norway – The research vessel *G.O. Sars* will conduct pelagic studies including an acoustic survey in the northern region of Subarea 48.6 for krill and icefish. This study has adopted an ecosystem approach to look at the ecology of the

[1] A global standard being developed for the storage of hydroacoustic data.

region, including zooplankton and phytoplankton, and to quantify the prey available to land-based predators. The *G.O. Sars* will perform acoustic target strength studies on krill and icefish near South Georgia in Subarea 48.3.

Provisionally, the fishing vessel *Saga Sea* will also be used as an observation platform in Area 48. A range of new environmental sampling systems will be used in the Norwegian survey, including the MESSOR and MUST plankton and environmental samplers and midwater trawl for macrozooplankton.

(ii) Germany – The research vessel *Polarstern* will work in the southern region of Subarea 48.6 and conduct a SYSCO benthic survey for CAML and a SCACE physical oceanography and climate survey. Opportunities exist for the collection of acoustic data and RMT samples (December–January).

(iii) New Zealand – The research vessel *Tangaroa* will conduct a CAML survey of the Ross Sea (Subarea 88.1) to measure and describe key elements of species distribution, abundance and biodiversity. A wide range of taxonomic groups will be studied, with an emphasis on the biodiversity of benthic, demersal and mesopelagic species, and on by-catch associated with the toothfish (*Dissostichus* spp.) fishery in Subarea 88.1.

(iv) Japan – The research vessel *Umitaka Maru* will conduct a survey near Syowa Station (JARE Survey Area A; Division 58.4.2) and a CEAMARC survey near Dumont d'Urville for CAML (Division 58.4.1). This work will include pelagic sampling with RMT8 nets and the collection of acoustic, physical and chemical oceanographic data. The *Umitaka Maru* is a university vessel and the survey will be conducted in cooperation with the Australian Antarctic Division; Dr G. Hosie is the CAML IPY contact at the AAD.

(v) UK – The research vessel *James Clark Ross* will conduct Discovery 2010 and BIOFLAME surveys of the West Antarctic Peninsula and Scotia Sea, South Georgia and South Shetland Islands region (Area 48). All trophic levels will be studied at fixed and reactive stations, using RMT and other nets, and a full suite of acoustic data.

(vi) CAML – CAML surveys will be conducted around Antarctica to provide a bench of current biodiversity and describe the associated processes. CEAMARC surveys in eastern Antarctica will use the Japanese vessel *Umitaka Maru* (pelagic and mesopelagic sampling), the Australian vessel *Aurora Australis* (physical and chemical oceanography, demersal and benthic sampling) and the French vessel *l'Astrolabe* (with supplementary inshore pelagic sampling). In addition, a circum-Antarctic CPR survey will be conducted with some 14 vessels likely to be involved.

(vii) ICED Program – ICED is investigating the interactions of physical oceanography, biogeochemical cycles and the food web. This is a long-term project which will start in the IPY. ICED will provide circum-Antarctic sampling opportunities similar to CAML, and seeks to develop links with other IPY projects. Closer links could be developed between ICED, CCAMLR and CAML.

5.86 The Working Group noted that a synoptic survey for krill in Area 48 (i.e. similar to the CCAMLR-2000 Survey) is not planned under the auspice of IPY in 2008.

Key points for consideration by the Scientific Committee

Status of predators, krill resource and environmental influences

Predators

5.87 The Working Group noted that the ability of the krill fishery to develop in areas with no monitoring data may be restricted in relation to those areas with more data, and that data collection now is an investment in the future management of the fishery (paragraph 5.5).

5.88 All Members conducting research of interest to CCAMLR are encouraged to contribute to the CEMP database and to the work of the Working Group (paragraph 5.6).

5.89 The Working Group expressed its appreciation for the work presented from the Ross Sea region and encouraged future contributions that would assist in providing advice to CCAMLR regarding the ecosystem effects of the toothfish fishery in Subareas 88.1 and 88.2 (paragraph 5.26).

Krill resources

5.90 The Working Group encouraged further studies on the segregation of *E. superba* and *E. crystallorophias* in the Ross Sea and other high-latitude areas around the continent, for the purpose of subdividing subareas and setting future precautionary catch limits (paragraph 5.34).

5.91 The Working Group noted that the revised estimate of krill B_0 in the survey stratum of Division 58.4.2 (12.46 million tonnes, CV = 15.15%) will be further revised using the agreed CCAMLR methods for target strength estimation and target identification (Annex 8) and submitted to the Scientific Committee to revise the existing precautionary catch limits (paragraph 5.39).

5.92 The Working Group encouraged Members to continue to collect krill density and recruitment indices for Subarea 48.1 and to submit these to the Working Group, as these are important input parameters for the GYM to calculate potential yield (paragraph 5.43).

5.93 The Working Group recommended that krill length-frequency data from the fishery, which cover larger areas and periods than are available from surveys, are standardised and reported with information on gear type and mesh size to allow optimal interpretation of the stock composition (paragraph 5.51).

Environment

5.94 The Working Group noted that the results of a comprehensive review of the structure and operation of the Scotia Sea ecosystem indicated that a combination of historical exploitation and the effects of climate change could lead to significant and rapid changes over the next two to three decades (paragraph 5.57).

Methods

5.95 Members are encouraged to submit data on the most up-to-date forms which are available on the CCAMLR website (paragraph 5.73).

5.96 The Working Group recommended that issues relating to methods for the ordination of CEMP data be the subject of a scoping paper submitted to WG-SAM for its advice (paragraphs 5.75 and 5.76).

Future surveys

5.97 The Working Group recommended that, regarding acoustic surveys of krill and icefish, all CCAMLR-adopted acoustic protocols and guidelines for krill surveys be collated into a single document (paragraph 2.31).

5.98 The Working Group recommended that, regarding methods and protocols for CCAMLR-IPY surveys, Members carrying out IPY surveys refer to, and follow, the acoustic protocols for data collection provided in Table 3 of Annex 8 (paragraph 5.84).

5.99 The Working Group suggested that the CCAMLR Secretariat contact all CAML investigators via Dr V. Wadley (AAD, Australia), Secretary of CAML, and request that they adhere to CCAMLR-IPY protocols when conducting their respective IPY surveys, and that the Secretariat produces a summary of all IPY acoustic data and related metadata submitted to CCAMLR, and report to SG-ASAM by April 2009 (SC-CAMLR-XXVI/BG/3, paragraph 22).

STATUS OF MANAGEMENT ADVICE

Protected areas

6.1 The Advisory Subgroup on Protected Areas met during WG-EMM-07 to review and present advice on the following topics.

CEMP site protection

6.2 The Working Group considered a request of the Scientific Committee that the requirements to review CEMP site protection under Conservation Measure 91-01 in respect of

Conservation Measures 91-02 and 91-03 (protection of Cape Shirreff and Seal Islands CEMP sites respectively) should be clarified and, if required, reviewed at the earliest opportunity (SC-CAMLR-XXV, paragraph 3.17).

6.3 The Working Group agreed that management plans for the Cape Shirreff and Seal Islands CEMP sites had been modified in 2004 (CCAMLR-XXIII, paragraphs 10.26 and 10.27), therefore, a formal review of the two relevant measures (Conservation Measures 91-02 and 91-03 respectively) would not be required until 2009.

6.4 However, the Working Group recognised that all CEMP-related work on the Seal Islands had ceased in 1997 (WG-EMM-07/4, Table 1) and that the USA had indicated that it has no plans to conduct such work in the future. Therefore, the Working Group suggested that the protection of the Seal Islands CEMP Site under Conservation Measure 91-03 should be discontinued.

CEMP site maps

6.5 The Working Group noted that the USA had submitted a map depicting the study site on Admiralty Bay where CEMP data are collected annually. The map was a subset of the one prepared for ASMA No. 01 encompassing the entire Admiralty Bay area and including ASPA No. 128. The map shows the locations of seabird colonies and topographical features at the CEMP site. The location of the ‘US summer field camp’ known locally as Copacabana Field Camp (also known as Pieter J. Lenie Camp) is shown.

6.6 The Working Group was informed by Dr Holt that the last time CEMP data had been collected and submitted for the Anvers Island site was in 1999 and that no data would be submitted in the future. Therefore, no new maps would be submitted for the site.

6.7 The Working Group noted that the last time CEMP data were submitted for the Elephant Island (Stinker Point) CEMP site was in 1992 by Brazil. Dr E. Fanta (Brazil) indicated that there will be a project at Elephant Island during 2008. She indicated that more information on the project will be available at the time of SC-CAMLR-XXVI and she would inquire if CEMP work might be resumed and if an updated map could be prepared for the site.

Bioregionalisation

6.8 The Working Group noted that the Scientific Committee had provided detailed terms of reference for a steering committee to facilitate collaboration with CEP to organise a workshop to establish a bioregionalisation of the Convention Area and to consolidate advice on a system of protected areas (SC-CAMLR-XXV, paragraphs 3.30 to 3.55).

6.9 The Working Group noted that the Bioregionalisation Workshop is scheduled to be held from 13 to 17 August 2007 in Brussels, Belgium. Attendance is expected to number approximately 33 participants, representing 10 Members, the Secretariat, and invited experts.

6.10 The objective of the workshop is to advise the Scientific Committee and Commission on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces. The 2007 workshop is viewed as a next step in the progression of endeavours leading to the establishment of a system of MPAs harmonised for the protection of the Antarctic marine environment across the Antarctic Treaty System (SC-CAMLR-XXV, paragraph 3.32).

ATCM draft management plans for protected areas
with marine components

6.11 The USA submitted to the Commission, and requested the Working Group to provide comments on, the Draft Management Plan for ASMA Number X: Southwest Anvers Island and Palmer Basin (CCAMLR-XXVI/BG/3 (as submitted to ATCM XXX (2007) WP5)). As indicated by the title, the proposed ASMA contains a marine component.

6.12 The Working Group noted that it is not within its remit to approve or disapprove of a proposed management plan but to provide advice to the Scientific Committee according to the procedure nominated by the Commission (CCAMLR-XX, paragraph 11.17). In this regard, the Working Group also noted that:

(i) in 2001 (CCAMLR-XX, paragraph 11.17) and again in 2006 (CCAMLR-XXV, paragraph 6.1), the Commission reaffirmed its support of the ATCM (as expressed now in ATCM Decision 9 (2005)) that those ASMAs and ASPAs with a marine component that need the approval of CCAMLR are those:

   (a) in which there is actual harvesting or potential capability of harvesting of marine living resources which might be affected by site designation; or

   (b) for which there are provisions specified in a draft management plan which might prevent or restrict CCAMLR-related activities;

(ii) when such a proposal is submitted to CCAMLR, the Commission requests advice from the Scientific Committee as to the impact of a management plan with respect to these two points, although other scientific advice may be provided as well (CCAMLR-XX, paragraph 11.17).

6.13 The Working Group noted that the site:

(i) contains the US Palmer Station which has been for many years, and continues to be, the site from which year-round research is conducted. It includes both marine and land-based research and includes all aspects of ecosystem research (seabird, finfish, oceanographic etc.);

(ii) is included in the US LTER area in which a study has been conducted since 1990. This research, which occurs in an area without commercial harvesting, has the potential to provide information which can be compared to the US AMLR research, located directly adjacent to the north, to investigate krill fishing effects;

(iii) the proposed marine component represents a small proportion of the fishable area in Subarea 48.1 (approximately 0.5% of the total surface area – 3 275 km^2 in the ASMA (CCAMLR-XXVI/BG/3) versus 672 000 km^2 in Subarea 48.1 (*CCAMLR Statistical Bulletin*));

(iv) has not been subjected to sustained commercial harvesting (less than 4 tonnes of krill has been taken from the proposed ASMA during 2002/03 (*CCAMLR Statistical Bulletin*, in CCAMLR-XXVI/BG/3)).

6.14 The Working Group noted that the information provided above constitutes the only quantitative advice with respect to these issues and therefore is the best scientific advice available for the Commission to consider.

6.15 Dr Naganobu stated that he cannot support the proposed ASMA, which includes a large marine area for the following reasons:

(i) Article II of the Convention includes rational use and this needs to be ensured in this case;

(ii) the marine component of the proposed ASMA does have the potential for commercial krill harvesting, as shown by the commercial catches taken in the past;

(iii) krill spatial fishing patterns have been variable in recent years and areas in Bransfield Strait, similar in size and location to the proposed area in this ASMA, were commercially fished during 2007.

6.16 Dr V. Bizikov (Russia) indicated that because the proposed ASMA contains a sizable marine area with some potential for commercial fishing, the management plan should not restrain any possible fishing activity which might yield research data. He also emphasised that the proposed ASMA should not contradict the principles of conservation as stated in Article II of the Convention.

6.17 Others noted that, in addition to the advice in paragraph 6.13 that:

(i) such a small area in the region is unlikely to contribute to the economic viability of a krill or other fishery;

(ii) on the basis of our understanding of the dynamics of krill, should the fishery be dependent on this area alone in Area 48, or even Subarea 48.1, then the state of the krill stocks will be such that the fishery should probably be closed;

(iii) if the western Antarctic Peninsula is an important area for reproduction and recruitment of krill for the entire southwest Atlantic (WG-EMM-07/P8) then maintaining the area free of fishing would be of benefit to the population as a whole.

Harvesting units

6.18 The Working Group further considered procedures to subdivide large CCAMLR statistical areas into ecologically based harvesting units. The Scientific Committee had suggested that advice on this topic should await the results of the Australian survey of Division 58.4.2, which could provide an example of using environmental data to assist in the subdivision process (SC-CAMLR-XXV, Annex 4, paragraph 5.21).

6.19 WG-EMM-07/33 provided details on the results of the Australian survey of Division 58.4.2, which included an assessment of whether the division could be divided into regions that were ecologically distinct. The paper indicated that the division could be split in two along the 55°E line of longitude, reflecting the oceanographic influence of the Weddell Gyre in the west and the Prydz Bay Gyre in the east. A further subdivision was suggested along the 65°S line of latitude, which separated the oceanic krill populations from those in more coastal areas. A four-way subdivision of Division 58.4.2 would also reflect the population structure of krill observed on the survey.

6.20 The rationale for the latitudinal subdivision of Division 58.4.2 is to ensure that any precautionary catch limits established in this region recognised the existence of both oceanic and coastal krill populations. This would ensure that a krill fishery operating in Division 58.4.2, which, based on historical data would most likely occur in the coastal zone, would not take the catch limit that resulted from an assessment of krill across the entire division from only the coastal zone.

6.21 Some members felt that the further subdivision of Division 58.4.2, separating the krill population in the waters to the north of 65°S from those to the south, was not justified.

6.22 The Working Group agreed that dividing Division 58.4.2 along the 55°E line of longitude was ecologically appropriate and would also reflect differences in krill stocks in this area.

6.23 In considering the issue of subdividing other large statistical areas, the Working Group agreed that there were a wide range of options available in the absence of recent survey data. Many of these approaches had been presented to the Scientific Committee in 2001 (SC-CAMLR-XX/BG/24) but they included:

- data from oceanographic surveys
- information on bathymetry and the presence of island groups
- information from the upcoming bioregionalisation workshop
- use of arbitrary subdivisions, such as the SSRUs developed for the toothfish fishery.

6.24 The Working Group sought advice from the Scientific Committee on its preferred approach(es).

Small-scale management units

6.25 The Working Group noted that WG-SAM was asked by the Scientific Committee to further develop approaches to subdividing the Area 48 catch limit for krill amongst SSMUs (SC-CAMLR-XXV, paragraph 13.12). The deliberations and advice from WG-SAM are contained in Annex 7, paragraphs 5.7 to 5.51.

6.26 The Working Group recalled the options for subdividing the catch limit among SSMUs (Annex 7, paragraph 5.12) and endorsed 'structured fishing' as a useful elaboration of the meaning of Option 6 (Annex 7, paragraphs 5.13 and 5.14). This is considered further below.

6.27 The Working Group noted that WG-SAM-07/12 and 07/14 were available for consideration, along with three additional papers addressing issues relevant to the deliberations on SSMUs and management procedures for krill. The additional papers are presented here first before the general discussion on this issue.

6.28 Dr Naganobu introduced WG-EMM-07/7, which reported on survey work carried out to study the interactions between oceanographic conditions, and the distribution of krill as prey and baleen whales as predators in the Ross Sea and its adjacent waters, in the austral summer of 2004/05. The distribution of each species was compared to the distribution of ITEM-200 (see also paragraph 5.31). Antarctic krill was mainly distributed in the Antarctic surface water area (ITEM-200 = 0° to –1°C) compared to ice krill, which was clearly distributed in the shelf water but not Antarctic surface water. Humpback whales were mainly distributed in the ACC waters with highest densities near the southern boundary of that current. Antarctic minke whales were mainly distributed in the eastern part of the Ross Sea in the continental shelf slope frontal zone. The paper summarised a conceptual model of interaction between oceanography, relating water mass and circulation pattern of the oceanic surface layer with ITEM-200, and the distribution and abundance of krill and baleen whales.

6.29 The Working Group noted the distinction in the distribution of Antarctic and ice krill and the distributions of whales. In relation to the development of a Ross Sea ecosystem model, the following points may need to be taken into account:

(i) What is the distribution of killer whales in relation to these other species?
(ii) Why were the minke whales not found in the same location as Antarctic krill (their highest densities being in areas where few krill were observed)?

6.30 Dr Constable also noted that the conclusions of the paper were based on the physical and biological oceanography and the visual surveys of whales. This work was very useful for characterising the Ross Sea ecosystem. He concluded that the addition of data from individual whales was unnecessary for developing those conclusions.

6.31 WG-EMM-07/17 was presented by Dr Bizikov on behalf of the authors. This paper analysed variability of krill transport and distributions in two local areas, one each in the SSMUs of SOW and SGW. Repeated small-scale acoustic surveys were accompanied by trawls and CTD casts. The data were compared to geostrophic flows predicted from oceanographic models. The results indicated that temporal and spatial changes of krill abundance through krill transport need to be accounted for in the development of management procedures for the krill fishery, particularly in considering the catches that could be taken from within SSMUs. It was recommended that such work be based on actual data describing annual and seasonal variability of krill biomass and characteristic distribution patterns in SSMUs under the impact of transport processes.

6.32 The Working Group welcomed this paper and encouraged the authors to continue quantifying the spatial and temporal variability of krill in SSMUs. It noted that the spatial coverage of such work needs to be comparable to the scales of the SSMUs and the oceanographic processes being investigated. The scale of the study reported in this paper is useful for investigating temporal variability of abundance at the scale of the operation of a fishing vessel; however, the investigation of processes occurring at the scale of SSMUs would require studies over larger areas. As such, analyses of the sort reported here could assist with developing models of the dynamics of fishing fleets. It was noted that mesoscale studies, such as the US AMLR surveys around the Antarctic Peninsula, show a greater stability in relative abundances among SSMUs, even though there may be small-scale variability within SSMUs as to the location of the aggregations. The Working Group encouraged further work on these issues and requested that fuller explanations of the research design (acoustic transect details and integration intervals, number and depth of CTD samples and so on) be submitted along with the additional work.

6.33 WG-EMM-07/P7 was presented by Dr Constable, who noted that this paper is part of a very useful book on top predators in marine ecosystems and their importance in monitoring and management (Boyd et al., 2006). This particular chapter examined how goals and reference points might be set in quantitative terms for higher trophic levels – such as marine mammals, birds and fish. In terms of the work of CCAMLR, it discussed how to operationalise Article II by exploring the general characteristics of objectives for higher trophic levels within the context of ecosystem-based management, but noting that the emphasis for managing the effects of human activities on higher trophic levels is often biased towards fisheries-based approaches rather than approaches that take into account the maintenance of ecosystem structure and function. Following this, the precautionary approach developed in CCAMLR for taking account of higher trophic levels in setting catch limits for target prey species is described. The last section considered indicators of the status of predators with respect to establishing target and limit/threshold reference points that can be used directly for making decisions in a feedback management system, noting the value of closed areas to monitoring ecosystem processes and for evaluating the effects of fishing. Indicators are described that include univariate indices summarising many multivariate parameters from predators, known as composite standardised indices, as well as an index of predator productivity directly related to lower trophic species affected by human activities.

6.34 Dr Constable noted that the chapter summarised some of the issues that could be addressed in the evaluation of management strategies for the krill fishery, taking account of the small-scale requirements of predators.

Process for implementing a subdivision of Area 48 catch limit amongst SSMUs

6.35 The Working Group endorsed the process recommended by WG-SAM that the implementation of a subdivision of the Area 48 catch limit among SSMUs could be undertaken in stages based on the best scientific advice available at each stage (Annex 7, paragraphs 5.10, 5.11 and 5.49 to 5.51). Stage 1 can be delivered next year based on models and data currently available, and would involve the provision of advice on a total catch limit in Area 48 combined with catch limits in each SSMU. The advice would be couched in terms of risks to predators, krill and the fishery. It is intended that this would help provide for the orderly development of the krill fishery beyond the current trigger level of 620 000 tonnes, in advance of improved data and models and evaluation of structured fishing approaches, and a feedback management procedure.

6.36 While agreeing with the process to proceed to Stage 1 advice, Dr Naganobu noted that consideration needs to be given to how trends and variability in spatial distribution of krill could impact on whether a subdivision of the krill catch limit among SSMUs, once established, would remain appropriate in the future. He was also concerned that a subdivision might impede the ability of the fishery in some years to move to other areas because of substantial redistributions of krill that can sometimes occur.

6.37 Dr Bizikov noted that, taking account of the considerable variability in the distribution of krill, subdivision of krill catch limits among SSMUs should be necessarily re-evaluated annually based on the data obtained from scientific surveys and the fishery.

6.38 The Working Group noted a number of important points in this case:

(i) the staged approach provides for updating the advice on the SSMU subdivision after Stage 1, particularly after the acquisition of more data and reassessment of the subdivision as further work is undertaken (in the same manner as stock assessments are updated for toothfish);

(ii) the initial subdivision and an associated catch limit are not intended to unnecessarily impede the flexibility of the fishery;

(iii) there is an expectation that information and modelling will improve over the coming years and that the strategy for managing the fishery in terms of catch limits within SSMUs will evolve to provide better and updated advice on the subdivision;

(iv) there is also an expectation that the full management strategy will include feedbacks from the fishery (catches, fishery performance) as well as fishery-independent monitoring (krill, predators and/or environment) to help:

  (a) redistribute catches among SSMUs based on an assessment model and decision rules;

  (b) overcome issues of trends and interannual variability in abundance of krill and responses of predators by using such indicators in an assessment model that appropriately predicts future harvest strategies (over, say, one or two years);

(v) the process of evaluating these feedback management strategies in Stage 2 and subsequent stages if needed can be used to identify the impacts of different harvest strategies (catch and effort distribution among SSMUs) on krill and its predators;

(vi) the proposal to have a structured fishing program during the development of the fishery aims to obtain data necessary for refining the management strategy, including data acquisition programs, assessment models and decision rules governing the distribution of catches among SSMUs.

Scenarios to be evaluated in Stage 1

6.39 The Working Group noted the consideration by WG-SAM of the models that can be used to evaluate scenarios for Stage 1 advice (Annex 7, paragraphs 5.28 to 5.35), including advice (Annex 7, paragraph 5.36) that catch limits will be represented in the models as proportions of the harvest rate, γ, with;

(i) the trigger level of 620 000 tonnes corresponding to 0.15 x γ;

(ii) the subdivision applying to the aggregate catch for Subareas 48.1, 48.2 and 48.3 of 3.168 million tonnes, which is based on the proportion of area in those subareas compared to the combined area of Subareas 48.1, 48.2, 48.3 and 48.4, would correspond to 0.8 x γ.

6.40 The Working Group endorsed the model scenarios considered essential by WG-SAM (Annex 7, paragraphs 5.37 and 5.38) but noted that some consideration of the spatial impact of the subdivision options on the krill fishery should be essential in the risk assessment, rather than optional.

6.41 In considering this further, the Working Group noted that the following would be important to consider in the risk assessment, although this need not require detailed implementation of models of fleet dynamics in Stage 1:

(i) the potential for the catchability of krill to be different in coastal and shelf areas compared to oceanic areas and how this might impact on the performance of the krill fishing vessels and therefore could be a cost to the fishery;

(ii) the potential for sea-ice to impact on performance of the fishery.

6.42 The issue of catchability could be addressed in the first instance by comparing the relative 'performance' of the fishery in the different SSMUs in model outputs. Other observations (external to the models) would be used to determine if krill are likely to be more difficult to catch in some SSMUs compared to others, and these differences would be applied to the relative performance data to adjust the risk assessment.

6.43 The Working Group agreed that data requested from the fishery in the past on what influences the performance of a fishing vessel, the basis on which vessels move between fishing grounds (SC-CAMLR-XXV, Annex 4, paragraphs 3.67 to 3.71) and haul-by-haul data from the fishery will be important for these analyses. It also noted that spatial patchiness of krill could be derived from existing survey data. The Working Group encouraged analyses leading to an understanding of how catchability and fishing performance may vary between coastal and oceanic SSMUs.

6.44 The Working Group agreed that not all scenarios need to be explored by each model but that there needs to be sufficient overlap in scenarios between models to understand the relative model performance.

6.45 The Working Group noted the importance of using field and other data in the models to establish that the relative differences amongst SSMUs in the models reflect reality. It noted and endorsed the process of using data outlined by WG-SAM (Annex 7, paragraphs 5.17 to 5.27). The data suggested by WG-SAM for validating the models (Annex 7, paragraphs 5.24 and 5.26) were considered by the Working Group, as requested by WG-SAM, and WG-EMM noted the following for using these data:

(i) the strongest signals in empirical data are those for penguins and seals;

(ii) variability in krill abundance can be documented from the US AMLR, BAS and LTER survey series;

(iii) changes in krill abundance prior to these survey series are less well supported by data, particularly when the errors in the estimates of abundance are considered;

(iv) trends in whale populations are unclear and very much dependent on which species is considered.

Risk Assessment for Stage 1

6.46 The Working Group endorsed the approach of WG-SAM to the performance measures and risk assessments to be undertaken in Stage 1 (Annex 7, paragraph 5.48). It noted that the 'benchmark levels' indicated by WG-SAM are really 'reference levels', which are quite distinct from the benchmark data used to validate the models.

Developing approaches beyond Stage 1

6.47 The Working Group endorsed the further development of feedback management approaches (Option 5) and structured fishing (Option 6) after the work for Stage 1 is completed (Annex 7, paragraph 5.16), noting that structured fishing (Annex 7, paragraph 5.13) could provide useful results to assist, during the development of the fishery, in the elaboration of a feedback management in the longer term (Annex 7, paragraph 5.14).

Analytical models

6.48 The Working Group noted:

(i) the work of WG-SAM at its first meeting, particularly its work on integrated assessments for krill and the subdivision of the krill catch limit among SSMUs;

(ii) the name and terms of reference of WG-SAM (Annex 7, paragraph 8.18) and the recommended process for reviewing quantitative assessment methods, statistical procedures and modelling approaches that lead to advice when the Working Group cannot agree on the appropriateness, implementation or interpretation of results from a quantitative method (those defined in the terms of reference of WG-SAM) proposed for use by the Working Group (Annex 7, paragraph 8.19);

(iii) KPFM is now to be known as FOOSA (Annex 7, paragraph 8.20);

(iv) a desirable process for interaction between WG-SAM and other working groups on issues referred to in (ii) would be through the development of tasks using scoping papers (Annex 7, paragraph 6.9).

Existing conservation measures

6.49 The Working Group thanked the Secretariat for its updated krill fishery report (WG-EMM-07/5). It noted the conservation measures in force and considered what might be required for this fishery in addition to what is contained within existing measures. In so doing, it discussed WG-EMM-07/23, provided by Australia according to the undertaking made to the Commission last year (CCAMLR-XXV, paragraphs 12.65 and 12.66). The outcomes of these discussions and recommendations are summarised in paragraphs 4.73 to 4.76. These will have implications for all conservation measures for krill fisheries.

6.50 More specifically, the Working Group noted the advice that will need to be considered with respect to conservation measures this year:

(i) the recommended change in the yield of krill in Area 48 (Conservation Measure 51-01) (paragraph 2.41);

(ii) the need for the Commission to clarify the implementation of the trigger level in Conservation Measure 51-01 (paragraphs 2.56 and 2.57);

(iii) as a result of work at the B_0 workshop, a revised yield will be available for krill in Division 58.4.2 (Conservation Measure 51-03), including a subdivision of that yield into two smaller areas (paragraphs 2.29, 2.53 and 6.22);

(iv) the need to clarify the notification procedure for krill (Conservation Measure 21-03), including the proposed change to the form contained in Annex 21-03/A of that conservation measure (paragraphs 2.79, 4.20, 4.77 and 4.78 and Appendix D);

(v) the need to report biological information from the krill fishery, requiring the application of Conservation Measure 23-05 to the krill fishery and to include reference to biological information in Conservation Measure 23-06 (paragraphs 4.70 to 4.72);

(vi) the recommendation to consider krill fishing in Subarea 48.6 and Area 88 as exploratory fisheries (with reference to Conservation Measure 21-01), and the need to undertake B_0 surveys before the fishery expands in those areas (paragraph 2.79);

(vii) the recommendation to remove the Seal Island CEMP site from Conservation Measure 91-03 (paragraphs 6.3 and 6.4);

(viii) with respect to the request in Conservation Measure 22-05 for the Scientific Committee to review the use of high-seas bottom trawling gear in high-seas areas, the discussion by the Working Group is in paragraph 7.29.

Key points for consideration by the Scientific Committee

Protected areas

6.51 The Working Group agreed that management plans for the Cape Shirreff and Seal Islands CEMP sites and the two relevant measures (Conservation Measures 91-02 and 91-03 respectively) would not need to be reviewed until 2009 (paragraph 6.3). However, the Working Group suggested that the protection of the Seal Islands CEMP site under Conservation Measure 91-03 should be discontinued (see rationale in paragraph 6.4).

6.52 No new maps would be submitted for the Anvers Island site, as CEMP data will no longer be collected at the site (paragraph 6.6).

6.53 The Working Group noted the progress towards the Bioregionalisation Workshop, scheduled to be held in August 2007 in Brussels, Belgium (paragraphs 6.8 to 6.10).

6.54 The Working Group wished to refer the Scientific Committee to the discussion and advice on the submission by the USA to the Commission of the Draft Management Plan for ASMA Number X: Southwest Anvers Island and Palmer Basin, which contains a marine component (paragraphs 6.11 to 6.17).

Harvesting units

6.55 The Working Group recommended subdividing Division 58.4.2 along the 55°E line of longitude to reflect differences in krill stocks in this area (paragraph 6.22).

6.56 The Working Group sought advice from the Scientific Committee on its preferred approaches to considering the subdivision of other large statistical areas in the absence of recent survey data (paragraphs 6.23 and 6.24). This would facilitate designing surveys of krill populations for the purposes of estimating B_0. Many of these approaches had been presented to the Scientific Committee in 2001 (SC-CAMLR-XX/BG/24) and they included:

- data from oceanographic surveys
- information on bathymetry and the presence of island groups
- information from the upcoming bioregionalisation workshop
- use of subdivisions, such as the SSRUs developed for the toothfish fishery.

Small-scale management units

6.57 The Working Group wished to draw the attention of the Scientific Committee to its deliberations on SSMUs (paragraphs 6.25 to 6.47), paying particular attention to:

(i) its endorsement that 'structured fishing' is a useful elaboration of the meaning of Option 6 (paragraph 6.26);

(ii) its endorsement of the process recommended by WG-SAM that the implementation of a subdivision of the Area 48 catch limit among SSMUs could be undertaken in stages based on the best scientific advice available at each stage (paragraph 6.35);

(iii) that Stage 1 advice can be delivered next year based on models and data currently available, and would involve the provision of advice on a total catch limit in Area 48 combined with catch limits in each SSMU and that the discussion surrounding this advice is provided in paragraphs 6.35 to 6.38;

(iv) its endorsement of the model scenarios for delivering Stage 1 advice, and the need to consider the implications for the fishery of potential differences in catch rates in shelf versus oceanic SSMUs (paragraphs 6.39 to 6.44);

(v) the importance of using field and other data in the models to establish that the relative differences among SSMUs in the models reflect reality, and its endorsement of the process of using data outlined by WG-SAM (paragraph 6.45), including consideration of the benchmark data suggested by WG-SAM for validating the models, noting:

    (a) the strongest signals in empirical data are those for penguins and seals;

    (b) variability in krill abundance can be documented from the US AMLR, BAS and LTER survey series;

    (c) changes in krill abundance prior to these survey series are less well supported by data, particularly when the errors in the estimates of abundance are considered;

    (d) trends in whale populations are unclear and very much dependent on which species is considered.

(vi) its endorsement of the approach of WG-SAM to the performance measures and risk assessments to be undertaken in Stage 1, noting that the 'benchmark levels' indicated by WG-SAM are really 'reference levels', which are quite distinct from the benchmark data used to validate the models (paragraph 6.46);

(vii) its endorsement of the further development of feedback management approaches (Option 5) and structured fishing (Option 6) after the work for Stage 1 is completed, noting that structured fishing could provide useful results to assist, during the development of the fishery, in the elaboration of a feedback management in the longer term (paragraph 6.47).

Existing conservation measures

6.58 The Working Group wished to refer the Scientific Committee to its consideration of the important scientific requirements for the orderly development of krill fisheries (paragraph 6.49).

FUTURE WORK

Predator surveys

7.1 The Working Group considered progress towards a workshop in 2008 on the estimation of land-based predator abundance (SC-CAMLR-XXV, paragraphs 3.25 and 10.1(k)). WG-EMM-07/20 summarised recent intersessional deliberations of the land-based predator correspondence group prior to WG-EMM-07.

7.2 The Working Group agreed to the following terms of reference for the workshop:

(i) consider candidate procedures for deriving abundance estimates for priority land-based predator species in the southwest Atlantic region between 70°W and 30°W;

(ii) identify the minimum data requirements to satisfy the preferred candidate procedures;

(iii) examine available existing datasets to determine the degree to which the minimum requirements are met, and identify inadequacies or gaps in existing data;

(iv) where feasible, apply preferred candidate procedures to existing data to derive abundance estimates;

(v) identify and prioritise gaps in existing data as a basis for assessing where and how any future survey work would be conducted;

(vi) develop a plan for work beyond the workshop, including the use of diet and energetics data to convert estimates of abundance to consumption.

7.3 The Working Group noted that the estimation of predator demand will require a considerable program of work up to and beyond the 2008 workshop, and accordingly agreed to elevate the status of the correspondence group to a subgroup (Subgroup on Status and Trend Assessment for Predator Populations (WG-EMM-STAPP)), to be convened by Dr Southwell, with the following terms of reference:

Develop, review and update as necessary, protocols and procedures for:

(i) the analysis of existing data to estimate the abundance of nominated predator species in specified regions of the CCAMLR Convention Area, including estimation of uncertainty in those abundance estimates;

(ii) the analysis of existing data to estimate trends in abundance of nominated predator species in specified regions of the CCAMLR Convention Area, including estimation of uncertainty in those trend estimates;

(iii) the identification of gaps in existing data that constrain abundance and trend estimation;

(iv) the future collection of data, where necessary, for estimation of predator abundance and trends.

7.4 The Working Group considered the timing and location for the workshop, originally planned to be held in conjunction with the 2008 meeting of WG-EMM (SC-CAMLR-XXV, paragraph 10.1(k)). After consideration of several other meetings and workshops planned for 2008, it was agreed that the workshop need not be held in conjunction with WG-EMM, provided there were no budgetary implications. The subgroup was tasked to plan for the workshop accordingly, and indicated that it was likely to be held in Hobart, Australia, in June 2008. The workshop details, when finalised, will be communicated to SCAR.

7.5 The Working Group expressed its thanks to Dr Southwell for undertaking to convene the subgroup and looked forward to a full discussion of the outcomes from the workshop.

Ecosystem models, assessments and approaches to management

7.6 A joint WG-FSA and WG-EMM one-day workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA) was held on 16 July 2007. The FEMA report (SC-CAMLR-XXVI/BG/6), prepared by the Co-Conveners of the workshop, is not an official report of WG-EMM, but was presented to, and discussed at, WG-EMM.

7.7 The Working Group welcomed this report and agreed that WG-EMM should continue to consider scientific information on the ecosystem effects of finfish fisheries in the Convention Area.

7.8 The Working Group noted that the Scientific Committee should benefit from bringing together expertise from WG-SAM, WG-FSA and WG-EMM into a workshop. The workshop considered methods to assess and investigate ecosystem effects of finfish fisheries in the Convention Area. The Working Group noted that in expanding consideration of fishing in the greater ecosystem context, this work should not become fragmented on the basis of considerations of target species.

7.9 A workshop 'Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries' was organised at the request of the Lenfest Ocean Program and occurred during the week of 21 May 2007 (henceforth referred to as 'Lenfest Workshop'). The Chair of the Scientific Committee conveyed a letter to the Working Group from the workshop conveners (Drs M. Mangel (USA), Nicol and Reid) which provided an overview of the Lenfest Workshop (WG-SAM-07/15), summarised as follows:

(i) The Lenfest Workshop considered the general characteristics of the krill-centric ecosystems of the South Atlantic including the role of physical forces, krill and dependent predators.

(ii) The Lenfest Workshop considered modelling approaches to krill-centric ecosystems. Discussion focused on model validation methods and performance measures. The Lenfest Workshop concluded that the use of models to investigate ecosystem effects of the krill fishery should not be impeded by requiring models to have features and biological realism exceeding that required for the provision of advice.

(iii) The Lenfest Workshop noted the need for a model of fishing vessel behaviour.

(iv) The Lenfest Workshop concluded that the research priorities on krill-specific issues are:

(a) The distribution and abundance of krill at the spatial scale of SSMUs, and its seasonal variation. This requires improved understanding of what constitutes krill habitat and better understanding of current sampling techniques and how effectively they sample different parts of the krill population.

(b) The parameterisation of krill growth, mortality and recruitment functions. The comparison of length-frequency data from different sampling methods was suggested as a useful approach.

(v) The Lenfest Workshop concluded that the research priorities on krill–predator interactions are:

(a) regional and temporal estimates of krill consumption. Improving these estimates will require assessments of predator abundance, diet and movement;

(b) the characteristics of species and locations that are most sensitive to changes in krill abundance.

(vi) The Lenfest Workshop concluded that understanding relationships between the physical environment and biotic components of the krill-based system was a research priority. The key issue was considered to be the relationship between medium- to long-term trends in krill abundance and large-scale climatic processes, especially the regional and temporal relationship with sea-ice.

7.10 The Working Group welcomed workshops on krill-centric ecosystems outside the CCAMLR forum, such as the Lenfest Workshop. Such workshops provide an opportunity for people outside the CCAMLR community to contribute their experience, data and perspectives towards advancing our understanding of these ecosystems. The Working Group highlighted that it is important that CCAMLR continues to keep the wider scientific community informed of its work.

7.11 The Lenfest Workshop suggested using benchmarks to specify how closely models should reproduce key events and trends in the ecosystem to be considered sufficiently realistic for the provision of advice. WG-SAM provided similar suggestions on the necessary realism of models, the use of empirical data in validation, and the development of a calendar of key events and trends in Area 48 (Annex 7, paragraphs 5.17 to 5.27).

7.12 The Lenfest Workshop suggested that aggregate performance measures would be needed to summarise the output of complex models. Appropriate measures to evaluate the performance of management options were considered by WG-SAM (Annex 7, paragraphs 5.39 to 5.47). WG-SAM noted that aggregate performance measures will be sensitive to the particular method of aggregation chosen.

7.13 The Working Group noted that the letter from the conveners had been used in both WG-SAM and this Working Group in formulating advice in the appropriate sections of the reports.

7.14 The Working Group noted that there is broad agreement amongst krill experts, both within and outside the CCAMLR community, about the major issues that need to be addressed in the management of the krill fishery. In particular, recent research on many of the priority issues suggested by the Lenfest Workshop was considered by WG-EMM-07, including:

(i) understanding the status, trends and behaviour of the krill fishery (section 4; WG-EMM-07/10, 07/27, 07/P5);

(ii) understanding the distribution, abundance and seasonal variability of krill at the spatial scale of SSMUs (WG-EMM-07/8, 07/9, 07/17, 07/31, 07/33);

(iii) better understanding of current sampling techniques and how effectively they sample different parts of the krill population (WG-EMM-07/16, 07/25, 07/28);

(iv) appropriate parameterisation of krill growth, mortality and recruitment functions (WG-EMM 07/30 Rev. 1, 07/33, 07/P6);

(v) estimates of the regional and temporal estimates of krill consumption (WG-EMM-07/10);

(vi) characteristics of predator species and locations (WG-EMM-07/4, 07/11, 07/P1, 07/P2);

(vii) interactions between the physical environment and biotic components of the krill-based system (WG-EMM-07/12, 07/21, 07/P8, 07/P10).

7.15 The Working Group recognised the important role that monitoring plays in managing fisheries in the Convention Area (WG-EMM-07/24, 07/P7, 07/P9). Information collected by consistent methods over long periods of time is particularly valuable to the work of WG-EMM. The Working Group noted that consistent, long-term data are available from three study locations/programs in Area 48: US AMLR, BAS and Palmer-LTER. The continuity of data from these programs is extremely valuable for monitoring and understanding changes in krill abundance, and understanding the relationship with large-scale climatic processes, including sea-ice.

7.16 The Working Group encouraged the submission of information on krill population dynamics and the performance of dependent predators from the Palmer-LTER region to WG-EMM.

7.17 The Working Group identified three areas which may play an important role in the krill-centric ecosystem of the South Atlantic, but which are poorly represented in available data at present: Weddell Sea, Bellingshausen Sea and South Orkney Islands. WG-EMM encouraged increased research in these areas. The South Orkney Islands particularly are a focus for fisheries and are central to the SSMUs in Area 48.

7.18 The Working Group noted that there is a potential conflict between rapid expansion of the krill fishery and the ability to answer key scientific questions about the krill-centric system to enable effective management. It will be very important to ensure that the krill fishery does not impact on CCAMLR's ability to answer these key questions. This issue is of particular concern for areas where little research on krill, predators or the environment is currently available.

7.19 The Working Group recognised that the fishery for Antarctic toothfish in the Ross Sea has the potential to affect other ecosystem components, including predators of toothfish, such as Weddell seals, prey of toothfish, and through second-order ecosystem effects. Further work on assessing these threats and on approaches to managing these threats at the present level of understanding is required. In the meantime, the fishery should be managed at a precautionary level with respect to ecosystem effects.

7.20 Mass balance trophic models are recognised as being a valuable starting point for characterising ecosystem structure. The Working Group welcomed progress on a novel method for objectively establishing balance in trophic models based on estimates of the different level of uncertainty between parameters (WG-EMM-07/18).

7.21 The Working Group noted the conclusions of WG-EMM-07/P7 that the revised principles of Mangel et al. (1996) are useful in indicating what needs to be achieved to deliver a precautionary approach to marine ecosystem management, namely:

(i) manage total impact on ecosystems and work to preserve essential features of the ecosystem;

(ii) identify areas, species and processes that are particularly important to the maintenance of an ecosystem, and make special efforts to protect them;

(iii) manage in ways that do not further fragment natural areas;

(iv) maintain or mimic patterns of natural processes, including disturbances, at scales appropriate to the natural system;

(v) avoid disruption of food webs, especially removal of top or basal species;

(vi) avoid significant genetic alteration of populations;

(vii) recognise that biological processes are often non-linear, are subject to critical thresholds and synergisms, and that these must be identified, understood and incorporated into management programs.

Long-term work plan

7.22 The Working Group noted the combined set of tasks arising from its discussions (Table 3) and requested Members to review and participate where possible in this work plan. It noted the increasing volume of work and requested the Scientific Committee consider and advise on the relative priorities for this work plan.

7.23 The Working Group recognised the importance of streamlining the agendas of all working groups and workshops of the Scientific Committee. It noted that it was desirable to maximise the input of scientists to this work and that it would be helpful to manage the agenda of WG-SAM and this Working Group so that scientists could attend both groups for overlapping work but without having to attend both meetings for their entire time. The Working Group agreed that advance notice of the scheduling of key agenda items would be helpful in this regard.

7.24 The Working Group noted the following key points for consideration in the work of the Scientific Committee in the coming year:

(i) the recommended points for consideration by SG-ASAM at its next meeting (paragraph 2.32);

(ii) the need for the Working Group to review parameter settings in the estimate of γ, notably the currently available growth models, recruitment indices and mortality, and the implications of spatial and temporal variability in parameters (paragraph 2.43);

(iii) WG-EMM-STAPP will hold the predator survey workshop next year, probably in Hobart in June prior to WG-EMM, to consider the work plan identified in paragraphs 7.1 to 7.4. The workshop details, when finalised, will be communicated to SCAR.

7.25 Dr Constable summarised the work to date on the planning for the CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models (SC-CAMLR-XXVI/BG/5). A Joint Steering Group made up of representatives from both organisations was established in 2006 to plan for the workshop. It developed the following terms of reference to account for the needs identified by both organisations:

(i) for models on the Antarctic marine ecosystem, and in particular predator–prey relationships, that could be developed for providing management and conservation advice relevant to CCAMLR and IWC, consider the types, relative importance and uncertainties associated with input data for those models, in order to understand what is needed to reduce uncertainties and errors in their use;

(ii) review the available input data from published and unpublished sources that are currently available for such models;

(iii) summarise the nature of input data (e.g. abundance estimates, trend estimates, foraging scales, seasonal diet etc.), based on metadata (see definition below), by describing methodology, broad levels of uncertainty, time series and spatial extent and determine the appropriate scale at which those input data are relevant to these modelling efforts;

(iv) identify and prioritise the gaps in knowledge and types of analyses and field research programs needed to reduce important uncertainties in ecosystem models being developed for CCAMLR and IWC, and identify how scientists from the two Commissions can best collaborate and share data to maximise the rate of development and scientific quality of modelling efforts and input data.

7.26 Progress from 2006 to April 2007 was reported to the SC-IWC in SC-CAMLR-XXVI/BG/5. The outcomes of the discussion at the SC-IWC are contained in the report of the SC-CAMLR Observer to the SC-IWC (SC-CAMLR-XXVI/BG/4).

7.27 The Working Group welcomed progress on the planning for the workshop and the importance of increasing cooperation between SC-CAMLR and the SC-IWC. It welcomed the commitment by the SC-IWC for half the budget for the workshop.

7.28 In considering the planning for the workshop, the Working Group noted the following for consideration by the Steering Group and the Scientific Committee:

(i) the preference by the SC-IWC to hold the meeting later in 2008 was acceptable and that some time in August would be appropriate, given the timing of other meetings of the Scientific Committee, noting that translation of the report would not be possible until 2009;

(ii) the budget remains satisfactory but it would be desirable to minimise expenses wherever possible, particularly if experts can become involved voluntarily or funded by individual Members;

(iii) the overall budget should be expended in a way that delivers the best outcomes from the workshop and, as a result, it is expected that the invited experts will comprise mostly expertise not necessarily related to cetaceans;

(iv) the CCAMLR Secretariat remains the preferred location of the workshop;

(v) it is desirable that a more refined budget and work plan be made available to SC-CAMLR for consideration;

(vi) the compilation of data and reviews for mesopelagic and epipelagic predators and the other biological and physical components was likely to be of lower priority than the other groups;

(vii) it is important to hold the workshop in 2008 because of the momentum now gathered for this work and the requirements for the outcomes of this work to be included in consideration of Stage 2 of the work of WG-EMM in 2009 for subdividing the krill catch limit among SSMUs in Area 48;

(viii) the Chair of the Scientific Committee should consult with the Scientific Committee via an SC circular, as soon as practicable, to ascertain whether a request can be made of SCAR by CCAMLR to submit the results of the Antarctic pack-ice seals survey to the workshop, as those results will be very important in future modelling efforts of the Antarctic marine ecosystem.

7.29 The Working Group noted the desire of the Commission for the Scientific Committee to review the use of bottom trawling gear in high-seas areas of the Convention Area, including with respect to relevant criteria for determining what constitutes significant harm to benthos and benthic communities (Conservation Measure 22-05; CCAMLR-XXV, paragraphs 11.25 to 11.38). With respect to this request, the Working Group noted the following:

(i) krill trawling is unlikely to significantly impact on benthic communities as it is a pelagic fishery;

(ii) consideration of the nature of interactions of other fisheries activities would best be addressed within WG-FSA because of its expertise on finfish fisheries;

(iii) future work could be included in this Working Group on how to investigate adverse impacts of fisheries on marine ecosystems, noting the modelling work already under way to address the food-web effects of krill and finfish fisheries;

(iv) the Working Group would welcome submissions from Members providing suggestions on methodologies to be used to review the use of bottom trawling gear in high-seas areas and developing criteria for determining what constitutes significant harm to benthos and benthic communities.

7.30 The Working Group agreed that its priorities for work at its next meeting would be:

(i) the development and provision of advice on Stage 1 of the subdivision of the Area 48 krill catch limit among SSMUs;

(ii) revision, as needed, of estimates of yield for krill;

(iii) considering the outcomes of the work of WG-EMM-STAPP.

7.31 In considering these items, the Working Group noted that the usual workshop period could be used jointly for the work of WG-SAM and WG-EMM on the first priority item.

7.32 The Working Group noted that it would be useful to renew the long-term work plan at its next meeting, forecasting when expertise might be required for workshops or other priority activities of the group, such as is contained in Table 3 of SC-CAMLR-XXIII, Annex 4.

OTHER BUSINESS

8.1 No other business was raised at the meeting.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

9.1 The report of the thirteenth meeting of WG-EMM was adopted.

9.2 In closing the meeting, Dr Reid thanked all participants for a successful and convivial meeting, which had advanced the Convention's ecosystem approach to managing the krill fishery. He thanked the New Zealand Delegation for their warm hospitality, and for providing excellent meeting facilities, and in particular noted the outstanding contributions from Miss J. McCabe and Dr S. Mormede. Dr Reid also thanked the Secretariat staff for their dedicated support.

9.3 Dr Reid noted Dr Sabourenkov's retirement early next year. Dr Sabourenkov has had a long-standing involvement in the work of WG-EMM and its predecessors. This contribution included development of the CEMP standard methods. The Working Group presented a small gift to Dr Sabourenkov in recognition of his valuable service to CCAMLR's work as a whole, particularly in ecosystem monitoring and management.

9.4 Dr Holt, on behalf of the Working Group, thanked Dr Reid for his skill and dedication in leading WG-EMM over the past two years. His leadership had greatly facilitated the work of WG-EMM. The Working Group wished Dr Reid every success in his new role in the Secretariat.

9.5 The meeting was closed.

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Table 1: Guidelines on which acoustic protocols currently apply in a CCAMLR context for new data collected (see paragraph 2.27).

Protocol	Recommendations
Ship track (space)	Reference to Jolly and Hampton (1990) should be made for all questions of survey design.
Ship track (time)	Reference to Hewitt et al. (2004) should be made with regard to sampling by day and/or by night.
Transducers	Reference to Hewitt et al. (2004) and SG-ASAM-05 (SC-CAMLR-XXIV, Annex 6) should be made with regard to the transducer frequencies to use.
Calibration	Reference should be made to Hewitt et al. (2004) and Demer (2004) for questions regarding echosounder-system calibration and the survey sound-propagation model.
Resampling	Reference to Watkins and Brierley (2002) and Hewitt et al. (2004) should be made for questions regarding the resampling of S_v samples into bins.
S_v classification	When defining ΔS_v windows, it is recommended that the range of lengths be used that includes ≥95% of the krill length PDF and achieves the smallest ΔS_v windows. Reference to SG-ASAM-07 (SC-CAMLR-XXVI/BG/2) and WG-EMM-07/30 Rev. 1 should be made for further questions regarding the ΔS_v method.
EDSU dimensions	Reference to Hewitt et al. (2004) and MacLennan and Simmonds (2005) should be made for questions regarding the integration of S_v bins into elementary distance sampling units (EDSUs).
W(*L*) model	In order of preference, define the *W*(*L*) model in one of the following ways: • measure *W* and *L* directly during the survey • use literature values representative of survey location and time of year • use the *W*(*L*) model presented in Hewitt et al. (2004).
Target-strength model	Reference to Siegel et al. (2004) should be made for questions regarding the generation of length-frequency clusters, and to SG-ASAM-07 (SC-CAMLR-XXVI/BG/2) and SG-ASAM-05 (SC-CAMLR-XXIV, Annex 6) for questions regarding the implementation of the SDWBA model.
Calculation of biomass density	The correct equation for calculating *C* (*aka* CF) is presented in WG-EMM-07/30 Rev. 1 and Reiss et al. (submitted). The equation applied by Hewitt et al. (2004) is not strictly correct for a model that predicts target strength on the basis of target area rather than volume; because the Greene et al. (1991) model relates to target volume, the Hewitt et al. (2004) calculations will not have been significantly affected.
Biomass density to biomass	Reference to Hewitt et al. (2004) should be made for all questions of converting from biomass density to biomass.
Area	Reference to Trathan et al. (2001) should be made for all questions of area estimation.
Parameter and survey error	Reference to Jolly and Hampton (1990) should be made for questions regarding the estimation of survey sampling error. Demer (2004) should be consulted if an estimate of total random error is required.

Table 2: Outputs of the GYM runs conducted during the meeting. See paragraphs 2.38 to 2.42 for details.

	Current	Run 0	Run 1
Survey B_0	44.29	44.29	37.29
Survey CV	11.38	11.38	21.20
γ			
75% predator criterion	0.091	0.093	0.093
10% recruitment criterion	0.118	0.121	0.116
γ which satisfies rule	0.091	0.093	0.093
Area 48 catch limit (million tonnes)	4.03	4.12	3.47

Table 3: List of tasks identified by WG-EMM for the 2007/08 intersessional period. The paragraph numbers (Ref.) refer to this report.

	Task	Ref.	Action Required	
			Members/Subgroups	Secretariat
	Estimation of B_0 and precautionary catch limits for krill			
1.	Implement incremental improvements to acoustic protocols.	2.20	Members to implement	Assist
2.	Use current CCAMLR protocols for the acoustic estimation of krill biomass and procedures developed by SG-ASAM for target strength and species identification.	2.26, 2.66	Members to implement	Assist
3.	Produce a paper for WG-EMM describing details of data collection and analysis protocols for CCAMLR acoustic surveys.	2.31, 5.97	Dr T. Jarvis (Australia)	Remind
4.	Pass on WG-EMM recommendations on krill assessment to SG-ASAM for consideration.	2.32	SG-ASAM Convener	Implement
5.	Plan and conduct intersessional work to incorporate krill recruitment variability and *M* from long-term datasets into the assessment process.	2.42, 2.73	Members to implement	Assist
6.	Continue investigation into integrated assessment for krill and provide advice to WG-SAM in its work on developing feedback management for krill.	2.54	Members to implement	Assist
7.	Estimation of B_0 for Division 58.4.2 to be produced in time for the 2007 meeting of the Scientific Committee.	2.71, 5.39	Australia	Assist
8.	Update krill parameter values for GYM for the use at next meeting of WG-EMM.	2.40	Members to implement	Remind
9.	Consider advice of WG-SAM in planning future acoustic surveys to estimate krill B_0.	5.82	Members to implement	Remind
	Status and trends in the krill fishery			
10.	Implement ‘flow scale’ method to improve collection of catch data arising from continuous fishing system and undertake studies as proposed by the Scientific Committee in 2006.	4.13, 4.18	Norway	Remind
11.	Requirement to complete the CCAMLR questionnaire on the collection of data on fishery dynamics for krill fisheries.	4.27	Members to implement	Assist

	Task	Ref.	Action Required	
			Members/Subgroups	Secretariat
12.	Seek advice of WG-FSA on the use by CCAMLR observers of a field guide developed by Japan for identification of early life stages of Antarctic fish.	4.36	WG-EMM Convener	Assist
13.	Review other available fish identification guides and develop a common guide for the use of observers on board krill fishing vessels.	4.37	WG-FSA	Assist
	Scientific observation			
14.	Information of gear type and mesh size to be reported by scientific observers together with krill biological data.	5.51	Members to implement	Assist
15.	The frequency of occurrence of krill black-spots disease to be reported by scientific observers.	5.55	Members to implement	Assist
16.	Prepare an annual summary of observer data collected in krill fisheries and submit it to WG-EMM to review and approve its format for the use in the future.	4.58	WG-EMM Convener	Implement
17.	Enhance consistency in completion of Cruise Reports by observers.	4.59	Technical Coordinators	Assist
18.	Update Observer Cruise Report form by including schematic diagrams of trawl gear, e.g. used in krill fisheries.	4.59	Technical Coordinators	Implement
19.	Revise observer instructions based on workload estimates so that the observers can systematically collect the required data.	4.34	Dr S. Kawaguchi (Australia)	Implement
20.	Revise *Scientific Observers Manual*/observer logbooks to include fish larvae by-catch observation protocol and collection of data on krill infected by 'black-spot' disease.	4.65, 4.67	Technical Coordinators Working Group conveners	Implement
	Status and trends in the krill-centric ecosystem			
21.	Encourage Members with active research programs to join CEMP.	5.6	Members to implement	Assist
22.	Continue the assessment of the linkage between penguins and their ice environment to aid interpretation of CEMP results and predict changes in krill-dependent predator populations.	5.16	Members to implement	Remind
23.	Continue collection of krill density and recruitment indices in Subarea 48.1 as important input parameters to GYM to calculate precautionary catch limits.	5.43, 5.58	Members to implement	Remind

	Task	Ref.	Action Required	
			Members/Subgroups	Secretariat
24.	Pursue development of environmental indices to forecast krill fishing.	5.64	Members to implement	Remind
25.	Consider advice of WG-SAM in planning future acoustic surveys of icefish.	5.83	Members to implement	Remind
26.	Further studies on the segregation of *E. superba* and *E. crystallorophias* in the Ross Sea.	5.90	Members to implement	Remind
27.	Standardise krill length data from the fishery collected over large areas and periods, and report them with information on gear type and mesh size.	5.93	Members to implement	Assist
28.	Contact all CAML investigators and request that they adhere to CCAMLR-IPY protocols when conducting their respective IPY surveys.	5.99	Dr V. Wadley (Australia)	Implement
	Status of management advice			
29.	Review status of CEMP works on Elephant Island (Stinker Point).	6.6	Brazil	Assist
30.	Seek advice of the Scientific Committee on the approach to be followed for subdividing large statistical areas into harvesting units in the absence of recent survey data.	6.23, 6.24	SC Chair	Remind
31.	Conduct analyses leading to an understanding of how krill catchability and fishing performance may vary between coastal and oceanic SSMUs.	6.43	Members to implement	Remind
32.	Conduct further development of feedback management approaches.	6.47	Members to implement	Remind
33.	Modify CEMP Standard Method A7 for gentoo penguins to reflect differences in fledging behaviour noted at Admiralty Bay.	5.70	Dr W. Trivelpiece (USA)	Assist
34.	Consider utility of an alternative CEMP code for black-browed albatross that could be cross-referenced to the FAO species code.	5.72		Implement
35.	Ensure that only current CCAMLR forms are used for submitting CEMP data.	5.73, 5.95	Members to implement	Assist
36.	Produce a scoping paper for WG-SAM on the issues surrounding the ordination method for presenting trends in CEMP indices.	5.76, 5.96		Implement
37.	Conduct further work on determining the role of Weddell seals in the Ross Sea ecosystem and submit results of this work in the future.	5.79	Members to implement	Remind

	Task	Ref.	Action Required	
			Members/Subgroups	Secretariat
	Ecosystem models, assessments and approaches to management			
38.	Keep the wider scientific community informed of CAMLR work.	7.10	Members to implement	Assist
39.	Submit to WG-EMM information on the work conducted at the Palmer-LTER site.	7.15	USA	Remind
40.	Conduct work required to establish how research on the interaction between krill, predators and the environment would be affected if the krill fishery expands rapidly.	7.18	Members to implement	Remind
	Long-term work plan			
41.	Prepare and conduct a workshop on estimation of land-based predator abundance.	7.1–7.4	Dr C. Southwell (Australia)	Assist
42.	Prepare and conduct the CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models.	7.22–7.32	Dr A. Constable (Australia), Joint Steering Group	Assist
43.	Further work on streamlining the agendas of all working groups.	7.22–7.32	Working Group conveners	Assist
44.	Further work to review the use of bottom trawling gear in high seas of the Convention Area.	7.22–7.32	WG-EMM and WG-FSA	Assist

APPENDIX A

AGENDA

Working Group on Ecosystem Monitoring and Management
(Christchurch, New Zealand, 17 to 26 July 2007)

1. Introduction
   1.1 Opening of the meeting
   1.2 Adoption of the agenda and organisation of the meeting

2. WG-EMM Workshop to Review Estimates of B_0 and Precautionary Catch Limits for Krill

3. Feedback from the 2006 meetings of the Scientific Committee and the Commission

4. Status and trends in the krill fishery
   4.1 Fishing activity
   4.2 Description of the fishery
   4.3 Scientific observation
   4.4 Regulatory issues
   4.5 Key points for consideration by the Scientific Committee

5. Status and trends in the krill-centric ecosystem
   5.1 Status of predators, krill resource and environmental influences
   5.2 Other prey species
   5.3 Methods
   5.4 Future surveys
   5.5 Key points for consideration by the Scientific Committee

6. Status of management advice
   6.1 Protected areas
   6.2 Harvesting units
   6.3 Small-scale management units
   6.4 Analytical models
   6.5 Existing conservation measures
   6.6 Key points for consideration by the Scientific Committee

7. Future work
   7.1 Predator surveys
   7.2 Ecosystem models, assessments and approaches to management
   7.3 Long-term work plan
   7.4 Key points for consideration by the Scientific Committee

8. Other business

9. Adoption of report and close of meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Ecosystem Monitoring and Management
(Christchurch, New Zealand, 17 to 26 July 2007)

AGNEW, David (Dr) (to 23rd)	Biology Department Imperial College London Prince Consort Road London SW7 2BP United Kingdom d.agnew@imperial.ac.uk
BIZIKOV, Viacheslav (Dr)	Russian Federal Research Institute of Fisheries and Oceanography (VNIRO) 17 V. Krasnoselskaya Moscow 107140 Russia bizikov@vniro.ru
CONSTABLE, Andrew (Dr) (WG-SAM Co-convener)	Antarctic Climate and Ecosystems Cooperative Research Centre Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia andrew.constable@aad.gov.au
DEMER, David (Dr)	Fisheries Resources Division Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA david.demer@noaa.gov
FANTA, Edith (Dr) Chair, Scientific Committee	Departamento Biologia Celular Universidade Federal do Paraná Caixa Postal 19031 81531-970 Curitiba, PR Brazil e.fanta@terra.com.br

GOEBEL, Michael (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA mike.goebel@noaa.gov
HILL, Simeon (Dr)	British Antarctic Survey Natural Environment Research Council High Cross, Madingley Road Cambridge CB3 0ET United Kingdom sih@bas.ac.uk
HINKE, Jefferson (Mr) (first week only)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA jefferson.hinke@noaa.gov
HOLT, Rennie (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA rennie.holt@noaa.gov
JARVIS, Toby (Dr)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia toby.jarvis@aad.gov.au
JONES, Christopher (Dr) (WG-SAM Co-convener) (first week only)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA chris.d.jones@noaa.gov

KAWAGUCHI, So (Dr)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia so.kawaguchi@aad.gov.au
KNUTSEN, Tor (Dr)	Institute of Marine Research Research Group Plankton Nordnesgaten 50 PO Box 1870 Nordnes 5817 Bergen Norway tor.knutsen@imr.no
MORMEDE, Sophie (Dr)	Ministry of Fisheries PO Box 1020 Wellington New Zealand sophie.mormede@fish.govt.nz
NAGANOBU, Mikio (Dr)	Southern Ocean Living Resources Research Section National Research Institute of Far Seas Fisheries 2-12-4, Fukuura, Kanazawa Yokohama, Kanagawa 236-8648 Japan naganobu@affrc.go.jp
NICOL, Steve (Dr) (B_0 Workshop Convener)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia steve.nicol@aad.gov.au
PINKERTON, Matt (Dr)	National Institute of Water and Atmospheric Research (NIWA) Private Bag 14-901 Kilbirnie Wellington New Zealand m.pinkerton@niwa.co.nz

PLAGÁNYI, Éva (Dr)	Department of Mathematics and Applied Mathematics University of Cape Town Private Bag 7701 Rondebosch South Africa eva.plaganyi-lloyd@uct.ac.za
REID, Keith (Dr) (WG-EMM Convener)	British Antarctic Survey Natural Environment Research Council High Cross, Madingley Road Cambridge CB3 0ET United Kingdom k.reid@bas.ac.uk
REISS, Christian (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA christian.reiss@noaa.gov
SIEGEL, Volker (Dr)	Bundesforschungsanstalt für Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany volker.siegel@ish.bfa-fisch.de
SOUTHWELL, Colin (Dr)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia colin.southwell@aad.gov.au
TAKAO, Yoshimi (Mr) (first week only)	Fisheries Acoustics Section National Research Institute of Fisheries Engineering, FRA 7620-7 Hasaki Kamisu Ibaraki 314-0408 Japan ytakao@affrc.go.jp

TRIVELPIECE, Wayne (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA wayne.trivelpiece@noaa.gov
WATTERS, George (Dr) (to 18th)	Southwest Fisheries Science Center Protected Resources Division 1352 Lighthouse Avenue Pacific Grove, CA 93950-2097 USA george.watters@noaa.gov
WEEBER, Barry (Mr)	Antarctic Marine Project 3 Finnimore Terrace Vogeltown Wellington New Zealand b.weeber@paradise.net.nz
WILSON, Peter (Dr)	MFAT Scientific Adviser 17 Modena Crescent Glendowie Auckland New Zealand wilsonp@nmb.quik.co.nz

Secretariat:

Denzil MILLER (Executive Secretary) Eugene SABOURENKOV (Science/Compliance Officer) David RAMM (Data Manager) Genevieve TANNER (Communications Officer) Rosalie MARAZAS (Website and Information Services Officer) Fernando CARIAGA (Information Technology Manager) (first week only) Jacquelyn TURNER (Analytical Support Officer) (second week only)	CCAMLR PO Box 213 North Hobart 7002 Tasmania Australia ccamlr@ccamlr.org

APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Christchurch, New Zealand, 17 to 26 July 2007)

WG-EMM-07/1	Provisional Agenda and Provisional Annotated Agenda for the 2007 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-07/2	List of participants
WG-EMM-07/3	List of documents
WG-EMM-07/4	CEMP indices: 2007 update Secretariat
WG-EMM-07/5	Krill fishery report: 2007 update Secretariat
WG-EMM-07/6 Rev. 2	Summary of notifications for krill fisheries in 2007/08 Secretariat
WG-EMM-07/7	Interaction between oceanography, krill and baleen whales in the Ross Sea and adjacent waters, Antarctica in 2004/05 M. Naganobu, S. Nishiwaki, H. Yasuma, R. Matsukura, Y. Takao, K. Taki, T. Hayashi, Y. Watanabe, T. Yabuki, Y. Yoda, Y. Noiri, M. Kuga, K. Yoshikawa, N. Kokubun, H. Murase, K. Matsuoka and K. Ito (Japan) (*CCAMLR Science*, submitted)
WG-EMM-07/8	Demography of Antarctic krill and other Euphausiacea in the Lazarev Sea in winter 2006 V. Siegel, M. Haraldsson, M. Vortkamp, L. Würzberg and S. Schöling (Germany)
WG-EMM-07/9	State of Antarctic krill (*Euphausia superba*) fisheries in Statistical Area 48 (Subareas 48.2 and 48.1) in 2006 V.A. Bibik and N.N. Zhuk (Ukraine)
WG-EMM-07/10	Time and energy budgets during winter for gentoo penguins (*Pygoscelis papua*) in the South Shetland Islands J.T. Hinke (USA)

WG-EMM-07/11	Chinstrap penguins alter foraging and diving behaviour in response to krill size A.K. Miller and W.Z. Trivelpiece (USA)
WG-EMM-07/12	Trends and relationships between atmospheric tele-connections and Upper Circumpolar Deep Water (UCDW) influence on phytoplankton biomass around Elephant Island, Antarctica C. Reiss, O. Holm-Hansen and C.D. Hewes (USA)
WG-EMM-07/13	Protocol for aerial censusing of Weddell seals as an EMM protocol D. Ainley, D. Siniff, R. Garrott (USA) and P. Wilson (New Zealand)
WG-EMM-07/14	Short note on time series of Drake Passage Oscillation Index (DPOI) and its influence on environmental variability M. Naganobu and K. Kutsuwada (Japan)
WG-EMM-07/15	Long-term forecast of the conditions of krill (*Euphausia superba* Dana) fisheries in the Antarctic part of the Atlantic Ocean V.A. Bibik and V.A. Bryantsev (Ukraine)
WG-EMM-07/16	Analysis of scientific observer data from the *Saga Sea* 2006–2007 P. Orr, J. Hooper, D. Agnew, J. Roe, G. Doherty and A. Pryor (United Kingdom)
WG-EMM-07/17	Investigations of krill transport factors in the local areas in the Scotia Sea: variability of krill distribution in the fishing grounds under the transport impact S.M. Kasatkina and V.N. Shnar (Russia)
WG-EMM-07/18	A balanced trophic model of the ecosystem of the Ross Sea, Antarctica, for investigating effects of the Antarctic toothfish fishery M.H. Pinkerton, S.M. Hanchet and J. Bradford-Grieve (New Zealand)
WG-EMM-07/19	Stable isotope analysis of Southern Ocean fish tissue samples to investigate trophic linkages of Antarctic toothfish (*Dissostichus mawsoni*) M.H. Pinkerton, S. Bury, S.M. Hanchet and D. Thompson (New Zealand) (*CCAMLR Science*, submitted)

WG-EMM-07/20	Developments, considerations and recommendations by the land-based predator survey correspondence group: a second summary and update C. Southwell (Australia), P. Trathan (UK), W. Trivelpiece, M. Goebel (USA) and P. Wilson (New Zealand)
WG-EMM-07/21	The relationship between sea-ice cover and Adélie penguin reproductive performance at Béchervaise Island L. Emmerson and C. Southwell (Australia)
WG-EMM-07/22	Information on krill in reports from the CCAMLR scheme of international observation and its utility for management J. Foster, S. Nicol and S. Kawaguchi (Australia)
WG-EMM-07/23	Scientific requirements for an orderly development of the krill fishery A. Constable, G. Slocum and S. Nicol (Australia)
WG-EMM-07/24	Ecological risk management and the fishery for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica M.H. Pinkerton, A. Dunn and S.M. Hanchet (New Zealand)
WG-EMM-07/25	Interim protocol for fish/fish larvae by-catch observation in krill fishery S. Kawaguchi (Australia)
WG-EMM-07/26	CCAMLR scientific observation: tasks, priorities and time budget S. Kawaguchi (Australia)
WG-EMM-07/27	Analysis of krill fishery behaviour in the southwest Atlantic: potential signals for moving fishing activities amongst SSMUs S. Kawaguchi, A. Constable and S. Nicol (Australia) (*CCAMLR Science*, submitted)
WG-EMM-07/28	Size selectivity of the RMT8 plankton net and a commercial trawl for Antarctic krill V. Siegel (Germany) (*CCAMLR Science*, submitted)
WG-EMM-07/29	Histopathology of Antarctic krill (*Euphausia superba*) bearing black spots S. Miwa, T. Kamaishi, T. Matsuyama, T. Hayashi and M. Naganobu (Japan)
WG-EMM-07/30 Rev. 1	CCAMLR 2000 revisited D.A. Demer, A.M. Cossio and C.S. Reiss (USA) (*CCAMLR Science*, submitted)

WG-EMM-07/31	2007 krill biomass update of the South Shetland and Elephant Island regions of Area 48 C.S. Reiss and A.M. Cossio (USA)
WG-EMM-07/32	A guide to identification of fishes caught along with the Antarctic krill T. Iwami and M. Naganobu (Japan)
WG-EMM-07/33	Distribution and abundance of Antarctic krill (*Euphausia superba*) off East Antarctic (30–80°E) in January–March 2006 T. Jarvis, N. Kelly, E. van Wijk, S. Kawaguchi and S. Nicol (Australia)
WG-EMM-07/34 Rev. 1	Community structure of epipelagic macrozooplankton in the Ross Sea Y. Watanabe, S. Sawamoto, T. Ishimaru and M. Naganobu (Japan)

Other Documents

WG-EMM-07/P1	Seabird research at Cape Shirreff, Livingston Island, Antarctica, 2006/07 R. Orben, S. Chisholm, A. Miller and W.Z. Trivelpiece (USA) (*AMLR 2006/2007 Field Season Report*)
WG-EMM-07/P2	Cycles of *Euphausia superba* recruitment evident in the diet of Pygoscelid penguins and net trawls in the South Shetland Islands, Antarctica A. Miller and W. Trivelpiece (USA) (*Polar Biol.,* in press)
WG-EMM-07/P3	Insights from the study of the last intact neritic marine ecosystem D. Ainley (to be published as a ‘letter’ in *Trends in Ecology & Evolution*, autumn 2007)
WG-EMM-07/P4	The Antarctic toothfish: how common a prey for Weddell seals? P.J. Ponganis and T.K. Stockard (USA)
WG-EMM-07/P5	Learning about Antarctic krill from the fishery S. Kawaguchi and S. Nicol (Australia) (*Ant. Sci.,* 19 (2): 219–230 (2007))

WG-EMM-07/P6	Male krill grow fast and die young S. Kawaguchi, L.A. Finley, S. Jarman, S.G. Candy (Australia), R.M. Ross, L.B. Quetin (USA), V. Siegel (Germany), W. Trivelpiece (USA), M. Naganobu (Japan) and S. Nicol (Australia) (*Mar. Ecol. Prog. Ser.*, accepted)
WG-EMM-07/P7	Setting management goals using information from predators A. Constable (Australia) (Constable, A.J. 2006. Setting management goals using information from predators. In: Boyd, I., S. Wanless, C.J. Camphuysen (Eds). *Top Predators in Marine Ecosystems: their Role in Monitoring and Management*. Cambridge University Press, Cambridge: 324–346)
WG-EMM-07/P8	Spatial and temporal operation of the Scotia Sea ecosystem: a review of large-scale links in a krill centred food web E.J. Murphy, J.L. Watkins, P.N. Trathan, K. Reid, M.P. Meredith, S.E. Thorpe, N.M. Johnston, A. Clarke, G.A. Tarling, M.A. Collins, J. Forcada, R.S. Shreeve, A. Atkinson, R. Korb, M.J. Whitehouse, P. Ward, P.G. Rodhouse, P. Enderlein, A.G. Hirst, A.R. Martin, S.L. Hill, I.J. Staniland, D.W. Pond, D.R. Briggs, N.J. Cunningham and A.H. Fleming (United Kingdom) (*Phil. Trans. R. Soc. B*, 362: 113–148 (2007))
WG-EMM-07/P9	Monitoring and management in the Antarctic – making the link between science and policy K. Reid (United Kingdom) (*Ant. Sci.*, 19 (2): 267–270 (2007))
WG-EMM-07/P10	Circumpolar connections between Antarctic krill (*Euphausia superba* Dana) populations: Investigating the roles of ocean and sea ice transport S.E. Thorpe, E.J. Murphy and J.L. Watkins (United Kingdom) (*Deep-Sea Res.*, I, 54: 792–810 (2007))
WG-SAM-07/12	A spatial multi-species operating model of the Antarctic Peninsula krill fishery and its impacts on land-breeding predators É.E. Plagányi and D.S. Butterworth (South Africa)
WG-SAM-07/14	Rationale, structure and current templates of the Ecosystem, Productivity, Ocean, Climate (EPOC) modelling framework to support evaluation of strategies to subdivide the Area 48 krill catch limit amongst small-scale management units A. Constable (Australia)

WG-SAM-07/15	Lenfest Ocean Program Workshop ‘Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries’
CCAMLR-XXVI/BG/3	Draft Management Plan for ASMA No. X: Southwest Anvers Island and Palmer Basin Delegation of the USA (as submitted to ATCM XXX (2007), WP 5)
CCAMLR-XXVI/BG/11	On the scientific research of marine protected area within the bounds of the Argentina Islands Archipelago Delegation of Ukraine
SC-CAMLR-XXVI/BG/2	Report of the Third Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Cambridge, UK, 30 April to 2 May 2007)
SC-CAMLR-XXVI/BG/3	Report of the Planning Meeting of the CCAMLR-IPY Steering Committee (Cambridge, UK, 2 to 4 May 2007)
SC-CAMLR-XXVI/BG/4	Observer’s Report from the 59th Meeting of the Scientific Committee of the International Whaling Commission (Anchorage, Alaska, USA, 7 to 18 May 2007) CCAMLR Observer (K.-H. Kock, Germany)
SC-CAMLR-XXVI/BG/5	CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models: update on progress since 2006 Co-conveners, CCAMLR-IWC Workshop

ADDITION TO THE NOTIFICATION OF INTENT TO PARTICIPATE IN A KRILL FISHERY (CONSERVATION MEASURE 21-03, ANNEX 21-03/A)

Contracting Party: ______________________________

Fishing season: ______________________________

Name of vessel: ______________________________

Fishing technique:

☐ Conventional trawl

☐ Continuous fishing system

☐ Pumping to clear codend

☐ Other: Please specify ______________________

Matrix of areas and months to specify the timings of intended fishing activity to be considered by the Scientific Committee and to be agreed by the Commission.

ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 8 to 19 October 2007)

CONTENTS

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[1] Appendices D to Q have been published only in electronic format. For these reports, please refer to www.ccamlr.org/pu/e/e_pubs/fr/drt.htm.

Appendix O: Fishery Report: *Champsocephalus gunnari*
South Georgia (Subarea 48.3)

Appendix P: Fishery Report: *Champsocephalus gunnari*
Heard Island (Division 58.5.2)

Appendix Q: Fishery Report: *Dissostichus eleginoides*
Subarea 48.4

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 8 to 19 October 2007)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 8 to 19 October 2007. The Convener, Dr S. Hanchet (New Zealand), opened the meeting and welcomed participants.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The agenda of the meeting was discussed and it was agreed to add subitems on bottom fishing in CCAMLR high-seas areas, and bioregionalisation under Item 14. The revised agenda was adopted (Appendix A).

2.2 The report was prepared by the participants, and includes the Agenda (Appendix A), List of Participants (Appendix B), List of Documents considered at the meeting (Appendix C) and Fishery Reports (Appendices D to Q).

REVIEW OF AVAILABLE INFORMATION

Data requirements specified in 2006

Development of the CCAMLR database

3.1 The Data Manager, Dr D. Ramm, provided an update on recent developments in managing CCAMLR's data and associated work in support of WG-FSA and ad hoc WG-IMAF. During the intersessional period, the Secretariat had further developed procedures, databases and data forms at the request of the Scientific Committee and its working groups. Work relevant to WG-FSA was highlighted (WG-FSA-07/4) and included:

(i) revision of the data forms for fine-scale catch and effort data (C1, C2, C3 and C5) and catch and effort reports (TAC data) to take explicit account of fish released alive (including tagged and released, cut-offs), and recaptured tagged individuals (CCAMLR-XXV, paragraph 12.44). Consequential changes were made to the CCAMLR database. The revised data forms were placed on the CCAMLR website in November 2006, and have been in use in 2006/07. A data map was also developed (WG-FSA-07/4, Table 1) to illustrate the relationship between the data fields used in these forms;

(ii) initial validation of assessments involving CASAL using the input parameter files and associated papers submitted to WG-FSA. This work validated the input parameter files, and checked that the assessment results quoted in the accompanying papers could be reproduced using the available input files. The validations confirmed the parameter files, MPD estimates and yield estimates for the preliminary assessments for *Dissostichus* spp. in Subarea 48.3, Division 58.5.2 and the Ross Sea (Subarea 88.1 and SSRUs 882A–B);

(iii) development of a new routine to check vessels' positions reported in fishery and observer data (including tagging data). The routine was successfully used to identify errors (e.g. position error, date error) in fishery and/or observer data, and may be extended to other geo-referenced fishery datasets;

(iv) development of a new routine to capture the history of fishing vessels operating in CCAMLR fisheries, using data available in the CCAMLR databases.

Data processing

3.2 The Secretariat had processed fishery and observer data from the 2006/07 season which had been submitted prior to the meeting, and these data were available for analyses at the meeting. In addition, the Secretariat had processed available data from the fishery in the South African EEZ in Subareas 58.6 and 58.7 and Area 51 (Prince Edward and Marion Islands) in 2006/07, and re-submitted data from the French EEZs in Division 58.5.1 (Kerguelen Islands) and Subarea 58.6 (Crozet Island).

3.3 The Working Group thanked Prof. G. Duhamel and Mr N. Gasco (France) for re-submitting the French data in CCAMLR format. These data have provided new information on the catch history of target and by-catch species, and allowed the development of catch-weighted length frequencies for *D. eleginoides* (see Appendices K and M).

3.4 The Secretariat began validation of data from 2006/07 prior to the meeting, and this procedure will be completed in the forthcoming intersessional period.

3.5 The Working Group recalled its request that the Scientific Committee and Commission consider the feasibility of using VMS data to validate positional data reported in fine-scale and observer data (SC-CAMLR-XXV, Annex 5, paragraph 3.6). The Working Group noted that the Secretariat's new position-checking routine (paragraph 3.1(iii)) provides an interim method, pending the outcome of the feasibility study.

Fishery Plans

3.6 The Secretariat has maintained the database which holds the information on Fishery Plans and updated data from 2006/07 to the time series.

Fisheries information

Catch, effort, length and age data reported to CCAMLR

3.7 Under the conservation measures in force in 2006/07, fishing took place in 13 fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*Euphausia superba*) (CCAMLR-XXVI/BG/17). Activities in exploratory fisheries were summarised in WG-FSA-07/4 (Table 4).

3.8 Three other fisheries targeting toothfish were conducted in the Convention Area in 2006/07:

- 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, and Area 51 outside the Convention Area.

3.9 Catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in 2006/07 are summarised in Table 1.

3.10 The Working Group noted the Secretariat's work in monitoring fisheries in 2006/07 (CCAMLR-XXVI/BG/17). This had resulted in the closure of 12 fishing areas and three fisheries. In addition, the fishery for *Dissostichus* spp. in Division 58.4.3b was closed following information received from the People's Republic of China (COMM CIRCs 07/69 and 07/70). All of the closures were triggered when the catches of *Dissostichus* spp. approached the catch limits.

3.11 The Working Group recalled that the Commission had requested that the Scientific Committee and WG-FSA review the effectiveness of the move-on rule for macrourids caught in exploratory fisheries (CCAMLR-XXV, paragraph 4.67). The application of this rule continued to be monitored by the Secretariat in 2006/07, and Members were advised when their vessels invoked part, or all of the criteria of the rule. Details were presented in WG-FSA-07/4, Table 2.

3.12 Immediately prior to the meeting, the Secretariat had updated background information, including tables and figures, in all Fishery Reports (SC-CAMLR-XXV, Annex 5, paragraph 13.23). Updates and revisions were made to the sections on the catch history of target species, including IUU catch estimates, and by-catch species, catch-weighted length frequencies, research hauls and tagging in exploratory fisheries, and harvest controls in 2006/07.

3.13 To assist with the Scientific Committee's request that Members and WG-FSA investigate the spatial distribution of *D. eleginoides* and *D. mawsoni* in Subarea 48.6 (SC-CAMLR-XXV, paragraph 4.153), the Secretariat had investigated the geographic distribution of these species and their distributions by latitude and depth. Based on fine-scale data, *D. eleginoides* occurred predominantly north of 55°S and was recorded only from SSRU A, while *D. mawsoni* occurred predominantly south of 54°S. *Dissostichus eleginoides* were caught in depths from 380 to 1 925 m and *D. mawsoni* were caught in depths from 610 to 2 040 m (WG-FSA-07/4, Figures 1 to 3).

3.14 The Working Group noted the results from trials using a PIT-D device attached to a modified Spanish-type longline in the fishery for *Dissostichus* spp. in the Ross Sea in 2006/07 (WG-FSA-07/43). The device recorded pressure and temperature profiles and yielded information on sink rates. Sink rates ranged from 1.2 m s^{-1} near the surface, to 0.59 m s^{-1} immediately prior to the line settling on the sea floor. Water temperature was –0.2°C at the surface, increasing to 0.06°C at approximately 300 m depth, then decreasing to –0.05°C at fishing depths of 1 300–1 400 m.

Estimates of catch and effort from IUU fishing

3.15 WG-FSA reviewed the estimates of IUU catches in the Convention Area for 2006/07 prepared by the Secretariat and based on information submitted by 1 October 2007 (Table 2 and WG-FSA-07/10 Rev. 5). The deterministic method presently used by the Secretariat to estimate IUU fishing effort was the same method as used in previous years. This method used information on the number of vessels sighted/apprehended and reports of port inspections. Ancillary information on fishing trips and catch rates is derived from CCAMLR data on licensed vessels. The available catch history of *Dissostichus* spp. taken by IUU fishing in the Convention Area derived from longlining and gillnetting activities was summarised in Table 3. The Working Group endorsed these estimates for use in stock assessment and by ad hoc WG-IMAF (see Items 5, 7 and 8).

Catch and effort data for toothfish fisheries in waters adjacent to the Convention Area

3.16 Catches of *Dissostichus* spp. in CCAMLR waters reported to the Secretariat in STATLANT data and the catch and effort reporting system, and catches outside the Convention Area reported in the CDS in 2005/06 and 2006/07, were summarised in Table 4. As for previous seasons, most of the catch of *Dissostichus* spp. taken outside the Convention Area in 2005/06 and 2006/07 was reported from Areas 41 and 87.

3.17 Based on the historic fishing and trading patterns of vessels participating in the CDS, the Secretariat advised that catches reported outside the Convention Area in 2005/06 and 2006/07 indicated legitimate fishing activities and that there was no evidence to suggest that any misreporting had occurred.

3.18 The Working Group noted the small catches of *D. eleginoides* reported from the Indian Ocean outside the Convention Area (e.g. total of 35 tonnes from Areas 51 and 57 in 2006/07, see Table 4). The Working Group expressed concern that fishing for *D. eleginoides* in this region may not be sustainable.

3.19 The Working Group recalled its request for information on the sustainability of the *Dissostichus* resource in Area 41 in order to develop advice on the possible impact of fishing in Area 41 on the *Dissostichus* resource in the western section of Subarea 48.3 (SC-CAMLR-XXV, Annex 5, paragraph 3.22).

3.20 The Working Group noted the scientific observations collected on board a Ukrainian-flagged longliner fishing for *D. eleginoides* in Area 41 (WG-FSA-07/11). Observations included biological data on the target species and by-catch species, information on fishing gear and interactions with seabirds and marine mammals. Depredation by sperm whales occurred on Scotia Bank and the Patagonian Shelf. The Working Group thanked the author for providing these observations.

Scientific observer information

3.21 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. Scientific observers have participated in 56 cruises so far in 2006/07: 50 cruises on vessels targeting *Dissostichus* spp. or *C. gunnari* (40 cruises on longliners; 9 cruises on trawlers; and 1 cruise on a pot vessel); and 6 cruises on vessels fishing for *E. superba*. Details of scientific observer deployments are reported in the Secretariat papers WG-FSA-07/6 Rev. 1, 07/7 Rev. 1, 07/8 Rev. 1, 07/9 and SC-CAMLR-XXVI/BG/8. Scientific observations were discussed under Items 7 and 11.

Inputs for stock assessment

Catch-at-length/age from fisheries

3.22 Scientific observers on board vessels in the Australian fisheries in Division 58.5.2 have collected toothfish otoliths since the fishery commenced in the 1996/97 season. A summary (WG-FSA-07/45) of the otolith collection housed at the Australian Antarctic Division indicates that over 21 000 otoliths have been collected from toothfish in Division 58.5.2 and more than 2 500 otolith pairs have been collected from recaptured tagged fish. More than 3 200 otoliths have been processed to provide size-at-age estimates from fish captured between 1997 and 2003. It is likely that sufficient otoliths have been collected from the main trawl ground to construct age–length keys, however, the cost-benefit of proceeding to age–length keys in terms of the cost and numbers of otoliths to be read versus the precision of stock assessment requires simulation analysis. The Working Group encouraged Australia to investigate the feasibility of constructing age–length keys for toothfish taking into account the different seasons, gear types and areas fished.

3.23 A summary of data collected on toothfish and the associated by-catch by all vessels participating in the longline fishery in Subareas 88.1 and 88.2 are provided in WG-FSA-07/28. All SSRUs in the two subareas except for SSRUs 881D and 882C have now been fished. The 2007 *D. mawsoni* catch was the second highest on record. A three-year experiment, begun in the 2005/06 season, to manage SSRUs within the two subareas was undertaken, in part, to simplify the administration of the fishery by having fewer catch limits. This appeared to be moderately successful, with only one catch limit being slightly exceeded in the 2005/06 season, and two catch limits exceeded in the 2006/07 season. Although there was a large overrun of the catch limit in the north region, the overall catch limit for Subarea 88.1 was only exceeded by 2%. The catch limit was not reached in Subarea 88.2.

Research surveys

3.24 Australia presented results from a random stratified trawl survey conducted on the plateau in Division 58.5.2 during 2007 (WG-FSA-07/46). Surveys of this division have been conducted since 1997 and have been designed to provide data on abundance of pre-adult *D. eleginoides* and juvenile and adult *C. gunnari* for use in assessments. The 2007 survey was conducted in June and July, with 159 randomly allocated sampling stations covering nine separate strata. The catch composition from the survey showed a similar result to 2006, with *D. eleginoides*, *C. gunnari*, *Channichthys rhinoceratus*, *Macrourus whitsoni* and *Lepidonotothen squamifrons* the most common species in the catch. Results of stock assessments are presented for *D. eleginoides* in WG-FSA-07/53 Rev. 1 and for *C. gunnari* in WG-FSA-07/47.

3.25 Germany conducted a bottom trawl survey on board the RV *Polarstern* around Elephant Island and the South Shetland Islands from 19 December 2006 to 3 January 2007. Information on species composition, biomass and size composition of the abundant fish species was provided (WG-FSA-07/22). Biomass estimates during this survey, compared to those found during the 2002 and 2003 surveys, were found to be much lower for *C. gunnari, Chaenocephalus aceratus*, *Chionodraco rastrospinosus*, *Gobionotothen gibberifrons*, *L. larseni* and *L. squamifrons* in both areas. However, biomass estimates of *Notothenia coriiceps* around the South Shetland Islands and *N. rossii* at South Shetland and Elephant Islands were higher during 2007 compared to previous surveys. The Working Group agreed that it would be very informative to have a paper provided in the future summarising the time series of biomass estimates and length frequencies for Subareas 48.1 and 48.2.

3.26 A concentration of *N. rossii* was found in the same location where aggregations of the species have been detected in 1975/76 and 1977/78 before they were depleted by the commercial fishery. Two aggregations of *N. coriiceps*, 10 n miles apart, were found on the King George Island shelf. The location of one of these concentrations was known since 1998. Observations on both *N. coriiceps* and *N. rossii* confirmed that both species are highly gregarious. They tend to form concentrations in small areas while the vast majority of the area is only thinly populated. The results from this survey confirmed earlier observations by WG-FSA (Kock et al., 2004) that a stratified random survey design appears to be inappropriate to assess the status of populations of *N. rossii* and *N. coriiceps* properly.

3.27 The proportion of juvenile *G. gibberifrons* decreased further compared to previous surveys due to the production of very poor year classes since the late 1990s. In contrast, recruitment of juveniles to the adult population appears to be normal on the other side of Bransfield Strait off the tip of the Antarctic Peninsula. Juveniles were numerous in research catches there.

3.28 A comparison of the variations in mean annual lengths and density distributions, using samples of fish collected during a 24-year period at Potter Cove (Subarea 48.1) was discussed (WG-FSA-07/52). Two commercially exploited species, *N. rossii* and *G. gibberifrons*, were compared to the ecologically similar but unexploited *N. coriiceps*. During the 24-year period, both commercially exploited species exhibited a decrease in abundance with initial increases in mean size and then a reduction in mean size. This is consistent with low-strength cohorts. The length-frequency distributions of *N. coriiceps* throughout the whole study period did not show any definite change in modal size, nor a pattern in mean lengths as was the case with the exploited species.

3.29 The Working Group noted the apparent lack of recruitment reported in both the German and Argentine studies, both reporting over long time periods. The lack of recovery after being commercially depleted is of concern.

3.30 The UK conducted a random stratified bottom trawl survey in Subarea 48.3 in August–September 2007 (WG-FSA-07/56). Previous surveys (except 1997) have been conducted during the austral summer, but this survey was undertaken in winter to provide information on seasonal changes in icefish distribution and to provide an abundance estimate immediately prior to WG-FSA. As in summer surveys, the main icefish aggregations were found to the northwest of South Georgia, although feeding intensity was less than during summer. Preliminary analysis of the data indicated that during winter the bathymetric distributions of many species are deeper than during summer, perhaps as a result of the deeper cold-water mixed layer. The large cohort of *C. gunnari* caught as 2+ fish during the 2006 survey dominated catches (now 3+), with a smaller cohort (2+) detected at modal size of 18–22 cm. The large *D. eleginoides* cohort, first detected at Shag Rocks as 1+ fish in 2003, were caught as 6+ fish on the South Georgia and Shag Rocks shelf.

3.31 France conducted a random stratified bottom trawl survey between 100 and 1 000 m in Division 58.5.1 (the northern part of the Kerguelen Plateau) in September–October 2006 (WG-FSA-07/16). The total biomass was approximately 245 000 tonnes with about half (124 000 tonnes) being *D. eleginoides*. It was noted that four of the species (*D. eleginoides, M. carinatus, Bathyraja eatonii* and *B. irrasa*) extend deeper than 1 000 m, the limit of the 2006 survey. Some shelf and slope species (*C. gunnari* and *N. rossii*) exhibit low levels of biomass when compared to previous survey results (1987/88 survey). Other species (*C. rhinoceratus* and *L. squamifrons*) seem to have increased, even doubled, their biomass during the period between the two surveys. Besides the commercial species, two non-commercial fish species were also abundant: *Zanclorhynchus spinifer* on the slope and *Alepocephalus* cf. *antipodianus* in the deep sea. The geographical and bathymetrical distributions of the species indicate that they occur in very stable concentrations which are found in the same localised areas during both surveys (POKER 2006 and SKALP 1987/88).

3.32 The Working Group congratulated Australia, France, Germany and the UK, on completing very complex research surveys in 2006/07 and for providing data and results in very short time periods. The Working Group appreciated the huge amount of effort and resources required to conduct surveys which are part of long-term data series.

Tagging studies

3.33 WG-FSA-07/36 presented some designs for equipment used in the Ross Sea to land and tag large fish. The paper identified the most important factors determining successful tagging of large fish as being the speed of operation and the handling of fish on board. The Working Group welcomed the development of techniques to ensure vessels can tag a representative sample of toothfish, including ensuring that large fish are handled and tagged such that their survivorship is high. The Working Group requested that the plans and protocols described in the paper be posted on the CCAMLR website, and technical coordinators be directed to this information by the Secretariat.

3.34 WG-FSA-07/40 presented a description of the tagging program in Subareas 88.1 and 88.2. Overall, a total of 15 088 *D. mawsoni* have been reported as released and 458 recaptured since 2001; the equivalent numbers for *D. eleginoides* are 911 and 43 respectively. For the first time, long-distance movements of *D. mawsoni* were observed from toothfish tagged by fishing vessels. Six fish moved 400 to 600 km from the slope fisheries in SSRUs 881H, 881I and 881K to grounds off Terra Nova Bay and Ross Island in SSRU 881J. WG-FSA-07/40 also noted that the number of tags recaptured in the Ross Sea in 2007 by New Zealand vessels was higher than usual, and a large proportion were recaptured in a small number of discrete locations that had had intensive tagging in 2006. The Working Group noted that the nature of these observations suggested that assumptions of homogeneous mixing would need to be further investigated.

3.35 WG-FSA-07/40 also described the release and recapture rates of tags by vessels from different nations. The analysis presented in that paper found that recapture rates for tags released by vessels from different nations were different. The Working Group was very concerned at the low levels from some vessels, and that this created considerable uncertainty about the implementation of the tagging program by the fleet fishing in Subareas 88.1 and 88.2. The Working Group noted that this may be due to factors such as variable mortality rates due to different handling methods on different vessels.

3.36 The Working Group requested that the Scientific Committee and the Commission look at the reasons for the observed differences between rates that tags were recaptured from those released by vessels from different nations, and provide advice, for use in assessments, to the Working Group on how to resolve these observed differences.

3.37 WG-FSA-07/48 Rev. 1 presented an updated description of the tagging program in the Division 58.5.2 *Dissostichus* spp. fishery. A total of 15 190 toothfish have been tagged in Division 58.5.2, of which 3 131 have been recaptured in Division 58.5.2 and 35 have been recaptured in Division 58.5.1 and Subarea 58.6. Release and recapture rates are fishing method and area specific, with the great majority of tags released and recaptured in the relatively small area of the main trawl fishery, making it difficult to use tagging to inform assessments of the overall stock in Division 58.5.2.

3.38 Dr T. Carruthers (UK) presented a summary of the tagging program in Subarea 48.4 for the 2006/07 season (WG-FSA-07/32). The paper summarised results from the tagging experiment at the South Sandwich Islands. During the 2006/07 fishing season, one UK and one New Zealand vessel fished in Subarea 48.4, catching a total of 54 tonnes of toothfish. A total of 291 *D. eleginoides* and one *D. mawsoni* have been tagged, at a rate of 5.4 fish per tonne. Additionally, 100 rajids were tagged and released.

3.39 The objective of the tagging program was to estimate toothfish exploitation rates and abundance. During the three years of operation, 467 tags were released, and two recaptures have been recorded, both of which were 2006 releases that were recaptured in 2007. These were recaptured 84 and 14 km respectively from their released position. The number of recaptures was too low to provide an estimate of abundance.

3.40 The exploratory fishery has provided useful descriptive information about the spatial distribution of the target and by-catch species (WG-FSA-07/32). There was a correlation between the CPUE distribution of toothfish (*D. eleginoides*) and Macrouridae, with both having higher catch rates to the north. There was less overlap in the distribution of Rajidae and toothfish, with Rajid catch rates higher in the east.

3.41 The Working Group recommended that the tagging experiment in Subarea 48.4 be continued, so that further data can be collected which may allow estimates of abundance to be calculated in the future.

3.42 The Working Group recalled its advice that, to avoid bias in assessments, tags should be released in proportion to the fished population. However, the Working Group noted, with concern, that some vessels did not achieve the required tagging rates in Divisions 58.4.1 and 58.4.2 and Subarea 88.2 (Appendices E, F and I; Table 5).

3.43 The Working Group requested that SCIC review the information that it would like from WG-FSA in future to allow it to address this issue.

3.44 Considering the advice in paragraph 3.42, the Working Group recommended that Conservation Measure 41-01, Annex C, be amended by changing the second sentence of paragraph 2(i) to read 'Vessels shall only discontinue tagging if they leave the fishery having tagged toothfish at the specified rate'.

3.45 The Working Group reviewed the utility of having photographs of tags submitted with data for recaptures to the Secretariat. The Secretariat reported that this practice assisted in verifying the correct tag details, where problems with the recording of tag numbers and colours still remain.

3.46 The Working Group recommended that the practice of taking photos of tags from recaptured fish be made a standard requirement of observers. This will require a change to Conservation Measure 41-01, Annex C, paragraph 2(v), deleting footnote 2 which specifies this as a trial year for 2007.

3.47 The quality of the photographs was also discussed, as this ranged from excellent, where the tag number could easily be identified, to poor where no details could be seen. The Secretariat explained that the main problems with the photographs were due to low resolution making the numbers impossible to read, photographs being taken from too far away, flare from the flash obscuring the tag, or photos being taken of tags with the number obscured or on the non-facing side. Observers are therefore requested to ensure that the tag number and details can easily be read from the photograph which is submitted with the logbook, and that the tag takes up the entire frame in the photograph. The Secretariat is requested to update the observer logbook to reflect this change.

3.48 The Working Group also recommended that the Secretariat produce a photograph tag template, which would be used to place behind the tag when photographed. This would act as a background for the photographs, giving the observers a fixed area to focus on and provide a colour reference guide to aid in the identification of the tags. The Secretariat estimated the cost of producing waterproof templates would be approximately A$1 500.

3.49 The Working Group considered the proposal for increased emphasis on tagging during the proposed 'Year of the Skate' (paragraphs 6.34 to 6.39). The Working Group recommended that adopting a uniform, T-bar tag design, with colouration and numbering distinct from toothfish tags, would be appropriate, and that all skates should be double-tagged, with one tag in each wing, as proposed in WG-FSA-07/39. This would ensure that a uniform tagging protocol could be developed for inclusion in the CCAMLR *Scientific Observers Manual*, and considerations of tag shedding and tag-induced growth and mortality effects would be similar for skates tagged across all fisheries.

3.50 Dr D. Welsford (Australia) informed the Working Group that tagging of skates had been conducted in Division 58.5.2 for several years, using a double-tagging method consistent with that proposed for the Year of the Skate. Dr D. Agnew (UK) informed the group that a tagging program also existed in the Subarea 48.3 toothfish fishery. However, in both instances, and in the Ross Sea, tag recovery rates are low, and hence any skate tagging program would need to be focused to maximise the chances of getting useful numbers of recaptures.

3.51 The Working Group recommended that the Secretariat administer the tagging program for skates, in the first instance purchasing 50 000 tags to be distributed in 2007/08 in preparation for the Year of the Skate in 2008/09.

3.52 The Working Group noted the continuing advances in technology in producing tags which incorporate electronics including passive transponders, data loggers and acoustic tracking devices, and methods of automatically detecting and recording tag recaptures on board fishing vessels. The Working Group encouraged Members to consider application of such technologies to investigate key uncertainties for toothfish stocks such as fish behaviour and movement.

Management advice

3.53 The Working Group recommended that the protocols for tagging very large toothfish, and plans for equipment to assist with handling such fish described in WG-FSA-07/36, be posted on the CCAMLR website, and technical coordinators be directed to this information by the Secretariat.

3.54 In all exploratory fisheries, observers should take a photographic record of all tags recovered and forward these photographs and tags to the Secretariat. Footnote 2 in Conservation Measure 41-01, Annex C, paragraph 2(v), which specifies a trial of photographing tags in 2007, should be removed.

3.55 The Working Group requested that the Secretariat produce a waterproof template to assist observers with taking legible photographs of tag recaptures, to be distributed with tagging kits. The Secretariat should take responsibility for coordinating skate tagging programs in new and exploratory fisheries starting from the 2007/08 season, in preparation for the Year of the Skate in 2008/09.

3.56 All skate tags used by Members in exploratory fisheries should be purchased from the Secretariat for use in the 2008/09 season onwards. The Scientific Committee and SCAF should identify funds required by the Secretariat, which will be recovered through the sale of tags and tagging kits to Members undertaking exploratory fisheries.

3.57 The Working Group requested that the Scientific Committee and the Commission look at the reasons for the observed differences between rates that tags were recaptured from those released by vessels from different nations, and provide advice, for use in assessments, to the Working Group on how to resolve the observed differences.

3.58 The Working Group recommended that the tagging experiment in Subarea 48.4 be continued, so that further data can be collected that may allow estimates of abundance to be calculated in the future.

3.59 The Working Group requested that SCIC review the information that it would like from WG-FSA in future, to allow it to address the issue of reporting on vessels that have not met the required tagging rate in new and exploratory fisheries.

3.60 The Working Group recommended that Conservation Measure 41-01, Annex C, be amended by changing the second sentence of paragraph 2(i) to read 'Vessels shall only discontinue tagging if they leave the fishery having tagged toothfish at the specified rate'.

Biological parameters

3.61 No new biological parameter estimates were presented to WG-FSA. However, a summary of the biological properties of *C. gunnari* were provided in WG-FSA-07/12. The Working Group noted that no variance estimates were provided in association with statistical relationships, such as weight-at-length, because these were rarely available in the primary literature.

Stock structure and management areas

3.62 Aspects of the reproduction, size distribution and movements of *D. mawsoni* in Subareas 88.1 and 88.2 were reviewed in WG-FSA-07/35. Based on the presumed location and timing of spawning, and the probable early life-history characteristics of toothfish, it investigated models that mimic the drift of eggs and larvae over a 6- to 24-month period using an oceanic circulation model linked to the high-resolution global environmental model (HiGEM). The location of toothfish larvae after an 18- to 24-month period suggested by the models agreed moderately well with the distribution of the smallest toothfish taken in the toothfish fishery.

3.63 The paper hypothesised that *D. mawsoni* in Subareas 88.1 and 88.2 spawn to the north of the Antarctic continental slope, mainly on the ridges and banks of the Pacific-Antarctic Ridge. The spawning appears to take place during winter and spring, and may extend over a period of several months. Depending on the exact location of spawning, eggs and larvae become entrained by the Ross Sea gyres, and may either move west settling out around the Balleny Islands and adjacent Antarctic continental shelf, south onto the Ross Sea shelf, or eastwards with the eastern Ross Sea gyre settling out along the continental slope and shelf to the east of the Ross Sea in Subarea 88.2. As the juveniles grow in size they move west back towards the Ross Sea shelf and then move out into deeper water (>600 m). The fish gradually move northwards as they mature, feeding in the slope region in depths of 1 000–1 500 m, where they gain condition before moving north onto the Pacific-Antarctic ridge to start the cycle again. Spawning fish may remain in the northern area for up to 2 to 3 years. They then move southwards back onto the shelf and slope where productivity is higher and food is more plentiful and where they regain condition before spawning.

3.64 The Working Group welcomed the development of a plausible life history for *D. mawsoni* in the Ross Sea region, and noted that it would assist in the development of operating models for future management strategy evaluation of toothfish resources. It noted that the paper was highly speculative, but that there are now some clear questions as well as a working hypothesis that can be used to focus the research raised by this modelling.

3.65 The Working Group noted that almost nothing is known about the early life history for *D. mawsoni*. The current belief is that the larval forms and eggs are pelagic, and that settlement may take as long as 18 to 24 months. Russian vessels have taken larval fish in krill trawls from the surface waters in areas >1 000 m depth. A crucial question is to determine the hatching time for *D. mawsoni*. It is known that the hatching time in *D. eleginoides* is about four months, but this is further north. In the colder southern waters it may be that *D. mawsoni* takes twice as long, which would alter the expectations of the distribution of different life stages greatly. Some other key questions are how do the fish get to the spawning grounds, and how long do they stay there once having arrived.

3.66 The Working Group considered there were three key processes driving the dynamics of toothfish populations:

(i) pelagic component – can move very large distances
(ii) juvenile component – small fish seem to be in shallower habitats
(iii) location of the spawning fish – these areas seem to be very far apart from the juvenile areas.

3.67 The Working Group noted that some areas may be more important than others to different life stages of toothfish. There may also be some connection around the Antarctic with some source areas and sink areas (e.g. BANZARE Bank may well be a sink as small fish are rarely seen there). The paper represents a useful start to describing the general dynamics of these populations.

Depredation

3.68 No new estimates of removals due to depredation were presented to WG-FSA. WG-FSA-07/34 mentioned significant depredation of longline catches by cetaceans. It was noted that the use of pots significantly reduced or stopped depredations. The Working Group also noted that several papers considered mitigation of depredation which was taken up under 'Ecological interactions' (paragraphs 10.5 to 10.7). It further noted that such changes in longline gear may affect catch rates of toothfish and that this would need to be taken into account in future CPUE analyses.

PREPARATION FOR ASSESSMENTS AND ASSESSMENT TIMETABLE

Report of SG-ASAM

4.1 SG-ASAM met in Cambridge, UK, in April 2007 (Annex 8). The meeting focused on the development of methodologies for acoustic surveys of icefish (*C. gunnari*) and the review of the acoustic sampling protocols for krill (*E. superba*) for use by CCAMLR-IPY projects.

4.2 New information was presented on icefish acoustics from a UK survey in Subarea 48.3 and from data collected by a commercial vessel fishing in Subarea 48.3. The new data demonstrate that it is possible to visually discriminate icefish aggregations from other scatterers. SG-ASAM noted that icefish behaviour will impact on survey design, fish orientation, TS determination and species delineation, and recommended further research on icefish behaviour using a range of technologies and observation methods. SG-ASAM noted that in order to develop an acoustic estimate of icefish biomass it is essential to have data on target strength of icefish.

4.3 SG-ASAM addressed issues about data collection from commercial vessels and noted that an ICES Co-operative Report on this subject will be published in 2007.

4.4 SG-ASAM recommended that the TS of icefish and associated species continues to be studied using a variety of methods including *in situ* measurements, *ex situ* experiments on individuals and aggregations, and physics-based and empirical models.

4.5 SG-ASAM recommended that further work be undertaken to obtain density and sound-speed measurements for a range of Antarctic fish species, including icefish and myctophids, for input into TS models.

4.6 SG-ASAM recommended that a fourth meeting of the subgroup should be held in conjunction with the ICES WG-FAST meeting in 2009 to consider acoustic results from IPY surveys, development in TS modelling, and other new observations. SG-ASAM recommended that the Data Manager should attend future meetings of SG-ASAM, and that the Secretariat cost associated with attending meetings away from Hobart should be included in the Scientific Committee's budget.

Report of WG-SAM

4.7 Dr C. Jones (WG-SAM Co-convener) presented the report of WG-SAM (Annex 7) with respect to issues of concern to WG-FSA and highlighted the major recommendations:

(i) Refinements and new methods of parameter estimation (Annex 7, paragraphs 2.1 to 2.16):

(a) summaries of the tag–release and recapture data should be developed for the statistical areas to assist WG-FSA;

(b) further research is needed on the spatial pattern of tag recaptures and methods to describe movement;

(c) WG-FSA consider the development of advice on how it should manage the collection of non-toothfish tagging data;

(d) a new method for the calculation of effective sample size, and a method of detecting statistically significant systematic lack of fit of integrated model predictions of catch-at-age or catch-at-length frequencies was considered and WG-SAM encouraged further development of this approach for general use (Annex 7, paragraphs 2.11 to 2.13).

(ii) New assessment methods (Annex 7, paragraphs 3.1 to 3.10 for finfish, and 3.14 to 3.20 for by-catch species):

(a) a Leslie-DeLury depletion method for assessing toothfish on BANZARE Bank (Division 58.4.3b) is a useful approach to examine the status of stocks in that division and such examination will need to consider spatial aggregation of the fishery, the high level of IUU in this division, and the origin of recruits to this stock to ensure that the stock is not overexploited through fishing on both the recruits and adults as if they were separate stocks;

(b) an alternative method for assessing toothfish using a TSVPA in Subareas 88.1 and 88.2 had been considered, but WG-SAM agreed that the data and fitting of the approach were not well explained in the paper and that the method needed to be presented to WG-SAM for further consideration following a set of general guidelines developed for introducing alternative assessment methods (Annex 7, paragraph 6.3).

(iii) Review of preliminary available assessments for finfish (Annex 7, paragraphs 3.14 to 3.20 and 4.1 to 4.19):

(a) recommendations were made for this year's assessment of toothfish in Subarea 48.3 and Division 58.5.2, including examination of preliminary results from sensitivity tests for an integrated assessment of Division 58.5.2;

(b) a preliminary assessment of *D. mawsoni* in the Ross Sea was examined, noting a key uncertainty underlying the Ross Sea CASAL assessment is the impact of movements and spatial structure in the *D. mawsoni* population, with recommendations that the CASAL model be used to provide the assessment advice for *D. mawsoni* in Subareas 88.1 and 88.2, and that research priorities for the Ross Sea assessments in the medium term be those given in Annex 7, paragraphs 4.14 and 4.15;

(c) the quality of data arising from different vessels can be quite variable and it was recommended that WG-FSA and the Scientific Committee consider procedures necessary to ensure the provision of consistent high-quality data for assessments in multi-vessel, multi-nation fisheries (Annex 7, paragraph 4.16);

(d) a surplus production model implemented in a Bayesian framework for assessing rajid populations at South Georgia was examined, but it was noted that currently there is insufficient data to inform the assessment, that results were strongly dependent on the informed priors, and that tag–recapture data could improve the assessment if included as a harvest rate;

(e) a preliminary integrated assessment of rajid populations in the Ross Sea using CASAL showed the uncertainties that need to be addressed in finalising an assessment in this region, resulting in a number of recommendations for improving data necessary for an assessment (Annex 7, paragraph 3.18), including issues related to species identification, catch sampling, improving estimates of age and growth, improving tagging protocols and additional survivorship experiments;

(f) improving by-catch data was recognised to affect the workload of the scientific observers and that there needs to be consideration of priorities for by-catch species, which could be addressed by focusing each year on a particular species group, for example, 2008/09 could be the year of the rajid, and 2009/10 could be the year of the macrourid.

(iv) Evaluation of management strategies (Annex 7, paragraphs 5.1 to 5.6):

(a) an Assessment Strategy Evaluation (ASE) procedure was examined and considered promising for investigating a wide range of management strategies, and allowed investigation of sources of potential bias and error in assessments;

(b) a management procedure that adjusts catch limits according to control decisions based on changes in CPUE trend and mean length of the catch was examined, noting that evaluations were undertaken using several alternative operating models;

(c) Members were encouraged to develop management strategies suitable for use in *C. gunnari* fisheries.

(v) Other issues identified during last year's Scientific Committee meeting, including the potential of moving to multi-year or biennial stock assessments (Annex 7, paragraphs 6.11 to 6.18):

(a) WG-SAM proposed terms of reference for its work (set out in Annex 7, paragraph 6.2) and a process by which WG-SAM will judge the utility for implementation of a method, procedure, or approach, which is set out in Annex 7, paragraph 6.3;

(b) WG-SAM also provided guidance for other working groups that wish to have WG-SAM address their specific topics in the future, and to develop the annual WG-SAM agenda (set out in Annex 7, paragraphs 6.6 to 6.9);

(c) WG-SAM considered the consequences of conducting assessments at multi-year intervals:

- it agreed that this represents a trade-off between the risk of gross errors in an assessment, and the considerable time saved in both the meeting of WG-FSA and intersessionally (see discussion in Annex 7, paragraphs 6.11 to 6.18), noting that the need for annual assessments would need to be decided by WG-FSA for each fishery, that trials such as those described in Annex 7, paragraph 6.13, could be undertaken for new model scenarios or species to evaluate the risks of different frequencies of assessments, and that WG-FSA should retain the option to undertake an assessment in any given year if new or refined methods of assessment become available or parameters used in the assessment are revised significantly;

- it agreed that where a toothfish stock is at or above target levels, and where assessments have been stable, then assessments of toothfish could be performed on a biennial cycle without incurring significant additional risk;

- it encouraged further work to evaluate the risks and determine robust indicators to trigger assessment updates.

4.8 The Working Group noted the consideration of the TSVPA method (WG-SAM-07/9) by WG-SAM and encouraged the authors to attend WG-SAM to help explain the use of the TSVPA and to answer questions being asked by that group. It further encouraged the use of the approach in Annex 7, paragraph 6.3, to help evaluate this method. Advice to the scientists involved in the application of the TSVPA to the Ross Sea toothfish assessment is further considered in paragraphs 4.26 and 4.27.

4.9 The Working Group also noted that intensive studies on by-catch species, such as the Year of the Skate, would be beneficial and encouraged the By-catch Subgroup to look at this further. It was also noted that skates would be appropriately given a high priority because of the global interest in elasmobranchs and the recognition that elasmobranchs tend to have lower productivity than many commercially fished species. In this context, it may be more appropriate to design strategies for avoidance and mitigation, in the same way such strategies have been adopted for seabirds, as compared to developing productivity models and assessments of sustainable yield. The subgroup was asked to consider for skates, mechanisms for assessing productivity and life history as well as technical consideration for avoidance and mitigation.

4.10 The Working Group endorsed the recommendations of WG-SAM to continue evaluating assessment and management strategies.

4.11 With respect to multi-year assessments, the Working Group agreed to consider this further during the meeting.

Review of preliminary stock assessment papers

4.12 The Working Group reviewed six preliminary stock assessments that were developed during the intersessional period. These included *D. eleginoides* in Subarea 48.3, Division 58.5.2, Subarea 58.6/58.7 (Prince Edward Islands), *Dissostichus* spp. in Subarea 88.1/88.2 (Ross Sea), *Dissostichus* spp. in Division 58.4.3 and *C. gunnari* in Division 58.5.2

4.13 A preliminary assessment for *D. eleginoides* in Subarea 48.3 (WG-FSA-07/29) was presented by Dr R. Hillary (UK). The paper detailed an updated CASAL assessment incorporating 2007 CPUE data, catch-at-length data and updated mark–recapture data. The paper also described improvements to the fit-of-tag data through (i) estimating a length-based ogive for tag-induced mortality, and (ii) relating tag-induced growth retardation to size. Further, a new model was presented that used estimates of catches-at-age from 1998 to 2006 based on random sampling of otoliths collected over that period. The latter model demonstrated some improvements, although several poor fits remained. The predicted spawning stock biomass and the yields from all models presented were slightly higher than was estimated last year.

4.14 The Working Group noted that the relatively poor fit to the tag data remains an issue for the assessment of this fishery, and agreed that there are several factors that could influence this, including a potential cryptic biomass (which could result in a greater abundance of recruits than tags would indicate), variations in mortality, recruitment and growth. The Working Group noted that fits-to-age data appear reasonable, and that fits using the new age-based model were slightly better than the updated model. However, the same problem of underestimation of tags in younger fish and overestimation of tags in older fish remains.

4.15 Dr A. Constable (Australia) suggested that age-based selectivity may not provide appropriate estimation of a growth curve if there is length-based selectivity operating. Mr A. Dunn (New Zealand) recommended attempting length-based selectivity. The Working Group noted that yield and projections for the new methods are similar to the model updated from last year. Mr Dunn suggested that accounting for variability in recruitment estimates can improve estimates of B_0 and may have been the cause of the more precise estimates of B_0 in the age-based model.

4.16 The Working Group recommended using the updated assessment for this year, and agreed that the new assessment approaches look promising. It recommended that the new approaches presented in WG-FSA-07/29 be reviewed and evaluated during next year's meeting of WG-SAM.

4.17 A preliminary assessment for *D. eleginoides* in Division 58.5.2 using the CASAL modelling approach (WG-FSA-07/53) was presented by Dr S. Candy (Australia). The assessment included 2007 season data updates, and 2006 data not available for WG-FSA in 2006. Included were the following refinements: (i) estimation of the CV for length given age; (ii) use of non-informative priors for year-class strength parameters; (iii) separate selectivity parameters used for the pre-2005/06 compared to the 2005/06–2006/07 fishing seasons for the main trawl ground; (iv) separate selectivity parameters for the late (within-year) seasons compared to the combined early (within-year) seasons for the main trawl ground; and (v) the use of an improved method of determining effective sample size for commercial catch-at-length data. The assessment demonstrated sensitivities to the inclusion of different datasets and to the choices of parameters used in both the stock assessment and projections.

4.18 The Working Group suggested that age data would improve the assessment considerably, and recommended that progress be made in ageing otoliths that are currently available (WG-FSA-07/45). It was agreed that the use of mark–recapture data is currently not appropriate due to most releases taking place in a relatively small area and non-mixing, resulting in biomass levels reflecting only localised abundance (WG-FSA-07/48 Rev. 1). Until the difficulties with the use of mark–recapture data are resolved, the Working Group agreed that recruitment surveys currently provide the best means of establishing current stock status as an absolute index of abundance.

4.19 The Working Group noted that the *D. eleginoides* CASAL assessment in Division 58.5.2 used a multivariate normal approximation of the variability in parameters rather than using an MCMC, and that this may have implications in the assessment, given differences in the way that they explore variability between parameters. Mr Dunn suggested that it would be desirable to run the assessment using different starting points to confirm that the MPD solution is the global minimum. Dr Candy tested this, and determined that B_0 was very stable, and that the average difference using different starting values is 0.1%. The Working Group agreed that this was small, and that the assessment could be carried forward as presented in WG-FSA-07/53 Rev. 1.

4.20 A presentation on the assessment of the Prince Edward Island (South African EEZ in Subareas 58.6 and 58.7) *D. eleginoides* fishery using the ASPM model (WG-FSA-07/34 Rev. 1) was given by Dr R. Leslie (South Africa). In this assessment, a two-fleet (longline and pot) ASPM was used to update the assessment of the status of *D. eleginoides*. Most fishing in the South African EEZ takes place in Subareas 58.6 and 58.7 and Area 51. The assessment made use of all catches, standardised catch rates and catch-weighted length frequencies from the longline fishery. The model used biological parameters very similar to those currently used in Subarea 48.3. The paper also presented a sensitivity analysis where depredation was explicitly included in the model.

4.21 The Working Group noted that the two-fleet model used to conduct the assessment was not available for review during the meeting. The Working Group recommended that all relevant code be submitted to the Secretariat when a method or preliminary assessment is tabled for consideration by WG-FSA or WG-SAM. It was recommended by the Working Group that future assessments consider use of CPUE estimated by means of the GLMM, which may result in a less precipitous drop in catch rates during the early years of the fishery, and a potentially better model fit.

4.22 The Working Group recognised continuing potential issues surrounding the disparity between the EEZ boundaries of Prince Edward Island and the statistical zones from which data, such as IUU, are reported.

4.23 Preliminary assessments for *Dissostichus* spp. in Subareas 88.1 and 88.2 were presented in WG-FSA-07/37 and WG-SAM-07/9.

4.24 WG-FSA-07/37 presented a CASAL integrated assessment of the Ross Sea fishery (Subarea 88.1 and SSRUs 882A–B) that updated the 2006 assessment using new parameter estimates along with revised catch, catch-at-age and tag–recapture data. The Working Group noted that the inclusion of the 2007 recaptures of 2006 tags released had the most substantive impact on the model estimates.

4.25 The Working Group considered models using tag–recapture data from all vessels versus New Zealand vessels only, and noted the lower recapture rate by non-New Zealand vessels, particularly in the early years, resulted in a more optimistic assessment. The Working Group considered that these lower recapture rates may be related to different distributions of fishing effort by different vessels, to poorer survival of tagged fish, or to poorer detection rates. The Working Group agreed that the model continued to use mark–recapture information from New Zealand vessels only, until the reasons for the disparity in return rates is better understood or substantially reduced (paragraphs 3.34 to 3.36).

4.26 Dr K. Shust (Russia) noted that the area of the Ross Sea is considerably greater than Subarea 48.3, yet the estimates of available biomass for *Dissostichus* spp. between the two areas are not substantially different, nor are long-term precautionary yields. Dr Constable suggested that the reason for the apparent lower density of toothfish biomass in the Ross Sea could be related to food-web dynamics, where the Ross Sea region has generally lower productivity than the Scotia Arc. The Working Group agreed that these considerations are important and should be considered in further research.

4.27 WG-SAM-07/9 updated the application of an alternative assessment method for the Ross Sea *Dissostichus* spp. fishery by means of a TSVPA. The Working Group agreed that further work needed to be presented to WG-SAM for consideration and adopted as a suitable method before the method could be used in WG-FSA. Dr Shust discussed how to progress this work with the incoming Convener of WG-SAM, Dr Constable, and other members who participated in both WG-FSA and WG-SAM. It was agreed that the following would need to be addressed in a future submission to WG-SAM in order to improve the understanding of how the TSVPA works and for reviewing the efficacy of using the method given the uncertainties in the different datasets:

(i) A full paper detailing the method and its implementation needs to be compiled from existing work and presented to WG-SAM with further consideration of its implementation as discussed in the following points.

(ii) Simulated (theoretical) data need to be developed for a number of fishery–stock scenarios and those data be analysed using CASAL and the TSVPA in order to compare how the two methods perform using data from known population and fishery attributes.

(iii) Mathematical and statistical details of how the input data for the TSVPA are generated from the available datasets used in CASAL, including any pooling of the data in space and/or time, need to be provided.

(iv) Descriptions need to be provided on the methods for deriving the CPUE indices, including how the indices are standardised to account for differences and variability between vessels, times of year, location of fishing and so forth.

(v) Descriptions are needed on how uncertainty is treated in both the assessments and evaluation of yield.

4.28 A preliminary assessment of the exploratory fishery for *Dissostichus* spp. in Division 58.4.3b (BANZARE Bank; WG-FSA-07/44) was presented by Dr Welsford. The paper developed the initial exploration considered during the WG-SAM meeting (WG-SAM-07/8) by analysing the C2 fine-scale catch and effort data held by CCAMLR for the fishery in this division presented to WG-SAM in 2007, as well as descriptive analyses of the B2 biological data submitted by scientific observers on board vessels in the BANZARE fishery.

4.29 The Working Group noted that there was insufficient overlap of individual vessels in their operations between seasons to permit meaningful standardisation of the CPUE. However, the analyses presented to the Working Group showed strong evidence for depletion of toothfish at the scale of individual fishing grounds in the 2004/05 and 2005/06 seasons with the CPUE in the recent season being comparatively low and showing no trend. The Working Group also noted several inconsistencies between historical catch rates and catch compositions and those reported in the 2006/07 season, with *D. eleginoides* dominating in catches in one ground for the first time, and some observers reporting no biological information on important by-catch groups reported in the vessels' catch records.

4.30 The Working Group expressed deep concern regarding the substantial level of IUU fishing in this division, and noted that this can have a considerable effect on the data used for assessment purposes. The Working Group was further concerned about the lack of information on the origin of young fish contributing to the fishable biomass in Division 58.5.3b, and recommended that it would be worthwhile to examine fishery and population characteristics of *Dissostichus* spp. in divisions adjacent to BANZARE Bank with the aim of identifying potential sources of recruitment to the stock.

Preliminary assessments for *C. gunnari*

4.31 A preliminary assessment for the estimation of a precautionary yield of icefish in the vicinity of Heard Island (Division 58.5.2) for the 2007/08 CCAMLR season was presented in WG-FSA-07/47. This paper provided a preliminary assessment of yield based on results from the 2007 survey (WG-FSA-07/46), using standard short-term projection assessment methods previously employed for icefish in this division.

4.32 The Working Group noted that the population contains a large 1+ cohort, which is likely to have resulted from the spawning activity by mature 4+ fish evident in the population in 2006. Yields are projected to increase over the next two seasons as the biomass of this year class increases and recruits to the fishery. The Working Group noted that this dynamic of a single abundant year class dominating the population is typical of this stock and agreed that the preliminary assessment described in the paper was an appropriate scenario to proceed with for the assessment.

4.33 No preliminary assessments were provided to the Working Group for *C. gunnari* in Subarea 48.3. However, the Working Group reviewed the results of a trawl survey in Subarea 48.3 (WG-FSA-07/56), and agreed that information from this survey should be used for an assessment of this stock for the 2007/08 and 2008/09 fishing seasons.

Assessments to be carried out and assessment timetable

4.34 Assessment issues addressed during the course of WG-FSA were identified by the Scientific Committee during the previous year's CCAMLR meeting, the WG-SAM meeting, papers available to WG-FSA, and assessment subgroup discussions during WG-FSA.

4.35 With regard to the assessment of *D. eleginoides* in Subarea 48.3, the Working Group agreed that only the integrated assessment using CASAL be used to provide management advice for the 2007/08 fishing season for *D. eleginoides* in Subarea 48.3.

4.36 With regard to the assessment of *D. eleginoides* in Division 58.5.2, the Working Group agreed that the integrated assessment using CASAL, as described in WG-FSA-07/53 Rev. 1, be used to provide management advice for the 2007/08 fishing season for *D. eleginoides* in Division 58.5.2.

4.37 The Working Group reviewed the results of the bottom trawl survey conducted in Division 58.5.1 (Kerguelen), and discussed the potential of conducting an assessment of this division. However, the data from the survey were not available to the Working Group for further analysis. It was agreed that it would be advantageous to draw together all available data from the Secretariat with the aim of scoping the potential of a future assessment. This included a general characterisation of the fishery (spatial and temporal), CPUE and catch-at-age information. The Working Group concluded that this information would be required in order to formulate options for a future assessment of this stock.

4.38 The Working Group agreed that the assessment for the Ross Sea management area (Subarea 88.1 and SSRUs 882A–B) be based on the 2007 reference case (hereafter labelled the base-case) described in WG-FSA-07/37. The model was a CASAL Bayesian integrated sex- and age-model that used catch-at-age observations for the shelf, slope and north fisheries (WG-FSA-07/28) and the tag–release data from New Zealand vessels from 2000/01 to 2005/06 and their recaptures by New Zealand vessels from 2001/02 to 2006/07 (WG-FSA-07/40).

4.39 The Working Group did not have any new information for SSRU 882E on which to base new advice. The Working Group recommended that the catch limit for 2006/07 be carried forward for 2007/08. For SSRUs 882C, D, F and G, the Working Group could provide no new advice, but noted that the catches in these areas had provided some useful biological data for toothfish. Therefore, the Working Group recommended the current catch limits in these SSRUs be continued for the 2007/08 season.

4.40 The Working Group agreed that the approach presented in the preliminary assessment in the South African EEZ in Subareas 58.7 and 58.6 (Prince Edward Island; WG-FSA-07/34 Rev. 1) would be sufficient for generating management advice for this area.

4.41 The Working Group agreed that assessment of *C. gunnari* in Subarea 48.3 and Division 58.5.2 be undertaken for the 2007/08 and 2008/09 fishing seasons using the short-term projection approach, as has been employed in previous assessments of this stock.

4.42 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 Rev. 1, paragraph 6.3. The outcomes of the assessments were reported in the Fishery Reports.

4.43 The Working Group suggested that WG-SAM consider a standard set of diagnostics to help identify the quality of fits, and suggested the potential use of an MSE to determine what data might be needed to differentiate between important competing hypotheses.

ASSESSMENTS AND MANAGEMENT ADVICE

New and exploratory fisheries in 2006/07 and notifications for 2007/08

5.1 In 2006 the Commission agreed to seven exploratory longline fisheries for *Dissostichus* spp. in the 2006/07 season (Conservation Measures 41-04, 41-05, 41-06, 41-07, 41-09, 41-10 and 41-11), and no new fisheries had been notified for 2006/07. Activities in the exploratory fisheries are outlined below and summarised in Table 6.

5.2 Notifications for exploratory fisheries in 2007/08 are summarised in Table 7. Twelve Members submitted paid notifications 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. There were no notifications for new fisheries, and no notifications were received for fisheries in closed areas.

5.3 The Working Group agreed that it would not attempt to determine whether the notifications for exploratory fisheries satisfied the requirements of the notification procedure (Conservation Measure 21-02); this, it believed, should be done by SCIC.

5.4 Unstandardised CPUE data for *Dissostichus* spp. caught in exploratory longline fisheries between 1996/97 and 2006/07 are summarised in Table 8.

5.5 Under Conservation Measure 41-01, each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. is required to tag and release *Dissostichus* spp. at the rate of one toothfish per tonne of green-weight catch throughout the season in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.3a and 58.4.3b and three fish per tonne in Divisions 58.4.1 and 58.4.2. In 2006/07, 5 530 *Dissostichus* spp. were reported to have been tagged and released in the exploratory fisheries (Table 9). In 2006/07, 244 tags were recovered (Table 10).

Progress towards assessments of new and exploratory fisheries

5.6 The Working Group noted that further progress had been made this year in assessing stocks of *Dissostichus* spp. in the Ross Sea to develop management advice (see Appendix I and paragraphs 5.89 to 5.106).

5.7 The Working Group considered WG-FSA-07/44, which undertook an analysis of CPUE in Division 58.4.3b using the Leslie depletion analysis. The Working Group thanked Australia for its work, and agreed that it was valuable, however, the Working Group was currently unable to provide estimates of yield from this fishery due to high levels of IUU fishing in that division (see paragraphs 5.77 to 5.79).

5.8 For the other subareas and divisions in which exploratory fisheries are conducted, the Working Group was unable to develop management advice based on assessments of yield and is therefore unable to provide any new advice on catch limits for these fisheries. The reported catches in these fisheries are summarised in Table 11.

5.9 Given the large number of notifications for 2007/08, the Working Group reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status in exploratory fisheries other than in Subareas 88.1 and 88.2.

Data requirements and research protocols using commercial vessels

5.10 The Working Group noted that three notifications of intent to conduct toothfish longline research using commercial vessels under the provisions of Conservation Measure 24-01 had been received this year.

5.11 The Working Group recognised that the purpose of allowing research harvest under the terms of Conservation Measure 24-01 is to ensure that data are collected which will eventually allow an assessment of fish stocks in the sampled area to be completed. The Working Group also recognised the need to restrict initial effort, such as provided in Conservation Measure 41-09 (paragraph 12), to prevent over-harvesting before sufficient data are obtained to conduct an assessment. Some standardisation of effort (number of hooks per line) must be done to ensure catch limits (e.g. 10 tonnes) are not exceeded.

5.12 For areas where no fishing has occurred, such as closed SSRUs, research should be conducted in two stages. The first stage should establish if the proposed area warrants further research. Data collected should establish catch rates, species composition, by-catch and potential for having significant adverse impact on vulnerable marine ecosystems.

5.13 If the potential for commercial fishing is established, subsequent research must provide data in addition to those above. This would include data on stock structure (length-frequency, tissue samples and otoliths), catch required to estimate CPUE, and the establishment of a long-term tagging program which will be designed to ensure sufficient fish are tagged and sufficient recaptured fish are obtained to allow a stock assessment to be completed.

5.14 Dr Constable undertook some preliminary analyses concerning the design of longline survey activities to assess the average CPUE of an area. In the first instance, he presented routines developed in R (R development team, 2007) by Mr J. McKinlay (Australia) to evaluate the uncertainty in the estimate of CPUE given a specified catch limit for a survey (the routines have been deposited with the Secretariat). Mr McKinlay's trials used data from the fishery on BANZARE Bank. The important features of these routines are:

(i) the data from the fishery can be subset by year, location, longline characteristics and so forth;

(ii) a number of replicate samples can be taken from the subset to simulate random samples from the areas fished in the commercial fishery, with each replicate longline retaining its characteristics of number of hooks, catch and CPUE;

(iii) the number of longlines in the sample is governed by the random sequence that results in the last line exceeding the catch limit and, hence, the number of lines in a sample will vary depending on the catch of each line;

(iv) summary statistics for each random sample are generated, including the total catch (kg and number), total hooks, total lines and CPUE (kg and number per hook);

(v) the combined summary statistics across the replicate trials can then be plotted as box plots;

(vi) an example output of results is illustrated in Figure 1, which also can include plots of the location of the subset, frequency plot of the number of hooks on each line and summary diagnostic plots showing key attributes of the samples. This is output to a pdf file.

5.15 These analyses were further enhanced to determine the probability of an estimate of CPUE arising from a survey being within 25% of the true value, where the true value is the grand mean CPUE from the dataset used in the resampling (this probably approaches one as the trial sample fraction of the dataset approaches one (the enhanced routines are available from the Secretariat)). A total of 1 000 replicate trials for each of eight different survey catch limits (5, 10, 20, 30, 40, 50, 75 and 100 tonnes) were undertaken by resampling from toothfish longline fishery datasets for Divisions 58.4.1, 58.4.2, 58.4.3b and 58.4.4. The results of these trials are shown for each division in Figure 2 and Table 12, where the data from a division is pooled (All) and then disaggregated by year.

5.16 The Working Group thanked Dr Constable and Mr McKinlay for their work and noted the following:

(i) the analyses are very useful for showing the variability in CPUE in the restricted areas fished to date in these divisions;

(ii) the results presented in Figure 2 and Table 12 could be used as a preliminary guide in considering minimum designs for research surveys in these divisions;

(iii) the research catch for estimating CPUE in a single survey would need to be in excess of 40 tonnes for most areas, given the variability in CPUE and that the CPUE data used in this analysis is highly aggregated and may not reflect the greater variability in CPUE across the larger areas;

(iv) simulation work will need to be undertaken to determine what the fishery research catch regime will need to be if a trend in CPUE needs to be detected.

5.17 The Working Group encouraged further work with these simulations and recommended that WG-SAM be asked to consider the optimal research design for estimating the mean CPUE of an area for use in developing advice on catch limits for an area.

5.18 The Working Group agreed that an adequate tagging effort will require an estimate of how many tags are required and how many years will be required to obtain recaptured fish. The catch (tonnes) of toothfish required to ensure the success of the tagging program must be specified. The type of shots needed to characterise an area may be determined by simulation.

5.19 Dr Hillary developed notes on how to link key tagging and biological parameters, such as the tagging rate per tonne, the catch biomass, reporting rate, natural mortality and the potential underlying biomass of a previously unassessed stock/population to the (potential) accuracy of an abundance estimate coming from a tagging program.

5.20 The method was tested using toothfish data from Subareas 48.3 and 48.4 – both have tagging programs, but while the stock in Subarea 48.3 is assessed, the toothfish population in Subarea 48.4 is not. For Subarea 48.3, the 2007 abundance CV predicted from the releases in 2006 was close, but slightly less than that predicted by the full CASAL assessment, and the likely reasons for this were given. For Subarea 48.4, the potential abundance CV was estimated for the last three years' catch levels, the maximum number of tag releases achieved and three postulated underlying exploitable biomass levels for Subarea 48.4. For all possibilities, an abundance CV between 0.45 and 0.7 was predicted. The key result is that there is a clear trade-off between the catch/effort taken/applied to a given population and the tagging rate achieved, with respect to the resultant accuracy of the tagging abundance estimate.

5.21 As an illustrative example, a simple calculation was undertaken that detailed the required catch biomass that would need to be taken to achieve a 33% CV in the estimated abundance, for 'low', 'medium' and 'high' tag rates per tonne and underlying exploitable biomass levels. Table 13 details the results of this example. If a given precision is required in the abundance estimate from a tagging program, there is a clear dependency on what tag rate is achieved and what the underlying biomass might be, in terms of what catch limit will be required.

5.22 The details of this work, along with some work on suggestions made by the subgroup related to this approach will be presented at the next WG-SAM meeting.

5.23 Finally, the Working Group agreed that completion of a long-term tagging protocol, as well as other research on toothfish, will require cooperation, collaboration and consistency among surveys over several seasons. For example, New Zealand has collected data in SSRU 881A during the last two years and any subsequent research surveys will need to be consistent with this effort.

Role of SSRUs to ensure stock assessments and sustainability are achieved

5.24 The use of SSRUs to manage toothfish stocks in new and exploratory fisheries was reviewed by the Working Group. It noted that SSRUs were initially defined in the Ross Sea and East Antarctica to try to aggregate fishing effort to better understand stocks in some areas and to ensure sufficient sampling to estimate CPUE and recapture probabilities in the mark–recapture program. It was intended that after stock assessments were made in those initial areas that other areas would then be fished. In doing so, protocols to ensure adequate scientific information is provided, must be developed. For example, a protocol to determine CPUE in the closed areas needs to be developed because CPUE is not constant over all areas and furthermore there is no relation between CPUE and bottom area. Specifically, the level of fishing and tagging effort required to ensure assessment of stocks in those areas must be provided.

5.25 It was noted that by restricting data to that gained from a commercial fishery that was constrained to fish in certain SSRUs, it is difficult to gain information on such issues as the geographic and depth distribution of the target fish, as well as differing length composition of toothfish among areas. In addition, the Commission has been asked to allow harvesting in SSRUs now closed (CCAMLR-XXVI/37).

5.26 However, the Working Group also noted that toothfish do, on occasion, move over a large area and in the long term would move in and out of closed SSRUs so this should not hamper fishing.

5.27 The Working Group noted that the catch limits for toothfish in Subareas 88.1 and 88.2 in the Ross Sea were changed as part of a three-year experiment (SC-CAMLR-XXIV, paragraphs 4.163 to 4.166). The experiment will end after the 2007/08 season. It was suggested that if the concentrated sampling protocol was abandoned before the end of the experiment and fishing effort was dispersed, the tagging program would be diluted, which would adversely affect the ability of the Scientific Committee to provide management advice. Before altering the effort distribution, the Working Group noted that consideration will need to be given on how to avoid negative effects on the assessments by such changes in effort distribution.

5.28 Therefore, it was agreed that methodological work on designing research experiments should be developed for consideration by WG-SAM in 2008. This would allow WG-FSA to develop protocols to ensure adequate information can be provided by the fisheries. The Working Group invited papers on such topics as fishing operations and protocols, data collection structure, role of SSRUs, relationship between geographical distributions, bottom surface and sea currents, relationship with interannual ice coverage and others.

5.29 The Working Group also noted that research vessels which notify and fish specific areas are asked to provide a full report of the effort within 12 months (Conservation Measure 24-01, paragraph 4(c)), however, it was requested that a report be submitted in time for consideration of its 2008 meeting. This task could be aided by the development of pro formas for research proposals and research summaries.

Notifications to conduct research surveys using commercial fishing vessels under Conservation Measure 24-01

5.30 Japan submitted a notification to conduct scientific research in 2007/08 (COMM CIRC 07/109 and SC-CAMLR-XXVI/9). The notification is to conduct research on the distribution and population structure of toothfish in Divisions 58.4.4a and 58.4.4b. The survey vessel will use longlines and is expected to take no more than 150 tonnes of toothfish. The notification falls under paragraph 3 of Conservation Measure 24-01. Conservation Measures 41-01 and 32-10 may also apply to this notification. The main objective outlined in the notification is to collect various biological and physical oceanographic data on toothfish required for assessing the status of the stocks. This information is important because it has been five years since the area has been open to fishing. In addition, tagging activities will be conducted to contribute to future investigations on the distribution and population structure of toothfish in these areas. A two-phase research plan is outlined. Completion of the research plan will require 240 shots during which up to 150 tonnes of toothfish may be taken.

5.31 The Working Group expressed appreciation to Japan for providing its proposal which represented a great deal of thought and work.

5.32 The Working Group noted that commercial harvesting of toothfish in Division 58.4.4 was prohibited in 2002 because rapidly declining fish stocks attributed to intense IUU fishing activities. Toothfish stocks were believed to have been depleted to the point that any fishery was not viable. Furthermore, the Working Group agreed, based on information of recovery of stocks in other regions, that it was unlikely that toothfish stocks in Division 58.4.4 have substantially recovered since 2002.

5.33 The Working Group also agreed that much of the information proposed to be collected can be obtained from relatively small catches. For example, information on stock structure (genetic samples) could be obtained from relatively few fish or biological data, such as fish size, may be obtained from relatively few fishing lines.

5.34 At present, the amount of toothfish catch specified in Conservation Measure 24-01, Annex A, to support tagging studies is set at 10 tonnes although, as discussed above (paragraphs 5.19 to 5.22), larger catches may be needed to estimate CPUE and to support a tagging program. However, the Working Group agreed that catch rates required for such assessments may be greater than is sustainable. Therefore, it would be difficult to justify catches as large as 150 tonnes to support a tagging program. The Working Group suggested that catch levels of no more than 10–20 tonnes in each SSRU were appropriate in the absence of further justification to show how the data will be used in an assessment and that the recovery of fish stocks will not be impeded.

5.35 Dr M. Naganobu (Japan) thanked the Working Group for its scientific assessment and indicated he understood its views; however, he stressed the importance of evaluating the effect of the management action taken in 2002 when the fishery was closed. Without the proposed Japanese survey no information on the current status of the stock will be available, hence prohibiting any formal evaluation of the effectiveness of the management action taken. He proposed that catch from the proposed research survey will not exceed 103 tonnes which was the precautionary catch limit set in 2001 before the fishery was closed in 2002. This amount is expected to be safe for the stock, and he prefers that the proposal to take no more than 103 tonnes be considered not only by the Working Group, but also by the Scientific Committee and the Commission.

5.36 Spain submitted two notifications to conduct scientific research in 2007/08 (COMM CIRC 07/114). One notification is to fish in SSRU 881A while the second notification is to fish in SSRUs 5841D, F and H. The survey vessel will use longlines and is expected to take no more than 10 tonnes of toothfish per SSRU (plus by-catch). The notification falls under paragraph 2 of Conservation Measure 24-01. Conservation Measures 41-01, 41-09 and 41-11 also apply to this notification.

5.37 The Working Group thanked Spain for providing its notifications for comments; however, it agreed that it would have benefited from having a Spanish scientist attend the meeting. The notifications did not provide sufficient scientific information on which advice could be provided in many aspects.

5.38 The Working Group noted its comments above that all research effort in an area should be done in cooperation and collaboration with other ongoing and proposed efforts. In this case, there have been extensive tagging efforts by New Zealand in Subarea 88.1. The Working Group also noted that Conservation 41-09 (paragraph 12) limits research fishing to a single vessel in each of SSRUs 881A, D, E and F during the entire season.

5.39 Australia submitted a notification to conduct scientific research in 2007/08 (COMM CIRC 07/117). The notification is to conduct research on the status of toothfish and major by-catch species in Division 58.4.3b. The survey vessel will use longlines and will take approximately 50 tonnes of finfish, but Australia indicated it is likely that the survey may catch in excess of 50 tonnes of finfish and more than 10 tonnes of toothfish. The notification falls under paragraph 3 of Conservation Measure 24-01. Conservation Measures 41-01 and 41-07 may also apply to this notification. The specific research objectives for the survey are to: (i) quantify the relative abundance of toothfish and major by-catch species available to the longline method across BANZARE Bank; (ii) determine the demographic characteristics of the target and major by-catch species across BANZARE Bank (i.e. size distribution, sex ratios, reproductive status); and (iii) collect biological material which can be used to determine the relationships between toothfish stocks in the southwestern Indian Ocean sector.

5.40 The Working Group expressed appreciation to Australia for providing its proposal for review. The Working Group noted, as indicated in its proposal, that under Conservation Measure 24-01 (paragraph 1), catches taken in any area where catch levels exist will be considered as part of the catch limit, and in areas with a zero catch limit, the catches taken will be considered to be the catch limit for the season in that area.

5.41 Dr Constable noted that fishery data exists in Division 58.4.3b, but it is very patchy, therefore the present proposal is to conduct a standardised random survey across the entire area. This will be the first such effort and standardised CPUE data will greatly enhance the ability of the Working Group to determine the biomass of toothfish in this division and to better understand the relative importance of the existing fishery grounds to the stock in this division.

General comments relative to Conservation Measure 24-01

5.42 The Working Group recognised the utility of providing a provision for Members to conduct research surveys in order to obtain assessment information which otherwise might not be available. However, it also recognised the possibility that this measure had the potential to be utilised to conduct commercial harvesting under the guise of research.

5.43 The Working Group encouraged the Scientific Committee to review this conservation measure to ensure it was consistent with its intended purpose. Specifically, the Working Group felt all efforts notified under this provision should be required to provide a research proposal to WG-FSA on which scientific advice could be offered to the Scientific Committee. In addition, the Working Group suggested that all notifications which proposed taking toothfish should be required to include research proposals for review by the Working Group. Finally, as noted above, it would be highly desirable for Members submitting research proposals using commercial vessels to ensure appropriate scientists attend the Working Group meetings.

General management advice for new and exploratory fisheries

5.44 The Working Group reiterated the necessity for Members fishing in exploratory fisheries for *Dissostichus* spp. to conduct the fishery-based research outlined in Conservation Measure 41-01, and that the data are submitted to the Secretariat in a timely manner.

5.45 In addition, the Working Group reiterated the importance for Members to conduct tagging and to submit data as part of the Research and Data Collection Plan (Conservation Measure 41-01). Members should also be urged to emphasise to their vessels the need to look out for tagged fish and submit accurate tag–recapture data to the Secretariat in a timely manner (see also paragraphs 3.35 and 3.36).

5.46 The Working Group did not attempt to determine whether the notifications for exploratory fisheries satisfied the requirements of Conservation Measure 21-02.

5.47 With the exception of Subareas 88.1 and 88.2, the Working Group was unable to provide any new advice on catch limits for *Dissostichus* spp. or any by-catch species in any of the exploratory fisheries.

5.48 For the other areas and divisions in which exploratory fisheries are conducted, the Working Group reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status for all exploratory fisheries. In this context, it noted that with the continuing tagging programs in a number of areas, in the medium to long term it may be possible to obtain mark–recapture estimates of abundance provided that sufficient tags are deployed each year.

5.49 The Working Group drew the attention of the Scientific Committee to the fact that there are significant differences in the tagging rates achieved by different Members in some areas, and not in others (WG-FSA-07/40; paragraph 3.35). It is important to understand whether this is due to operational constraints which might suggest differences in mark–recapture model parameters, or to other reasons.

5.50 The Working Group further drew the Scientific Committee's attention to the fact that in the 2006/07 season, several vessels either did not conduct, or did not report, research sets in the exploratory fisheries in Subarea 48.6, Divisions 58.4.2, 58.4.3a and 58.4.3b as required under Conservation Measure 41-01, Annex C (Table 2 in Appendices D, F, G and H). The Working Group encouraged Flag States to ensure that research sets are completed and reported, as the data collected from these activities are essential for developing assessments.

5.51 There are similar differences in by-catch rates between Members, and between different areas which need to be understood (paragraph 6.9).

5.52 The Working Group recalled the advice of CCAMLR-XXIV (paragraph 4.51) that, where possible, vessels should release rays from the lines by cutting the snoods when rays are still in the water, unless requested not to do so by the observer during the biological sampling period.

5.53 Noting the considerations in the by-catch section paragraph 6.38, the Working Group recommended that Conservation Measure 33-03 be amended to include the following paragraph after paragraph 3:

> 'Unless otherwise requested by observers, vessels, where possible, should release rays from the line by cutting snoods and, when practical, removing the hooks'.

Dissostichus spp. Subarea 48.6

5.54 Three vessels (Japan, Republic of Korea and Norway) fished in the exploratory fishery in Subarea 48.6 in 2006/07. The precautionary catch limit for *Dissostichus* spp. was 910 tonnes and the total catch was 113 tonnes. Information on this fishery is summarised in Appendix D.

5.55 The fishery was operated predominantly in SSRU A and the main species caught is *D. eleginoides* over the course of the fishery.

5.56 There was no evidence of IUU fishing in 2006/07.

5.57 A total of 128 toothfish was tagged and released during in 2006/07. Two tagged toothfish were recaptured during this season.

5.58 Four Members (Japan, Republic of Korea, New Zealand and South Africa) and a total of eight vessels notified their intention to fish for toothfish in Subarea 48.6 in 2007/08.

Management advice for Subarea 48.6

5.59 Given the concentration of fishing effort within SSRU A, the Working Group recommended that this SSRU be separated into two SSRUs along longitude 1.5°E (Figure 3). This separation would be beneficial for increasing information about catch rates by distributing a greater number of research sets over a larger area. The catch limit could be split between the two new SSRUs.

5.60 The Working Group noted that the catch limit for the *Dissostichus* spp. exploratory fishery in Subarea 48.6 had not been reviewed since 1997 when the catch limit was estimated based on seabed areas and catch rates from the Subarea 48.3 *D. eleginoides* fishery (SC-CAMLR-XVI, paragraphs 9.53 to 9.71). As it is now understood that there is considerable variation in catch rates across the Convention Area, the Working Group considered that the catch limit in place for this subarea was no longer precautionary.

5.61 The Working Group recommended that all the requirements of the fishery, including fishery-based research (Conservation Measure 41-01), by-catch limits (Conservation Measure 33-03) and associated measures, be carried forward to the 2007/08 season.

Dissostichus spp. Subarea 58.4

Dissostichus spp. Division 58.4.1

5.62 Four Members (Republic of Korea, Namibia, Spain and Uruguay) and four vessels fished in the exploratory fishery in Division 58.4.1 in 2006/07. The precautionary catch limit for toothfish was 600 tonnes and the reported catch was 645 tonnes. The catch limit was slightly over-run in all three SSRUs open to fishing. Information on this fishery is summarised in Appendix E.

5.63 The fishery targeted *D. mawsoni* and operated in SSRUs C, E and G. Information on IUU activities indicated that 612 tonnes of toothfish were taken in 2006/07.

5.64 A total of 1 507 toothfish was tagged and released during the 2006/07 season. Three tagged toothfish were recaptured during this season.

5.65 Eight Members (Australia, Japan, Republic of Korea, Namibia, New Zealand, Spain, Ukraine and Uruguay) and a total of 15 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2007/08.

Dissostichus spp. Division 58.4.2

5.66 Two Members (Republic of Korea and Namibia) and three vessels fished in the exploratory fishery in Division 58.4.2 in 2006/07. The precautionary catch limit for toothfish was 780 tonnes and the reported catch was 124 tonnes. Information on this fishery is summarised in Appendix F.

5.67 The fishery targeted *D. mawsoni* and operated in SSRUs A and E. Information on IUU activities indicated that 197 tonnes of toothfish were taken in 2006/07.

5.68 A total of 248 toothfish was tagged and released during the 2006/07 season. One tagged toothfish was recaptured during this season.

5.69 Eight Members (Australia, Japan, Republic of Korea, Namibia, New Zealand, Spain, Ukraine and Uruguay) and a total of 15 vessels notified their intention to fish for toothfish in Division 58.4.2 in 2007/08.

Dissostichus spp. Division 58.4.3a

5.70 Two Members (Japan and Spain) and two vessels fished in the exploratory fishery in Division 58.4.3a in 2006/07. The precautionary catch limit for toothfish was 250 tonnes and the reported catch was 4 tonnes. Information on this fishery is summarised in Appendix G.

5.71 The fishery operated in SSRU A. There was no evidence of IUU fishing in 2006/07.

5.72 A total of nine toothfish was tagged and released during the 2006/07 season. No tagged toothfish was recaptured during this season.

5.73 One Member (Uruguay) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2007/08.

Dissostichus spp. Division 58.4.3b

5.74 Four Members (Japan, Namibia, Spain and Uruguay) and four vessels fished in the exploratory fishery in Division 58.4.3b in 2006/07. The precautionary catch limit for toothfish was 300 tonnes and the reported catch was 253 tonnes. Information on this fishery is summarised in Appendix H.

5.75 The fishery operated in SSRU A. Information on IUU activities indicated that 2 293 tonnes of toothfish were taken in 2006/07.

5.76 A total of 289 toothfish was tagged and released in 2006/07. One tagged toothfish was recaptured during this season.

5.77 WG-FSA-07/44 developed further the initial exploration of the C2 fine-scale catch and effort data held by CCAMLR for the fishery in this division presented to WG-SAM in 2007, as well as descriptive analyses of the observer data submitted from vessels in the BANZARE fishery.

5.78 CPUE data for BANZARE Bank show high levels of heterogeneity in catch and effort. These areas have sustained effort and show evidence of depletion within a single season (Figure 4). By-catch levels are also variable; however, the uneven level of data collection on by-catch between vessels makes assessment of status impossible.

5.79 The paper recommended that WG-FSA evaluate management options in Division 58.4.3b, including the lowering of catch limits commensurate with the rapid and unsustainable depletion seen in the fishery, the development of SSRUs to better represent the concentrated nature of the fishery in Division 58.4.3b, commensurate management of areas that are obviously depleted, and the design of a longline survey to attempt to verify some of the trends in catch rates and catch composition seen in the main fishing areas.

5.80 Six Members (Australia, Japan, Republic of Korea, Namibia, Spain and Uruguay) and a total of 11 vessels notified their intention to fish for toothfish in Division 58.4.3b in 2007/08.

Management advice for *Dissostichus* spp. in Subarea 58.4

5.81 In 2006 the Scientific Committee noted several features of exploratory *Dissostichus* spp. fisheries in the southern Indian Ocean (Subarea 58.4) which gave cause for concern as to the status of the resource in this area, and the lack of a scientific basis for setting catch limits (SC-CAMLR-XXV, paragraphs 4.184 to 4.192). In its management advice for this and other exploratory fisheries, the Scientific Committee requested urgent consideration by Members of methods for collecting data and of assessing these stocks.

5.82 The Working Group requested submissions by Members on stock structure, biological parameters (e.g. growth, length–weight relationship, maturity), recruitment and methods for assessment of these stocks.

5.83 The Working Group recommended that the minimum tag rate be at least three fish per tonne for Subarea 58.4 and that the Scientific Committee consider whether a higher rate should be applicable for each of the divisions of Subarea 58.4 which:

(i) was commensurate with the size of the fishery and the stock abundance in the division;

(ii) took into account the practical considerations of maintaining a high-quality tagging program.

5.84 The Working Group recommended that a depletion analysis similar to that applied to Division 58.4.3b and presented in WG-FSA-07/44 be completed for Divisions 58.4.1 and 58.4.2.

5.85 The Working Group recommended that Division 58.4.3b be divided into two SSRUs with the line of division running along latitude 60°S. This division would separate the main fishing grounds and could be used to better manage those grounds (Figure 5).

5.86 The Working Group recommended that the precautionary catch limit for *Dissostichus* spp. in Division 58.4.3b, which was 300 tonnes, should be reviewed given the rapid and unsustainable depletion seen in the fishery.

5.87 The Working Group further recommended that the new southern SSRU from the recommended division of Division 58.4.3b be closed to fishing for the 2007/08 season, given the rapid and unsustainable depletion seen in the fishery.

5.88 Dr Naganobu expressed the view that the priority is to decrease the level of IUU occurring in Division 58.4.3b before considering a closure of part or all of the division, as this is the reason why the stock has sustained such a high level of depletion.

Dissostichus spp. Subareas 88.1 and 88.2

5.89 In 2006/07, eight Members (Argentina, Republic of Korea, New Zealand, Norway, Russia, South Africa, UK and Uruguay) and 15 vessels fished in the exploratory fishery in Subarea 88.1. The fishery was closed on 2 February 2007 and the total reported catch of *Dissostichus* spp. (excluding research fishing) was 3 093 tonnes (101% of the limit) (CCAMLR-XXVI/BG/17, Table 3). The following SSRUs were closed during the course of fishing:

- SSRUs B, C and G closed on 28 December 2006, triggered by the catch of *Dissostichus* spp. (total catch 584 tonnes; 164% of the catch limit);

- SSRUs H, I and K closed on 2 February 2007, triggered by the catch of *Dissostichus* spp. (total catch 2 080 tonnes; 104% of the catch limit).

The IUU catch for the 2006/07 season was estimated to be zero tonnes. Information on this fishery and management advice is summarised below (paragraphs 5.101 to 5.106).

5.90 Nine Members (Argentina, Republic of Korea, Namibia, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and a total of 21 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.1 in 2007/08.

5.91 Five Members (Argentina, Norway, Russia, UK and Uruguay) and seven vessels fished in the exploratory fishery in Subarea 88.2. The fishery closed on 31 August 2007 and the total reported catch of *Dissostichus* spp. was 347 tonnes (63% of the limit) (CCAMLR-XXVI/BG/17). SSRU E was closed on 4 March 2007, triggered by the catch of *Dissostichus* spp. (total catch 325 tonnes; 95% of the catch limit). Information on this fishery and management advice is summarised below (paragraphs 5.101 to 5.106).

5.92 Seven Members (Argentina, New Zealand, Norway, Russia, Spain, UK and Uruguay) and a total of 15 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2007/08.

5.93 The Fishery Report for *Dissostichus* spp. in Subareas 88.1 and 88.2 is contained in Appendix I.

5.94 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 (Subarea 88.1 and SSRUs 882A–B), and (ii) SSRU 882E.

5.95 The catch limits for Subarea 88.1 and 88.2 SSRUs in the Ross Sea were changed as part of a three-year experiment (SC-CAMLR-XXIV, paragraphs 4.163 to 4.166). To assist administration of the SSRUs, the catch limits for SSRUs 881B, C and G were amalgamated into a 'north' region and those for SSRUs 881H, I and K were amalgamated into a 'slope' region. Within Subarea 88.2, SSRU 882E was treated as a separate SSRU with its own catch limit, whilst SSRUs 882C, D, F and G were amalgamated with a single catch limit.

5.96 In all seasons, there was a broad mode of adult fish at about 120–170 cm. In 2005/06, there was a strong mode at about 60 cm in Subarea 88.2. These fish were predominantly caught at the edge of the continental shelf in SSRUs 882F and G. This mode was not apparent in 2006/07, as there was no fishing on the shelf in these SSRUs in 2006/07.

5.97 Under Conservation Measure 41-01, each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. is required to tag and release *Dissostichus* spp. at a rate of one toothfish per tonne of green weight caught throughout the season.

5.98 In 2006/07, all vessels in Subarea 88.1 achieved a tagging rate of one toothfish per tonne of toothfish landed. In Subarea 88.2, four of the seven vessels failed to achieve the required tagging rate: the *Antartic II* (Argentina), *Frøyanes* (Norway), *Argos Georgia* (UK) and *Argos Helena* (UK).

5.99 Since 2000/01, more than 15 000 *Dissostichus* spp. have been tagged in Subareas 88.1 and 88.2 (WG-FSA-07/40), and about 500 tagged fish were recaptured. Since 2000/01, a total of 6 989 *D. mawsoni* have been tagged by New Zealand vessels in the Ross Sea (Subarea 88.1 and SSRUs 882A–B) and 179 of these were recaptured by New Zealand vessels. The New Zealand vessel data were used as inputs for the base-case model (WG-FSA-07/37).

5.100 The CASAL model, using catch-at-age and tag–recapture data and *D. mawsoni* biological parameters, was used to estimate the current and initial population size, and to calculate the long-term annual yield that would satisfy the CCAMLR decision rules.

Management advice for *Dissostichus* spp. in Subareas 88.1 and 88.2

5.101 The constant catch for which there was median escapement of 50% of the median pre-exploitation spawning biomass level at the end of the 35-year projection period for the Ross Sea (Subarea 88.1 and SSRUs 882A–B) was 2 700 tonnes. At this yield, there is a less than 10% chance of spawning biomass dropping to less than 20% of the initial biomass. A yield of 2 700 tonnes is therefore recommended.

5.102 For SSRU 882E, the Working Group did not have any new information on which to base new advice. The Working Group recommended that the catch limit for 2006/07 be carried forward for 2007/08. A yield of 353 tonnes is therefore recommended for 2007/08.

5.103 For SSRUs 882C, D, F and G, the Working Group could provide no new advice, but noted that the catches in these areas had provided some useful biological data for toothfish. Therefore, the Working Group recommended the current catch limits in these SSRUs be continued for the 2007/08 season.

5.104 The Working Group recommended that the allocation method used to set the 2005/06 catch limits for SSRUs in Subarea 88.1 be continued for the 2007/08 season.

5.105 The Working Group recalled its advice that the current designations of SSRUs in Subareas 88.1 and 88.2 are almost certainly not optimal, but a detailed revision of these would require, at least, a consolidated movement model for fish in these subareas, which is not yet available. Such a revision should take account not only of the principal target species, but also of by-catch species and ecosystem considerations.

5.106 The Working Group noted that there was considerable uncertainty about the implementation of the tagging program by the fleet fishing in Subareas 88.1 and 88.2 (paragraphs 3.35 and 3.36). The Working Group also noted that there may be a number of reasons for the differences between observed recapture rates of tags released by vessels from different nations. The Working Group requested that the Scientific Committee and the Commission look at the reasons for these differences, and provide advice to the Working Group on how to resolve the observed differences between rates that tags were recaptured from those released by vessels from different nations.

Dissostichus eleginoides South Georgia (Subarea 48.3)

5.107 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Appendix J.

5.108 In 2005, Subarea 48.3 was subdivided into areas, one containing the South Georgia–Shag Rocks (SGSR) stock and other areas, to the north and west, that do not include the

SGSR stock. Within the SGSR area, three management areas (A, B and C) were defined (Conservation Measure 41-02, Annex A). Catch limits for the areas to the north and west were set at zero for 2006/07.

5.109 The catch limits for *D. eleginoides* in the 2006/07 season for areas A, B and C were 0 (excepting 10 tonnes for research fishing), 1 066 and 2 488 tonnes respectively, with an overall catch for SGSR of 3 535 tonnes. The total declared catch was 3 535 tonnes. There was no recorded IUU catch for the 2006/07 season. Catches in areas A, B and C were 7, 976 and 2 552 tonnes respectively.

5.110 The standardised GLMM CPUE analyses were updated. The CPUE data display high levels of variability up to 1995, and lower variability from 1996 to the present, the apparent discontinuity arising during a period of major and rapid change in the structure of the fleet and management of the fishery. Major changes occurring between 1993 and 1996 include changes in the spatial distribution of fishing, a change in the nationalities fishing, the introduction of 100% observer coverage and a shift to night setting and a winter fishery.

5.111 During 2006/07, a further 4 653 tagged *Dissostichus* spp. have been released in SGSR, bringing the total number of tagged fish released to around 17 800. In 2007, 530 recaptures of tagged fish were reported.

5.112 The Working Group agreed on a single CASAL assessment model, which was structurally similar to that presented at WG-FSA-06. A simple update of that assessment (which included both low $M = 0.13$ and low $L_{\infty} = 152.8$ cm) resulted in a reduced estimate of B_0, principally due to the influence of the 2006 tag returns. Table 6 in Appendix J outlines the data and parameters used in the assessment model, as well as the structure of the model.

5.113 Likelihood profiles were presented for the base-case in Appendix J, Figures 15 and 16). Recent CPUE, the length-frequency data, and the tag data are consistent in their information on a level of B_0 (around 100 000 tonnes). It is clear that the tag data are the primary data source with respect to information on likely upper limits of B_0 (and, consequently, absolute levels of abundance) and give a consistent estimate of current, and, hence, historic abundance. It is also clear from the likelihood profiles that, as the number of releases and recaptures increases, so does the amount of information held in the tagging data on absolute levels of abundance. A new proposed assessment model was presented in WG-FSA-07/29, utilising catch-at-age data, new tagging parameters and estimating year-class strength. The Working Group recommended that the new model be reviewed at the next WG-SAM meeting.

5.114 Stock status and the long-term yield were calculated using the MCMC samples for the updated assessment model, as was done last year, with the appropriate long-term yield being 3 920 tonnes. The critical decision rule was the requirement that spawning biomass at the end of a 35-year projection period should be 50% of the initial spawning biomass.

5.115 As outlined in the Fishery Report (Appendix J), there were still some trends in the fits to the mark–recapture data which may be due to complex interactions between the various assumptions about natural mortality-at-age, tagging parameters, growth and selectivity. Investigation of the driving factors behind these trends should be undertaken intersessionally. It was acknowledged that the results of this investigation may have implications for all current assessments.

Management advice

5.116 The Working Group recommended that the catch limit for toothfish in Subarea 48.3 (SGSR stock) should be 3 920 tonnes for the 2007/08 fishing season.

5.117 The Working Group noted that the current model had produced a yield of 3 920 tonnes when updated with catch, length-frequency, CPUE and tagging data from 2007. It noted that some uncertainties with the assessment remain, such as the fits to the tag data. A significant revision of the model is under development, which will allow direct estimation of present and future recruiting cohort strength, which is not possible with the current model. The catch limit for 2008/09, if estimated with this new model, may be different from 3 920 tonnes.

5.118 The catch limits for management areas A, B and C should be adjusted in a pro-rata manner to 0 (excepting 10 tonnes for research fishing), 1 176 and 2 744 tonnes respectively. By-catch limits for skates/rays and macrourids should be similarly revised to 196 and 196 tonnes respectively.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

5.119 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Appendix K.

5.120 The catch of *D. eleginoides* reported for this division to 31 August 2007 was 3 438 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2006/07 season was zero inside the French EEZ. Some IUU fishing may occur outside the EEZ as reported in WG-FSA-07/10 Rev. 5.

5.121 Analyses show a general decreasing trend in the standardised CPUE up until 2003 followed by a period up to the current year for which the CPUE estimates are relatively constant.

5.122 The survey being conducted on the FV *Austral* at Kerguelen from September to October 2006 completed 207 trawls and 639 toothfish have been tagged. The Working Group encouraged further tagging.

5.123 By-catch removals are important for this fishery, and the majority of the catch is processed, but no stock assessment is available for evaluation of the impact on affected populations. Skates started to be cut off in December 2006.

Management advice

5.124 The Working Group encouraged the estimation of biological parameters for Kerguelen. The Working Group encouraged the development of a stock assessment for this area, and also encouraged cooperative work in the intersessional period between France and Australia on analysis of catch and effort data and other data that could be used to progress understanding of fish stock and fishery dynamics for Divisions 58.5.1 and 58.5.2 and Subarea 58.6. The Working Group encouraged France to continue its tagging program in Division 58.5.1.

5.125 The Working Group recommended that avoidance of fishing in zones of specific high rates of abundance in by-catch should also be considered.

5.126 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 Conservation Measure 32-13, remain in force.

5.127 The Working Group noted that France had made significant progress in mitigating by-catch, including area/season closures (Annex 6, paragraph II.23). It noted that the CPUE analysis would probably be robust to these changes so long as detailed haul-by-haul data continued to be available.

Dissostichus eleginoides Heard Island (Division 58.5.2)

5.128 The Fishery Report for *D. eleginoides* in Division 58.5.2 is contained in Appendix L.

5.129 The catch limit of *D. eleginoides* in Division 58.5.2 west of 79°20'E for the 2006/07 season was 2 427 tonnes (Conservation Measure 41-08) for the period from 1 December 2006 to 30 November 2007. The catch of *D. eleginoides* reported for this division as of 5 October 2007 was 1 956 tonnes. Of this, 1 338 tonnes (68%) was taken by trawl and the remainder by longline. The estimated IUU catch for the 2006/07 season, 0 tonnes, was the lowest since IUU fishing began in 1995/96.

5.130 The von Bertalanffy growth parameters from the 2005 assessment were replaced in the 2006 assessment and for this year by a mean length-at-age vector based on the von Bertalanffy growth curve with an early age adjustment for fish less than five years. Natural mortality was assumed to be 0.13 year^{-1} as for the other toothfish assessments.

5.131 Additional length-at-age samples for fish of age >20 years can be obtained from the longline fishery. The complete holdings of otoliths that have been collected from research surveys, commercial trawl and longline fisheries were summarised for the Working Group (WG-FSA-07/45) and this indicates the large potential for further ageing work to provide improvements to the assessment. The Working Group encouraged such work for both improving the growth model and providing catch-at-age data to future assessments.

5.132 The Working Group endorsed the refinements to the assessment based on the CASAL model introduced at WG-FSA-06 with similar CASAL models used for Subareas 48.3 and 88.1 and SSRU 882E. This assessment has a number of differences to those assessments including:

- the use of survey data as observations of young fish;

- tagging data are unable to be used in the assessment because of the underestimation of biomass that would arise from the current localised concentration of tag releases and recaptures;

- recruitment is modelled without assuming a stock–recruitment relationship, and variability in recruitment is estimated from the vector of year-class strengths estimated in the model.

5.133 The Working Group also noted that the assessment of yield can be sensitive to the number of age classes in the population and agreed as in WG-FSA-06 that the assessment be based on a population with the plus class at 35 years rather than 50 years because of the absence of evidence that the fish grow appreciably after 35 years.

5.134 The CASAL assessment used abundance-at-length estimated from the surveys, catch-at-length from the fisheries and standardised CPUE time series to estimate current and initial population size and year-class strengths since 1981. These results were then used in projections to estimate the long-term annual yield that satisfies the CCAMLR decision rules for toothfish.

5.135 A revision of the WG-FSA-06 CASAL assessment was presented in WG-FSA-07/53 Rev. 1 which involved refinements to the WG-FSA-06 assessment including: (i) updates to the data from the 2007 season and incorporating 2006 data unavailable for the previous assessment; (ii) modifications to the CASAL model specification; (iii) modification to the method of data weighting used for parameter estimation; and (iv) modification to the method of incorporating recruitment variability in forward projections using a two-year running mean to smooth the annual estimates of number of age-1 recruits. During the meeting, the stability of the parameter estimation was confirmed by starting the estimation from a range of initial parameter values.

5.136 Long-term annual yield was estimated to be 2 500 tonnes giving 50.5% escapement with a probability of depletion of 0.08.

Management advice

5.137 The Working Group recommended that the catch limit for *D. eleginoides* in Division 58.5.2 west of 79°20'E should be 2 500 tonnes for the 2007/08 fishing season.

Dissostichus eleginoides Crozet Islands (Subarea 58.6)

5.138 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Appendix M.

5.139 The catch of *D. eleginoides* reported for this subarea to 31 August 2007 was 333 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2006/07 season was zero inside Subarea 58.6 as reported in WG-FSA-07/10 Rev. 5.

5.140 Depredation on toothfish catches by killer whales has become a major problem for this longline fishery.

5.141 Analyses show a general decreasing trend in standardised CPUE to 2002/03 with a subsequent slight increase in 2003/04 and 2005/06 and a decrease for the 2006/07 season.

5.142 During the season, 677 toothfish were tagged by observers on board commercial vessels. The Working Group encouraged France to continue with its tagging program.

5.143 By-catch removals are important for the fishery, but only a small part of the catch is processed, and no stock assessment is available for evaluation of the impact on affected populations. Skates started to be cut off in December 2006.

Management advice

5.144 The Working Group encouraged the estimation of biological parameters for Crozet, and the development of a stock assessment for this area. The Working Group encouraged France to continue its tagging program in Subarea 58.6.

5.145 The Working Group recommended that avoidance of zones of specific high by-catch abundance should also be considered.

5.146 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 Conservation Measure 32-13, remain in force.

5.147 The Working Group noted that France had made significant progress in mitigating by-catch, including area/season closures (Annex 6, paragraph II.23). It noted that the CPUE analysis would probably be robust to these changes so long as detailed haul-by-haul data continued to be available.

Dissostichus eleginoides Prince Edward and Marion Islands (Subareas 58.6 and 58.7)

5.148 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 inside the South African EEZ is contained in Appendix N.

5.149 The catch limit of *D. eleginoides* in the South African EEZ for the 2006/07 season was 450 tonnes for the period from 1 December 2006 to 30 November 2007. The catch reported for Subareas 58.6 and 58.7 as of 5 October 2007 was 125 tonnes, all of which was taken by longlines. The IUU catch for the 2006/07 season was assumed to be equal to the IUU catch in 2004/05 at 156 tonnes.

5.150 Cetacean depredation of longline catches is reported to be significant, implying that total removals are greater than just the estimated fishery catches. It was noted that the pot fishery, which avoided depredation, operated only in 2004 and 2005.

5.151 The CPUE series was updated for the meeting and, as in previous years, the biological parameters from Subarea 48.3 were used.

5.152 An augmented two-fleet ASPM that used catches, standardised CPUE, and catch-at-length data was used to estimate a long-term annual yield. The results from the model were only slightly sensitive to whether or not cetacean depredation was included in the calculations and whether or not year-specific weights were used with the CPUE indices. The model estimated the spawning biomass of the resource to be between 37 and 40% of its average pre-exploitation level, although significant uncertainties remain in the assessment.

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

5.153 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 and that the concerns over the sensitivity of the ASPM to weightings used for different data sources and the estimation of recruitment levels for forward projections be noted.

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

5.154 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 Conservation Measures 32-10, 32-11 and 32-12, remain in force.

Champsocephalus gunnari South Georgia (Subarea 48.3)

5.155 The Fishery Report for *C. gunnari* for South Georgia (Subarea 48.3) is contained in Appendix O.

5.156 In the 2006/07 fishing season the catch limit set for *C. gunnari* in Subarea 48.3 was 4 337 tonnes. During the 2006/07 season the fishery caught 3 940 tonnes by the end of October 2007. The fishery remains open until 14 November 2007 and it is anticipated that the full catch will be taken.

5.157 In September 2007 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-07/56). The survey did not achieve as many trawl stations as previous surveys, and hauls were separated into eight strata (rather than the 12 used in 2006) to generate a standing stock estimate. Whilst the estimated mean value of the standing stock decreased by 8% from 105 000 tonnes in January 2006 to 98 000 tonnes in September 2007, the lower one-sided CI decreased by 35% from 37 500 to 23 400 tonnes.

5.158 The catch-weighted length frequencies obtained from the trawl survey (WG-FSA-07/56) indicated that the population was dominated by a strong cohort of 3+ fish, with a 2+ cohort present that may not have been fully sampled by the survey.

5.159 The Working Group agreed that a short-term assessment should be implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2007 survey.

5.160 Most input parameters for the assessment remained unchanged from 2006 except for selectivity, which reverted to the pre-2006 form (see SC-CAMLR-XXV, Annex 5, paragraph 5.130 for explanation of change in 2006).

Management advice

5.161 The Working Group recommended that the catch limit for *C. gunnari* should be set at 2 462 tonnes in 2007/08 and 1 569 tonnes in 2008/09 based on the outcome of the short-term assessment.

5.162 The Working Group recognised that the spawning of *C. gunnari* has little spatial overlap with the fishery and that the requirement of vessels fishing between 1 March and 31 May to undertake 20 research trawls is likely to increase the risk of seabird mortality. The Working Group recommended that the existing Conservation Measure 42-01 be amended to:

(i) remove the requirement that vessels fishing between 1 March and 31 May be required to undertake 20 research trawls (as detailed in Conservation Measure 42-01, Annex A);

(ii) that the catch during 1 March to 31 May not be limited to 25% of the catch limit.

5.163 The Working Group recommended that the impact of changes in Conservation Measure 42-01 should be reviewed at WG-FSA-08, particularly with respect to the maturity of fish caught throughout the year and the timing of fishing effort (particularly during the March–May period).

Champsocephalus gunnari Heard Island (Division 58.5.2)

5.164 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Appendix P.

5.165 The catch limit of *C. gunnari* in Division 58.5.2 for the 2006/07 season was 42 tonnes for the period from 1 December 2006 to 30 November 2007. The catch reported for this division as of 5 October 2007 was 1 tonne.

5.166 Due to a lack of significant targeting of *C. gunnari* in 2006/07, no catch-weighted length frequency was available. A large 1+ 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 June–July 2007.

5.167 The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2007 survey, and equalled 220 tonnes. All other parameters were the same as in previous years.

Management advice

5.168 The Working Group recommended that the catch limit for *C. gunnari* in 2007/08 be no more than 220 tonnes.

5.169 The Working Group recommended that other measures in the conservation measure be retained.

5.170 The Working Group recommended that further work on developing a management procedure for *C. gunnari* is a high priority (SC-CAMLR-XXIV, Annex 5, Appendix M, paragraph 26).

Assessment and management advice for other fisheries

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

5.171 CCAMLR closed commercial finfishing in the Antarctic Peninsula (Subarea 48.1) and the South Orkney Islands (Subarea 48.2) after the 1989/90 season. Both subareas should only be reopened to commercial exploitation if scientific surveys had demonstrated that the condition of fish stocks had improved to the extent which would allow commercial harvesting.

5.172 Germany conducted a bottom trawl survey in the Elephant Island–South Shetland Islands (part of Subarea 48.1) from 19 December 2006 to 3 January 2007 (WG-FSA-07/22, see also paragraphs 3.25 to 3.27). The Working Group concluded that biomass of most finfish stocks was found to be lower than during the last surveys in 2002 and 2003. They are currently not at a level which would allow reopening of the fishery.

Management advice

5.173 The Working Group recommended that the existing Conservation Measures 32-02 and 32-04 on the prohibition of finfishing in Subareas 48.1 and 48.2 respectively remain in force.

South Sandwich Islands (Subarea 48.4)

5.174 The Working Group developed a Fishery Report for *D. eleginoides* in Subarea 48.4 (Appendix Q). A mark–recapture experiment in Subarea 48.4 started in 2004/05 and this is the third year of the experiment. Two vessels from the UK and New Zealand fished in the area in 2006/07 and continued the tagging program. A total of 467 *D. eleginoides* and 11 *D. mawsoni* (total 478 fish) have been tagged and released, and two *D. eleginoides* have been recaptured in the subarea. In addition, one fished tagged in Subarea 48.4 was recaptured in Subarea 48.3. It is expected that the mark–recapture experiment will continue in Subarea 48.4 over the 2007/08 fishing season in order to assist in the assessment of the toothfish population structure and size in accordance with Conservation Measure 41-03.

Management advice

5.175 The Working Group noted that Conservation Measure 41-03 is in force until the end of the 2007/08 season. Further, it noted that the results from the tagging experiment would be reported at the 2008 meeting, and this would provide an opportunity for WG-FSA to review the results, and develop the assessment and management of this fishery, including fishery-based research requirements. Given the current low rates of tagging, an extension of the current experiment for one or two further years may be required.

5.176 Future development of this fishery may include a similar tagging experiment for *D. mawsoni* in the southern region of Subarea 48.4, and the introduction of catch limits for by-catch species.

Stone crabs (*Paralomis* spp.) (Subarea 48.3)

5.177 Stone crabs were not exploited in the 2006/07 season. No proposal for the harvest of crabs has been received by CCAMLR for the 2007/08 season.

Management advice

5.178 Stone crabs are subject to Conservation Measure 52-01 and 52-02 regulating the fishery and experimental harvest of crabs. The Working Group recommended that these conservation measures remain in force.

Squid (*Martialia hyadesi*) (Subarea 48.3)

5.179 The exploratory fishery on *M. hyadesi* was subject to Conservation Measure 61-01. No new information on the species was available. No new request has been submitted to CCAMLR to continue exploratory fishing on this species in 2007/08.

Management advice

5.180 The Working Group recommended that the existing Conservation Measure 61-01 remain in force.

FISH AND INVERTEBRATE BY-CATCH

6.1 The long-term status of by-catch taxa has been identified as an issue for urgent attention by the Scientific Committee (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.153). The key issues that need to be addressed are:

- assessment of the status of by-catch taxa (particularly rajids and macrourids)
- assessment of the expected impact of fisheries on by-catch species
- consideration of mitigation measures.

6.2 The Working Group identified the following areas of particular interest for the 2007 meeting:

(i) review of by-catch in longline and finfish trawl fisheries to include:
   (a) comparison between vessel-reported and observer-recorded data
   (b) differences in by-catch between autoline and Spanish longline systems
   (c) the fate of skates caught in longline fisheries;

(ii) development of assessments of by-catch species;

(iii) developing protocols for reporting benthic by-catch;

(iv) proposals for the Year of the Skate in 2008/09;

(v) mitigation trials to reduce macrourid by-catch;

(vi) review the move-on rule for macrourid by-catch in new and exploratory fisheries (Conservation Measure 33-03).

6.3 The Working Group agreed that consideration of by-catch issues in the krill fishery for 2006/07 would not be considered under this agenda item but would be dealt with under section 10 'Considerations of ecosystem management'.

Estimation of by-catch in longline fisheries

6.4 Fine-scale (C2) data estimates of total removals of by-catch species reported from longline fisheries within the CAMLR Convention Area are shown in Tables 14 and 15. Observer by-catch data for longline fisheries for the 2006/07 season are summarised in WG-FSA-07/6 Rev. 1. By-catch limits were not reached for any species.

Rajids

6.5 Reported retained rajid by-catch (as a percentage of *Dissostichus* spp. catch) in longline fisheries within the Convention Area in 2006/07 was low (<4% *Dissostichus* spp. catch) except in those areas where almost all rajids are retained and processed (French EEZs: Division 58.5.1 and Subarea 58.6) as highlighted in SC-CAMLR-XXIV, Annex 5, Appendix N, paragraph 22.

6.6 The numbers and fate of *Dissostichus* spp., macrourids, rajids and 'Other species' reported in 2006/07 in fine-scale data are detailed in Table 15. With the exception of the French EEZs, a large proportion of skates were cut off lines in most regions.

6.7 Total catch of rajids in tonnes (Table 16) was estimated by summing the numbers caught and released in the C2 data and multiplying by the mean weight of skates caught in each subarea derived from corresponding C2 data (except for Division 58.5.1 and Subarea 58.6 for which these data were not available). Estimates of total catches in Subarea 48.3 and Division 58.4.3b were around 50% of the catch limit and 81% of the catch limit in Subarea 88.1. The Working Group noted that many skates survive being cut off, and that longline catches do not represent total removals, however, the fate of cut-off skates remains uncertain and further survival experiments are essential to derive estimates of total removals of skates.

6.8 Comparative estimates of total catches (by number and weight) were also derived from the observer data reported during tally periods on L5 forms and are given in Table 17. Extrapolated estimates were calculated by raising numbers recorded in tally periods using the percentage of hooks observed by set and then multiplying by area-specific average weights (derived from biological data on L6 forms) to give tonnes.

6.9 Estimates of rajid by-catch from extrapolated observer data (Table 17) are similar to those based on C2 data (Table 16) for most areas. Exceptions include estimates from Subareas 48.4, 58.6 and 88.1 which were between two- and 60-times lower and from Division 58.4.3b which was approximately four-times higher. Lower observer estimates may be a result of difficulties in observing cut-offs and the higher estimate in Division 58.4.3b might result from vessels under-reporting cut-offs in this area.

6.10 Observer data from the L11 forms was extracted to investigate the fate and condition of skates caught on longlines in 2006/07 (Table 18). The Working Group noted the practical limitations in reporting of rays (see WG-FSA-07/39) and inconsistencies in reporting amongst observers. For example, not all rays reported under each discard fate have a corresponding release condition recorded, and in some cases an incorrect release condition code is recorded which does not correspond logically to the discard fate given to the same animal.

6.11 Comparison of numbers of skates recorded on L5 and L11 forms also indicates that observers may, in some cases, be double-recording skates. The Working Group recommended that the observer instructions be amended to indicate that individual skates are recorded on either the L5 or the L11 form, but not on both.

Macrourids

6.12 By-catch rates for macrourids (as a percentage of *Dissostichus* spp. catch) for the 2006/07 fishing season ranged from 3.9 to 27.1% (Table 14). By-catch limits were not reached in any subarea.

6.13 In comparison with the 2005/06 season, the by-catch of macrourids was similar in Subarea 48.3, reduced in Subareas 88.1 and 88.2, but increased in Divisions 58.5.2 (from

26 to 61 tonnes) and 58.5.1 (French EEZ; 339 to 476 tonnes) (Tables 14 and 15). A small number of macrourids were reported as 'released' in Division 58.4.1 and Subarea 88.1 (Table 15), but are highly unlikely to survive.

6.14 The differences in the by-catch of macrourids between Spanish and autoline systems in Subareas 48.3, 48.6 and 88.1 and Division 58.5.2 are detailed in Table 19. Catches of macrourids were generally higher with the autoline system, but relative catches of macrourids by autoliners have declined substantially in the last two seasons in Subarea 88.1. The Working Group welcomed the decline (relative and absolute) in macrourid catch in Subarea 88.1 and considered that this may be a consequence of the move-on rule (Conservation Measure 33-03) encouraging vessels to fish in areas of lower macrourid abundance and the modification to Conservation Measure 41-01 that removed the requirement to space research lines 5 n miles apart, thus allowing vessels to avoid areas of high macrourid biomass.

6.15 In the 2006/07 data there is some variation between observer-extrapolated catch estimates (Table 17) and the C2 catch data for macrourids (Tables 14 and 15). Observer estimates were higher in Subareas 48.3, 48.6, 58.7, 88.1 and 88.2 and Divisions 58.4.3a and 58.4.3b than the fine-scale data, while in Divisions 58.4.1, 58.4.2 and 58.5.2 and Subarea 58.6 observer-extrapolated estimates were lower than the fine-scale data. In Subareas 48.3 and 88.1, where macrourid catches were highest, the observer estimates were higher than the C2 data, but were still below the catch limits. Differences between the two estimates could be due to a number of different factors. Average weight of macrourids and catch rates will vary both within and between sets, and scaling observer data up from tally period observations assumes catch rates and fish weights are constant for the entire set.

6.16 The Working Group noted the lack of a field for reporting 'lost' fish in the L5 form during tally periods. Instructions direct observers to record 'all fish that are discarded, including tagged and released fish and those cut off or flicked off, are recorded in the discard section'. However, it also states that 'fish lost at the surface should not be counted as a discard', so there is no scope for recording numbers of fish lost for species other than skates which can be reported on the L11 forms. Dr Leslie reported that macrourids have been known to be lost from lines at the surface.

6.17 The Working Group recommended that the longline and pot tally forms be amended to reflect catch definitions in the C2 form.

Other species

6.18 By-catch of other species were generally low (<4% of *Dissostichus* spp. catch), the exception being Division 58.4.3a, where 1 tonne (20.9%) of 'Other species' was caught, with 4 tonnes of toothfish.

6.19 Observer data (WG-FSA-07/6 Rev. 1) provided information on the species composition of the 'Other species' listed in the fine-scale by-catch data (Tables 14 and 15). In the Division 58.4.3a longline fishery, where 'Other species' accounted for 20.9 % (by weight) of the catch in the fine-scale data, the observer data shows that 32 % of the catch (by number) was *Antimora rostrata*. The observer data also suggested that *A. rostrata* was the principal by-catch species attributed to 'Other species' in the Subareas 88.1, 88.2 and 48.3 toothfish longline fisheries. Table 18 provides catch estimates of *A. rostrata* derived from observer data recorded in the L5 forms.

Estimation of by-catch in trawl fisheries

6.20 By-catch in trawl fisheries for icefish (Subarea 48.3 and Division 58.5.2) and toothfish (Division 58.5.2) derived from fine-scale (C1) data are detailed in Table 20. Observer by-catch data from trawl fisheries in 2006/07 were summarised in WG-FSA-07/7 Rev. 1.

6.21 The by-catch in the trawl fishery for *C. gunnari* in Subarea 48.3 was negligible and less than 2005/06 despite a doubling in the catch of the target species. The decline in by-catch was probably due to higher catch rates of *C. gunnari* with fewer hauls undertaken to attain the quota.

6.22 In the Division 58.5.2 *C. gunnari* fishery, the by-catch of *C. rhinoceratus* was three-times greater than the catch of the target species, and only took 1 tonne of the target species.

6.23 The principal by-catch species in the Division 58.5.2 toothfish trawl fishery were *C. rhinoceratus*, *L. squamifrons*, rajids and macrourids. Catches were below catch limits, but it should be noted that catch limits are for the trawl and longline fisheries combined. Note that the data in Table 11 of WG-FSA-06 (SC-CAMLR-XXV, Annex 5) are incorrect for Division 58.5.2.

6.24 The Working Group noted the difficulties that observers had in estimating the percentage of the catch observed during the period in the trawl fishery. The Working Group therefore recommended a change to the trawl tally period form (T3) to record the weight of sub-samples and to record counts of each species retained or discarded.

Assessments

6.25 No new assessments for by-catch species were presented to the Working Group. The Working Group recommended that by-catch limits should remain unchanged for the 2007/08 season.

6.26 The priority by-catch taxa for which assessments of status are required are macrourids and rajids (SC-CAMLR-XXI, Annex 5, paragraph 5.154).

6.27 Two papers presented preliminary assessment models for rajids in the Convention Area, but both identified that insufficient data was available to develop a full assessment. In WG-SAM-07/4 the catch histories, growth parameters and commercial catch-at-length frequencies for Antarctic skates and rays are updated and the paper reports on the development of an assessment model for Antarctic skates and rays.

6.28 WG-SAM-07/11 presented a preliminary assessment of rajid populations in Subarea 48.3 using a surplus production model implemented in a Bayesian framework. This model was used because insufficient tagging data were available to carry out alternative approaches such as an integrated assessment. Model estimates of abundance and exploitation rates were both uncertain and strongly dependent on prior estimates of the intrinsic rate of increase. The model should therefore be considered a risk assessment, but its integrated design has the potential to incorporate future tagging data.

6.29 The Working Group reiterated the urgent need for assessments of macrourids and rajids in assessed and new and exploratory fisheries in the Convention Area. Dr Hanchet informed the Working Group of a New Zealand survey to the Ross Sea in 2008 that is intended to assess macrourid abundance.

6.30 The Working Group noted that by-catch limits do not imply that a sustainable fishery is possible for these species. By-catch limits are, in most cases, based on a percentage of the *Dissostichus* spp. catch, rather than any knowledge of sustainable levels of exploitation. All fisheries should aspire to keep by-catch rates to a minimum.

Benthic by-catch

6.31 The Working Group recognised the urgent need to quantify benthic by-catch in bottom trawl and longline fisheries, particularly with respect to slow-growing and habitat-forming species such as corals (Agenda Item 14.1).

6.32 The Working Group noted that identification of benthic by-catch to species, genus or even family level is difficult. The Working Group recommended that suitable area-specific benthic identification guides be developed for use by observers. The Working Group recommended that, during the biological sampling period, observers be tasked to identify (to phyla) and weigh benthic by-catch.

6.33 The Working Group noted that the identification and quantification of benthic by-catch does not take account of the interaction of the fishing gear with benthos. Some gears do not catch or retain benthic by-catch, but are likely to impact on the benthos, and this needs to be assessed by other methods.

Proposed 'Year of the Skate'

6.34 The Working Group recommended the proposal to make 2008/09 the CCAMLR Year of the Skate as proposed in WG-FSA-07/39, recognising that enhanced data collection and tagging are essential to develop assessments.

6.35 The Working Group recommended that the Year of the Skate should incorporate all *Dissostichus* spp. fisheries in the Convention Area, with a tagging program focusing on new and exploratory fisheries. Assessed fisheries already have tagging programs in place (see paragraph 3.50).

6.36 In preparation for the Year of the Skate, the Working Group identified the following priorities:

(i) formation of a subgroup to communicate intersessionally and coordinate planning;

(ii) development of detailed, region-specific, identification guides for skates based on characters that can easily be determined on vessels by observers;

(iii) modification of the L11 form (for 2008/09) to capture detailed information about the fate of skates (see below);

(iv) the skate tagging program in new and exploratory fisheries be revised (see WG-FSA-07/39) and tested in 2007/08 prior to being adopted by all vessels in 2008/09;

(v) that the Secretariat be asked to coordinate the skate tagging program in new and exploratory fisheries, and be the repository of skate tagging kits for the new and exploratory fisheries.

6.37 The Working Group recommended modifications to the L11 form for the 2008/09 season to provide more detailed information on the fate of captured skates including the following:

(i) was the skate retained, lost, released with tag, released without tag, or unknown?

(ii) for released skates, was it released at the surface or out of the water?

(iii) was the hook still in or had it been removed?

(iv) what was the health and fate of the fish when released[1]: excellent health, average, poor, dead, uncertain, or predated on release?

(v) record pelvic length in preference to total length and include a schematic diagram on the form to illustrate measurement of pelvic length;

(vi) include an estimated weight category with three options: small (<5 kg), medium (5–10 kg) and large (>10 kg);

(vii) allow the collection of sex and male maturity data;

(viii) species drop-down menu be limited to skate species only.

6.38 The Working Group considered the proposal to bring all captured skates on board prior to release to increase the probability of tag detection (WG-FSA-07/39). The Working Group agreed that bringing skates on board[2] would increase tag detection, assist in identification, permit the condition of skates to be better determined and allow length measurements to be taken. However, the Working Group recognised that it may not be

[1] Definitions of excellent, good and poor health need to be developed.
[2] Or brought to the vessel side to be examined.

practical to bring skates on board on all vessels. The Working Group recommended that in the 2007/08 season, where possible, skates be brought on board prior to release, with a view to making this mandatory in 2008/09.

6.39 The Working Group recognised that increased observer effort on skate data collection will likely impact on observer work on other by-catch species such as macrourids, but it is envisaged that a 'Year of the Macrourid' may follow in 2009/10 following appropriate preparatory work.

Mitigation of macrourid by-catch

6.40 WG-FSA-07/33 presented the results of experimental trials carried out in Subareas 48.3, 88.1 and 88.2, testing different hook and bait types as mitigation measures to reduce the by-catch of macrourids on autoline vessels. Hook types did not influence catch rates of macrourid or target species significantly. Mackerel bait greatly reduced catch rates of both macrourids and toothfish, and was therefore not considered a useful mitigation measure alone. A follow-on proposal (WG-FSA-07/31) from the UK to undertake further trials using different weighting mechanisms in conjunction with different bait types was discussed. The Working Group agreed that although trials testing mitigation measures should be encouraged, they must be reviewed to ensure that the experimental designs are robust and able to assess impacts on all species, including species not targeted by the mitigation measure.

6.41 The Working Group also agreed that where considerable changes in gear configuration were to be tested in trials (e.g. trotline), provision for this to be recorded as a different gear-type by the vessel must be made. Currently there is no way of separating data from gear types other than Spanish and autoline systems in C2 data. The Working Group recommended that the C2 form be modified to allow other gear types to be recorded.

Review of Conservation Measure 33-03

6.42 Conservation Measure 33-03 limits by-catch in new and exploratory fisheries. At the 2006 meeting, the Scientific Committee requested that WG-FSA-07 review the by-catch move-on rule (Conservation Measure 33-03, paragraph 5):

> 'If the catch of *Macrourus* spp. taken by a single vessel in any two 10-day periods* in a single SSRU exceeds 16% of the catch of *Dissostichus* spp. by that vessel in that SSRU in those periods, the vessel shall cease fishing in that SSRU for the remainder of the season.' (*A 10-day period is defined as day 1 to day 10, day 11 to day 20 or day 21 to the last day of the month.)

6.43 The move-on rule was enforced on seven occasions during the 2005/06 season (in Subareas 88.1 and 88.2) and on nine occasions during 2006/07 (Subareas 48.6, 88.1, 88.2 and Division 58.4.1). The Working Group noted that the last two seasons had seen a reduction in macrourid by-catch in Subarea 88.1 from 462 tonnes in 2004/05 to 153 tonnes in 2006/07, which may be attributed to the conservation measure. The Working Group also noted that other macrourid mitigation measures apply to new and exploratory fisheries, such as Conservation Measure 33-03 (paragraph 4).

6.44 The Working Group noted that it is possible, for operational reasons, that a vessel may fish for a single day during a 10-day period with a high catch of macrourids and this would count as the first 10-day period, making a vessel reluctant to fish in the SSRU again.

6.45 SC-CAMLR-XXVI/8 presented three potential modifications to the move-on rule. In Option 1, the move-on rule is not triggered until 50% of the macrourid catch limit is reached. The Working Group considered that this option may allow vessels to catch macrourids without constraint early in the season and agreed that it is not an appropriate management measure. Options 2 and 3 proposed modifying the conservation measure by requiring vessels to have fished for a threshold number of days in an SSRU during a reporting period. The Working Group welcomed the proposals and considered a fourth option in which a threshold level of macrourid catch is required by each vessel, in each 10-day period in each SSRU to trigger the move-on rule.

6.46 The Working Group examined daily catch rates (mean and maximum) of macrourids in new and exploratory fisheries and noted that the mean daily catch rates of macrourids in 2006/07 were 306 kg day^{-1} in Subarea 88.1 and 121 kg day^{-1} in Subarea 48.6, and considered that a threshold level should be set at approximately five days at the mean daily catch rate in Subarea 88.1. The Working Group therefore agreed that a threshold macrourid catch level of 1 500 kg be added to the conservation measure.

6.47 The Working Group recommended that paragraph 5 of Conservation Measure 33-03 be amended as follows:

> 'If the catch of *Macrourus* spp. taken by a single vessel in any two 10-day periods* in a single SSRU exceeds 1 500 kg in each 10-day period and exceeds 16% of the catch of *Dissostichus* spp. by that vessel in that SSRU in those periods, the vessel shall cease fishing in that SSRU for the remainder of the season.' (*A 10-day period is defined as day 1 to day 10, day 11 to day 20 or day 21 to the last day of the month.)

6.48 The Working Group recommended that the alteration to Conservation Measure 33-03 be reviewed at WG-FSA in 2008, particularly examining the effect of the change on macrourid catches and catch rates.

Management advice

6.49 The Working Group recommended that the observer instructions be amended to indicate that individual skates are recorded on either the L5 or the L11 form, but not on both.

6.50 The Working Group recommended that the observer longline and pot tally forms be amended to reflect catch definitions in the C2 form.

6.51 The Working Group recommended a change to the trawl tally period form (T3) to record the weight of sub-samples and to record counts of each species retained or discarded.

6.52 The Working Group recommended that 2008/09 be the CCAMLR Year of the Skate.

6.53 The Working Group recommended that the Year of the Skate should incorporate all *Dissostichus* spp. fisheries in the Convention Area, with a tagging program focusing on new and exploratory fisheries.

6.54 The Working Group recommended that in the 2007/08 season, where possible, skates be brought on board prior to release, with a view to making this mandatory in 2008/09.

6.55 The Working Group recommended modifications to the L11 form for the 2008/09 season to provide more detailed information on the fate of captured skates.

6.56 The Working Group recommended that the C2 form be modified to allow gear types other than Spanish and autoline systems to be recorded.

6.57 The Working Group recommended that paragraph 5 of Conservation Measure 33-03 be amended as follows:

> 'If the catch of *Macrourus* spp. taken by a single vessel in any two 10-day periods* in a single SSRU exceeds 1 500 kg in each 10-day period and exceeds 16% of the catch of *Dissostichus* spp. by that vessel in that SSRU in those periods, the vessel shall cease fishing in that SSRU for the remainder of the season.' (*A 10-day period is defined as day 1 to day 10, day 11 to day 20 or day 21 to the last day of the month.)

6.58 The Working Group recommended that the alteration to Conservation Measure 33-03 be reviewed at WG-FSA in 2008, particularly examining the effect of the change on macrourid catches and catch rates.

INCIDENTAL MORTALITY OF MAMMALS AND SEABIRDS ARISING FROM FISHING

7.1 In previous years, WG-FSA has included in its report a detailed summary of the ad hoc WG-IMAF report, and the latter has been added as an appendix to the WG-FSA report. Given the status of WG-IMAF as an autonomous ad hoc working group of the Scientific Committee, and that few IMAF experts are present during the adoption of the WG-FSA report to provide comment on the WG-FSA summary of the WG-IMAF report, WG-FSA recommended the following:

- this year the advice from ad hoc WG-IMAF to the Scientific Committee should be presented as a Scientific Committee document and it should be translated as it has been in past years; in addition, the full report of WG-IMAF should be presented as a stand-alone document for consideration of the Scientific Committee;
- in future years, the entire report of ad hoc WG-IMAF would be treated as a separate working group report and annexed to the report of the Scientific Committee;
- WG-FSA's consideration of Agenda Item 7 will this year, and in future, be restricted to comments arising from consideration of the report of ad hoc WG-IMAF.

7.2 The Working Group noted from the report of ad hoc WG-IMAF that considerable progress has been made in reducing the incidental mortality of Convention Area seabirds and mammals in Convention Area fisheries over the last decade. These reductions have been achieved primarily through modifications of gear and fishing seasons. The detailed discussion of the construction and performance of different gears in the ad hoc WG-IMAF report is of considerable value to WG-FSA.

7.3 WG-FSA and ad hoc WG-IMAF have both recommended that information on the specific type of longline gear that is used on each haul be recorded by vessels on C2 data forms.

7.4 The Working Group recommended a change to the C2 form to record the number of hooks attached to sections of longline which are lost per set. This information would also be of use to ad hoc WG-IMAF.

Management advice

7.5 Noting that there may be unrecorded mortality associated with lost sections of longline, and that this may impact on calculations of stock and by-catch status, WG-FSA recommended that information on the number of hooks that are lost attached to sections of longline during fishing be recorded by vessels on C2 data forms.

EVALUATION OF THREATS ARISING FROM IUU ACTIVITIES

Development of approaches for estimating total removals of toothfish

8.1 The Working Group noted the Secretariat's development of a trial matrix for estimating the uncertainty associated with IUU fishing events, and noted that this work will be reviewed by SCIC (WG-FSA-07/10 Rev. 5).

8.2 WG-FSA agreed that the method currently used by the Secretariat could be further improved by the addition of a measure of the local density of licensed vessels. Such a measure would reflect the ability of licensed vessels to detect (i.e. sight) IUU fishing. Various measures were discussed, including the number of days in a season when legal vessels are present in an area. Such measures would provide an estimate of the probability of detecting an IUU fishing event, and may indicate areas where such a probability was low.

8.3 The Working Group requested that the Secretariat consider including a measure of the local density of licensed vessels in the tables it prepared on IUU fishing (e.g. Table 1 in WG-FSA-07/10 Rev. 5). Low probabilities of detection of IUU fishing may lead to an underestimation of the catch from IUU fishing reported in Table 3.

Review of historical trends in IUU fishing activity

8.4 The Working Group reviewed the catch history of *Dissostichus* spp. taken by IUU fishing in the Convention Area (Table 3). This time series had been updated using estimates reported in WG-FSA-07/10 Rev. 5.

8.5 IUU fishing activities peaked in the mid-1990s in areas which nowadays are well patrolled. Routine surveillance in the sub-Antarctic Indian Ocean led to a gradual reduction in IUU fishing, from an estimated total of 32 673 tonnes of *Dissostichus* spp. taken by IUU fishing in 1996/97, to 2 178 tonnes in 2003/04.

8.6 Since 2003/04, the available information indicates that IUU fishing activities have moved to the high-latitude regions of the Indian Ocean (Subarea 58.4), and have increased in intensity. For the last two years this has included a significant amount of IUU catch from gillnet vessels. The estimated total catch of *Dissostichus* spp. taken by IUU fishing in 2006/07 was 3 615 tonnes, most of which was taken in Division 58.4.3b (2 293 tonnes).

8.7 The Working Group expressed concern at this shift and increase in IUU fishing. The extent of fishing grounds for *Dissostichus* spp. in Subarea 58.4 is much smaller than that in Subarea 88.1, yet the estimated total removals from Subarea 58.4 are comparable to the catches reported in Subarea 88.1.

8.8 The Working Group noted that the estimated catch from IUU fishing in Division 58.4.3b in 2006/07 was 7.6-times greater than the precautionary catch limit for the exploratory longline fishery in that division. This is the third consecutive year of high IUU catches and it was agreed that this high level of IUU fishing in Subarea 58.4 was unsustainable.

BIOLOGY, ECOLOGY AND DEMOGRAPHY OF TARGET AND BY-CATCH SPECIES

Review of information to the meeting

9.1 Eighteen papers were provided to WG-FSA which contained biological and ecological information on either target species or by-catch species. They could be roughly divided into five groups of papers:

(i) identification guides – 3
(ii) aspects of the biology of *D. mawsoni* – 5
(iii) the diet of juvenile *D. eleginoides* – 1
(iv) by-catch species in the longline fishery (also dealt with by the By-catch Subgroup) – 2
(v) aspects of the biology and ecology of icefish and *Patagonotothen guntheri* – 7.

9.2 Summaries of working documents containing biological information will be available in the *CCAMLR Scientific Abstracts* and therefore are not repeated here.

9.3 The three identification guides included the identification of fish caught along with *E. superba*, a field guide to the main Ross Sea fish caught in the *D. mawsoni* fishery, and the determination of Antarctic skates. The field guide to fish associated with *E. superba* aggregations permits the rapid identification of more than 40 species (WG-EMM-07/32). The field guide to Ross Sea fish covers 27 taxa. Identification was provided to the species level if possible. However, for a number of groups (liparids, zoarcids, bathydraconids and the genera *Pogonophryne* and *Muraenolepis*), the key remained still at the family or genus level (WG-FSA-07/41). The key to skates of the Southern Ocean revealed a much larger heterogeneity in some characters than hitherto thought. A number of specimens have been tentatively assigned new species status (WG-FSA-07/27).

9.4 Papers on *D. mawsoni* span a wide range, including the use of stones in toothfish stomach in revealing bottom structure, morphological features, gametogenesis and stomach content with respect to the most abundant fish and squid species. WG-FSA-07/35 provided the first hypothetical life cycle of *D. mawsoni*. WG-FSA-07/58 noted that *D. mawsoni* take up stones from the sea floor randomly and that this information could be used as an additional means to reveal the geological structure of the Antarctic continental shelf and slope. Males and females of *D. mawsoni* were mostly in maturity stage III in December–February, which was in line with observations that the species spawns in July–August (WG-FSA-07/38 Rev. 2, 07/49). The most important food items of *D. mawsoni* in the Amundsen Sea in 2006/07 were the grenadier *M. whitsoni*, the icefish *Chionobathyscus dewitti* and the mesopelagic ionah fish *Notolepis coatsi*, and the cephalopods *Mesonychoteuthis hamiltoni*, *Psychroteuthis glacialis* and *Kondakovia longimana*. The prey composition underlined the notion that *D. mawsoni* are fast-swimming predators with a wide food spectrum (WG-FSA-07/50). Widespread information on the biology and ecology of *D. mawsoni* was condensed into a hypothetical life cycle of the species augmented by some computer animation which hypothetically showed the drift of early life stage animals into and out of the Ross Sea. The Working Group welcomed this attempt although it was well aware of the fact that the hypothesised life cycle is likely to change while new information comes in.

9.5 The distribution and diet of juvenile *D. eleginoides* was described from four annual trawl surveys around Shag Rocks and South Georgia (WG-FSA-07/P4). Most juveniles were caught on the Shag Rocks shelf and the northwest of South Georgia. Stomach content analysis revealed that juvenile toothfish were largely piscivorous. The diet consisted mostly of *P. guntheri* at Shag Rocks while various nototheniid fish and *E. superba* formed the diet around South Georgia.

9.6 Analyses of recent commercial catches, research surveys and data on larval and postlarval fish coupled with historical information indicated that *C. gunnari* spawns inshore in bays and over the shelf to the northeast of the island from January to June (WG-FSA-07/55). The current conservation measure restricts the catch limit during the presumed spawning period from March to May. In case the commercial fishery remains restricted to the northwest of South Georgia, this conservation measure is unlikely to protect spawning aggregations as intended (paragraph 5.162).

9.7 The icefish *C. dewitti* is a common by-catch in longlining in the Ross Sea (WG-FSA-07/25). Fifty per cent of the fish were mature at 34–36 cm and 3–4 years of age. Spawning appears to occur in February–March. Unvalidated maximum ages of 8–11 years were obtained. The analysis of biological information of *Pseudochaenichthys georgianus* on the South Georgia shelf from 1986 to 2006 suggested that fish grow fast in the first four years, as do other icefish species (WG-FSA-07/21). Stomach content analyses in 2005 and 2006 indicated that the species is a pelagic or semipelagic predator taking overwhelmingly krill, while nototheniids and other channichthyids form only a minor part of the diet. WG-FSA-07/P1 provided further insight into the biology of the icefish *Chaenodraco wilsoni* off the tip of the Antarctic Peninsula and in the Cosmonauts and Commonwealth Seas. Fish spawn in October–November. Absolute fecundity is low and does not exceed 2 000–3 000 eggs. Fish fed almost exclusively on krill. They are unlikely to exceed 10 years of age.

9.8 The distribution of *P. guntheri* is restricted to the Shag Rocks area where it occurs from 111 to 470 m depth (WG-FSA-07/P3). They feed on the copepod *Rhincalanus gigas* when they are smaller (<14 cm) and take the hyperiid *Themisto gaudichaudii* and krill when they grow larger.

9.9 Mercury levels in five species of Antarctic fish from the Ross Sea were highly variable both within and between the five species (WG-FSA-07/24). The low level of mercury in *D. mawsoni* relative to its prey species and the four-fold difference in mercury concentrations between it and *D. eleginoides* were unexpected. They can only be explained by a lower rate of mercury assimilation and/or a higher rate of mercury elimination by *D. mawsoni*.

9.10 The Working Group agreed on the following three topics for the meeting in 2008 and encouraged Members to submit papers on:

- stock structure in *D. eleginoides*
- reconstruction of the life history of *D. eleginoides* in different areas
- a field guide for skates in the Southern Ocean.

9.11 The Working Group felt that more credit needs to be paid to empirical field work and its presentation within WG-FSA. Field work is essential in underpinning assessment work. Steps aimed in that direction are the workshops held by WG-FSA at regular intervals on special topics, such as: the Workshop on Approaches to the Management of Icefish in 2001; the focus on certain specific topics in the submission of biological papers to WG-FSA in the last few years; review papers submitted to WG-FSA, such as ‘A hypothetical life cycle for Antarctic toothfish *Dissostichus mawsoni in* Antarctic waters of CCAMLR Statistical Area 88’ (WG-FSA-07/35); and the Species Profiles. The Working Group envisaged that it will have more time to dedicate to the results of empirical field work once assessment work is conducted on a biennial basis (paragraphs 12.9 to 12.13).

Species profiles

9.12 The compilation of species profiles of those three species currently exploited in the Southern Ocean was initiated in 2005. These species profiles should condense all biological information into one concise paper which is currently spread over a large number of publications and working group papers which are not readily available to readers outside CCAMLR. It was decided to publish those species profiles in a special volume of *CCAMLR Science* and update an electronic version of these papers continuously thereafter.

9.13 A species profile of *D. mawsoni* was completed at the 2006 meeting of CCAMLR. The second species profile of *C. gunnari* was completed before the 2007 meeting of CCAMLR and is currently under review. The outstanding species profile on *D. eleginoides* is likely to be submitted in the course of 2008. All three species profiles are likely to be available for final consideration and adoption by WG-FSA at its 2008 meeting. The publication of the special volume of *CCAMLR Science* is likely to occur in the course of 2009.

Otolith network

9.14 No report on the progress of work in the CCAMLR Otolith Network (CON) has been submitted to CCAMLR this year.

CONSIDERATION OF ECOSYSTEM MANAGEMENT

Report of the Workshop on the Fisheries and Ecosystem Models in the Antarctic (FEMA)

10.1 Developments in evaluating ecosystem effects of the Convention finfish fisheries were discussed at the FEMA workshop (SC-CAMLR-XXVI/BG/6, paragraphs 45 to 48). WG-FSA recognised that this had been an important opportunity for interaction between the three working groups of the Scientific Committee. They noted that although Ecosystem Approaches to Fishing (EAF) had been an integral aspect of the management of the krill fishery, less direct attention had been paid to it in managing the icefish and toothfish fisheries and there had been no suitable forum for discussing this work within CCAMLR.

10.2 The Working Group generally agreed that the workshop had provided a good opportunity to review progress on ecosystem modelling for some of CCAMLR's finfish fisheries. It recognised the need for the further development of ecosystem models which could take into account the complex interactions between predators, target species, prey and other fisheries. It agreed that the ecosystem modelling should focus in the short to medium term on developing minimum realistic models to assess potential risks to the ecosystem. However, it recognised that the complex nature of some of the interactions means that the results from such models would need to be considered in a strategic rather than tactical sense. It also noted the value of following the 'best-practice' approach recommended by FAO in the development of the model.

10.3 WG-FSA discussed the future integration of the work of WG-FSA, WG-EMM and WG-SAM on ecosystem modelling:

- It agreed that in the first instance the ecosystem/multi-species models would need to be evaluated by WG-SAM.

- It also agreed that the results of ecosystem/multi-species models could be discussed under the WG-FSA agenda item 'Consideration of ecosystem management'. This would provide a useful forum for considering input into the fish, squid and invertebrate components of the ecosystem models.

- While the current WG-FSA agenda allowed only restricted time for discussion, it was hoped that a move to multi-year intervals between full assessments may provide greater opportunities for the discussion of the ecosystem effects of fishing.

- WG-FSA also agreed that interactions of the target fish species with top predators and with krill and the krill fishery may best be considered within the WG-EMM agenda under its consideration of the status of the krill-centric ecosystem.

Management advice

10.4 Further substantial work to elucidate the role of fish in various Antarctic ecosystems and describe their importance as predators of krill in quantitative terms (see Murphy et al., 2007) is required in the near future. In order to achieve this, close collaboration between WG-FSA and WG-EMM is essential. WG-FSA recommended that the Scientific Committee consider holding a further workshop in 2009 or 2010.

Depredation

10.5 Four working group papers and one observer report described attempts to reduce depredation of longlines by killer whales and sperm whales:

(i) WG-FSA-07/11 described the use of a mammal exclusion device in longlining operations in FAO Area 41 outside the CAMLR Convention Area. The exclusion device is a protection (cone) net and slides down over the hooks and catch as soon as the line is hauled. The design is shown in Figure 6. In addition, bunches of kapron (artificial fibre) filaments were fastened to outside the net. Estimating the effects of this gear modification has been difficult. However, depredation became negligible after the protection net had been introduced.

(ii) A similar modification to the longline had been introduced to the Chilean longline fishery along the southern South American coast (WG-FSA-07/14) (Figure 7) with great success. The Chilean longline fishery was able to reduce estimated depredation by killer whales and sperm whales by two-fold.

(iii) A similar exclusion device to reduce depredation was introduced in the Uruguayan longline fishery from 40° to 50°S (WG-FSA-07/23, Figure 4). The exclusion device reduced depredation from 71% of the sets to 27%. When using exclusion devices, catch rates increased from 15.53 to 23.03 kg hour^{-1}. In addition to cetaceans, depredation occurred also by sleeper sharks (*Somniosus* spp.) which usually become hooked and die. Depredation by sleeper sharks has also been mentioned elsewhere. However, quantitative information on the importance of depredation by sleeper sharks and to what extent sleeper sharks might be affected by longline activities is lacking.

(iv) Trials using cone nets in longlining have also been conducted by the UK at South Georgia in 2006 (WG-FSA-07/31 and scientific observer report from the *Jacqueline*). Initial results were promising, and the UK intends to proceed with further, more extensive trials in the 2007/08 season.

(v) An 'Orca Acoustic Sphere Device' suspended from the side of the vessel has been reported by the UK observer as being used on the Spanish *Viking Bay* to deter killer whales, but it had only been successful on the first day. From the second day onwards, no obvious effects of the deterrent could be detected and killer whales were observed as close to the vessel as in cases when no deterrent devices had been used. Pingers attached at intervals along the longline had no effect on depredation (scientific observer report from the *Viking Bay*).

10.6 The Working Group endorsed the attempts to reduce depredation by cetaceans in longline fisheries. In addition, the Working Group recommended adding a column to the C2 form to indicate if and when exclusion devices have been used on board longliners. However, the Working Group also noted that CPUE may be affected by such mitigation measures. Experimental work to compare effects of mitigation on data critical for assessments should be conducted.

10.7 The new exclusion devices may affect skates negatively. Skates caught on hooks protected by the new exclusion devices could be compressed over the considerable time of the hauling process. This may impair their chances to survive the hauling process substantially. The Working Group recommended that further research is needed to explore any negative effects of the new devices on the survival rate of skates.

Review of the CCAMLR *Scientific Observers Manual*

10.8 WG-FSA-07/54 summarised the suggestions made by WG-EMM to address the requests made by the Scientific Committee in relation to the *Scientific Observers Manual* for the krill fishery. Three main issues of high priority had been identified by the Scientific Committee:

(i) understand the differences in selectivity between the various krill fishing gear configurations;

(ii) determine the level of by-catch of fish larvae in the krill fishery;

(iii) determine the level of warp strikes by seabirds and incidental mortality of seals.

10.9 The Working Group endorsed considerations on the fish larvae by-catch protocol and the sample storage and post-cruise analysis issues as set out in WG-FSA-07/54. The Working Group reiterated previous requests to assess the impact the krill fishery might have on recruitment of Antarctic fish and to what extent the krill fishery may add to 'natural' mortality of Antarctic fish at an early stage. These assessments require close collaboration between WG-FSA and WG-EMM.

10.10 A number of studies from the early 1980s to the mid-1990s underpinned previous notions that the by-catch of larval, post-larval and juvenile fish has the potential to impact on the recruitment of species such as *C. gunnari* and other species (Iwami et al., 1996; Nevinsky and Shust, 1996). Since then, very few studies have been undertaken to further elucidate the impact a krill fishery might have on recruitment in Antarctic fish stocks. This problem was accentuated when the technology of continuous pumping of krill was introduced in 2003/04 (SC-CAMLR-XXIII, paragraphs 4.2, 4.3, 4.11 and 4.16) with more vessels recently using this new technology. The Working Group recommended that additional research be initiated to better estimate the impact the krill fishery might have on larval, post-larval and juvenile fish of a larger number of species. The Working Group welcomed activities by Japan, Russia and the UK to produce identification keys to fish taken in the krill fishery. It recommended that these activities be combined and that one concise key be produced in the near future. In order to speed up the compilation of such a key, the Working Group recommended that, as a first step, the Russian key to early life stages of Antarctic fish, which was published by VNIRO with graphs provided by Yefremenko in 1986 and contains ≈16 pages in A5 format, be translated by the Secretariat as soon as possible. As soon as the translation is available, scientists from Japan, Russia and the UK and any other interested nations should come together to produce a concise key to the identification of Antarctic larval, post-larval and juvenile fish (Annex 4, paragraph 4.37).

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

11.1 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.

11.2 Information collected by scientific observers was summarised in WG-FSA-07/6 Rev. 1, 07/7 Rev. 1, 07/8 Rev. 1 and 07/9.

11.3 The following cruises were conducted during the 2006/07 season:

(i) Longline: Forty cruises with scientific observers (international and national) on board all vessels. Ten cruises were undertaken in Subarea 48.3 by 10 vessels, one cruise was undertaken in Subarea 48.4, three cruises were undertaken by three vessels in Subarea 48.6, six cruises were undertaken by six vessels in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, two cruises were conducted by one vessel in Division 58.5.2, three cruises were conducted by two vessels in Subareas 58.6 and 58.7 and 15 cruises were undertaken in Subareas 88.1 and 88.2 by 15 vessels.

(ii) Trawl – finfish: Six vessels conducted nine trawl cruises targeting finfish. All trawlers fishing for finfish carried scientific observers. In total, three national and five internationally designated scientific observers participated in these operations.

(iii) Trawl – krill: Six scientific observation programs were conducted by five internationally designated scientific observers on board krill vessels operating in the Convention Area. As observer coverage is not mandatory, and because of the limited amount of fine-scale data available for the krill fishery for 2007 to date, it is not possible to estimate the proportion of effort that was observed.

(iv) One pot cruise targeting *D. eleginoides* was conducted during the 2006/07 season. This cruise was undertaken in Subarea 48.3 by the Uruguayan vessel *Punta Ballena* with an international scientific observer on board.

11.4 The ability of WG-FSA to supply the best scientific advice to the Scientific Committee is dependant on the CCAMLR Scheme of International Scientific Observation.

11.5 In 2006, the Working Group considered that the Scheme of International Scientific Observation could be used to help determine levels of reporting and detection of tag–recapture events on board fishing vessels. It recommended that work be carried out by Members in the intersessional period to determine whether methods could be developed in which the scheme could be used for this purpose.

11.6 The Working Group suggested changes to the logbook to facilitate the recording of losses to catches, such as by depredation, in fisheries in the CAMLR Convention Area. These changes bring the observer logbook in line with the vessel reporting format (C2 form) (see paragraph 6.17).

11.7 Although observer information from commercial vessels is a key input to the work and advice provided by two groups (WG-FSA and ad hoc WG-IMAF), several papers (WG-FSA-07/25, 07/27, 07/36, 07/37 07/39, 07/40, 07/41, 07/44 and 07/54) prepared for this session of WG-FSA identified uncertainties in key data used for assessments of target species and of by-catch species. These problems are of sufficient seriousness that deficiencies in the data available has impacted on the work of WG-FSA, and on the recommendation that WG-FSA can make to the Scientific Committee and the Secretariat, e.g. the assessment of *Dissostichus* spp. in Subarea 88.1.

11.8 Conflicting demands on the observers' time and conflicting priorities also seem to result in variation in the quality and quantity of other data and on activities required to verify catch records or biological parameters used in assessments.

11.9 There are also current and ongoing issues with the recording of by-catch and new developments in the krill fishery.

11.10 Considering the above and the discussions by the Scientific Committee last year (SC-CAMLR-XXV, paragraphs 2.9 to 2.21), the Working Group agreed that an appropriate option would be to form an ad hoc technical subgroup to consider the observer issues.

Advice to the Scientific Committee

11.11 An ad hoc technical group that reports to the Scientific Committee should be constituted to discuss issues in relation to the Scheme of International Scientific Observation identified as impacting on the work of the Scientific Committee, as well as other technical issues related to at-sea implementation of management measures in the Convention Area:

(i) The ad hoc technical group should comprise experienced observers, regional observer coordinators, representatives of fishers and operators, science representatives and the Secretariat, as well as any other expertise identified as necessary.

(ii) The following issues should be specifically addressed:

(a) ensuring an equivalent level of training and accreditation for observers across the Convention Area, considering the results provided in SC-CAMLR-XXVI/BG/9 Rev. 1, which indicated that levels of training across all Member States is variable;

(b) the context of the specific data types collected, and their use in developing management advice. This would further enable observers to focus on collecting important data, rather than data which is redundant, or would be better collected through remote sensing if required, e.g. estimates of sea-surface temperature or sea state;

(c) design of a sampling and data collection protocol for recording by-catch of benthic invertebrate fauna to enable the identification and description of vulnerable marine ecosystems (VMEs) (paragraphs 6.31 to 6.33 and Agenda Item 14.1);

(d) time management and prioritisation of observer tasks, considering that any increase in workload for observers is likely to cause issues for the quality of data able to be collected by observers, as well as the range of target species, gear types and stage of development of fisheries and research priorities within the Convention Area;

(e) additional tasks that will be required by the proposed Year of the Skate and the impact that these additional tasks will have on the workload of observers and on the quality of other required tasks (paragraphs 6.34 to 6.39);

(f) consideration of technological improvements in data capture and management systems, and the potential for increased use of hardware and software to improve the quality and quantity of data collected by observers. This could include semi-automated methods of observing fisheries operations, measuring catch and by-catch and wildlife interactions using cameras and portable computers;

(g) exchange of expertise and experience between technical coordinators and experienced observers on methods of recruiting, training and managing observers, and systems of acquisition, quality assurance, securing and delivering observer data to the Secretariat;

(h) review the *Scientific Observers Manual* and the electronic logbooks to incorporate outcomes from the meeting;

(i) any other technical issues related to at-sea implementation of management measures in the Convention Area.

(iii) The Working Group proposed that the ad hoc technical group develop a matrix as an aid to prioritise the tasks undertaken by scientific observers. A skeleton design is presented in Table 21. The columns of the matrix are:

(a) User Group: The groups within CCAMLR that use the data fields. The suggested user groups are WG-FSA, ad hoc WG-IMAF, SCIC and SC-CAMLR;

(b) Data Type: A broad category for the type of data considered in a group of table rows;

(c) Description: A sub-category of the data type and/or a detailed description of the specific data considered in a particular row of the matrix;

(d) Use: How the particular data will be utilised by that particular user group. Note that if a particular specific data type is utilised differently by two or more user groups it may appear multiple times in the matrix, e.g. in the example matrix (Table 21). Vessel sightings data are utilised differently by WG-FSA and by SCIC;

(e) Optimal Collection: How, from a statistical and/or scientific view-point the data should be collected in an ideal scenario. This could include the frequency of sampling, whether the samples should be collected using a random or stratified sampling procedure, the ideal sample size etc.;

(f) Practical limitations: Practical considerations with respect to sample collection, i.e. what aspects of the Optimal Collection above will be attainable under practical conditions and taking cognisance of the other tasks that the observer must undertake, e.g. although the ideal may be to collect a specific type of data from every set, it may only be possible to sample every second set.

(iv) The Scientific Committee should advise on a suitable time and place for the ad hoc technical group to meet, bearing in mind that many of the scientists that are involved in WG-FSA and in ad hoc WG-IMAF would also be likely to be relevant to this technical group.

11.12 Advice to the Scientific Committee regarding the Scheme of International Scientific Observation may also be found in paragraphs 3.53 to 3.55 (tagging) and 6.49 to 6.51 (by-catch).

FUTURE ASSESSMENTS

12.1 The Working Group identified the following work needed for future assessments, noting that the first four items have the highest priority in the coming year:

(i) Undertake methodological work to design research programs for exploratory fisheries (paragraph 5.28), including consideration of:

(a) optimal designs for:

- estimating CPUE of an area for use in developing advice on catch limits for an area (paragraph 5.17);
- tagging rates and catches needed for estimating suitably precise recapture rates in exploratory fisheries (paragraph 5.18);

(b) approaches to identify precautionary catch limits when assessments are not possible, noting differences between areas yet to be fished compared to areas where stock depletion is known to have occurred.

(ii) Undertake evaluations of assessment methods and management strategies for assessed fisheries, including, as a priority, evaluations of management strategies for *C. gunnari* (paragraph 4.10).

(iii) Development of methods for estimating abundance and productivity of key by-catch species, notably rajids and macrourids.

(iv) Developing approaches to minimise the effects of changing gears or implementing by-catch mitigation measures in toothfish fisheries on assessments of CPUE and stock status, including the potential confounding of mitigation measures and whether or not depredation is occurring.

(v) Development of pro formas for presentation of:

   (a) preliminary assessments, including diagnostics, sensitivity test etc. (WG-SAM) (paragraph 4.43);

   (b) stock assessments in fishery reports (WG-SAM).

(vi) Evaluation of approaches to considering recruitment in assessments of yield, including:

   (a) alternative models of recruitment in assessments of stock status, such as stock–recruitment relationships and modelling recruitment variability with or without such relationship;

   (b) methods to estimate parameters;

   (c) how recruitment is represented in projections used to estimate yield.

(vii) Advance toothfish assessments by considering:

   (a) methods to estimate and include the length-specific trends seen in tag growth-shock and mortality (Appendix J, paragraph 43);

   (b) the estimation of growth parameters within the assessment model for *D. eleginoides* in Subarea 48.3 (Appendix J, paragraph 43);

   (c) approaches to trends seen in tag–recapture fits in the assessment of *D. eleginoides* in Subarea 48.3 (Appendix J, paragraph 43);

   (d) development of methods for estimating natural mortality;

   (e) examination of data weighting methods used in current integrated assessments.

(viii) Consider issues in the application of TSVPA to toothfish assessments (paragraph 4.27).

(ix) Consideration of the optimal survey design and stratification of icefish surveys in Subarea 48.3 and the effects of different stratification schemes on the assessments (Annex O, paragraph 18).

(x) Review a proposed modelling approach of impacts of fisheries mortalities on petrel populations.

(xi) Develop approaches in support of assessments of VMEs and the scale of disturbance by fishing gears (paragraph 14.40).

Subarea 48.3 – *D. eleginoides*

12.2 With regard to future developmental work for the stock assessment model used for this stock, the Working Group noted that the new model presented in WG-FSA-07/29 was a marked improvement on the updated model used this year for stock assessment purposes. The main features of work suggested for the development of this new model were:

- investigation of the best way to both estimate and include the length-specific trends seen in tag growth-shock and mortality;
- suitable values of future recruitment variability to be used when calculating the yields via projections, given that this model now estimates year-class strength;
- the correct way to estimate the growth parameters within the assessment model, and the potential implications of fixing the t_0 parameter as was done in the paper;
- further investigate the mechanism(s) driving the apparent trends seen in the tag–recapture fits;
- the inclusion of sexual dimorphism within the model.

Division 58.5.2 – *D. eleginoides*

12.3 The Working Group noted the successful progress in developing an integrated assessment of *D. eleginoides* in CASAL. It agreed that further work could be undertaken to refine this assessment, including examining:

(i) whether the model could be developed as a two-sex model;

(ii) whether improvement in the model structure can be made to allow the inclusion of tagging data in the assessment;

(iii) construction of age–length keys, if possible, as an alternative method for estimating densities of cohorts given the lack of defined modes in the length-density data;

(iv) optimal sampling schemes for establishing age–length keys.

Subareas 58.6, 58.7, South African EEZ – *D. eleginoides*

12.4 The Working Group encouraged South Africa to consider:

(i) requesting that rather than making assumptions about cetacean depredations, scientific observers on board its vessels should report on the extent of cetacean activity and to collect data on toothfish remains on longline hooks evidencing cetacean predation;

(ii) in the absence of research surveys, to consider a 'commercial survey' conducted as a component of commercial operations whereby certain locations are fished in a systematic manner each year to provide an index that is comparable over time.

Subarea 88.1 – *D. mawsoni*

12.5 The Working Group recommended that, in order to distinguish between different methods for providing advice on harvest strategies, the robustness of different assessment methods for achieving the objectives of the Commission be evaluated using simulation evaluation methods.

12.6 The Working Group also recommended that alternative assessment methods be reviewed for application to the Ross Sea assessment, including the CASAL integrated assessment method (WG-FSA-07/37) and the TSVPA method (WG-SAM-07/9).

Subarea 48.3 – *C. gunnari*

12.7 The Working Group identified a number of future research requirements for the intersessional period:

(i) the acoustic protocol for assessing *C. gunnari* in Subarea 48.3, including:

(a) discrimination of *C. gunnari* from other acoustic scatterers
(b) further improvements in TS estimates for *C. gunnari*
(c) age-specific patterns in daily vertical distribution of *C. gunnari*
(d) combination of trawl and acoustic indices for stock assessment;

(ii) consideration of optimal survey design and stratification, particularly the survey coverage of the southern shelf, and the effects of different stratification schemes on the assessments;

(iii) development of an icefish population model.

Division 58.5.2 – *C. gunnari*

12.8 The Working Group agreed that further work on developing a management procedure for *C. gunnari* is a high priority (SC-CAMLR-XX, Annex 5, Appendix D). It also recommended that biological parameters and cohort progression be reviewed based on survey and catch data.

Frequency of future assessments

12.9 The Working Group reviewed the advice of WG-SAM with respect to multi-year assessments. In particular, it noted discussions set out in Annex 7, paragraphs 6.11 to 6.18. The Working Group agreed that movement toward conducting assessments at multi-year intervals represents a trade-off between the risk of gross errors in an assessment, and the considerable time saved in the meeting of WG-FSA, enabling faster progress with other topics of high priority, as well as continued evaluation and refinement of existing approaches.

12.10 The Working Group noted WG-SAM's conclusion that the risk of an over-catch of two- and three-times the estimated yields for one and two years in a row to South Georgia and Ross Sea toothfish stocks was very small. The Working Group further noted WG-SAM's contention that where a toothfish stock is at or above target levels, and where assessments have been stable, then assessments of toothfish could be performed on a biennial cycle without incurring significant additional risk.

12.11 Based on this advice, the Working Group supported moving toward biennial assessment cycles for *Dissostichus* spp. It was noted that WG-FSA already conducts biennial assessments for the *C. gunnari* fisheries in Subarea 48.3 and Division 58.5.2 and, although there are considerable differences between assessment approaches for these two species groups, there is precedent in CCAMLR for managing fisheries using multi-year catch limits. It was agreed that it would be premature at this time to consider triennial assessment cycles for *Dissostichus* spp.

12.12 The Working Group agreed that WG-FSA would retain the option to undertake an assessment in any given year if, for example, any of the following factors were to occur during the intersessional period:

(i) new or refined methods of assessment become available and recommended by WG-SAM for use in the assessment;

(ii) parameters used in the assessment are revised significantly; or

(iii) a large IUU catch (unless this was anticipated in the assessment).

The need to undertake an annual assessment should be decided for each fishery.

12.13 The Working Group acknowledged that data such as catch, CPUE, and tag–recapture will be updated on an annual basis. While contribution of the information may influence advice on precautionary yield in an annual assessment, the evaluation of risk by WG-SAM indicated that forgoing this information for one year would likely have a small influence on the stability of the stock, given the 35-year projection period used in the decision rules. The

Working Group agreed that there would need to be further work to evaluate and determine the robustness of other indicators, such as sudden changes in CPUE or tag–recapture rates, before they could be added to the list in paragraph 12.12 to trigger assessment updates.

Management advice

12.14 The Working Group noted that assessments of long-term precautionary yield for *Dissostichus* spp. in the Ross Sea and Subarea 48.3 and Division 58.5.2 had been moderately stable in the last few years, and stocks were at or above target levels. The Working Group requested information from the Scientific Committee on the procedural steps to enable multi-year assessments.

FUTURE WORK

Intersessional work

13.1 Future work identified by the Working Group is summarised in Table 22 and Annex 6, Table 21 (ad hoc WG-IMAF), together with the persons or subgroups identified to take the work forward and references to sections of this report where the tasks are described. The Working Group noted that these summaries list the tasks identified at the meeting or associated with established meeting procedures, and do not include ongoing tasks undertaken by the Secretariat, such as data processing and validation, publications and routine preparations for meetings.

13.2 The Working Group reviewed its activities in 2006/07. WG-SAM had produced valuable work and information that had contributed to the assessments and review of information available to WG-FSA. The Working Group thanked Drs Jones and Constable for co-convening WG-SAM and providing significant guidance to the development of assessment models. The Working Group also thanked its subgroups and the Secretariat for their contributions to its work.

13.3 WG-FSA encouraged the subgroups to continue their work in the forthcoming intersessional period, focusing, where possible, on a small number of key issues identified at the meeting and summarised in Table 22. In addition, the subgroups provide a conduit for information on a wide range of related research. The Working Group reminded participants that membership to the subgroups was open to all.

13.4 The Working Group agreed to the following intersessional work plan for the subgroups (coordinators are listed in brackets):

- Subgroup on By-catch (Drs M. Collins and R. Mitchell (UK)) will review and further develop the assessment of the status of by-catch species and groups, estimation of by-catch levels and rates, assessment of risk and mitigation measures.

- Year-of-the-Skate Coordination Group (Drs Welsford, Hanchet and Mitchell and the Secretariat) to plan and develop the requirements for the Year of the Skate in 2008/09.

- Subgroup on Tagging (Mr Dunn, Dr Welsford and the Secretariat) will review and further develop the tagging programs and the treatment of tagging data, the structure of the tagging database and the tagging protocol, the characterisation of tagging programs in the Convention Area, including skates and rays and tagging in EEZs, and the Secretariat-based coordination of tagging efforts in exploratory fisheries.

- Subgroup on the Observer Program (Drs Leslie and Welsford and the Secretariat) will review and further develop the observer protocols, the *Scientific Observers Manual* and priorities for scientific observers in various fisheries.

- Subgroup on Biology and Ecology (Drs K.-H. Kock (Germany) and Welsford) will review the literature, identify gaps in knowledge and update and coordinate the development of species profiles.

- CON (Dr M. Belchier (UK)) will review and further develop ageing techniques and age estimation, the development of the CCAMLR ageing database, and advise on the distribution of *D. eleginoides* and *D. mawsoni* in the fisheries in Subarea 58.4 using otolith morphology.

- Subgroup on Ecosystem Interactions (Dr Kock) will review the literature and facilitate interactions with WG-EMM and SG-ASAM.

- Subgroup on IUU Fishing (Dr Agnew and the Secretariat) will review and further develop approaches for improved estimation of IUU fishing and total removals, and develop the time series of catches estimated from IUU fishing.

13.5 Each subgroup was requested to develop a work plan for the intersessional period, in consultation with the appropriate colleagues, members of WG-SAM and WG-EMM where appropriate, the Convener of WG-FSA and the Chair of the Scientific Committee.

13.6 In addition, the Working Group assigned other tasks to the Secretariat and/or Members.

13.7 The responsibilities for coordinating the intersessional activities of ad hoc WG-IMAF are set out in Annex 6, Table 21.

Meeting of WG-SAM

13.8 During the course of its meeting, the Working Group identified a number of matters which were referred to WG-SAM (paragraphs 12.1 to 12.7).

Meeting of an ad hoc technical group

13.9 The Working Group identified the need for an ad hoc technical group to discuss and develop matters related to the Scheme of International Scientific Observation and fishery-based data collections (paragraph 11.11). The Working Group envisaged that such a technical group would report to the Scientific Committee and address issues of importance to WG-FSA, ad hoc WG-IMAF and WG-EMM. Advice was sought from the Scientific Committee on establishing an ad hoc technical group and arrangements for a meeting.

Meeting of SG-ASAM

13.10 The Working Group noted that the next meeting of SG-ASAM was scheduled for 2009 (Annex 8, paragraph 84).

Fishery Reports

13.11 The Working Group requested that the Secretariat continue updating the Fishery Reports and include a section on the development of catch limits in each fishery.

OTHER BUSINESS

Bottom fishing in CCAMLR high-seas areas

14.1 The Working Group noted that the Scientific Committee has been tasked to review the criteria for determining what constitutes significant harm to benthos and benthic communities (Conservation Measure 22-05; CCAMLR-XXV, paragraphs 11.25 to 11.37). It also noted that, in 2006, the United Nations General Assembly (UNGA) agreed the Sustainable Fisheries Resolution (61/105), which calls upon States and RFMOs or other arrangements to take immediate action to ensure fish stocks are managed sustainably and to protect VMEs, including seamounts, hydrothermal vents and cold-water corals, from destructive fishing practices. More specifically, UNGA Resolution 61/105 calls upon States and RFMOs and other arrangements to regulate and manage all bottom fisheries in high-seas areas so as to prevent significant adverse impacts on VMEs by no later than 31 December 2008 (UNGA Resolution 61/105, OP80 – OP91).

14.2 In order to facilitate the work of the Scientific Committee and to assist the Commission in meeting the timetable in the UN resolution, the Working Group discussed processes that could be used to help specify operational requirements of fishers and the research and data collection requirements necessary to meet these obligations. It noted that many existing processes and procedures have been established in CCAMLR that enable these requirements to be met. This discussion provides advice on how these issues might be considered and developed by the Scientific Committee and Commission.

14.3 SC-CAMLR-XXVI/10 discusses how these tasks need consideration of the relationship between bottom fisheries, benthic habitats and related ecosystems and how they also require consideration of the steps needed to ensure that destructive fishing practices are eliminated. The paper provides definitions for 'destructive fishing practices', 'vulnerable marine ecosystems' and 'significant harm' as per Conservation Measure 22-05, noting that the term 'significant adverse impacts' as described in UNGA Resolution 61/105 is equated with the term ‘significant harm’. It elaborates important concepts that underpin these definitions, including consideration of the scales of effects and the resistance and resilience of species. It then proposes a process for addressing these issues, including:

(i) methods for immediately evaluating interactions between bottom fisheries and marine habitats;

(ii) consideration of processes for managing bottom fisheries and whether they will eliminate destructive fishing practices.

14.4 The Working Group thanked Drs Constable and R. Holt (USA) for providing this paper to the Scientific Committee to help progress consideration of this issue. It noted that the principles elaborated in this paper would be considered further by the Scientific Committee but agreed that:

(i) a **destructive fishing practice**[3] is one that has the potential to result in:

(a) prejudicing of the conservation status of one or more species; and/or
(b) significant loss of habitat; and/or
(c) significant disruption of ecosystem processes;

(ii) the concept of **vulnerability** of an ecosystem to fishing needs to accommodate consideration of:

(a) the direct interactions of the gear with the organisms (through death, injury or displacement) and how that might impact on population and ecosystem processes of those organisms, along with

(b) the spatial extent of the impacts (immediate as well as cumulative over many deployments of the gear) on both the organisms affected and the processes to which those organisms contribute (considered relative to the spatial extent of the organisms and their ecological processes), as well as

(c) the length of time those direct impacts may cause the system to deviate from where it would have been in the absence of fishing, particularly if fishing were to cease;

(iii) **significant harm** would arise if the structure and function of the ecosystem are altered outside the natural variation (spatial and temporal) expected in an ecosystem in the absence of fishing and/or the time to recover is inconsistent with natural rates of recovery, where:

(a) natural variability is reflected in the spatial mosaic of patches and the temporal dynamics of organisms within and between patches, which could be represented as probabilities of finding the different states in space and time;

[3] Here, ‘fishing practice’ is considered as a combination of the fishing method, including mitigation devices, combined with the spatial, temporal and operational limits on the use of the method.

(b) significant harm would therefore be changes in the occurrence (and types) of patches in the spatial mosaic of assemblages and/or changes in the different states of non-target species over time, such as variability and magnitude of abundance.

14.5 The Working Group noted that some assemblages are easily classified as vulnerable when they are characterised by slow-growing, habitat-forming, sessile species that, once dislodged by fishing gear, cannot recover except by settlement and growth of new larvae from distant areas. Bottom fishing in these areas may cause new patches to arise that are much larger than the natural patches formed by natural disturbances. Repeated fishing could cause an accumulation of disturbed patches at a rate much faster than the natural frequency of patch formation. In considering the implementation of the 2006 UNGA Resolution 61/105, the avoidance of significant interaction with these types of assemblages will be an important first step in eliminating destructive bottom fishing practices, although other types of assemblages may be important to consider under the circumstances described above. Some of these assemblages have been identified in the UNGA Resolution 61/105, including cold-water coral communities (also known as deep-water or deep-sea corals), sponge communities and other communities associated with seamounts, hydrothermal vent communities and methane cold-seep communities.

14.6 The Working Group noted that these requirements are encapsulated in the objectives of CCAMLR. Article II.3(b) requires the maintenance of the ecological relationships and the restoration of depleted populations. It also noted that concepts of resistance, resilience and recovery are identified in Article II.3(c) where CCAMLR must prevent changes or minimise the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades. Importantly, the Working Group agreed that there was sufficient evidence globally that benthic habitats comprising slow-growing, habitat-forming, sessile species could take much longer than three decades to recover from significant fisheries disturbances.

14.7 The Working Group also noted that past practice of CCAMLR indicates a variety of mechanisms and policies that could be used to substantially help ensure bottom fisheries do not cause significant adverse impacts on VMEs. These are included in:

(i) Article IX;

(ii) the exploratory fisheries conservation measure (Conservation Measure 21-02);

(iii) past new and exploratory fisheries measures that have been used to avoid benthic impacts (Conservation Measures 41-05, 41-11) and undertake experimental work to investigate whether impacts might arise if fishing were to proceed (Conservation Measures 43-04 [186/XVIII], 212/XIX);

(iv) existing approaches to avoid and mitigate by-catch of finfish, birds and marine mammals, including approaches to acquiring information through research or fishery data collection activities and for using that information to advise on appropriate conservation measures;

(v) the regulatory framework considered by the Scientific Committee (SC-CAMLR-XVIII, paragraphs 7.11 to 7.23; SC-CAMLR-XIX, paragraphs 7.2 to 7.20) and Commission (CCAMLR-XIX, paragraphs 10.2 to 10.8).

14.8 The Working Group agreed that important questions to be addressed in an evaluation of potential adverse impacts are:

(i) What are the likely effects of fishing on species and assemblages in the areas being fished, including consideration of their resistance and resilience, and what are the likely rates of recovery of species and the spatial mosaic in the fished areas if fishing were to cease?

(ii) What are the size and ecosystem attributes, including species, of the fished area to date, paying attention to the potential effects on the natural spatial mosaic?

(iii) How much of the ecosystem attributes could have been affected by fishing overall, including areas outside the fished areas, and will the rate of recovery deviate from natural rates of recovery as a consequence?

14.9 The Working Group also agreed that the following tasks would contribute to this evaluation:

(i) mapping of geomorphic features (e.g. SC-CAMLR-XVI/BG/27), which can be used to document the broad physical habitats in the benthic environment;

(ii) identification of the types of organisms, including habitat-forming species, and ecosystem processes likely to be present in the physical habitats, which can be documented from available biological and ecological knowledge, as well as consider their resistance and resilience to the bottom fishing method being used in the area;

(iii) quantification of the footprint of bottom fishing in each of the geomorphic features from the location of shots combined with the effort associated with each shot (e.g. swept area or length of line);

(iv) generation of summary statistics on the potential area and ecosystem attributes affected by bottom fishing activities.

14.10 In considering these tasks, the Working Group noted that the work undertaken at the Workshop on Bioregionalisation of the Southern Ocean (Annex 9) could assist in this process, including papers submitted to the Scientific Committee on the benthic regionalisation (SC-CAMLR-XXVI/BG/28) and the mapping of geomorphic features in the Southern Ocean (SC-CAMLR-XXVI/BG/27).

14.11 The Working Group also agreed that there will need to be specific requirements of fisheries to provide data to assist in identifying vulnerable marine ecosystems in need of protection. It noted that studies such as the research program by Australia to develop camera gear for deployment by observers on fishing gears (longlines, trawls and pots) to investigate potential interactions of bottom fishing gears with benthic habitats (SC-CAMLR-XXVI/BG/30) could provide an approach for assisting this work. A general process for assisting the Commission in this task is considered further below.

History of bottom fishing in the CCAMLR high-seas areas

14.12 Large catches of demersal finfish species were taken from throughout the Southern Ocean in the 1970s and 1980s. The records of these catches do not contain detailed information of catch rates or location and are difficult to use in understanding the footprint of this historical fishing.

14.13 Since then bottom fishing in high-seas areas of CCAMLR can be categorised as follows:

(i) finfish fisheries, which primarily used bottom trawls, in Subareas 48.1 and 48.2 were closed in 1990;

(ii) since the late 1990s, bottom fishing activities have been primarily using longlines in Subareas 48.6, 88.1, 88.2 and 88.3 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b;

(iii) benthic habitats in high-seas areas specifically protected from bottom fishing include the continental shelf in Divisions 58.4.1 and 58.4.2;

(iv) high-seas areas closed to bottom fishing include long-term closures in Subareas 48.1 and 48.2 and annual closures in the exploratory toothfish fisheries in SSRUs in Subareas 88.1 and 88.2 and Divisions 58.4.1 and 58.4.2;

(v) IUU fishing in the Convention Area is undertaken using bottom longlines and gillnets.

Effective fishing footprint

14.14 On behalf of the Working Group, Dr Constable undertook an analysis of the footprint of bottom fishing to illustrate the manner in which such analyses might be undertaken in this process. Data processing code was developed in R (R Development Team, 2007) and archived with the Secretariat. In this analysis, data held in the CCAMLR database were separated into 'longline', 'trawl' and 'pot' gears. Data were pooled across all target species that could be taken by deploying the fishing gear on the bottom. Over a specified time interval, all catch and effort is summed in grid cells (as an example, 0.25° latitude x 0.5° longitude was used, intending to approximate 15 x 15 n miles for most of the Convention Area). For most high-seas areas, the time series of catches is relatively small. Thus, data were pooled across years as well.

14.15 The 'effective fishing footprint' was identified by the Working Group to comprise areas of greatest interest to fisheries production (catch) in the region of interest (statistical area) for the time period of interest (in this case, all years). Areas of investigative or scientific research activities, as well as pilot fishing, were considered to be less important in defining a fishing footprint even though these shots are archived in the CCAMLR database. In this respect, the Working Group defined the effective fishing footprint as comprising those grid cells that contribute to a fixed proportion, say 90%, of the total catch of target species from a management unit – the main catch – and those cells that are outliers – the remainder of the catch. For all cells with effort, including cells with zero CPUE, the cells are ranked from the greatest catch to the least and the cumulative proportional contribution to the total catch of each successive cell is determined. The cells are then separated into those cells contributing to the main catch and those contributing to the remainder. The cumulative proportions of each cell are plotted against the total catch for that cell along with additional plots showing the total effort in the respective cells. The effort in each cell of the two groups of cells can be plotted on the maps for scrutiny by the Scientific Committee and its working groups in order to:

(i) understand which areas are of greatest interest to the fishery, as well as
(ii) provide an indication of the potential levels of interaction between the specified fishing gear and benthic habitats in those areas.

14.16 The total effort deployed in each cell has been plotted for consideration by the Working Group and are available from the Secretariat if needed for further consideration by the Scientific Committee or Commission. However, in this report, presentations of the effective footprint simply divide the cells into the main catch and the remainder of the catch, leaving out the scaling of effort in each cell. This is to take account of the data confidentiality provisions in public presentation of CCAMLR catch and effort data.

14.17 The Working Group agreed that this method of plotting the data displayed all the information necessary for the Scientific Committee and the Commission to consider the characteristics of the fishing footprint and, in particular, the effective fishing footprint. It noted that these plots can also show the potential interactions of bottom fishing with benthic habitats by comparing the results with the topographic features shown by the bathymetry contours.

14.18 The Working Group also noted that it may be of interest to characterise the footprint as the cells contributing to say, 90%, of the effort in the area.

14.19 In evaluating the potential effects of fishing on VMEs in a given area, the Working Group noted that a method for assessing the amount of seabed directly affected by the gears would be useful. It suggested that information and research materials be collated on:

(i) direct interactions of gears, including the types and spatial extent of disturbance that might arise from different gears and fishing methods;

(ii) how the area directly affected by gears may be determined for each shot of a fishery.

The latter methods could then be used to better evaluate the potential spatial extent of disturbance of VMEs at scales less than the resolution of the cell size used in evaluating the effective fishing footprint.

14.20 Plots for the high-seas statistical divisions and subareas are shown in Figures 8 to 16. Only longlining results are presented because location data for trawling in high-seas areas was patchy. No pots have been reported to have been used in high-seas areas.

Annual process

14.21 The Working Group considered an overall procedure for managing the interactions of bottom fishing with the benthic environment in order to avoid significant adverse impacts on VMEs. It noted that avoiding significant adverse impacts could be achieved using a number of mechanisms, including, *inter alia*, the development of mitigation methods, within-season avoidance (move-on) provisions or the designation of longer-term closed areas.

14.22 This draft procedure identifies critical elements to be developed by the Scientific Committee in helping the Commission implement UNGA Resolution 61/105. In so doing, the draft procedure substantially adopts existing practice in CCAMLR in implementing the precautionary approach to avoiding significant adverse impacts rather than managing the impacts after they have arisen. The Working Group agreed that a procedure of this kind will not have substantial quantities of data from Antarctica and the Southern Ocean to readily classify VMEs and identify areas necessary for their conservation. It was therefore considered important to be able to acquire data through a standard overarching process and, where evidence of VMEs is found, a specific process would be set in train to provide interim protection while sufficient data are collected to enable the Commission to judge whether continued protection of an area is needed or not.

14.23 The proposed procedure is shown in Figure 17.

14.24 The draft process is built on the current process in exploratory fisheries where a notification (proposal for bottom fishing) is considered, a data collection plan (Research and Data Collection Plan – RDCP) developed and the areas open to fishing are the only areas subject to fishing operations in the current season. The data arising from those operations are then used by the Scientific Committee and its working groups to assess and evaluate the proposed fishing operations for the next season. The addition of a Fisheries Operations Plan (FOP) provides clear specification of actions required to help avoid significant adverse impacts during a season. In this case, it is envisaged to be of a similar form to the inclusion of current by-catch move-on provisions in conservation measures and the mitigation measures needed to avoid by-catch of seabirds but with some potential additional actions needed to manage interactions with VMEs.

14.25 The Working Group noted that UNGA Resolution 61/105 envisages a process for identifying VMEs and establishing measures to avoid significant adverse impacts within a season and in the longer term. It recognised that the absence of data will create uncertainty as to whether VMEs could be adversely impacted by bottom fisheries. As a result, the Working Group agreed that there will need to be a progression of classification of areas from open areas to vulnerable areas, the latter of which would have specific requirements on fishing activities. Areas would likely differ in their associated requirements for data collection, mitigation and actions. In the absence of data from a particular location, the evidence required to trigger actions may be much smaller than for areas where data on by-catch and other interactions have been accumulating for some time. Similarly, areas with a greater potential for a type of habitat, assemblage or ecosystem to be significantly adversely affected by a small number of shots of a particular type of gear, may require lower trigger levels for actions than areas where the assemblages are likely to be more robust to those types of gears, e.g. the difference between sponge habitats and muddy habitats.

14.26 In this process, areas are likely to fall into four general categories:

(i) **Open areas (effective fishing footprint)**, which would normally be larger management areas, in which approved commercial fishing activities would occur according to a FOP and an RDCP.

(ii) **Areas outside the effective fishing footprint** would have no commercial fishing operations in the current season but other activities may be permitted to enable the development of appropriate FOPs and RDCPs.

(iii) **Potentially vulnerable areas**, which would be identified on the basis of accumulated evidence, over one or more years, from commercial fishing or research activities, would have only restricted designated activities while it is confirmed whether or not VMEs exist in the area (RDCP) or a strategy (Mitigation Development Strategy – MDS) can be developed to mitigate and/or avoid interactions of the fishery with prospective VMEs predicted from the evidence.

(iv) **Vulnerable areas**, which are envisaged to have been assessed to have VMEs, will be added to a Register of Vulnerable Areas (RVA), a Conservation Management Plan (CMP) developed and specific activities designated, if needed, to assist in the implementation of the CMP and/or the development of mitigation/avoidance strategies for particular gears (MDS).

14.27 The size of areas that might be considered in this classification scheme will vary depending on the size of the potential VME in an area and the scale of fishing operations (in the case of identifying the effective fishing footprint). Some areas may be equivalent in size to a fishing shot while others may be very large areas covering a complex mosaic of benthic habitats. This could potentially lead to a mosaic of vulnerable areas. Each year, consideration would need to be given as to whether a mosaic of smaller vulnerable areas would better be managed in a combined larger area, thereby making such areas easier to administer from the perspective of both the fisheries and the Commission.

14.28 The Working Group noted that there are practical management considerations in the designation of areas bounding VMEs and the effective fishing footprint (see paragraph 14.39(i)).

14.29 The Working Group noted that different gears and operations used by different vessels will differ in the nature and potential for their interactions with benthic environments. The potential of an individual vessel to affect benthic habitats may also vary in space and time. These vessel-specific characteristics of the interactions will require a regular process for assessing and evaluating the potential for areas to be vulnerable to significant adverse impacts by fishing operations.

14.30 An annual or regular cycle is envisaged to consider proposals for bottom fishing in high-seas areas and to consider, using updated information collected from activities in the areas, whether areas should be added to the RVA as either Potentially Vulnerable or as a VME.

14.31 The following documents, which may be vessel, gear and/or area specific, will have the following functions in this process:

(i) **Fisheries Operations Plan (FOP)** will specify the evidence needed to trigger action with respect to VMEs and the types of actions needing to be taken, both of which will be dependent on the gear, the location and the types of habitat (or ecosystems) that may be expected to be encountered in those locations (see below).

(ii) **Research and Data Collection Plan (RDCP)** will specify:

(a) protocols for observers to collect data needed to facilitate an assessment of potential interactions of the gears with habitat (or the ecosystem);

(b) protocols for collecting data that would trigger action;

(c) specific fishery-independent and/or fishery-dependent research that may be needed to resolve issues in this process, particularly for areas that are considered potentially vulnerable, e.g. experimental or comparative work across a range of locations may be needed to establish the nature and extent of VMEs in the area of interest.

(iii) **Mitigation Development Strategy (MDS)** is an option that could be pursued to develop avoidance and/or mitigation strategies for the fishing vessel in order to operate in a 'Potentially Vulnerable' or Vulnerable Area without causing significant adverse impacts.

(iv) **Register of Vulnerable Areas (RVA)** is the record of the location and attributes of VMEs in high-seas areas of CCAMLR, including areas declared as Vulnerable Areas, Potentially Vulnerable Areas and those areas notified during a season as having evidence of a VME, and would be maintained by the CCAMLR Secretariat and used by vessels to identify where different types of fishing operations can and cannot occur during a season.

(v) **Conservation Management Plan (CMP)** specifies requirements, such as avoidance (closure of an area is an option) and/or mitigation strategies for specific gear types, for ensuring the avoidance of significant adverse impacts on VMEs identified to be in an area.

14.32 During the course of fishing operations, it is expected that the catch will be monitored for benthos by-catch and/or other evidence of the presence of VMEs in the fishing location. Specific data collection protocols, e.g. the use of cameras on longlines to determine effects of deployment and retrieval of anchors, may be required. The Working Group agreed that a trigger for action is needed, based on by-catch or other information obtained during fishing operations. In principle, a trigger similar to those used for triggering the move-on rule for finfish by-catch could be used. The trigger will be partly dependent on measures in place to protect VMEs, including the extent of areas already closed to fishing.

14.33 The Working Group discussed the potential nature of a trigger. For example, a trigger could be a quantity of benthos by-catch, say 25 litres of benthos in the case of longlining or 0.5 tonnes for trawls, accumulated over a specified number of shots, say two, within an area of, say, 5 n miles, recognising that the quantity of benthos landed on a vessel is not likely to be great for non-trawl gears and, for trawls as well, is likely to be lost in part or whole during retrieval. Use of camera systems may be required to confirm the nature and extent of VMEs.

14.34 Observers will need to monitor benthos by-catch to assist in the evaluation by the Scientific Committee after each season. Consideration needs to be given as to what data need to be collected to assist with this evaluation.

14.35 The Working Group considered three possible actions that could help fishing operations avoid significant adverse impacts during a season and for facilitating post-season evaluation of VMEs in the area:

(i) move-on to another location and stay away from the area until an evaluation has been undertaken by the Scientific Committee and its working groups. To be successful, consideration will need to be given to methods for:

  (a) identifying the location of the Potentially Vulnerable Area given the fishing method being used, which may include noting, say, the location of the by-catch on a longline[4];

  (b) designating the Potentially Vulnerable Area given the fishing method being used and the uncertainty in locating where the benthos was caught, say specifying a 5 n mile area surrounding a trawl or a similar distance surrounding the location corresponding to where on a longline the benthos may have been caught;

(ii) designated research activities, which might include a fixed number of repeat sampling (fishing or other research shots) and/or the use of cameras to gather data for use by the Scientific Committee in the evaluation of whether VMEs are present in the area;

(iii) temporarily closing the location (as specified according to the move-on provision) to all vessels, which could be facilitated by having the CCAMLR Secretariat listing the area as a temporary closure in the RVA and notifying all vessels.

14.36 The Working Group agreed that each of these actions may require separate triggers and that a within-season closure of a location to all vessels may not be easy to administer.

14.37 The evaluation of potential benthic interactions and classification of areas will use all relevant data submitted to the Scientific Committee and its working groups. It is not expected that the analysis would only be restricted to data arising from the triggering of actions because some data may be accumulated in locations over many shots by many vessels without actions being triggered. Such a scenario is plausible when the benthos may not be easily retained by the gears.

14.38 The data for the evaluation may come from current and historical records of by-catch in fishing operations, and research activities in the Convention Area (e.g. WS-BSO-07/10

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[4] Mr J. Fenaughty (New Zealand) indicated that benthos observed on landing in the Ross Sea was likely to have come from an area up to 2 km from the point where the landing occurred.

Rev. 1), which may include photographic or video materials, research survey data, as well as proximate data (proxies) derived from other studies. For example, geomorphological features can be good proxies for benthic habitats in many areas (e.g. SC-CAMLR-XXVI/BG/27). These would be a useful guide for identifying seamounts that have already been classified as potentially vulnerable in UNGA Resolution 61/105. Other proximate studies may also be used to help identify species, habitats or areas as potentially vulnerable. Strategies could then be developed in an RDCP to be undertaken as designated activities to ascertain whether an area should be placed on the RVA or not, such as requiring the use of camera gear on a number of shots in specified locations.

14.39 The Working Group noted the following:

(i) Measures to manage Vulnerable and Potentially Vulnerable Areas, including the specification of boundaries, will need to account for the degree to which management tools might be effectively used in this task. For example, the boundaries of areas should be easy to interpret by fishing vessels and the degree of compliance able to be monitored effectively. In this case, a small vulnerable area may require a larger boundary than just surrounding the VME in order to be confident that gears will not inadvertently interact with the VME as well as being sufficiently large to be able to effectively identify the location of a vessel relative to the VME (using VMS or other methods).

(ii) The requirements for research and data collection with respect to VMEs is most likely to be greatest in the early stages of a fishery in an area. It is expected that as a fishery progresses, a better understanding and the implementation of measures to avoid significant adverse impacts on VMEs will result in a clearer understanding of the requirements of fishers in eliminating destructive fishing practices. The Working Group noted that the mitigation of seabird by-catch in the Convention Area is a good illustration of this process.

(iii) As attributes of VMEs are likely to exist in areas at the scale of a shot rather than at the scale of management units, then a process needs to accommodate smaller scales of interactions of fisheries not currently considered in management of by-catch.

(iv) The development of camera gear for routine deployment by observers on fishing gears (SC-CAMLR-XXVI/BG/30) means that routine observations of the interactions of gears with benthic habitats during the course of routine fishing operations could be a useful method for routine monitoring of fishing with respect to VMEs.

Future work

14.40 The Working Group recognised that the full development of the process will require further work in both the Scientific Committee and the Commission in the intersessional period to meet the requirements of UNGA Resolution 61/105. It noted that such work could include, *inter alia*:

(i) development of rules and data collection requirements needed to trigger actions for different gears and situations during a season with respect to avoidance of Potentially Vulnerable Areas and the gathering of data to assist in identifying VMEs;

(ii) identifying the method for specifying areas in which evidence of VMEs is detected in order that interim within-season protection could be established either for the vessel concerned or the fishing fleet;

(iii) developing an approach, including data requirements, for annual assessments of benthic interactions of bottom fishing and identification of Vulnerable and Potentially Vulnerable Areas;

(iv) consideration of the requirements for observations and reporting;

(v) consideration of the available management approaches to avoid and mitigate interactions with VMEs;

(vi) further consideration of the relationship between effective fishing footprint and geomorphological features;

(vii) a method for assessing the amount of seabed directly affected by the gears, such as through the use of cameras, where such methods could then be used to better evaluate the potential spatial extent of disturbance of VMEs at scales less than the resolution of the cell size used in evaluating the effective fishing footprint.

14.41 The Working Group drew the attention of the Scientific Committee to existing practices and how these can be advanced to accommodate the requirements of UNGA Resolution 61/105 with respect to avoiding significant adverse impacts on vulnerable marine ecosystems. The process described here is an elaboration of the by-catch procedures already in place and shows the advances in CCAMLR of the ecosystem approach to managing fisheries.

14.42 The Working Group noted that:

(i) having a clear process, such as the one described here, makes it easier to understand what needs to be done and when and how this work contributes to CCAMLR achieving its objectives and complying with UNGA Resolution 61/105. It shows that in the absence of data, precautionary measures will need to be taken to ensure significant adverse impacts do not inadvertently arise while the data are being collected;

(ii) this process will require regular, if not annual, work.

14.43 The Working Group requested the Scientific Committee consider how the annual work that will arise from addressing UNGA Resolution 61/105 can be accommodated in the already large workload of the working groups. It noted that there are insufficient resources at present in the Secretariat and in the Scientific Committee to do the work required to fulfil these obligations.

Bioregionalisation

14.44 The Working Group considered the results of the Workshop on Bioregionalisation of the Southern Ocean (Annex 9), particularly in relation to benthic regionalisation and the distribution of fish and invertebrate fauna. It noted that a number of papers were also made available to WG-FSA to assist with this consideration.

14.45 SC-CAMLR-XXVI/BG/27 shows methods and results for classifying Antarctic sea-floor geomorphology as a guide to benthic bioregionalisation. It is an update of results first developed for the Bioregionalisation Workshop, the method of which was described in WS-BSO-07/8. The method uses publicly available bathymetry and geophysical data to map geomorphic features of the Antarctic continental margin and adjoining ocean basins at scales of 1:1–5 million. The geomorphic features identified and their properties can be related to major habitat characteristics such as sea-floor type (hard versus soft), ice-keel scouring, sediment deposition or erosion and current regimes. Where more detailed data are available, shelf geomorphology provides a guide to the distribution of the shelf benthic communities recognised by a number of authors. For areas off the shelf, the relationships between physical environmental parameters and the benthic biota are more poorly known, however, geomorphic mapping provides insights into major processes that are likely to influence benthic habitats. This study of sea-floor geomorphology from the Antarctic shows that there is enough data available already to produce a meaningful benthic bioregionalisation for an area as poorly known as the Antarctic continental margin and surrounding oceans. Studies of shelf biota that have tried to link the physical environment with benthic communities have found links strong enough to suggest that geomorphology is a useful first-pass tool for mapping the distribution of communities.

14.46 SC-CAMLR-XXVI/BG/28 is an update by the conveners of the Workshop on Bioregionalisation of the Southern Ocean on the benthic bioregionalisation of the Southern Ocean. The update finalised the work that was undertaken at the Workshop. It was agreed at the Workshop that physical variables could be used to produce primary physical regionalisations of the Southern Ocean and that benthic and pelagic zones should be considered separately. The paper provides a description of the process and results of the primary benthic regionalisation completed at the Workshop and subsequent refinements to this regionalisation, including the use of additional data which could not be incorporated at the Workshop. The process and results of evaluating the physical regionalisation with biological data are also described.

14.47 WS-BSO-07/10 Rev. 1 described an analysis of benthic invertebrate megafaunal community patterns of shelf habitats within the Atlantic sector of the Southern Ocean. Trawl catches were collected from four scientific surveys across five CCAMLR subareas of Area 48. The region for which the greatest complexity of data was available, the northern Antarctic Peninsula and the South Shetland Islands, revealed a two-layered pattern based on the standardised total biomass data and the composition of phyla that contributes to that biomass. By referencing physical oceanographic data for the region, a pattern of shelf faunal zonation was described, where the benthic invertebrate communities on the northern shelves of the South Shetland Islands and the northern Antarctic Peninsula were separated into two zoogeographic zones based on the physical properties of the ACC and the Weddell water masses that meet and mix in this region. Super-imposed on this geographic pattern are the apparent effects of disturbance regimes such as iceberg scouring or commercial bottom trawling, which work at smaller spatial scales. The procedure represented a potential methodology that could be used to describe broad patterns of epibenthic invertebrate megafauna.

14.48 The Working Group recalled the book by Dr Shust (1998, 2001) on fish and fish resources of the Antarctic in which he analysed the distributions of Antarctic finfish species and how they relate to the geomorphology and hydrological structure of the Antarctic area. He described eight zones in this work based on a number of indicator species:

I. Circum-Antarctic – Southern Polar Front (SPF), including the SPF itself and the northern periphery of the Antarctic Circumpolar Current (ACC). Indicator species – *Electrona carlsbergi*.

II. South Georgia Shelf, including South Georgia and Shag Rocks shelf waters. Indicator species – *Notothenia rossii, Champsocephalus gunnari, Patagonotothen guntheri* and *Dissostichus eleginoides*.

III. Kerguelen Shelf, including Kerguelen, Heard and McDonald (and close lying banks) Island shelf waters. Indicator species – *N. rossii rossii, C. gunnari, Lepidonotothen squamifrons* and *D. eleginoides*.

IV. Ob and Lena underwater rises. Indicator species – *L. squamifrons*.

V. Transitional–South Antilles, including South Shetland and South Orkney shelf waters. Indicator species – *N. rossii, C. gunnari* and *Gobionotothen gibberifrons*.

VI. West Antarctic Coastal, including shelf waters of the northern Antarctic Peninsula, Joinville and D'Urville Islands. Indicator species – *Chaenodraco wilsoni, Trematomus eulepidotus*, *Pleuragramma antarcticum*, *G. gibberifrons*, *L. larseni* and *L. nudifrons.*

VII. Near-continental Deep-water (300–600 m), including the submerged shelf, island shelves, rises in near-continental seas. Indicator species – *P. antarcticum, Chionodraco myersi, D. mawsoni* and *Trematomus* spp.

VIII. Near-continental Shallow-water (50–300 m), including inner-shelf rises. Indicator species – *C. wilsoni, T. newnesi* and *T. eulepidotus*.

14.49 Dr Shust further elaborated noting that the distribution of these main finfish species show geomorphological features and that oceanography influences the distribution and abundance of dominant finfish species. An important question will be to determine how much exchange there is amongst populations in the different locations.

14.50 The Working Group noted the similar conclusions being drawn from all of this work, and that there are some broad regional characteristics of the Southern Ocean, such as those shown by the finfish regionalisation above. It agreed that geomorphology and oceanography combine to form heterogeneity of habitats at much smaller scales than the statistical areas of CCAMLR, as shown in the studies in SC-CAMLR-XXVI/BG/27 and WS-BSO-07/10 Rev. 1. In the first instance, a characterisation of the geomorphology of the Southern Ocean provides an important foundation for a regionalisation in this region. It agreed that WS-BSO-07/10 Rev. 1 provides a useful method for developing a finer-scale bioregionalisation from that identified by geomorphology.

ADOPTION OF THE REPORT

15.1 The report of the meeting was adopted.

CLOSE OF MEETING

16.1 Dr Hanchet thanked the subgroup coordinators, rapporteurs, other participants and Secretariat staff for their contributions and participation in the meeting, as well as in intersessional activities.

16.2 As this was Dr Hanchet's last year as Convener of WG-FSA, he welcomed the incoming Convener, Dr Jones, to the position.

16.3 Dr Constable, on behalf of the Working Group, thanked Dr Hanchet for providing expert guidance during his four-year term as Convener, which saw the Working Group achieve significant developments, including the introduction of assessments in exploratory fisheries and the consideration of multi-year assessments. Dr Hanchet's leadership had contributed greatly to the work of WG-FSA and the Scientific Committee.

16.4 In closing the meeting, Dr Hanchet, on behalf of the Working Group, acknowledged Dr Sabourenkov's career contribution to the work of the Scientific Committee and its working groups, as well as that of the Commission and SCIC. Dr Sabourenkov will be retiring in early 2008, after serving in the Secretariat for 24 years. The Working Group wished Dr Sabourenkov well in his retirement.

16.5 The meeting was closed.

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Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in the 2006/07 season. **Bold:** fishery closed on advice from the Secretariat. (Source: catch and effort reports submitted by 5 October 2007 unless otherwise indicated.)

Target species	Region	Fishery	Fishing season		Conservation measure	Catch (tonnes) of target species		Reported catch (% limit)
			Start	End		Reported	Limit	
Champsocephalus gunnari	48.3	Trawl	15-Nov-06	14-Nov-07[a]	42-01 (2006)	3 940	4 337	91
	58.5.2	Trawl	01-Dec-06	30-Nov-07	42-02 (2006)	1	42	3
Dissostichus eleginoides	48.3	Longline, pot	01-May-07	**24-Aug-07**	41-02 (2006)	3 535	3 554	99
	48.4	Longline	01-Apr-07	30-Sep-07	41-03 (2006)	54	100	54
	58.5.1 French EEZ[b]	Longline, trawl	ns	ns	ns	3 438	ns	
	58.5.2	Longline, trawl	01-Dec-06	30-Nov-07	41-08 (2006)	1 956	2 427	81
	58.6 French EEZ[b]	Longline	ns	ns	ns	333	ns	
	58 South African EEZ[c]	Longline	ns	ns	ns	126	ns	
Dissostichus spp.	48.6	Exploratory longline	01-Dec-06	30-Nov-07	41-04 (2006)	113	910	12
	58.4.1	Exploratory longline	01-Dec-06	**13-Mar-07**	41-11 (2006)	645	600	108
	58.4.2	Exploratory longline	01-Dec-06	30-Nov-07	41-05 (2006)	124	780	16
	58.4.3a	Exploratory longline	01-May-07	**31-Aug-07**	41-06 (2006)	4	250	2
	58.4.3b	Exploratory longline	01-May-07	30-Jun-07	41-07 (2006)	253	300	84
	88.1	Exploratory longline	01-Dec-06	**02-Feb-07**	41-09 (2006)	3 096	3 072[d]	101
	88.2	Exploratory longline	01-Dec-06	31-Aug-07	41-10 (2006)	347	567[d]	62
Euphausia superba	48	Trawl	01-Dec-06	30-Nov-07	51-01 (2006)	104 364	4 000 000	3
	58.4.1	Trawl	01-Dec-06	30-Nov-07	51-02 (2006)		44 0000	
	58.4.2	Trawl	01-Dec-06	30-Nov-07	51-03 (2006)		450 000	
Lithodidae	48.3	Pot	01-Dec-06	30-Nov-07	52-01 (2006)	1[e]	1 600	0
Martialia hyadesi	48.3	Exploratory jig	01-Dec-06	30-Nov-07	61-01 (2006)		2 500	

[a] Under review
[b] Data reported by France for fishing to August
[c] From Subareas 58.6 and 58.7
[d] Includes research fishing (see measure)
[e] By-catch in fishery for *D. eleginoides*
ns Not specified by CCAMLR

Table 2: Estimated effort, catch rates and total catches from IUU fishing for *Dissostichus* spp. in the Convention Area in the 2006/07 season. The estimates are derived from information on longliners and gillnetters. (Source: WG-FSA-07/10 Rev. 5)

Subarea/division	Estimated start of IUU fishing	No. of vessels sighted	Additional no. of vessels extrapolated to 30 Nov 07	Estimated no. of IUU fishing vessels	Estimated no. of days fished (not extrapolated)	Estimated no. of days fished (extrapolated)	Mean catch rate (tonnes/day)	Estimated IUU catch to 1 Sep 07 (not extrapolated)
		1	2	3	4	5	6	7
48.3	1991						2.1	0
58.4.1	2005	4	1.2	5.2	218	309	2.8	612
58.4.2	2002	2	0.6	2.6	109	200	1.8	197
58.4.3a	2003						0.8	0
58.4.3b	2003	20	6	26	1092	1183	2.1	2293
58.4.4	1996	1	0.3	1.3	55	146	2.0	109
58.5.1	1996	2	0.6	2.6	109	200	3.7	404
58.5.2	1997						1.9	0
58.6	1996						0.6	0
58.7	1996						0.5	0
88.1	2002						4.8	0
88.2	2006						2.9	0
Total		29						3615

Table 3: 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-07/10 Rev. 5 and SC-CAMLR reports.)

Season	Subarea or division													All areas
	Unknown	48.3	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
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			16 666
1996/97		0					375	6 094	7 117	11 760	7 327	0		32 673
1997/98		1 46					1 298	7 156	4 150	1 758	598	0		15 106
1998/99		667					1 519	1 237	427	1 845	173	0		5 868
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	508	23		86	98	1 015	220	268	265	12	60	23	0	2 578
2005/06	336	0	597	192	0	1 903	104	144	74	55	0	0	15	3 420
2006/07		0	612	197	0	2 293	109	404	0	0	0	0	0	3 615
All seasons	844	17 945	1 209	1 065	98	5 457	7 116	35 640	23 485	26 822	13 673	355	15	133 724

Table 4: 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 2005/06 and 2006/07. (Source: reported catch – past season from STATLANT data, and current season from catch and effort reports and data reported by France; IUU catch – WG-FSA-07/10 Rev. 5; CDS catch – data to October 2007, with the allocation between EEZ and high seas based on the Secretariat's knowledge of vessel activity such as licence information, vessel size and trip duration.)

2005/06 season

Inside	Subarea/division	Reported catch	IUU catch	Total CCAMLR	*Catch limit*
	48.3	3 535		3 535	*3 556*
	48.4	19		19	*100*
	48.6	163		163	*910*
	58.4.1	421	597	1 018	*600*
	58.4.2	164	192	356	*780*
	58.4.3	449	1 903	2 352	*550*
	58.4.4	0	104	104	*0*
	58.5.1	5 156	144	5 300	*0 outside EEZ*
	58.5.2	2 528	74	2 602	*2 584*
	58.6	801	55	856	*0 outside EEZ*
	58.7	124		124	*0 outside EEZ*
	88.1	2 969		2 969	*2 964*
	88.2	514	15	529	*487*
	88.3	0		0	*0*
	Unknown		336	336	*0*
	Total inside	16 843	3 420	20 263	
Outside	**Area**	**CDS catch EEZ**	**CDS catch high seas**	**Total outside CCAMLR**	
	41	1 986	3 179	5 165	
	47		230	230	
	51	3		3	
	57			0	
	81	407		407	
	87	3 985	0	3 985	
	Total outside	6 381	3 409	9 790	
Global total				30 053	

2006/07 season (to 5 October 2007)

Inside	Subarea/division	Reported catch	IUU catch	Total CCAMLR	*Catch limit*
	48.3	3 535		3 535	*3 554*
	48.4	54		54	*100*
	48.6	113		113	*910*
	58.4.1	645	612	1 257	*600*
	58.4.2	124	197	321	*780*
	58.4.3	257	2 293	2 550	*550*
	58.4.4	0	109	109	*0*
	58.5.1	3 438	404	3 842	*0 outside EEZ*
	58.5.2	1 956	112	1 956	*2 427*
	58.6	357	24	357	*0 outside EEZ*
	58.7	101		101	*0 outside EEZ*
	88.1	3 096		3 096	*3 072*
	88.2	347		347	*567*
	88.3	0		0	*0*
	Total inside	14 023	3 615	17 638	

(continued)

Table 4 (continued)

Outside	Area	CDS catch EEZ	CDS catch high seas	Total outside CCAMLR
	41	1 178	2 620	3 798
	47		321	321
	51	15	20	35
	57			0
	81	299	407	299
	87	4 623	8	4 631
	Total outside	6 115	2 969	9 084
Global total				26 722

Table 5: 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 2006/07 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. Vessels which tagged more than 500 fish are indicated (see Conservation Measure 41-01, Annex C). The number of *D. eleginoides* tagged is indicated in brackets. * reported catch of *Dissostichus* spp. < 5 tonnes. (Source: observer data and catch and effort reports.)

Subarea or division (required rate)	Flag State	Vessel name	*Dissostichus* spp. tagged and released		
			Number of fish		Tagging rate
48.4 (5)	New Zealand	*San Aspiring*	252	(251)	5.25
	UK	*Argos Helena*	40	(40)	6.44
	Total		292	(291)	
48.6 (1)	Japan	*Shinsei Maru No. 3*	99	(76)	1.00
	Korea, Republic of	*Jung Woo No. 2*	18	(14)	2.8
	Norway	*Frøyanes*	11	(1)	1.57
	Total		128	(91)	
58.4.1 (3)	Korea, Republic of	*Insung No. 1*	732	(9)	(>500 fish)
	Namibia	*Antillas Reefer*	3	(0)	0.13
	Spain	*Tronio*	502	(5)	(>500 fish)
	Uruguay	*Paloma V*	270	(231)	2.29
	Total		1507	(245)	
58.4.2 (3)	Korea, Republic of	*Insung No. 1*	88	(0)	4.36
	Korea, Republic of	*Jung Woo No. 2*	74	(0)	1.94
	Namibia	*Antillas Reefer*	86	(0)	1.32
	Total		248	(0)	
58.4.3a (1)	Japan	*Shinsei Maru No. 3*	4	(4)	1.83*
	Spain	*Tronio*	5	(5)	2.23*
	Total		9	(9)	
58.4.3b (1)	Japan	*Shinsei Maru No. 3*	112	(37)	1.02
	Namibia	*Antillas Reefer*	49	(47)	2.06
	Spain	*Tronio*	81	(0)	1.00
	Uruguay	*Paloma V*	47	(43)	1.24
	Total		289	(127)	

(continued)

Table 5 (continued)

Subarea or division (required rate)	Flag State	Vessel name	*Dissostichus* spp. tagged and released		
			Number of fish		Tagging rate
88.1 (1)	Argentina	*Antartic II*	228	(0)	1.45
	Korea, Republic of	*Insung No. 22*	352	(20)	1.16
	Korea, Republic of	*Jung Woo No. 2*	198	(19)	1.24
	New Zealand	*Avro Chieftain*	289	(0)	1.06
	New Zealand	*Janas*	184	(0)	1.13
	New Zealand	*San Aotea II*	385	(10)	1.25
	New Zealand	*San Aspiring*	463	(1)	1.11
	Norway	*Frøyanes*	168	(0)	1.11
	Russia	*Volna*	103	(0)	1.04
	Russia	*Yantar*	371	(0)	1.11
	South Africa	*Ross Mar*	51	(0)	1.00
	UK	*Argos Georgia*	240	(20)	1.01
	UK	*Argos Helena*	270	(3)	1.36
	Uruguay	*Ross Star*	152	(2)	1.14
	Uruguay	*Viking Sur*	141	(0)	1.34
	Total		3595	(75)	
88.2 (1)	Argentina	*Antartic II*	2	(0)	0.05
	Norway	*Frøyanes*	97	(0)	0.89
	Russia	*Volna*	55	(0)	1.03
	Russia	*Yantar*	100	(0)	1.01
	UK	*Argos Georgia*	0		0*
	UK	*Argos Helena*	14	(0)	0.46
	Uruguay	*Viking Sur*	10	(0)	1.07
	Total		278	(0)	

Table 6: Participation in exploratory fisheries for *Dissostichus* spp. in 2006/07. Participating Members includes Members who submitted notifications but did not fish. (Source: WG-FSA-07/4)

Subarea/division	Participating Member	Number of vessels fishing	*Dissostichus* spp. catch (tonnes)	
			Limit	Reported
Exploratory fisheries in Area 48 (Atlantic Ocean sector)				
48.6	Japan	1		
	Korea, Republic of	1		
	New Zealand	-		
	Norway	1		
Total		3	910	113
Exploratory fisheries in Area 58 (Indian Ocean sector)				
58.4.1	Australia	-		
	Korea, Republic of	1		
	Namibia	1		
	New Zealand	-		
	Spain	1		
	Uruguay	1		
Total		4	600	645

(continued)

Table 6 (continued)

Subarea/division	Participating Member	Number of vessels fishing	*Dissostichus* spp. catch (tonnes)	
			Limit	Reported
58.4.2	Australia	-		
	Korea, Republic of	2		
	Namibia	1		
	New Zealand	-		
	Spain	-		
	Uruguay	-		
Total		3	780	124
58.4.3a	Japan	1		
	Korea, Republic of	-		
	Spain	1		
Total		2	250	4
58.4.3b	Australia	-		
	Japan	1		
	Korea, Republic of	-		
	Namibia	1		
	Spain	1		
	Uruguay	1		
Total		4	300	253
Exploratory fisheries in Area 88 (Southwest Pacific sector)				
88.1	Argentina	1		
	Korea, Republic of	2		
	New Zealand	4		
	Norway	1		
	Russia	2		
	South Africa	1		
	Spain	-		
	UK	2		
	Uruguay	2		
Total		15	3072*	3096
88.2	Argentina	1		
	New Zealand	-		
	Norway	1		
	Russia	2		
	Spain	-		
	UK	2		
	Uruguay	1		
Total		7	567*	347

* Includes research fishing (see conservation measure).

Table 7: Number of vessels notified in exploratory longline fisheries for *Dissostichus* spp. in the 2007/08 season (a), and corresponding number of participating Members, number of vessels and catch limits agreed in conservation measures in force in the 2006/07 season (b). (Source: CCAMLR-XXVI/12)

Member notifications	Number of vessels notified per 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 *Dissostichus* spp. in the 2007/08 season							
Argentina						2	2
Australia		1	1		1		
Japan	2	1	1		2		
Korea, Republic of	4	5	5		4	5	
Namibia		2	2		2	1	
New Zealand	1	3	2			4	4
Russia						2	2
South Africa	1		1			1	1
Spain		1	1		1	1	1
Ukraine		1	1				
UK						3	3
Uruguay		1	1	1	1	2	2
Number of Members	4	8	9	1	6	9	7
Number of vessels	8	15	15	1	11	21	15
(b) Conservation measures in force in the 2006/07 season							
Number of Members	4	6	6	3	6	9	7
Number of vessels	1[1]	10	9	1[1]	1[1]	21	16
Target species catch limit (tonnes)	910	600	780	250	300	3032	547

1 Maximum number per country at any one time.

Table 8: Unstandardised CPUE (kg/hook) of *Dissostichus* spp. in exploratory longline fisheries reported between 1996/97 and 2006/07. (Source: fine-scale data from commercial and fishery-based research hauls, with SSRUs as defined in Conservation Measure 41-01 (2006).)

Subarea/ 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
48.6	486A								0.04	0.07	0.16	0.11
	486D											0.05
	486E									0.08		0.13
58.4.1	5841C									0.13	0.18	0.15
	5841E									0.22	0.10	0.13
	5841G									0.20	0.22	0.24
58.4.2	5842A									0.08	0.08	0.13
	5842C							0.10		0.07	0.17	
	5842D							0.19	0.06		0.03	
	5842E							0.21	0.11	0.14	0.22	0.15
58.4.3a	5843aA									0.05	0.05	0.02
58.4.3b	5843bA								0.09	0.16	0.16	0.13

(continued)

Table 8 (continued)

Subarea/ 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
88.1	881A	0.01				0.02		0.16			0.08	0.05
	881B	0.05	0.03			0.16	0.25	0.27	0.11	0.55	0.07	0.33
	881C					0.44	0.87	0.58	0.31	0.53	1.07	0.71
	881E		0.07	0.06		0.03		0.05	0.08	0.28		0.02
	881F		0.00					0.03				0.16
	881G		0.06	0.02		0.13	0.12	0.16	0.12	0.15	0.63	
	881H		0.17	0.26	0.38	0.41	0.72	0.45	0.21	0.73	0.60	0.38
	881I		0.37	0.23	0.28	0.28	0.43	0.20	0.16	0.44	0.39	0.34
	881J			0.09	0.18	0.04			0.04	0.21	0.36	0.36
	881K		0.32	0.15	0.39		0.45		0.01	0.32	0.50	
	881L					0.12			0.10	0.14	0.16	
88.2	882									0.38		
	882A						0.82		0.11	0.48	0.54	
	882B								0.06			
	882D										0.43	0.31
	882E							0.35	0.42	0.70	0.33	0.22
	882F										0.26	0.02
	882G										0.03	

Table 9: Number of *Dissostichus* spp. tagged and released in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR.)

Subarea/ division	Season							
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Total
48.6				4	62	146	128	340
58.4.1					462	469	1 507	2 438
58.4.2					342	136	248	726
58.4.3a					199	104	9	312
58.4.3b					231	175	289	695
88.1	326	756	1 068	1 752	3 221	2 977	3 085	13 185
88.2		12	94	433	341	444	264	1 588
Total	326	768	1 162	2 189	4 858	4 451	5 530	19 284

Table 10: Number of tagged *Dissostichus* spp. recaptured in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR.)

Subarea/ division	Season							
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Total
48.6						3	2	5
58.4.1							3	3
58.4.2							1	1
58.4.3a						6		6
58.4.3b					1	6	1	8
88.1	1	4	13	40	59	70	204	391
88.2				10	17	28	33	88
Total	1	4	13	50	77	113	244	502

Table 11: Reported catch of *Dissostichus* spp. in exploratory fisheries. (Source: STATLANT data for past seasons, and catch and effort reports for current season.)

Season	Reported catch (tonnes) of *Dissostichus* spp. in exploratory fisheries							
	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2	All exploratory fisheries
1996/97						<1	<1	<1
1997/98						42	<1	42
1998/99						297		297
1999/00						751	<1	751
2000/01			<1			660	<1	660
2001/02						1 325	41	1 366
2002/03			117			1 831	106	2 055
2003/04	7	<1	20	<1	7	2 197	375	2 605
2004/05	51	480	127	110	297	3 120	411	4 594
2005/06	163	421	164	89	361	2 969	514	4 680
2006/07	113	645	124	4	253	3 096	347	4 581
Total	333	1 547	551	203	917	16 287	1 793	21 630

Table 12: Summaries of data used in simulation trials of the probability that the mean CPUE estimated from a longline survey for *Dissostichus* species is within 25% of the true CPUE when a catch limit is fixed for the survey. For each of the areas for which data was extracted from the CCAMLR database, the number of records (shots) is shown along with the mean CPUE (kg). Statistics are shown for all data and for each year where data is present.

	All	2000	2001	2002	2003	2004	2005	2006	2007
58.4.1									
Records	902						285	215	402
CPUEMean	0.175						0.169	0.193	0.169
58.4.2									
Records	569				141	45	163	108	112
CPUEMean	0.150				0.181	0.091	0.101	0.213	0.144
58.4.3b									
Records	652					19	160	191	282
CPUEMean	0.144					0.087	0.159	0.160	0.128
58.4.4									
Records	373	319	54						
CPUEMean	0.063	0.067	0.041						

Table 13: Catch biomass levels required to attain a 33% CV in the estimated abundance for three representative levels of tag rate per tonne and exploitable biomass. The natural mortality and tagging mortality/detection rates were those used in Subarea 48.3. EB is the exploitable biomass of the stock/population in question and all biomass levels are in tonnes, and tpt signifies the tags per tonne.

CV = 33%	EB = 5 000	EB = 10 000	EB = 20 000
Tag rate = 2.5 tpt	131	186	264
Tag rate = 5 tpt	92	132	187
Tag rate = 7.5 tpt	76	108	153

Table 14: Catches for macrourids, rajids and other species taken as by-catch from longline fisheries in 2006/07, and reported in fine-scale data. Catches are given in tonnes and as a percentage of the catch of *Dissostichus* spp. (TOT) reported in fine-scale data. (Rajids cut from the longlines and released are not included in these estimates.) na – not applicable.

Subarea/division	Target catch (tonnes)	Macrourids			Rajids			Other species		
		Catch (tonnes)	% TOT	Catch limit	Catch (tonnes)	% TOT	Catch limit	Catch (tonnes)	% TOT	Catch limit
48.3	3333	131	3.9	177	4	0.1	177	27	0.8	-
48.4	54	14	25.7	-	2	3.2	-	0	0.6	-
48.6	112	13	11.5	146	0	0.0	100	2	1.6	120
58.4.1	634	41	6.5	96	0	0.0	50	2	0.3	60
58.4.2	124	7	5.7	124	0	0.3	50	0	0.4	60
58.4.3a	4	0	11.1	26	0	0.5	50	1	20.9	20
58.4.3b	251	17	6.7	159	3	1.2	50	1	0.4	20
58.5.1 French EEZ	3184	476	15.0	na	379	11.9	na	0	0.0	na
58.5.2	624	61	9.8	360	8	1.3	120	1	0.1	50
58.6 French EEZ	333	90	27.1	na	83	25.0	na	0	0.0	na
58 South African EEZ	112	7	6.1	na	0	0.0	na	1	0.7	na
88.1	3096	153	4.9	485	38	1.2	152	43	1.4	160
88.2	347	54	15.6	88	0	0.0	50	13	3.6	100

Table 15: Number of macrourids, rajids and other species caught or released from longline fisheries in 2006/07, and reported in fine-scale data.

Subarea/division	*Dissostichus* spp.		Macrourids		Rajids		Other species	
	Caught	Released	Caught	Released	Caught	Released	Caught	Released
48.3	755 789	3 873	83 408	0	519	9 265	19 849	20
48.4	3 668	292	13 208	0	285	6 515	518	98
48.6	6 150	255	12 528	0	3	0	1 868	0
58.4.1	25 006	767	35 695	9	13	0	2 281	9
58.4.2	3 711	160	5 500	0	61	0	537	0
58.4.3a	506	12	535	0	8	0	675	0
58.4.3b	10 733	286	22 714	0	840	1 267	1 209	67
58.5.1 French EEZ	681 321	0	268 316	0	64 259	0	0	0
58.5.2	111 616	580	78 036	0	1 030	7 693	9 375	1
58.6 French EEZ	68 941	0	64 250	0	21 227	0	0	0
58 South African EEZ	17 921	26	5 687	0	0	0	584	0
88.1	120 367	3 564	121 989	6	4 802	7 352	99 586	42
88.2	10 063	271	52 283	0	16	0	15 036	1

Table 16: Estimated total catch in tonnes of rajids (including those cut off or released) in 2006/07 derived from fine-scale (C2) data.

Subarea/division	Rajids					
	Caught	Released	Estimated total catch (tonnes)	Mean weight (kg)	Catch limit (tonnes)	% of catch limit
48.3	519	9 265	72.6	7.42	177	41.0
48.4	285	6 515	41.7	6.13	-	-
48.6	3	0	0.0	6.83	100	0.0
58.4.1	13	0	0.1	8.12	50	0.2
58.4.2	61	0	0.3	5.22	50	0.6
58.4.3a	8	0	0.0	2.88	50	0.0
58.4.3b	840	1 267	7.5	3.57	50	15.0
58.5.1 French EEZ	64 259	0	358.6	5.58*	na	na
58.5.2	1 030	7 693	68.9	7.90	120	57.4
58.6 French EEZ	21 227	0	64.4	3.03*	na	na
58 South African EEZ	0	0	0.0	2.87*	na	na
88.1	4 802	7 352	97.2	7.99	152	63.9
88.2	16	0	0.1	7.95	50	0.3

* Derived from observer biological data (L6) as no weight data were available within fine-scale data.

Table 17: Observed (numbers) and estimated catches (numbers and weight) of macrourids, rajids and *Antimora rostrata* derived from observer (L5) data.

Subarea/ division	Observed macrourids (*n*)	Extrapolated macrourids (*n*)	Extrapolated macrourids (tonnes)	Observed rajids (*n*)	Extrapolated rajids (*n*)	Extrapolated rajids (tonnes)	Observed *Antimora* (*n*)	Extrapolated *Antimora* (*n*)	Extrapolated *Antimora* (tonnes)
48.3	29 328	89 852	156	2 463	7 490	65.13	5 323	15 271	23.56
48.4	4 445	10 744	14	16	43	0.26	98	261	0.35
48.6	9 689	19 523	24	0	0	0.00	869	1 750	2.89
58.4.1	11 189	19 504	27	1	2	0.02	4	6	0.01
58.4.2	646	646	1	0	0	0.00	5	5	0.01
58.4.3a	204	599	1	143	340	1.28	273	695	1.03
58.4.3b	12 027	26 420	25	1 554	2 360	30.57	191	593	0.92
58.5.1	-	-	-	-	-	-	-	-	-
58.5.2	13 784	37 400	56	4 128	11 042	61.62	211	559	0.86
58.6	1 696	8 956	13	8	43	0.13	171	1 032	1.42
58.7	3 240	13 481	19	7	25	0.07	194	1 341	1.84
88.1	63 035	111 611	212	4 638	6 598	43.71	1 566	2 503	4.49
88.2	33 800	54 351	80	3	30	0.21	2 964	5 436	8.55

Table 18: Fate and condition of skates captured in longline fisheries determined from observer data (L11) during the 2006/07 season.

Fate	Condition	Subarea/division											
		48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.5.2	58.6	58.7	88.1	88.2
Cut off the line	1	51	15				14					4	
	2	8	3				3					83	
	3	252	49		1		3	1	1			217	2
	4	907	278	1			2		48			872	
	Not recorded	839	285	0	0		0	0	0			60	0
	Total	2 057	630	1	1		22	1	49			1 236	2
Landed and discarded	1	22	15			10			38			14	
	2	1		1	5	5			7			14	
	3	11		2	4	29			2			87	
	4	61			3	18			110			62	
	Not recorded	4	0	0	0	0			0			0	
	Total	99	15	3	12	62			157			177	
Lost at the surface/dropped off by itself	1						1					3	
	2						1					3	
	3	3	3									103	
	4	26	2									14	
	Not recorded	53	1				0					1	
	Total	82	6				2					124	
Shaken/flicked off/removed with a gaff	1	5											
	2	1					5					1	
	3	5								20	22		
	4	5										3	
	Not recorded	4	1				0			0	0	0	
	Total	20	1				5			20	22	4	
Tagged and released	1								3				
	2								2			4	
	3								79			32	
	4	73							94			366	
	Not recorded	1							0			1	
	Total	74							178			403	

(continued)

Table 18 (continued)

Fate	Condition	Subarea/division											
		48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.5.2	58.6	58.7	88.1	88.2
Fish landed and retained on board	1								171			145	3
	2								240			21	
	3								381			440	
	4								95			1	
	Not recorded								1			18	0
	Total								888			625	3

Released condition code refers to the status of released animals.

1: Rajid is dead. No movement of spiracles. No response when touched.

2: Rajid is alive. Life-threatening injuries (e.g. crushed or missing jaws/mouthparts, prolapsed intestines, severely ripped muscles in the oesophagus and mouth).

3: Rajid is alive. Injuries serious enough to possibly reduce survival post release (e.g. large areas of ripped soft tissue in the oesophagus and mouth, small areas of ripped muscle).

4: Rajid is alive and in good condition or may have some small injury that is not deemed to be life threatening (e.g. small areas of ripped tissue and muscles of the pectoral fins; hook puncture wounds in the soft tissue of the mouthparts).

Table 19: Macrourid by-catch (tonnes) as a percentage of *Dissostichus* spp. (tonnes) catch in Subareas 48.3, 48.6 and 88.1 and Division 58.5.2. Derived from fine-scale (C2) data.

Season	Subarea/division							
	48.3		48.6		58.5.2		88.1	
	Autoliner	Spanish	Autoliner	Spanish	Autoliner	Spanish	Autoliner	Spanish
1994/95	25.44	0.34						
1995/96	6.32	4.69						
1996/97	-	1.87						
1997/98	1.58	3.47					22.32	
1998/99	1.66	0.48					9.69	
1999/00	1.95	0.82					10.46	
2000/01	3.74	0.50					24.50	13.11
2001/02	-	2.65					11.61	
2002/03	3.78	1.28			0.99		21.78	0.52
2003/04	9.74	1.60		4.05	7.67		33.22	7.01
2004/05	14.03	1.73		2.30	10.78		27.65	6.33
2005/06	6.79	1.19		6.05	4.00		16.95	2.51
2006/07	5.31	2.23	9.37	11.8	9.8		6.13	2.34

Table 20: Catches (tonnes) of target species and by-catch from trawl fisheries in 2006/07, and reported in fine-scale data. ANI – *Champsocephalus gunnari*; GRV – *Macrourus* spp.; KRI – *Euphausia superba*; LIC – *Channichthys rhinoceratus*; NOR – *Notothenia rossii*; NOS – *Notothenia squamifrons*; SGI – *Pseudochaenichthys georgianus*; SRX – *Rajid* spp.; SSI – *Chaenocephalus aceratus*; TOP – *Dissostichus eleginoides*; TOT – *Dissostichus* spp.

Subarea/ division	Target species	Catch (tonnes)											
		Target	ANI	GRV	KRI	LIC	NOR	NOS	SGI	SRX	SSI	TOT	Other
48.1	KRI	7 147	0	0	7 147	0	0	0	0	0	0	0	0
48.2	KRI	38 033	0	0	38 033	0	0	0	0	0	0	0	0
48.3	KRI	4 055	0	0	4 055	0	0	0	0	0	0	0	0
48.3	ANI	4 091	4 091	0	0	0	0	0	<1	0	0	0	<1
58.5.2	ANI	1	1	0	0	3	0	<1	0	<1	0	<1	<1
58.5.2	TOT	1 349	0	9	0	14	0	17	0	13	0	1 349	3

Table 21: Suggested outline of a matrix to list and prioritise observer tasks. See text for further explanation.

User group	Data type	Description	Use	Optimal collection	Practical limitations
FSA	Length frequency (sex-specific)	Target species	Critical input to size- and age-based assessment models.	Random sample from every shot or set.	May not be possible to sample every catch due to time constraints. Limited sample size. The size of the fish.
		By-catch species	Will be required input if size- or age-based assessment models are developed for any of the by-catch species.	Random sample from every shot or set.	May not be possible to sample every catch due to time constraints. Limited sample size.
	Biological (target and by-catch species)	Weight	Used to determine length–weight and age–weight regressions to convert model output in numbers to biomass.		
		Maturity stage and/or gonad weight	Maturity ogives (preferably determined annually) required model input.		
		Otoliths	Required input to age-based models.		
	Catch composition	Estimates of total removals per species. Note this requires estimation of additional mortality, e.g. discards, fish lost from lines, depredations etc.	Estimates of total removals are essential input to assessment models. Estimates of the fate (survivorship) of live released animals needed to estimate total mortality.		
	Tagging	Tag and recapture information (toothfish and skates)	Used in tag–recapture assessment models.	Data on all tagged and recaptured animals and on the number of animals examined for tags.	
	Vessel sightings	Reports of unknown and IUU vessels active in the area.	Estimates of IUU catch included as part of the total removals for stock assessment models.		
	Conversion factors	Relationship between processed and green weight.	Used to estimate the green weight from the reported processed weight.		

(continued)

Table 21 (continued)

User group	Data type	Description	Use	Optimal collection	Practical limitations
IMAF	Incidental mortality	Record mortality of seabirds and marine mammals.	Estimate mortalities within the Convention Area caused by fishing.		
	Seabirds and marine mammal interactions with fishing gear	Record entanglement and injury to seabirds and marine mammals.	Estimate mortalities within the Convention Area caused by fishing.		
		Trawl warp strikes	Estimate mortalities within the Convention Area caused by trawling.		
	Implementation of mitigation measures	Description and specification of mitigation measures (L2 data).	To assess the performance of the measures to review attainment of minimum requirements.		
	Interactions with predators	Fish depredation			
SCIC	Implementation of mitigation measures	Data related to compliance with various elements of mitigation measures in force.	To evaluate compliance with various mitigation measures in force.		
	Vessel sightings	Reports of unknown and IUU vessels active in the area.	Used to monitor IUU activity.		
Scientific Committee	Fishery statistics and biological data for both target and by-catch species	Review of summarised observer data on removals of target and by-catch species.	To evaluate performance of conservation measures in force.		
	Implementation of mitigation measures	Review of summarised observer data on incidental mortality and mitigation measures.	To evaluate performance of conservation measures in force.		

Table 22: List of tasks identified by WG-FSA for the 2007/08 intersessional period. The paragraph numbers (Ref.) refer to this report. E – established practice. Priority: high priority (1); general request (2).

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	Organisation of the meeting				
1.	Submit papers to WG-FSA-08 in accordance with the guidelines.	E	1	Members to implement	Coordinate and implement
2.	Circulate list of documents with agenda items at start of meeting.	E	1	Convener to implement	Assist
	Review of available information				
3.	Submit data in a timely manner and using current CCAMLR formats.	E	1	Members to implement	Assist
4.	Process fishery, observer and survey data submitted to CCAMLR.	E	1		Implement
5.	Validate data and liaise with Members to resolve inconsistencies.	E	1	Members to assist	Implement
6.	To the extent possible, update the tables, figures and general text of data in the Fishery Reports, and add a section on the history of the development of catch limits.	13.11	1		Implement
7.	Update estimates of reported catches, catches from IUU fishing and total removals by season and area within the Convention Area.	E	1	Members to provide information on IUU fishing by 1 October	Implement
8.	Update estimates of catches reported in CDS data by season and area outside the Convention Area.	E	1		Implement
9.	Update information on scientific observations.	E	1		Implement
10.	Update Fishery Plans.	E	2		Implement
11.	Notify research surveys.	E	1	Members to implement	
12.	Conduct statistical evaluation of new methods to assess the performance of new gear, its selectivity and impact on ecosystem components.	E	2	Members to implement	
13.	Provide information of the sustainability of the *Dissostichus* resource on the Scotia Ridge.	3.19	2	Members to implement	Archive

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	Assessments and management advice				
14.	Investigate reasons for differences between rates that tags were recaptured from those released by vessels from different nations, and advise on how to resolve these observed differences.	3.36, 5.49, 5.106	1	Scientific Committee and Commission to consider	
15.	Continue the tagging experiment in Subarea 48.4, so that further data can be collected which may allow estimates of abundance to be calculated in the future.	3.41, 5.175	1	Members to implement	
16.	Review compliance with requirements in exploratory fisheries and advise on the information which WG-FSA should provide to SCIC in future to allow it address this issue.	3.43	1	SCIC to consider	
17.	Revise C2 data form.	6.56, 7.5, 10.6	1	Members to implement	Implement
18.	Develop management strategy evaluations.		1	Members to implement	
	Fish and invertebrate by-catch				
19.	Review and further develop the assessment of the status of by-catch species and groups, estimation of by-catch levels and rates, assessment of risk and mitigation measures.	13.4	1	Subgroup on By-catch to coordinate	Assist
20.	Plan and develop the requirements for the Year of the Skate in 2008/09.	13.4	1	Coordination group to implement	Assist
21.	Understand variations in reported by-catch rates between Members, and between different areas.	5.51	1	Members to implement	Assist
22.	Bring all rajids on board, where possible, prior to release.	6.38	1	Members to implement	
23.	Provide data for the analysis of by-catch at the start of the meeting.	E	1	Subgroup on By-catch to coordinate	Implement
24.	Conduct further research to explore any negative effects of new by-catch exclusion devices on the survival rate of skates.	10.7	1	Members to implement	

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	Evaluation of threats arising from IUU activities				
25.	Review and further develop approaches for improved estimation of IUU fishing and total removals and develop the time series of catches estimated from IUU fishing.	13.4	1	Subgroup on IUU Fishing to coordinate	Assist
26.	Consider including a measure of the local density of licensed vessels in the tables WG-FSA prepared on IUU fishing.	8.3	2		Implement
	Biology, ecology and demography of target and by-catch species				
27.	Review the literature, identify gaps in knowledge and update and coordinate the development of species profiles.	13.4	1	Subgroup on Biology and Ecology to coordinate	Assist
28.	Review and further develop ageing techniques and age estimation, the development of the CCAMLR ageing database, and advise of the distribution of *Dissostichus* spp. in the fisheries in Subarea 58.4 using otolith morphology.	13.4	1	CCAMLR Otolith Network to coordinate	Assist
29.	Consider publishing the species profiles in a special volume of *CCAMLR Science* and update an electronic version of these papers continuously thereafter.	9.12, 9.13	2	Authors to implement	Implement
	Consideration of ecosystem management				
30.	Review the literature and facilitate interactions with WG-EMM and SG-ASAM.	13.4	1	Subgroup on Ecosystem Interactions to coordinate	Assist
31.	Further develop close collaboration between WG-FSA and WG-EMM, with a view to holding a workshop in 2009 or 2010.	10.4	2	Members to contribute	Assist
32.	Assess the impact the krill fishery might have on recruitment of Antarctic fish and to what extent the krill fishery may add to ‘natural’ mortality of Antarctic fish at an early stage.	10.9	2	Members to implement	
33.	Translate the Russian key to early life stages of Antarctic fish.	10.10	1		Implement
34.	Further develop CCAMLR’s work on evaluation of the impact of bottom fishing in high-seas areas.	14.40–14.43	1	Scientific Committee and Commission to consider	

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	New and exploratory fisheries				
35.	Conduct the fishery-based research including tagging, outlined in Conservation Measure 41-01, and submit the data to the Secretariat in a timely manner.	5.44, 5.45, 5.50	1	Members to implement	Archive
36.	Look out for tagged fish and submit accurate tag–recapture data to the Secretariat in a timely manner.		1	Members to implement	Archive
37.	Undertake a depletion analysis for Divisions 58.4.1 and 58.4.2.	5.84	2	Members to implement	Assist
38.	Develop the assessments in exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 58.4 and 88.2.	4.30, 5.48, 12.1	1	Members to implement	Assist
39.	Further develop the assessment of *Dissostichus* spp. in Subarea 88.1.	12.5, 12.6	1	Members to implement	Assist
40.	Review and further develop the tagging programs and the treatment of tagging data.	13.4	1	Subgroup on Tagging to coordinate	Assist
	Scheme of International Scientific Observation				
41.	Review and further develop the observer protocols, the *Scientific Observers Manual* and priorities for scientific observers in various fisheries.	13.4	1	Subgroup on the Observer Program to coordinate	Assist
42.	Use only current versions of CCAMLR data forms.	E	1	Members to implement	Assist
43.	Update the *Scientific Observers Manual* and data forms.	E	1		Implement
44.	Produce a photograph tag template, which would be used to place behind the tag when photographed.	3.48	1	Members to use	Implement
45.	Observers/vessels to take time-stamped photographs of all returned tags and forward them to the relevant tagging program coordinator and the Secretariat.	3.46	1	Members to implement	Archive
46.	Continue to coordinate the tagging program for toothfish.	E	1	Subgroup on Tagging to provide guidance	Implement
47.	Administer the tagging program for skates during the Year of the Skate.	3.49–3.51, 3.56	1	Subgroup on Tagging to provide guidance	Implement

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
48.	Consider the applications of new technology to investigate key uncertainties for toothfish stocks, such as fish behaviour and movement.	3.52	2	Members to implement	Assist
49.	Place the protocols for tagging very large toothfish, and plans for equipment to assist with handling such fish described in WG-FSA-07/36, on the CCAMLR website, and advise technical coordinators.	3.53	1	Members to implement	Implement
50.	Revise observer data forms.	6.50, 6.51, 6.55	1	Members to implement	Implement
51.	Contribute to the work of the ad hoc Technical Group.	11.11	1	Members to implement	Assist
	Future assessments				
52.	Further develop the assessment of *D. eleginoides* in Subarea 48.3.	12.2	1	Members to implement	Assist
53.	Further develop the assessment of *D. eleginoides* in Division 58.5.2.	12.3	1	Members to implement	Assist
54.	Further develop the assessment of *D. eleginoides* in the South African EEZ.	12.4	1	Members to implement	Assist
55.	Further develop the assessments of *D. eleginoides* in the French EEZs.	5.124, 5.144	1	Members to implement	Assist
56.	Further develop the assessment of *C. gunnari* in Subarea 48.3.	12.7	1	Members to implement	Assist
57.	Further develop the assessment of *C. gunnari* in Division 58.5.2.	12.8	1	Members to implement	Assist

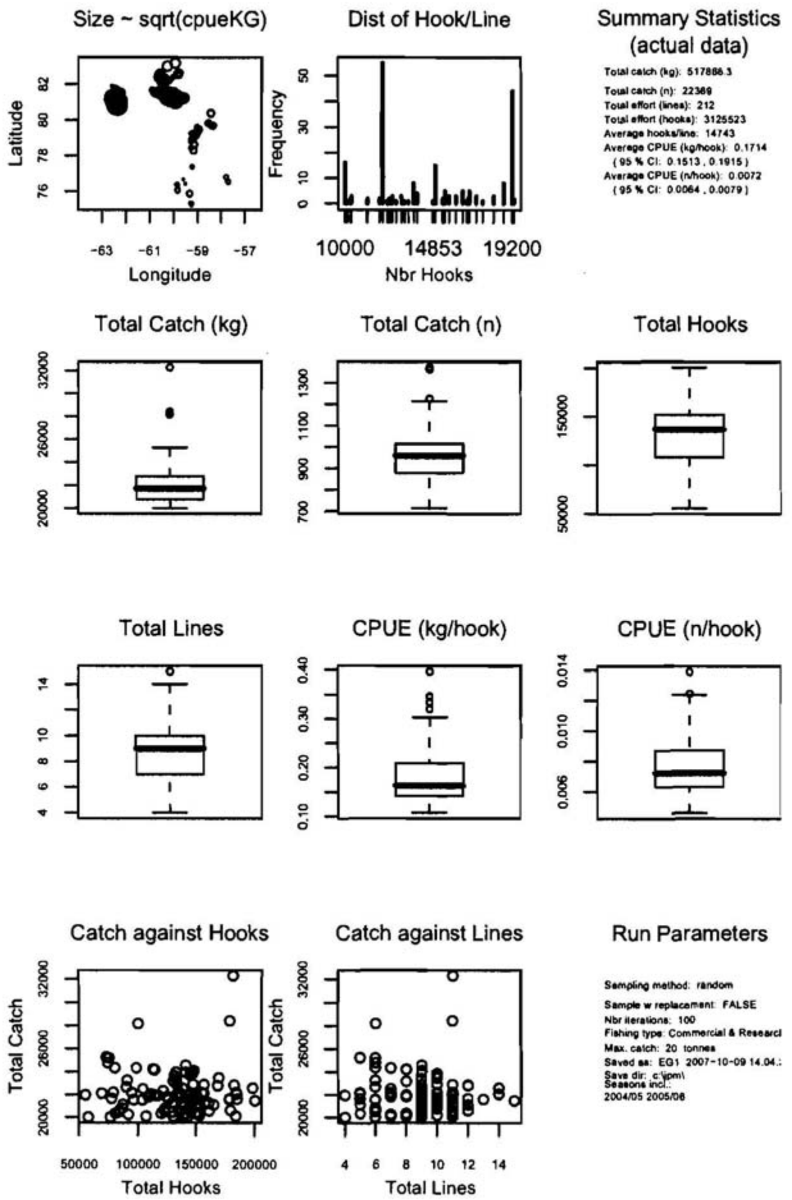


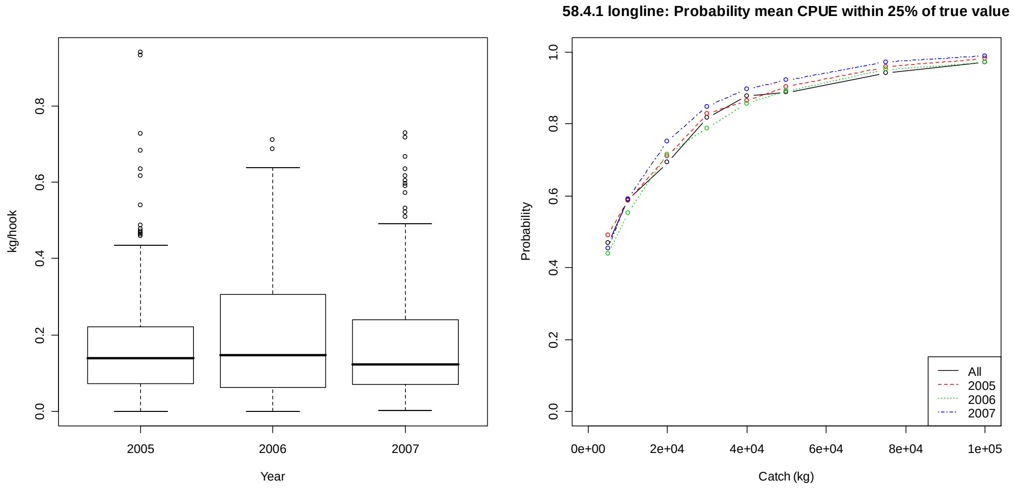
Figure 1: Results from an example run from a simulator to examine the precision of estimates of CPUE expected from a longline survey of *Dissostichus* species when a catch limit is fixed for the survey. Simulation trials are based on actual fisheries data for an area extracted from the CCAMLR database (in this case Division 58.4.3b). Details for each row of panels are:

Top row – summaries of the data selected in the simulation along with their summary statistics, including a bubble plot showing catches of shots and their locations, as well as the frequency of lines with different numbers of hooks.

Second and third rows – box plots summarising the outcomes from the replicate trials (100 in this case) indicating the total catch (kg and number) taken in the survey and total hooks and lines deployed, and the resulting estimates of mean CPUE (in kg and number of fish).

Fourth row – simple plots of total catch against total hooks for each replicate and total lines deployed, along with the parameters of the run.

Division 58.4.1
Total hooks – 9 080 386; Total catch – 1 535 204 kg



Division 58.4.2
Total hooks – 3 827 955; Total catch – 540 527.1 kg

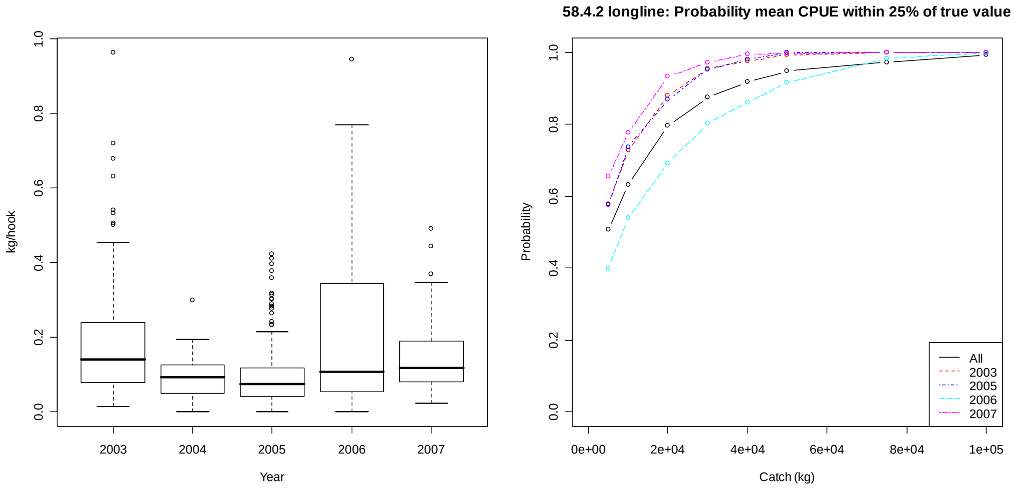


Figure 2: Results of simulation trials of the probability that the mean CPUE estimated from a longline survey for *Dissostichus* species is within 25% of the true CPUE when a catch limit is fixed for the survey. Simulation trials are based on actual fisheries data for an area extracted from the CCAMLR database. Right panels summarise the data extracted for an area for each year of data. Left panels show the probabilities of the estimated CPUE being within 25% of the true value for a range of survey catch limits. In these trials, the probabilities were determined for all data pooled into a single trial and then trials undertaken for each year for which there was sufficient data to do the simulation. Results are shown for data from Divisions 58.4.1, 58.4.2, 58.4.3b and 58.4.4.

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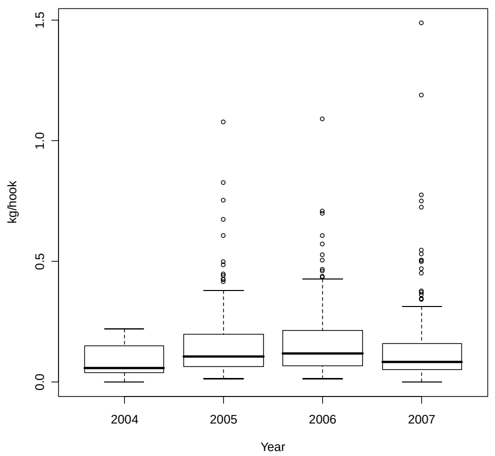
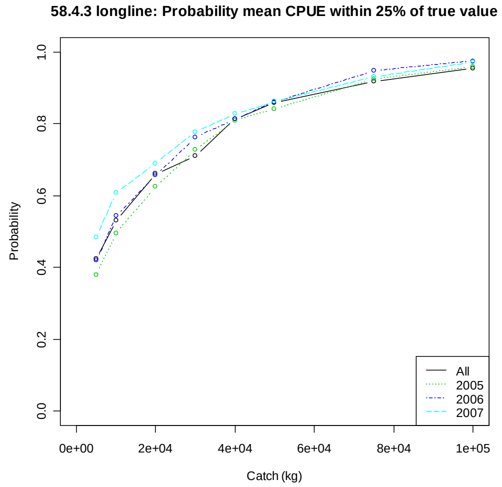
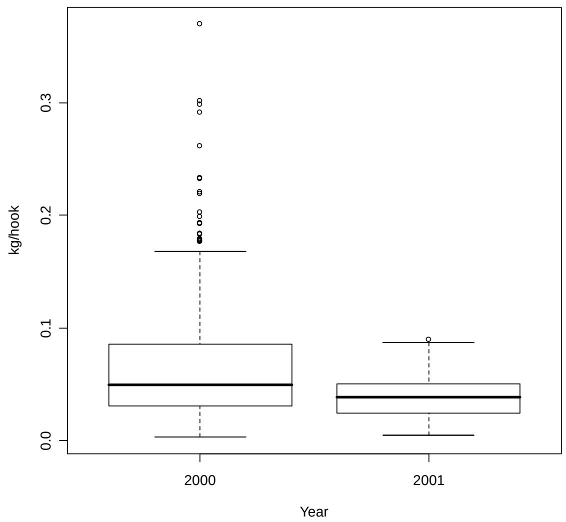
Division 58.4.3b
Total hooks – 6 708 084; Total catch – 919 975 kg





Division 58.4.4
Total hooks – 1 795 685; Total catch – 149 170.3 kg



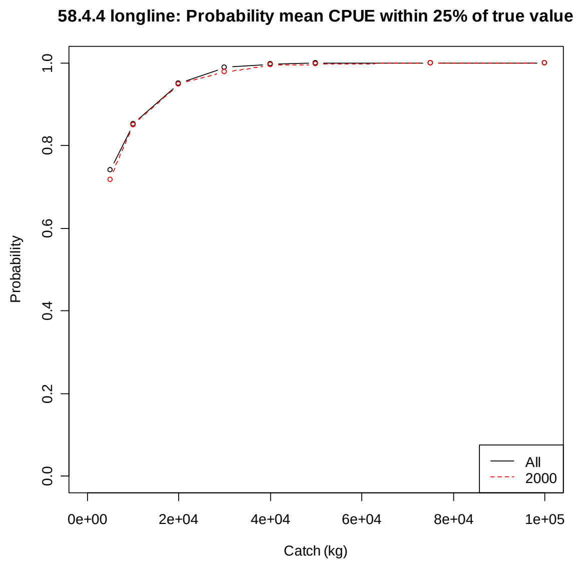


Figure 2 (continued)

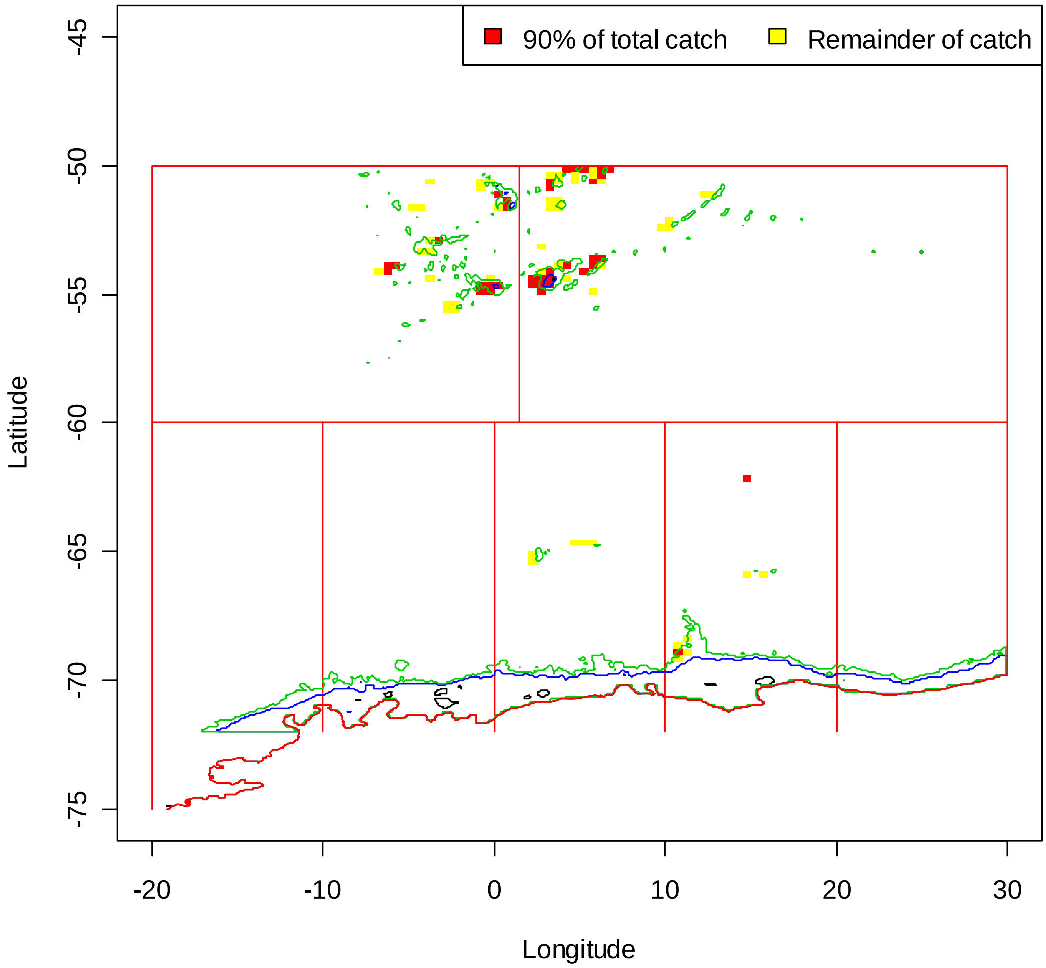


Figure 3: Map of Subarea 48.6 showing the proposed subdivision of the existing northern SSRU A into two smaller SSRUs. This map also includes the catch information discussed in section 14 (see Figure 8).

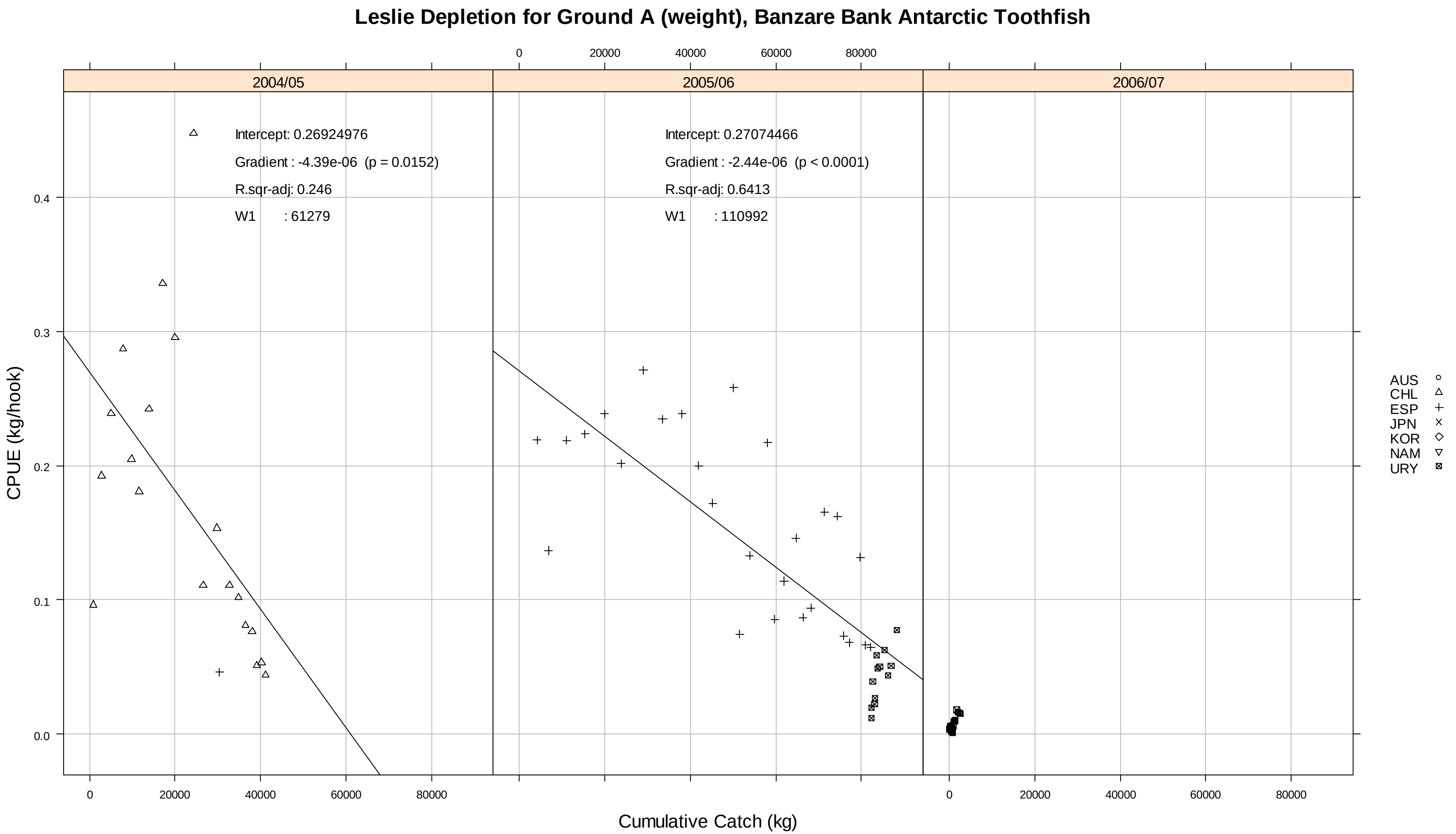


Figure 4: Plots of CPUE (kg/hook) against cumulative catch (kg) of *Dissostichus mawsoni* for primary fishing grounds A and B in Division 58.4.3b (BANZARE Bank) in seasons 2003/04–2006/07. Fitted regression lines have been added to those relationships showing a significant negative slope, indicating significant depletion of available toothfish biomass within the 2004/05 and 2005/06 seasons. CPUE in 2006/07 is shown to be consistently very low in Ground A. Panel inserts show regression parameters and estimates of initial biomass in kilograms (W1).

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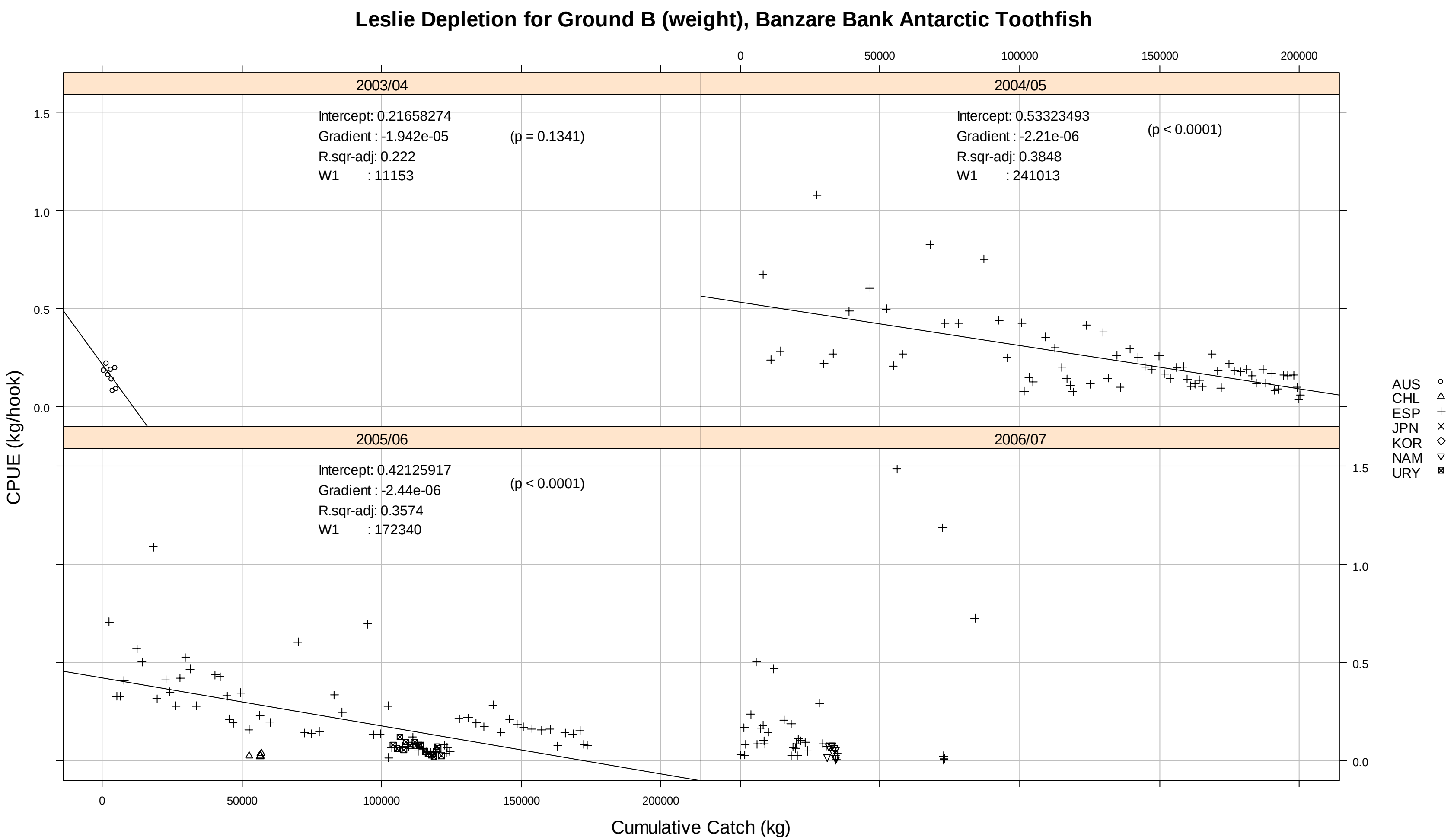

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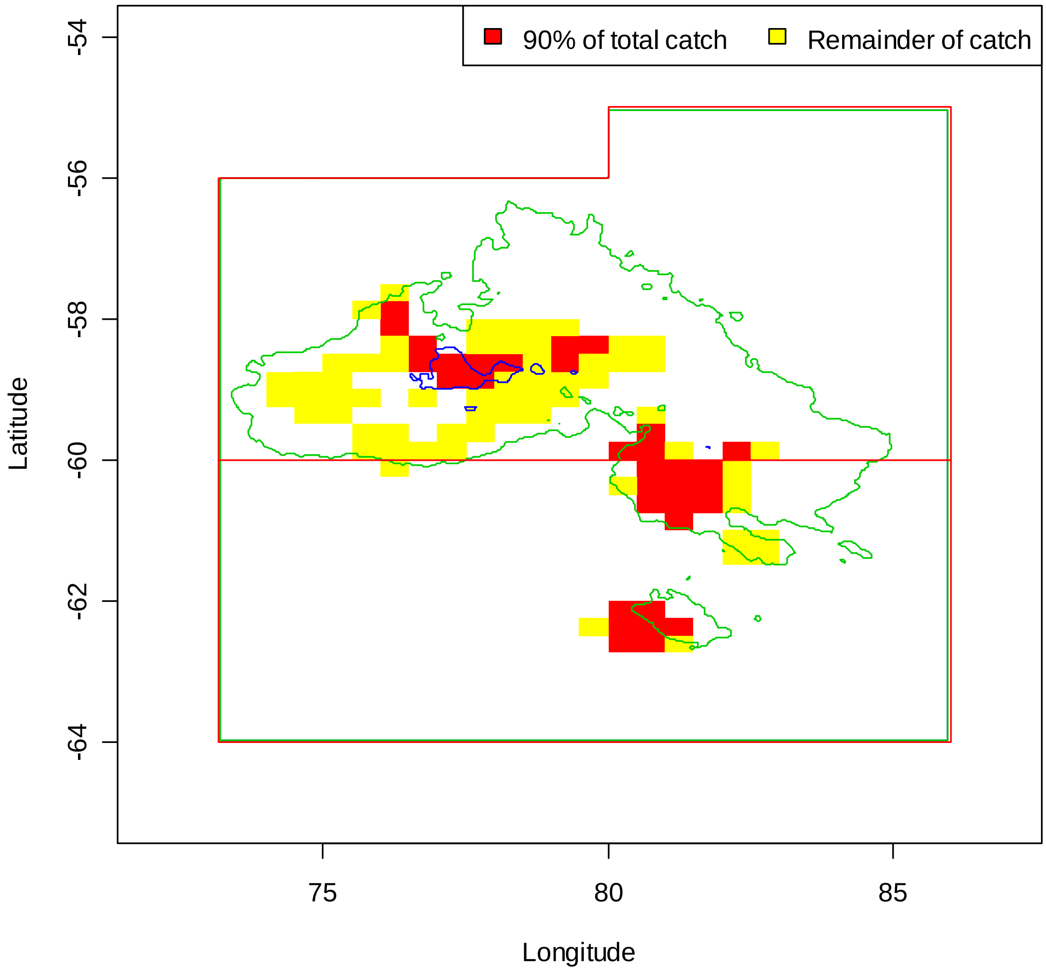

Figure 5: Map of Division 58.4.3b showing the proposed subdivision into two small SSRUs. This map also includes the catch information discussed in section 14 (see Figure 11).

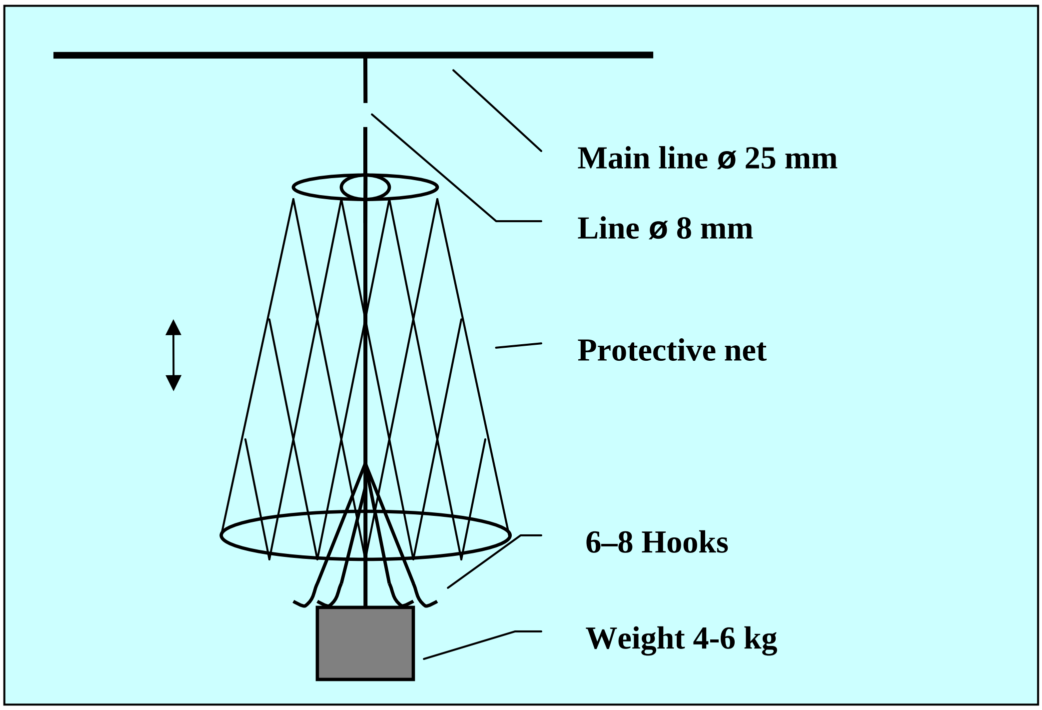

Figure 6: Cetacean exclusion device in a Russian longliner fishing off the Patagonian shelf as described in WG-FSA-07/11.

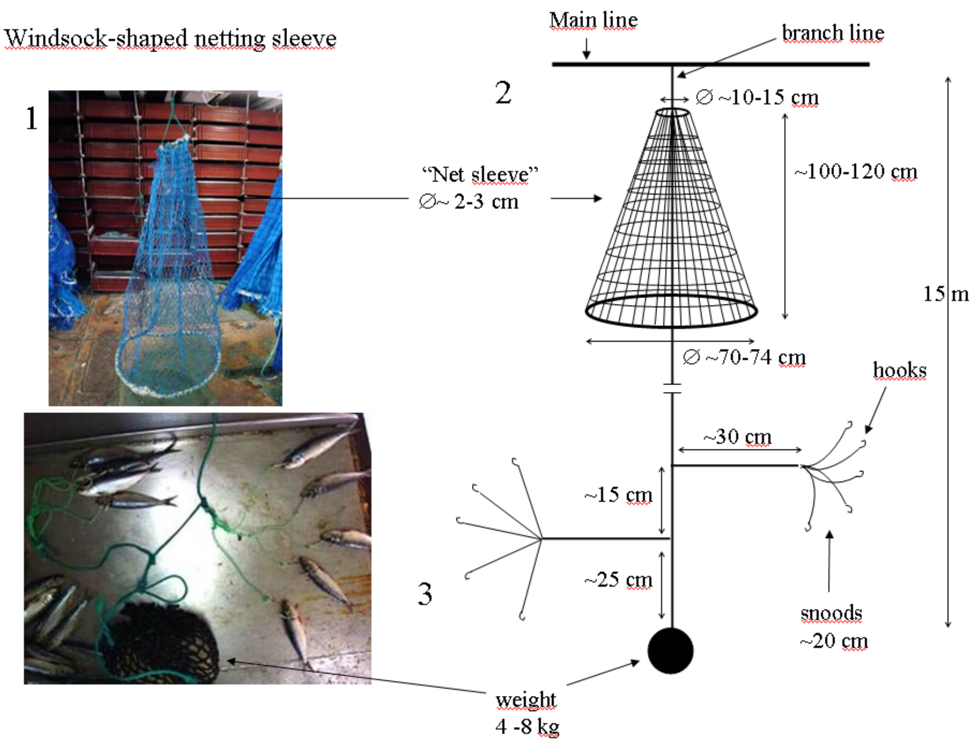

Figure 7: Cetacean exclusion device in Chilean longliners fishing off the southwest coast of Chile as described in WG-FSA-07/14.

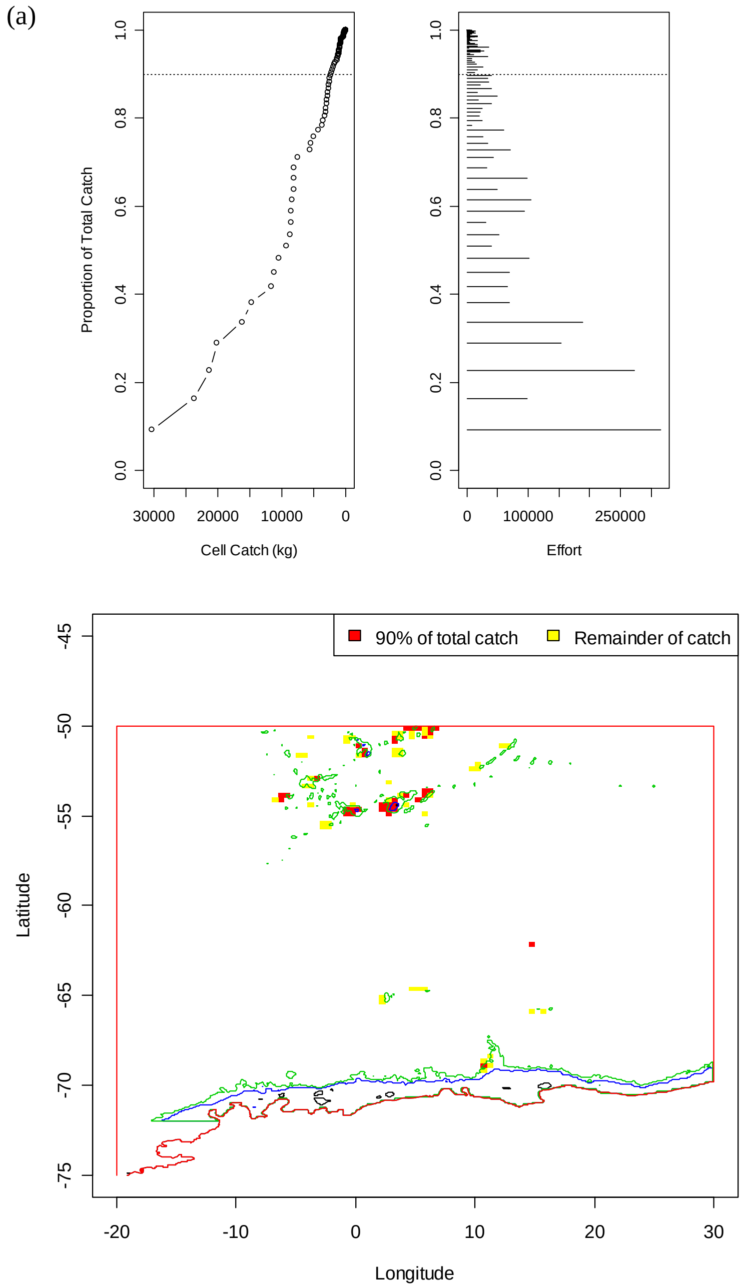

Figure 8*: Effective fishing footprint for longline fishing effort (hooks) in Subarea 48.6 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

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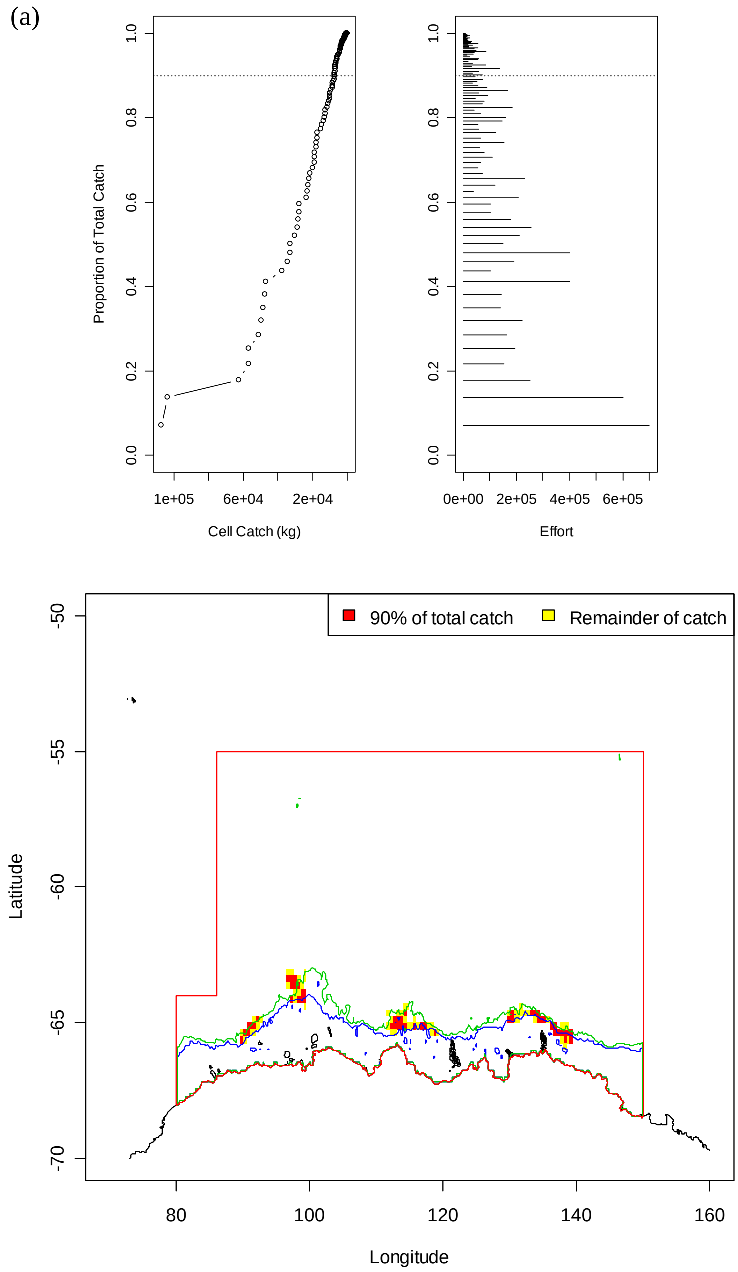

Figure 9*: Effective fishing footprint for longline fishing effort (hooks) in Division 58.4.1 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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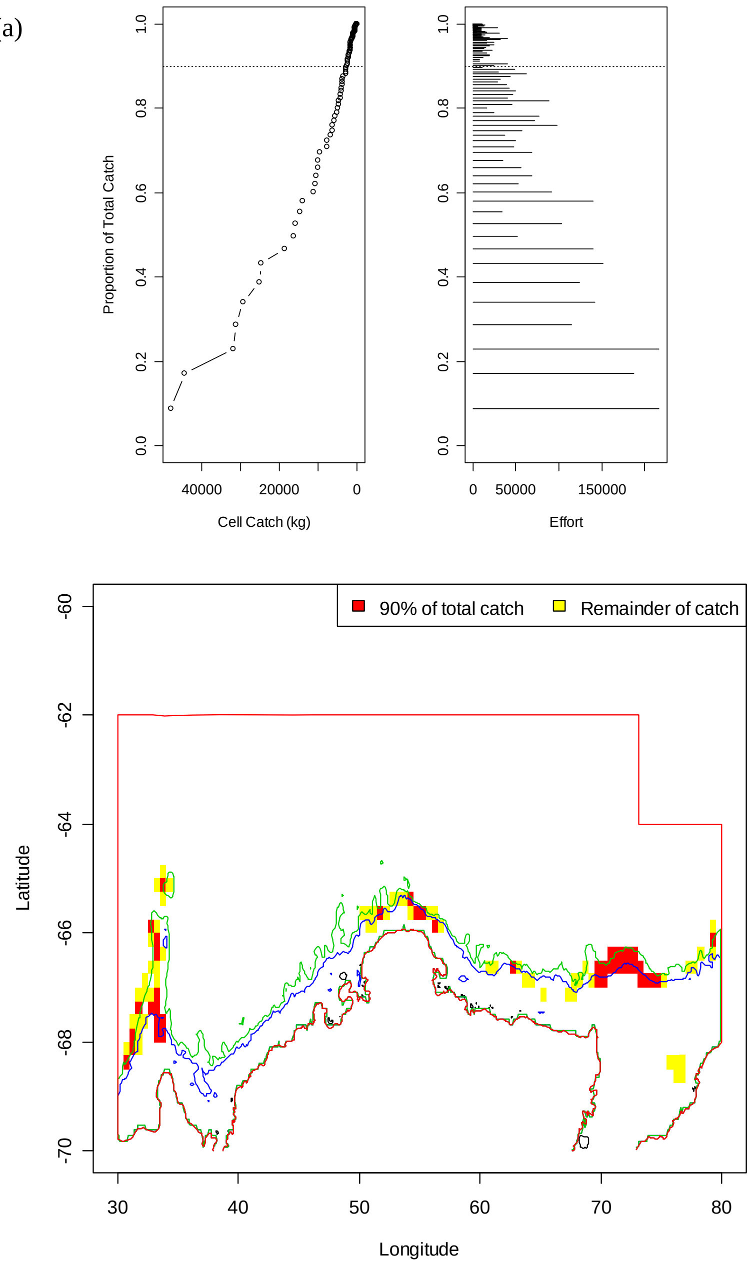

Figure 10*: Effective fishing footprint for longline fishing effort (hooks) in Division 58.4.2 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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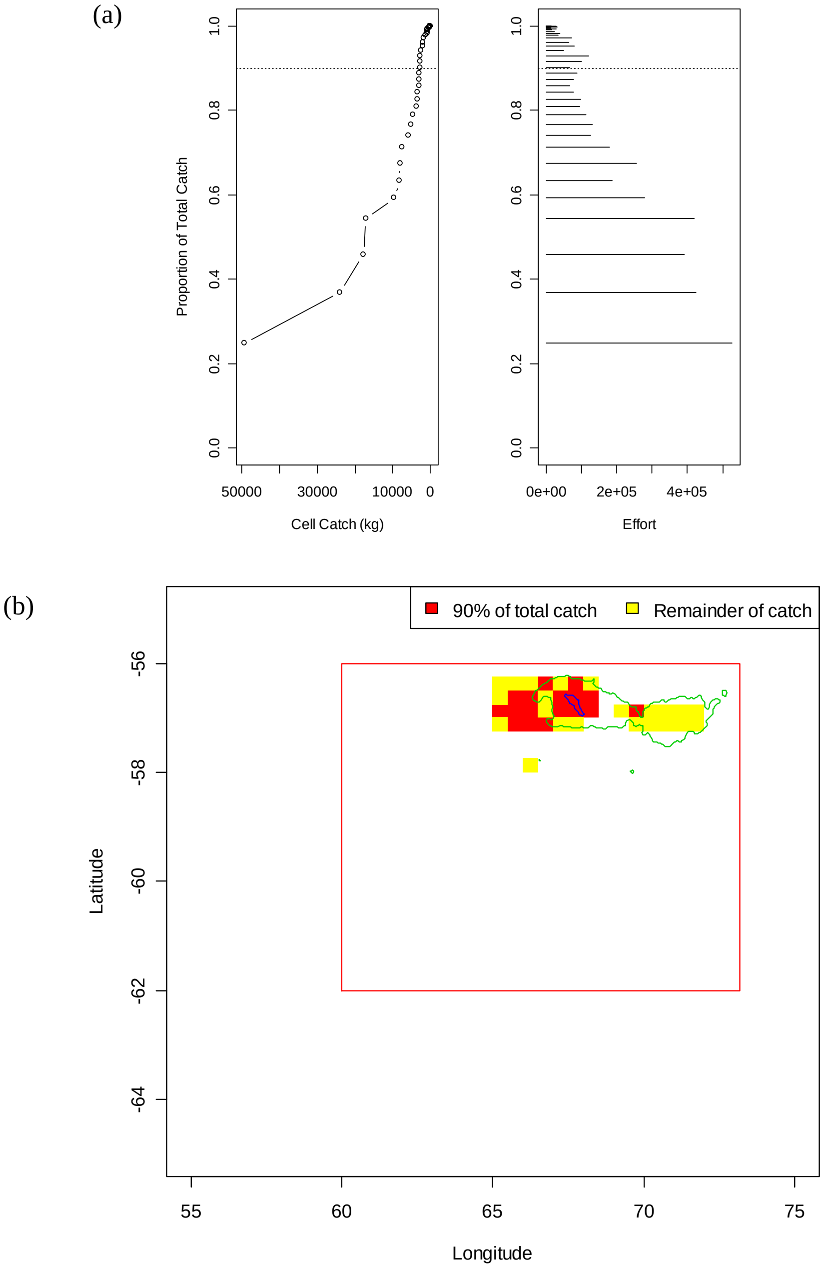

Figure 11*: Effective fishing footprint for longline fishing effort (hooks) in Division 58.4.3a (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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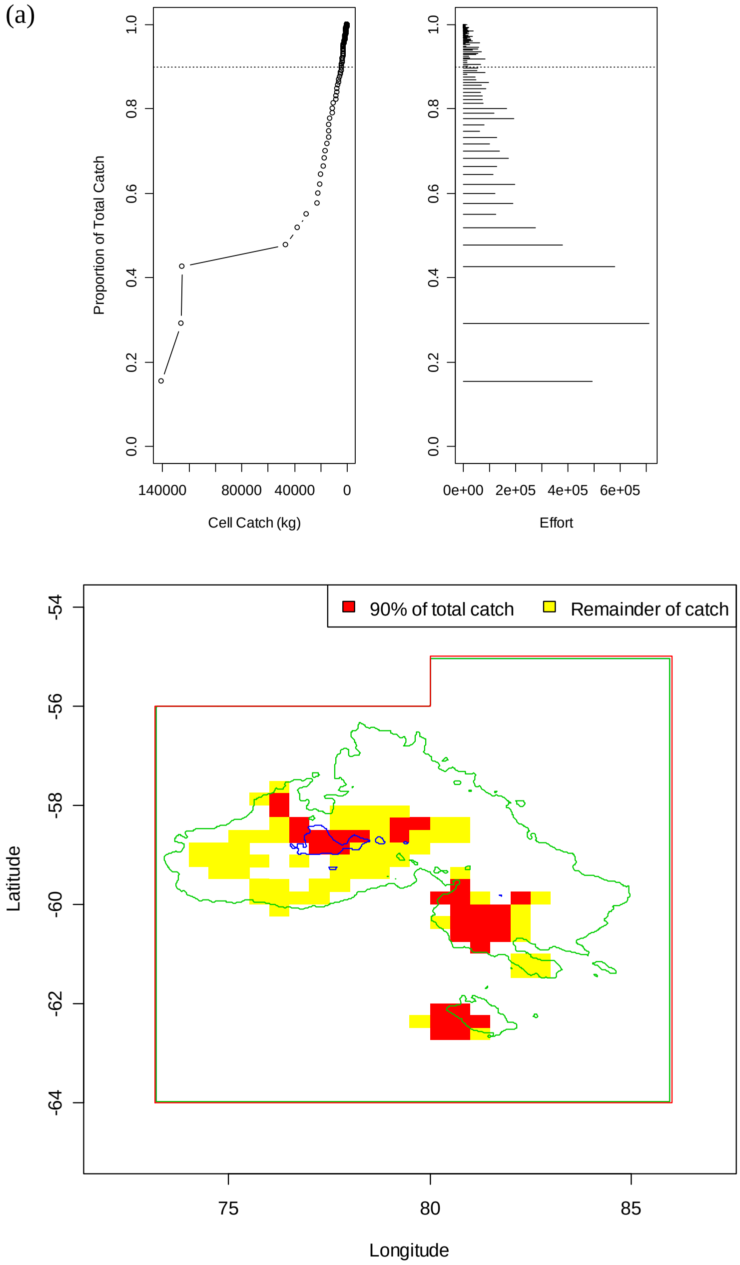

Figure 12*: Effective fishing footprint for longline fishing effort (hooks) in Division 58.4.3b (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing 1 000 m isobath (dark), 2 000 m isobath (light) and the statistical boundary (straight line). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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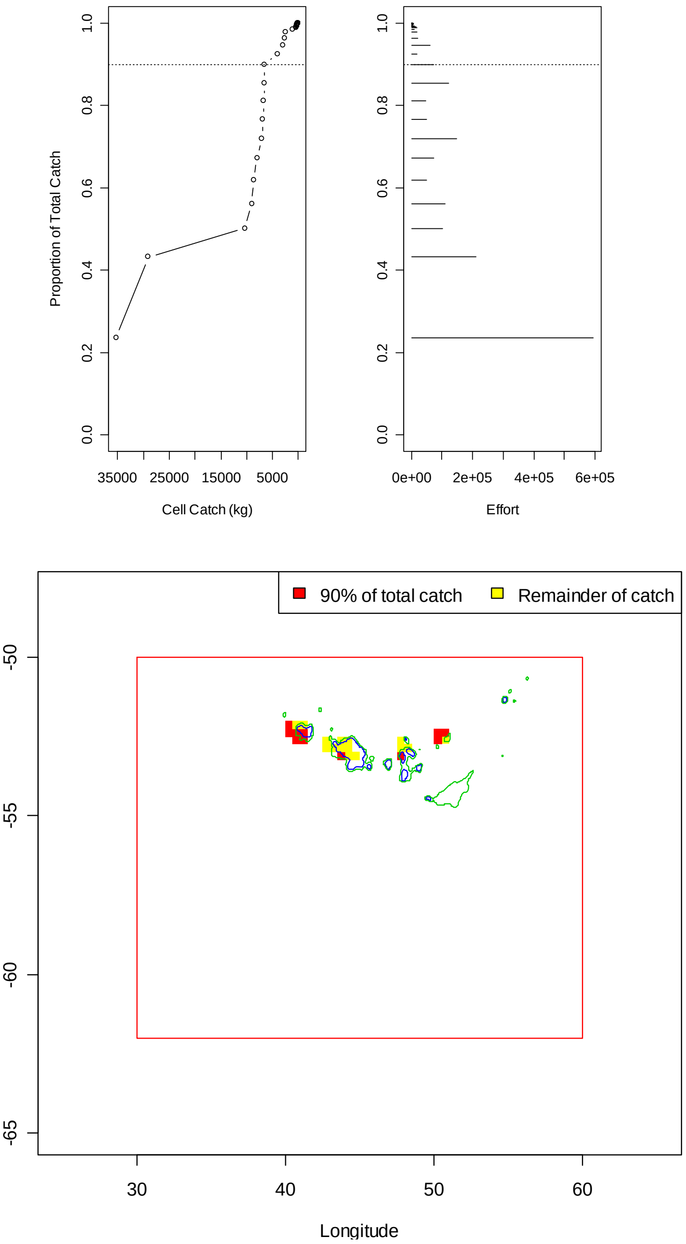

Figure 13*: Effective fishing footprint for longline fishing effort (hooks) in Division 58.4.4 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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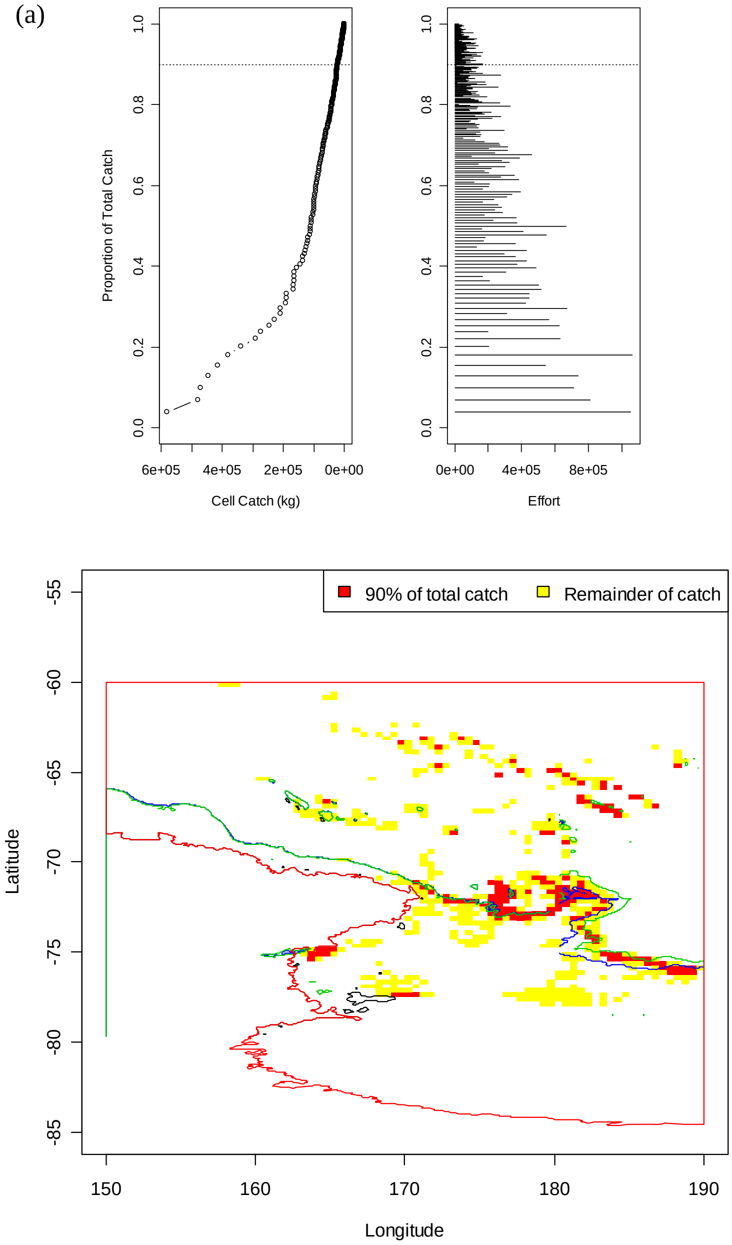

Figure 14*: Effective fishing footprint for longline fishing effort (hooks) in Subarea 88.1 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. A plot showing total effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

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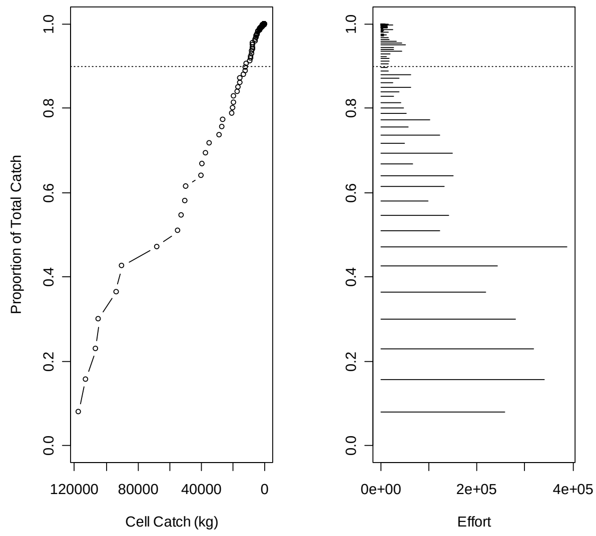
* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

(a)



(b)

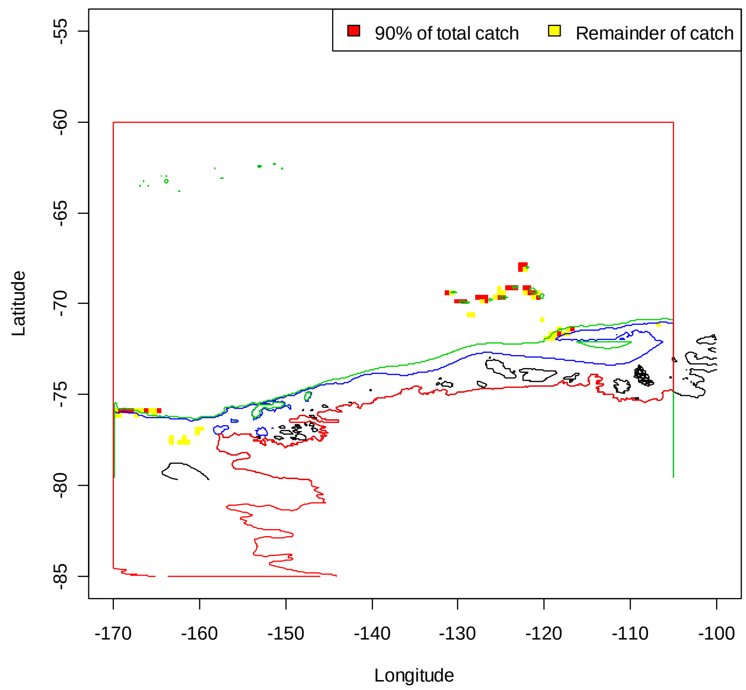


Figure 15*: Effective fishing footprint for longline fishing effort (hooks) in Subarea 88.2 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

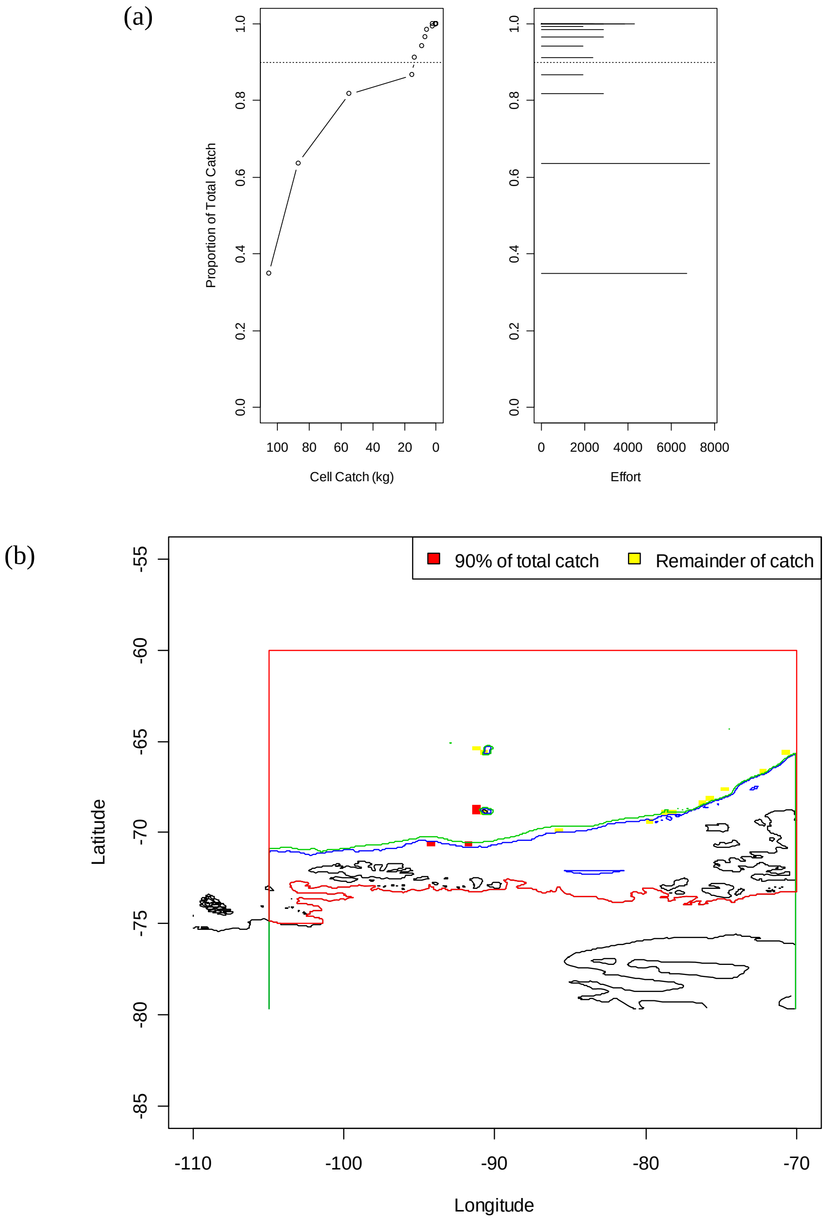


Figure 16*: Effective fishing footprint for longline fishing effort (hooks) in Subarea 88.3 (all years).

(a) Cumulative proportion for successively ranked cells of total catch of targeted species with cells ranked from highest to lowest (left panel). In the right panel, the total effort (hooks) in each cell is shown in a corresponding position on the y-axis. Dotted horizontal lines on both panels reflect the 90 percentile where the accumulated catch from all cells below the line contribute to 90% of the total catch of targeted species in the area over the sample period.

(b) Map showing coastline and islands (black), 1 000 m isobath (blue), 2 000 m isobath (green) and the statistical boundary (red). Cells are 0.25° latitude by 0.5° longitude. Relative effort in each cell is archived with the Secretariat. Cells contributing to 90% of the total catch of targeted species in the area are shown with red (dark) shading, with the outlier cells contributing to the remainder of the catch shown with yellow (light) shading.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

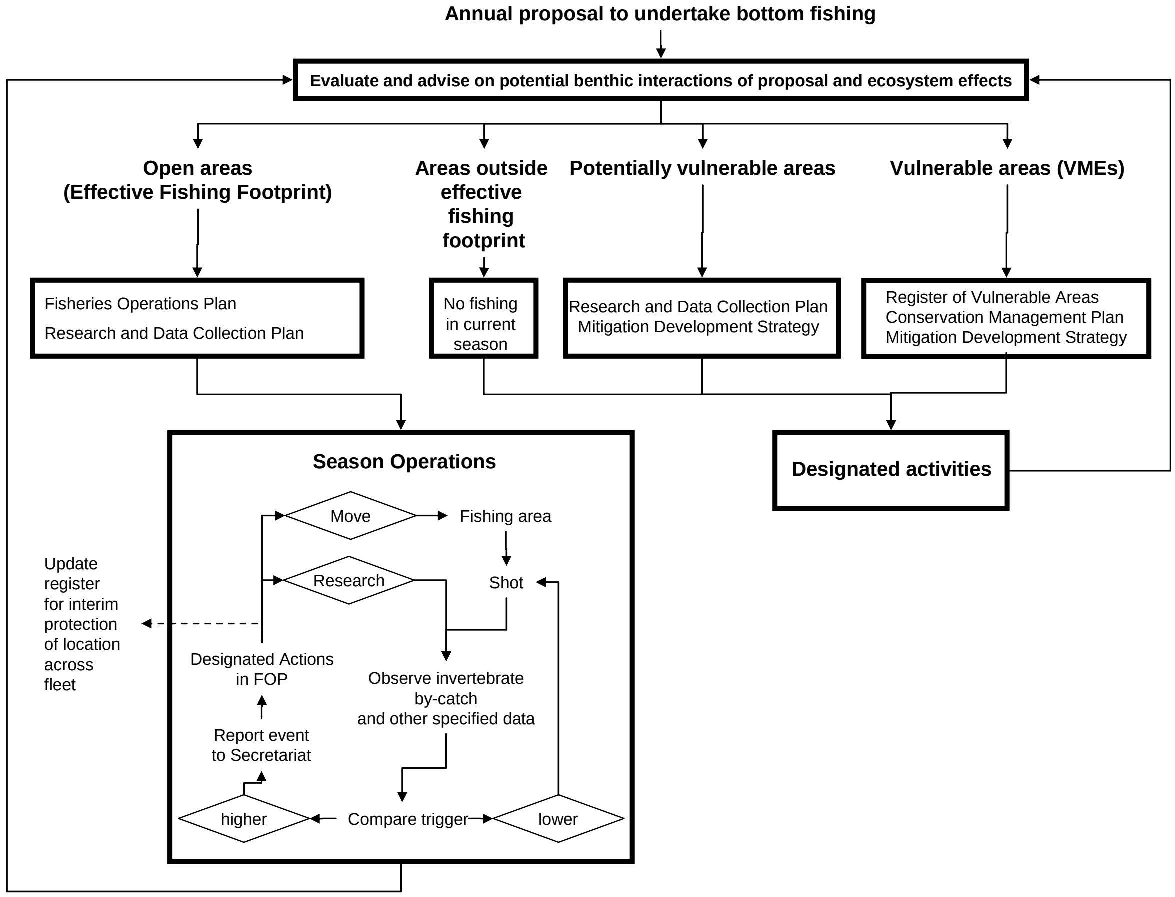


Figure 17: Draft annual procedure for managing bottom fisheries in high-seas areas of CCAMLR.

APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2007)

1. Opening of the meeting

2. Organisation of the meeting and adoption of the agenda

    2.1 Organisation of meeting

3. Review of available information

    3.1 Data requirements specified in 2006
        3.1.1 Development of the CCAMLR database
        3.1.2 Data processing
        3.1.3 Fishery plans

    3.2 Fisheries information
        3.2.1 Catch and effort data reported to CCAMLR
        3.2.2 Estimates of catch and effort from IUU fishing
        3.2.3 Catch and effort data for toothfish fisheries in waters adjacent to the Convention Area
        3.2.4 Scientific observer information

    3.3 Inputs for stock assessment
        3.3.1 Catch-at-length/age from fisheries
        3.3.2 Research surveys
        3.3.3 CPUE analyses
        3.3.4 Tagging studies
        3.3.5 Biological parameters
        3.3.6 Stock structure and management areas
        3.3.7 Depredation

4. Preparation for assessments and assessment timetable

    4.1 Report from Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)

    4.2 Report from the Working Group on Statistics, Assessments and Modelling (WG-SAM)

    4.3 Review of preliminary stock assessment papers

    4.4 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 2006/07
5.1.2 New and exploratory fisheries notified for 2007/08
5.1.3 Progress towards assessments of other exploratory fisheries
5.1.4 Update Fishery Report for Subarea 48.6
5.1.5 Update Fishery Reports for divisions in Subarea 58.4
5.1.6 Update Fishery Report for Subareas 88.1 and 88.2

5.2 Update Fishery Reports for the following assessed fisheries
5.2.1 *Dissostichus eleginoides* South Georgia (Subarea 48.3)
5.2.2 *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)
5.2.3 *Dissostichus eleginoides* Heard Island (Division 58.5.2)
5.2.4 *Dissostichus eleginoides* Crozet Islands (Subarea 58.6)
5.2.5 *Dissostichus eleginoides* Prince Edward and Marion Islands (Subarea 58.6/58.7)
5.2.6 *Champsocephalus gunnari* South Georgia (Subarea 48.3)
5.2.7 *Champsocephalus gunnari* Heard Island (Division 58.5.2)

5.3 Assessment and management advice for other fisheries
5.3.1 Antarctic Peninsula (Subarea 48.1) and South Orkney Islands (Subarea 48.2)
5.3.2 South Sandwich Islands (Subarea 48.4)
5.3.3 Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)
5.3.4 *Martialia hyadesi* (Subarea 48.3)

6. Fish and invertebrate by-catch

6.1 Assessment of the status of by-catch species and groups
6.2 Estimation of by-catch levels and rates
6.3 By-catch reporting
6.4 Assessment of risk
6.5 Mitigation measures

7. Incidental mortality of mammals and seabirds arising from fishing (ad hoc WG-IMAF Report)

8. Evaluation of the threats arising from IUU activities

8.1 Development of approaches for estimating total removals of toothfish
8.2 Review of historical trends in IUU activity

9. Biology, ecology and demography of target and by-catch species

9.1 Review information available to the meeting
9.2 Species profiles
9.3 CCAMLR otolith network

10. Considerations of ecosystem management

    10.1 Ecological interactions (e.g. multi-species, benthos, depredation etc.)
    10.2 Interactions with WG-EMM
    10.3 Development of ecosystem models

11. Scheme of International Scientific Observation

    11.1 Summary of information extracted from observer reports and/or provided by technical coordinators

    11.2 Implementation of observer program
        11.2.1 *Scientific Observers Manual*
        11.2.2 Sampling strategies
        11.2.3 Priorities

12. Future assessments
    12.1 Generic and specific work for developing assessments
    12.2 Frequency of future assessments

13. Future work

    13.1 Organisation of intersessional activities in subgroups
    13.2 Intersessional meetings

14. Other business
    14.1 Bottom fishing in CCAMLR high-seas areas
    14.2 Bioregionalisation

15. Adoption of the report

16. Close of the meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2007)

AGNEW, David (Dr)	Department of Biology Imperial College London Prince Consort Road London SW7 2BP United Kingdom d.agnew@imperial.ac.uk d.agnew@mrag.co.uk
BAKER, Barry (Mr)	ACAP Representative Latitude 42 Environmental Consultants 114 Watsons Road Kettering Tasmania 7155 Australia barry.baker@latitude42.com.au
BALL, Ian (Dr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia ian.ball@aad.gov.au
BIZIKOV, Viacheslav (DR)	VNIRO 17a V. Krasnoselskaya Moscow 107140 Russia bizikov@vniro.ru
CANDY, Steve (Dr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia steve.candy@aad.gov.au

CARRUTHERS, Tom (Dr)	MRAG 18 Queen Street London W1J 5PN United Kingdom t.carruthers@mrag.co.uk
COLLINS, Martin (Dr)	British Antarctic Survey Natural Environment Research Council High Cross, Madingley Road Cambridge CB3 0ET United Kingdom macol@bas.ac.uk
CONSTABLE, Andrew (Dr) (Co-Convener, WG-SAM)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia andrew.constable@aad.gov.au
DUNN, Alistair (Mr)	National Institute of Water and Atmospheric Research (NIWA) Private Bag 14-901 Kilbirnie Wellington New Zealand a.dunn@niwa.co.nz
FANTA, Edith (Dr) (Chair, Scientific Committee)	Departamento Biologia Celular Universidade Federal do Paraná Caixa Postal 19031 81531-970 Curitiba, PR Brazil e.fanta@terra.com.br
FENAUGHTY, Jack (Mr)	Silvifish Resources Ltd PO Box 17-058 Karori Wellington New Zealand 6147 jmfenaughty@clear.net.nz
GALES, Rosemary (Dr)	Biodiversity Conservation Branch Department of Primary Industries and Water GPO Box 44 Hobart Tasmania 7001 Australia rosemary.gales@dpiw.tas.gov.au

GASCO, Nicolas (Mr)	La taste 33880 Cambes France nicopec@hotmail.com
HADDON, Malcolm (Assoc. Prof.)	Tasmanian Aquaculture and Fisheries Institute University of Tasmania Marine Research Laboratories Nubeena Crescent Taroona Tasmania 7053 Australia malcolm.haddon@utas.edu.au
HANCHET, Stuart (Dr) (Convener)	National Institute of Water and Atmospheric Research (NIWA) PO Box 893 Nelson New Zealand s.hanchet@niwa.co.nz
HAY, Ian (Mr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia ian.hay@aad.gov.au
HEINECKEN, Chris (Mr)	CapFish PO Box 50035 Waterfront Cape Town 8002 South Africa chris@capfish.co.za
HEWITT, Tara (Ms)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia tara.hewitt@aad.gov.au

HILLARY, Richard (Dr)	Department of Biology Imperial College Royal School of Mines Building Prince Consort Road London SW7 2BP United Kingdom r.hillary@imperial.ac.uk
HOLT, Rennie (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA rennie.holt@noaa.gov
JONES, Christopher (Dr) (Co-Convener, WG-SAM)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA chris.d.jones@noaa.gov
KIM, Doo Nam (Dr)	National Fisheries Research and Development Institute (NFRDI) 408-1 Shirang-ri Kijang-up, Kijang-gun Busan 619-902 Republic of Korea dnkim@nfrdi.re.kr
KOCK, Karl-Hermann (Dr)	Federal Research Centre for Fisheries Institute for Sea Fisheries Palmaille 9 D-22767 Hamburg Germany karl-hermann.kock@ish.bfa-fisch.de
LEBOEUF, Nicole (Ms)	Office of International Affairs NOAA Fisheries 1315 East-West Highway Silver Spring, MA 20910 USA nicole.leboeuf@noaa.gov
LESLIE, Robin (Dr)	Marine and Coastal Management Private Bag X2 Roggebaai 8012 South Africa rwleslie@deat.gov.za

MCNEILL, Malcolm (Mr)	Sealord Group Ltd Vickerman Street PO Box 11 Nelson New Zealand mam@sealord.co.nz
MARTEAU, Cédric (Mr)	Legal Fisheries and Environmental Affairs Rue Gabriel Dejean 97410 Saint-Pierre La Réunion cédric.marteau@taaf.fr
MELVIN, Ed (Mr)	Washington Sea Grant University of Washington 206B Fishery Sciences Box 355020 Seattle, WA 98195-5020 USA emelvin@u.washington.edu
MITCHELL, Rebecca (Dr)	MRAG Ltd 18 Queen Street London W1J 5PN United Kingdom r.mitchell@mrag.co.uk
MIYAGAWA, Naohisa (Mr) (week 2)	Overseas Operations Group Southern Fishery Team TAFO (Taiyo A & F Co. Ltd) Toyomishinko Building 4-5, Toyomi-cho, Chuo-ku Tokyo Japan 104-0055 kani@tafco.maruha.co.jp
NAGANOBU, Mikio (Dr) (week 2)	Southern Ocean Living Resources Research Section National Research Institute of Far Seas Fisheries 2-2-14, Fukuura, Kanazawa Yokohama, Kanagawa Japan 236-8648 naganobu@affrc.go.jp
PARKES, Graeme (Dr) (from 16th)	MRAG Ltd 18 Queen Street London W1J 5PN United Kingdom g.parkes@mrag.co.uk

PIERRE, Johanna (Dr)	Marine Conservation Unit PO Box 10-420 Wellington New Zealand 6143 jpierre@doc.govt.nz
PSHENICHNOV, Leonid (Dr)	YugNIRO Sverdlov str., 2 983000 Kerch Ukraine lkp@bikent.net
RIVERA, Kim (Ms) (Co-convener, WG-IMAF)	National Marine Fisheries Service PO Box 21668 Juneau, AK 99802 USA kim.rivera@noaa.gov
ROBERTSON, Graham (Dr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia graham.robertson@aad.gov.au
SHUST, Konstantin (Dr)	VNIRO 17a V. Krasnoselskaya Moscow 107140 Russia antarctica@vniro.ru kshust@vniro.ru
SMITH, Neville (Mr) (Co-convener, WG-IMAF)	Ministry of Fisheries PO Box 1020 Wellington New Zealand neville.smith@fish.govt.nz
SULLIVAN, Ben (Dr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia ben.sullivan@rspb.org.uk

WALKER, Nathan (Mr)

Ministry of Fisheries
PO Box 1020
Wellington
New Zealand
nathan.walker@fish.govt.nz

WAUGH, Susan (Dr)

Sextant Technology Ltd
116 Wilton Road
Wilton
Wellington 6012
New Zealand
s.waugh@sextant-technology.net

WELSFORD, Dirk (Dr)

Australian Antarctic Division
Department of the Environment
and Water Resources
203 Channel Highway
Kingston Tasmania 7050
Australia
dirk.welsford@aad.gov.au

SECRETARIAT

Executive Secretary	Denzil Miller
General Office Administrator	Rita Mendelson
Conference Facilitator/ General Office Administrator	Robyn Miller
Science/Compliance and Enforcement	
Science/Compliance Officer	Eugene Sabourenkov
Scientific Observer Data Analyst	Eric Appleyard
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Communications	
Communications Officer	Genevieve Tanner
Publications and Website Assistant	Doro Forck
French Translator/Team Coordinator	Gillian von Bertouch
French Translator	Bénédicte Graham
French Translator	Floride Pavlovic
French Translator	Michèle Roger
Russian Translator/Team Coordinator	Natalia Sokolova
Russian Translator	Ludmila Thornett
Russian Translator	Vasily Smirnov
Spanish Translator/Team Coordinator	Anamaría Merino
Spanish Translator	Margarita Fernández
Spanish Translator	Marcia Fernández
Website and Information Services	
Website and Information Services Officer	Rosalie Marazas
Information Services Assistant	Philippa McCulloch
Information Technology	
Information Technology Manager	Fernando Cariaga
Information Technology Support Specialist	Tim Byrne

APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2007)

WG-FSA-07/1	Provisional Agenda and Provisional Annotated Agenda for the 2007 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-07/2	List of participants
WG-FSA-07/3	List of documents
WG-FSA-07/4	CCAMLR fisheries: 2007 update Secretariat
WG-FSA-07/5	CCAMLR tagging program Secretariat
WG-FSA-07/6 Rev. 1	A summary of observations on board longline vessels operating within the CCAMLR Convention Area during the 2006/07 season Secretariat
WG-FSA-07/7 Rev. 1	Summary of observations aboard trawlers operating in the Convention Area during the 2006/07 season Secretariat
WG-FSA-07/8 Rev. 1	A summary of scientific observations related to Conservation Measures 25-02 (2005), 25-03 (2003) and 26-01 (2006) Secretariat
WG-FSA-07/9	Summary of an observation aboard a pot vessel operating in the Convention Area during the 2006/07 season Secretariat
WG-FSA-07/10 Rev. 5	Estimation of IUU catches of toothfish inside the Convention Area during the 2006/07 fishing season Secretariat
WG-FSA-07/11	Brief report on scientific observation on the fishery vessel *Simeiz* (FAO Statistical Area 41, November 2006 to March 2007) A.K. Zaytsev (Ukraine)
WG-FSA-07/12	Species profile of mackerel icefish (*Champsocephalus gunnari*) K.-H. Kock (Germany) and I. Everson (UK)

WG-FSA-07/13	Autoliners and seabird by-catch: do line setters increase the sink rate of integrated weight longlines? G. Robertson (Australia), J. Williamson, M. McNeill (New Zealand), S. Candy (Australia) and N. Smith (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-07/14	A new fishing gear in the Chilean Patagonian toothfish fishery to minimise interactions with toothed whales with associated benefits to seabird conservation C.A. Moreno, R. Castro, L.J. Mujica and P. Reyes (Chile) (*CCAMLR Science*, submitted)
WG-FSA-07/15	Line weights of constant mass (and sink rates) for Spanish-rig Patagonian toothfish longline vessels G. Robertson (Australia), C.A. Moreno, E. Gutiérrez (Chile), S.G. Candy (Australia), E.F. Melvin (USA) and J.P. Seco Pon (Argentina) (*CCAMLR Science*, submitted)
WG-FSA-07/16	Biomass abundance and distribution of fish in the Kerguelen Islands' zone (Division 58.5.1) G. Duhamel and M. Hautecoeur (France) (Available in French and English) (*CCAMLR Science*, submitted)
WG-FSA-07/17	Proposal to extend the fishing season for longline fishing in CCAMLR Statistical Division 58.5.2 I. Hay (Australia)
WG-FSA-07/18	Effect of two natural repellents on the depredation of mackerel baits by white-chinned petrels (*Procellaria aequinoctialis*) N. Gasco (France) and J.P. Pierre (New Zealand)
WG-FSA-07/19	Experience with seabird by-catch limits in a trial of longline fishing in the Macquarie Island toothfish fishery T. Hewitt and I. Hay (Australia)
WG-FSA-07/20	Educational poster on hook ingestion G. Robertson (Australia)
WG-FSA-07/21	Biology and distribution of South Georgia icefish (*Pseudochaenichthys georgianus*) around South Georgia and Shag Rocks S. Clarke, W.D.K. Reid, M.A. Collins and M. Belchier (United Kingdom)

WG-FSA-07/22	Composition and standing stock estimates of finfish from the *Polarstern* bottom trawl survey around Elephant Island and the South Shetland Islands (Subarea 48.1, 19 December 2006 to 3 January 2007) K.-H. Kock, J. Appel, M. Busch, S. Klimpel, M. Holst, D. Pietschok (Germany), L.V. Pshenichnov (Ukraine), R. Riehl, S. Schöling (Germany)
WG-FSA-07/23	Interaction of sperm whales with bottom longline and the Mammal and Bird Excluding Device (MBED) operation in the Patagonian toothfish (*Dissostichus eleginoides*) fishery in the southwestern Atlantic O. Pin and E. Rojas (Uruguay) (In Spanish, title and abstract available in English) (*CCAMLR Science*, submitted)
WG-FSA-07/24	Mercury concentrations of five species of Antarctic fish collected from CCAMLR Subareas 88.1 and 88.2 S.M. Hanchet, D.M. Tracey, A. Dunn, P.L. Horn and N. Smith (New Zealand)
WG-FSA-07/25	Biological parameters for icefish (*Chionobathyscus dewitti*) in the Ross Sea, Antarctica C.P. Sutton, M.J. Manning, D.W. Stevens, P.M. Marriott (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-07/26	Major Outcomes from the Third Meeting of ACAP's Advisory Committee ACAP Secretariat
WG-FSA-07/27	Identification and speciation of Antarctic skates P.J. Smith, C.D. Roberts, A.L. Stewart, M. McVeagh and C.D. Struthers (New Zealand)
WG-FSA-07/28	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2006/07 S.M. Hanchet, M.L. Stevenson and A. Dunn (New Zealand)
WG-FSA-07/29	Preliminary assessment of the South Georgia toothfish stock, 2007 D.J. Agnew, R. Hillary and J. Pearce (United Kingdom)
WG-FSA-07/30	Proposal for further trials aimed at reducing *Macrourus* spp. by-catch on autoliners targeting *D. eleginoides* with longlines around South Georgia Delegation of the United Kingdom

WG-FSA-07/31	Proposal for trials to test modified longline gear as a means to reduce cetacean depredation and mitigate incidental bird catch Delegation of the United Kingdom
WG-FSA-07/32	Results of the tagging experiment for (*D. eleginoides*) in Subarea 48.4, 2007 update J. Roberts and D.J. Agnew (United Kingdom)
WG-FSA-07/33	Preliminary trials to test mitigation measures aimed at reducing *Macrourus* spp. by-catch on autoliners targeting *D. eleginoides* with longlines in the CCAMLR Convention Area R.E. Mitchell, D.J. Agnew, T. Carruthers, J. Clark, L. Ross (United Kingdom) and J. van Heerden (South Africa)
WG-FSA-07/34 Rev. 1	2007 assessment of the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity A. Brandão and D.S. Butterworth (South Africa)
WG-FSA-07/35	A hypothetical life cycle for Antarctic toothfish *Dissostichus mawsoni* in Antarctic waters of CCAMLR Statistical Area 88 S.M. Hanchet, G.J. Rickard, J.M. Fenaughty, A. Dunn and M.J. Williams (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-07/36	Tagging larger toothfish, methods and equipment J.M. Fenaughty (New Zealand)
WG-FSA-07/37	Assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea including data from the 2006/07 season A. Dunn and S.M. Hanchet (New Zealand)
WG-FSA-07/38 Rev. 2	The morphology of Antarctic toothfish (*Dissostichus mawsoni* Norman 1937) males and females and new data on its gonad structure in the Ross Sea in the summer period S.V. Piyanova and N.V. Kokorin (Russia)
WG-FSA-07/39	Preparing for the Year of the Skate: proposed information collection and tagging protocol for skates S. Mormede, A. Dunn, J. Fenaughty, M. Francis, S. Hanchet, R. O'Driscoll and N. Smith (New Zealand)
WG-FSA-07/40	An updated descriptive analysis of the toothfish (*Dissostichus* spp.) tagging program in Subareas 88.1 and 88.2 for 2006/07 A. Dunn, S.M. Hanchet and S.L. Ballara (New Zealand)
WG-FSA-07/41	Field identification guide to the main fishes caught in the Ross Sea longline fishery P.J. McMillan, P. Marriott, S.M. Hanchet, J.M. Fenaughty, E. Mackay and H. Sui (New Zealand)

WG-FSA-07/42	Mincing, mealing and batching: waste management strategies aimed at reducing seabird interactions with trawl vessels E. Abraham and J. Pierre (New Zealand)
WG-FSA-07/43	Preliminary results of testing of PIT-D device at deepwater longline fishery of Antarctic toothfish (*D. mawsoni*) in the Ross Sea during the fishing season of 2006/07 N.V. Kokorin, V.V. Bulanov and V.V. Krjukov (Russia)
WG-FSA-07/44	Preliminary assessment of the exploratory fishery for *Dissostichus* spp. on BANZARE Bank (Division 58.4.3b), based on the analysis of fine-scale catch and effort data J.P. McKinlay, D.C. Welsford, A.J. Constable and G.B. Nowara (Australia) (*CCAMLR Science*, submitted)
WG-FSA-07/45	Summary of holdings of Patagonian toothfish (*Dissostichus eleginoides*) otoliths and size-at-age estimates from Heard and McDonald Islands (Division 58.5.2) D.C. Welsford and G.B. Nowara (Australia)
WG-FSA-07/46	Report on a random stratified trawl survey to estimate distribution and abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* conducted in the Heard Island region (Division 58.5.2), May–June 2007 G.B. Nowara and T. Lamb (Australia)
WG-FSA-07/47	Preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Heard Island and McDonald Islands (Division 58.5.2), based on a survey in July 2007, using the generalised yield model D.C. Welsford (Australia)
WG-FSA-07/48 Rev. 1	Overview and update of Australia's scientific tagging program in the Patagonian toothfish (*Dissostichus eleginoides*) fishery in the vicinity of Heard and McDonald Islands (Division 58.5.2) D.C. Welsford, T. Lamb and G.B. Nowara (Australia)
WG-FSA-07/49	Results of study of the oogenesis characteristics of Antarctic toothfish (*Dissostichus mawsoni* Norman 1937) (Nototheniidae) from Subareas 88.1 and 88.2 (Ross Sea) S. V. Piyanova and A.F. Petrov (Russia)
WG-FSA-07/50	Description of the most important species of finfish and cephalopods in diet of Antarctic toothfish (*Dissostichus mawsoni* Norman, 1937) (Perciformes, Nototheniidae), in the Amundsen Sea in 2006–2007 A.F. Petrov and J.A. Filippova (Russia)

WG-FSA-07/51	Integrated weight longlines: potential for reduction of skate by-catch in demersal longline fisheries K. Dietrich and E. Melvin (USA)
WG-FSA-07/52	Long-term changes in the size composition of fjord *Notothenia rossii, Gobionotothen gibberifrons* and *Notothenia coriiceps* at Potter Cove, after the 1978–1980 fishery in the area E.R. Marschoff, E.R. Barrera-Oro and N.S. Alescio (Argentina)
WG-FSA-07/53 Rev. 1	An integrated stock assessment for the Patagonian toothfish (*Dissostichus eleginoides*) in Division 58.5.2 using CASAL S.G. Candy and A.J. Constable (Australia) (*CCAMLR Science*, submitted)
WG-FSA-07/54	Revision of the CCAMLR *Scientific Observers Manual* S. Kawaguchi (Australia) and E. Appleyard (CCAMLR Secretariat)
WG-FSA-07/55	Spawning periods and locations of *Champsocephalus gunnari* in Subarea 48.3 (South Georgia and Shag Rocks): a review S. Clarke, M. Belchier and M.A. Collins
WG-FSA-07/56	Preliminary report of the UK winter icefish survey, South Georgia (CCAMLR Subarea 48.3), 27 August to 21 September 2007 M. Belchier, M.A. Collins, J. Moir-Clark, S. Fielding, J. Lawson, C. Main and A. Pande (United Kingdom)
WG-FSA-07/57 Rev. 1	BirdLife International Global Procellariiform Tracking Database B. Sullivan (BirdLife International)
WG-FSA-07/58	Stones in toothfish stomachs: an unusual source of geological information from closed regions of Antarctic shelf and slope N.V. Kokorin, D.S. Klucharev and M.A. Sukhoruchenkov (Russia)

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WG-FSA-07/P1	The biology of the spiny icefish (*Chaenodraco wilsoni* Regan, 1914) K.-H. Kock, L.V. Pshenichnov, C.D. Jones, J. Gröger and R. Riehl. (*Polar Biol.*, 31 (3): 381–393 (2007))
WG-FSA-07/P2	CCAMLR process of risk assessment to minimise the effects of longline fishing mortality on seabirds S.M. Waugh, G.B. Baker, R. Gales and J.P. Croxall (*Mar. Pol.*, in press)

WG-FSA-07/P3	Distribution, growth, diet and foraging behaviour of the yellow-fin notothen (*Patagonotothen guntheri*) on the Shag Rocks shelf (Southern Ocean) M.A. Collins, R. Shreeve, S. Fielding and M. Thurston (*J. Fish Biol.*, 72 (1): 271–286 (2008))
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CCAMLR-XXVI/12	Summary of notifications for new and exploratory fisheries 2007/08 Secretariat
CCAMLR-XXVI/13	Notifications of Argentina's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Argentina
CCAMLR-XXVI/14	Notifications of Australia's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Australia
CCAMLR-XXVI/15	Notifications of Japan's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Japan
CCAMLR-XXVI/16	Notifications of the Republic of Korea's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of the Republic of Korea
CCAMLR-XXVI/17	Notifications of Namibia's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Namibia

CCAMLR-XXVI/18	Notifications of New Zealand's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of New Zealand
CCAMLR-XXVI/19	Notifications of Russia's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Russia
CCAMLR-XXVI/20	Notification of South Africa's intention to conduct an exploratory longline fishery for *Dissostichus* spp. in 2007/08 Delegation of South Africa
CCAMLR-XXVI/21	Notifications of Spain's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Spain
CCAMLR-XXVI/22	Notifications of Ukraine's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Ukraine
CCAMLR-XXVI/23	Notifications of the United Kingdom's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of the United Kingdom
CCAMLR-XXVI/24	Notifications of Uruguay's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in 2007/08 Delegation of Uruguay
CCAMLR-XXVI/27	Reporting and communicating of longline sink rates Delegation of Australia
CCAMLR-XXVI/37	Proposed amendments to conservation measures regulating new and exploratory fisheries Delegation of Ukraine
CCAMLR-XXVI/BG/17	Implementation of fishery conservation measures in 2006/07 Secretariat
SC-CAMLR-XXVI/5	Report of the Working Group on Statistics, Assessments and Modelling (Christchurch, New Zealand, 9 to 13 July 2007)
SC-CAMLR-XXVI/6	Comments on the Scientific Committee's recommendations regarding bird mortality Delegation of France
SC-CAMLR-XXVI/8	A proposal to revise the limitation of Macrourus by-catch in new and exploratory fisheries Delegation of Japan

SC-CAMLR-XXVI/9	Notification for research vessel activity in Divisions 58.4.4a and 58.4.4b Delegation of Japan
SC-CAMLR-XXVI/10	Bottom fishing in high-seas areas of CCAMLR Delegations of Australia and USA
SC-CAMLR-XXVI/BG/2	Report of the Third Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Cambridge, UK, 30 April to 2 May 2007)
SC-CAMLR-XXVI/BG/6	Report of the Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA) (Christchurch, New Zealand, 16 July 2007)
SC-CAMLR-XXVI/BG/9 Rev. 1	A review of national observer training and education programs (Scheme of International Scientific Observation) Secretariat
SC-CAMLR-XXVI/BG/21	Note sur l'étude des effets environnementaux, spatiaux, temporels et opérationnels sur la mortalité accidentelle des oiseaux dans la pêcherie à la palangre dans les secteurs de Crozet et Kerguelen en 2003–2006 Délégation française (In French, with English abstract and figure and table legends)
SC-CAMLR-XXVI/BG/22	Note sur l'étude d'évaluation de l'impact des pêcheries sur les populations de pétrels à menton blanc *Procellaria aequinoctialis* et de pétrels gris *Procellaria cinerea* aux îles Crozet et Kerguelen Délégation française (In French, with English abstract and figure and table legends)
SC-CAMLR-XXVI/BG/27	Antarctic seafloor geomorphology as a guide to benthic bioregionalisation Delegation of Australia
SC-CAMLR-XXVI/BG/28	CCAMLR Bioregionalisation Workshop (Brussels, Belgium 13 to 17 August 2007) Update of benthic bioregionalisation of the Southern Ocean Co-conveners, CCAMLR Bioregionalisation Workshop
WG-SAM-07/4	Preliminary investigations of an assessment model for skates and rays in the Ross Sea A. Dunn, S.M. Hanchet, S.L. Ballara and M.P. Francis (New Zealand)
WG-SAM-07/9	Update of the Antarctic toothfish stock assessment for the Ross Sea by means of the TSVPA separable cohort model D. Vasilyev, K. Shust, V. Babayan and T. Bulgakova (Russia)

WG-EMM-07/32	A guide to identification of fishes caught along with the Antarctic krill T. Iwami and M. Naganobu (Japan)
WS-BSO-07/10 Rev. 1	On biogeographic patterns of benthic invertebrate megafauna on shelf areas of the Southern Ocean Atlantic sector S.J. Lockhart and C.D. Jones (USA)

Appendices D–Q (Fishery Reports) are only available electronically at:
www.ccamlr.org/pu/e/e_pubs/fr/drt.htm

ANNEX 6

REPORT OF THE AD HOC WORKING GROUP ON INCIDENTAL MORTALITY ASSOCIATED WITH FISHING

Part I
Ad Hoc WG-IMAF Advice to the Scientific Committee
(compiled by the Co-conveners of Ad Hoc WG-IMAF)

Part II
Report of Ad Hoc WG-IMAF
(Hobart, Australia, 8 to 12 October 2007)

PART I

AD HOC WG-IMAF ADVICE TO THE SCIENTIFIC COMMITTEE
(Compiled by the Co-conveners of Ad Hoc WG-IMAF)

CONTENTS

PART I

AD HOC WG-IMAF ADVICE TO THE SCIENTIFIC COMMITTEE
(Compiled by the Co-conveners of Ad Hoc WG-IMAF)

GENERAL
(see also Part II, paragraphs 1 to 5)

I.1 The plan of intersessional work for 2007/08 (Part II, Table 21) summarises requests to Members and others for information of relevance to the work of the Working Group (Part II, paragraphs 1 to 3). Members are particularly invited to review the membership of the Working Group, to suggest additional members and to facilitate attendance of their representatives at meetings, especially technical coordinators and South American Members (Part II, paragraphs 4 to 5).

INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS
IN FISHERIES IN THE CONVENTION AREA
(see also Part II, paragraphs 6 to 44)

Seabirds in longline fisheries

I.2 The total number of observed seabird mortalities in longline fisheries in 2006/07, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, was zero. This compared to two birds estimated killed, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, in 2005/06 (Part II, Table 2). When seabird mortalities reported from the French EEZs in Subarea 58.6 and Division 58.5.1 are included, the total extrapolated seabird mortalities during longline fishing operations in 2006/07 were estimated to be 2 257. This estimate includes 313 seabirds in Subarea 58.6 and 1 944 seabirds in Division 58.5.1 (Part II, Table 5). For the second time no albatrosses were observed captured in longline fisheries in the Convention Area (Part II, Tables 2 and 3).

I.3 The total number of seabirds observed caught and released uninjured, except for in the French EEZs in Subarea 58.6 and Division 58.5.1, was seven (Part II, Table 1) down from 32 in 2005/06 (SC-CAMLR-XXV, Annex 5, paragraph 7.3). The total number of seabirds observed caught and released uninjured in the French EEZs in Subarea 58.6 and Division 58.5.1 was 212 (Part II, Table 3) down from 258 in 2005/06 (SC-CAMLR-XXV, Annex 5, Appendix D, Table 4). The Working Group noted that the incidence of birds being caught injured and uninjured (i.e. birds that are caught on the haul), except for in the French EEZs in Subarea 58.6 and Division 58.5.1, accounted for all seabird captures in 2006/07 (Part II, Table 1). As last year, and in combination with the data from the French EEZs in Subarea 58.6 and Division 58.5.1, this proportion of seabirds caught on the haul suggests that an increased focus on haul mitigation measures is required (SC-CAMLR-XXV, Annex 5, paragraph 7.3).

French EEZs in Subarea 58.6 and Division 58.5.1

I.4 In 2006/07, data were available from 18 cruises in Subarea 58.6 and 22 cruises in Division 58.5.1. The proportion of hooks observed was 25.52 and 25.26% respectively (Part II, paragraph 14). In 2006/07 the total reported seabird mortality from observers for Subarea 58.6 and Division 58.5.1 was 80 and 491 birds respectively (Part II, Table 4). The corresponding incidental mortality rates were 0.0650 and 0.0798 birds/thousand hooks. The extrapolated total seabird mortalities for Subarea 58.6 and Division 58.5.1 were 313 and 1 944 respectively (Part II, Table 5). All vessels in the French EEZs were autoliners using 50 g m^{-1} IWLs in 2006/07. Two out of seven vessels caught 87.5% of the birds in Subarea 58.6, and in Division 58.5.1, 63% of captures were by three out of seven vessels. This may indicate that there are individual vessel effects that need to be examined to further reduce seabird captures in these areas (Part II, paragraph 14).

I.5 Similar to last year, the Working Group noted that 32% of seabirds captured were caught alive (28% in 2005/06), indicating that they were taken on the haul (Part II, Table 3). This re-emphasises a need to focus on haul mitigation measures to reduce the remaining seabird by-catch in these fisheries (Part II, paragraph 15).

I.6 The Working Group recognised that France has continued to reduce its total seabird by-catch each successive year and noted the efforts made to achieve this result in 2006/07 (a 13% decrease from the combined total estimated by-catch for Subarea 58.6 and Division 58.5.1 in the previous season). However, concern was expressed by the Working Group about the current level of seabird captures, noting that white-chinned petrels, which form a substantial proportion of the by-catch (Part II, Table 7), are globally threatened (Part II, paragraph 16).

I.7 The Working Group recommended that France strives to eliminate the incidental mortality of seabirds in accordance with CCAMLR policies and practices (SC-CAMLR-XVII, paragraph 4.71; Conservation Measure 25-02) (Part II, paragraph 17).

I.8 The Working Group acknowledged that some of the recommendations made by the Scientific Committee in 2006 regarding future research and monitoring of French seabird captures were again addressed (Part II, paragraphs 18 to 21) and noted that the following remain for 2007 (Part II, paragraphs 19 to 22). The Working Group recommended that:

(i) consideration be given to using observers to collect additional data describing fishing activity and mitigation measures (Part II, paragraph 19);

(ii) a detailed analysis of petrel population responses to fisheries and environmental factors be submitted for review to WG-SAM, and that WG-SAM report on the review to ad hoc WG-IMAF in 2008 (Part II, paragraph 20);

(iii) all relevant raw by-catch data be submitted in the appropriate format, as is done for other Convention Area subareas and divisions, to allow reporting on the total seabird by-catch for the entire Convention Area (Part II, paragraph 21);

(iv) analyses to address high capture rates on a few vessels, specifically addressing operational problems in the fishery, be conducted (Part II, paragraph 22).

I.9 To further address the only remaining significant incidental mortality of seabirds in longline fisheries in the Convention Area, the Working Group recommended that France:

(i) consider broadening the set of mitigation measures used, particularly during the haul (Part II, paragraphs 25 to 26);

(ii) work closely with ad hoc WG-IMAF participants to facilitate further research into the nature of seabird captures and consider experimental trials (Part II, paragraph 27);

(iii) utilise analyses of the factors that led to seabird by-catch within its EEZs to improve the direction of management actions intended to reduce seabird by-catch (Part II, paragraph 29);

(iv) urgently submit a strategic plan to eliminate seabird mortality which includes details of the implementation targets for recommended mitigation devices, establishment of by-catch targets reducing each year to near-zero levels in less than three years, and the implementation of additional seasonal and area closures if targets are not met (Part II, paragraph 30);

(v) submit a detailed paper describing the full set of regulatory instruments in place to reduce seabird mortality directly or indirectly (Part II, paragraph 31).

Seabirds in trawl fisheries

I.10 The percentage of trawl effort observed in 2006/07 for the Subarea 48.3 icefish fishery and the Division 58.5.2 toothfish/icefish fishery was 89% (100% of vessels) and 93% (100% of vessels) respectively. In the krill fishery, 17% of vessels fishing in Subarea 48.1, 20% of vessels fishing in Subarea 48.2 and 50% of vessels fishing in Subarea 48.3 had observers on board at some time during their fishing trips (Part II, paragraphs 33, 36 and 38). The Working Group reiterated its 2006 recommendation that coverage of the krill fishery be increased to allow for adequate and representative sampling across all trawl fisheries for monitoring of by-catch and efficacy of mitigation measures (SC-CAMLR-XXV, Annex 5, paragraph 7.8).

I.11 The Working Group noted a substantial drop in seabird mortalities reported in the icefish fishery in Subarea 48.3 (Part II, paragraph 35). In 2007, 6 seabirds, including albatross and petrel species, were observed killed in the Subarea 48.3 icefish trawl fishery, and another 3 released alive and uninjured (Part II, Table 11). The mortalities included 3 black-browed albatrosses, 2 white-chinned petrels and 1 grey-headed albatross and were reported from five vessels. This compares to 33 bird mortalities (and 14 released alive) in 2006. The rate of mortality in this subarea in 2007 was 0.07 birds per trawl compared to 0.07, 0.14 and 0.37 in 2006, 2005 and 2004 respectively (Part II, paragraph 34 and Table 12). There were two seabird mortalities observed in the Division 58.5.2 trawl fishery (both Cape petrels) (Part II, Table 11), an increase from the zero mortality in 2006 but below the level observed in 2005 (Part II, Table 12).

I.12 The Working Group noted that no seabird mortality was recorded on the *Saga Sea* while fishing with continuous trawls in Subareas 48.1 and 48.2. Similarly, no mortalities were recorded on the vessels using traditional krill pelagic trawl methods in Subarea 48.3 (Part II, paragraph 39).

Seabirds in pot fisheries

I.13 No incidental seabird mortalities were recorded during the only cruise targeting *D. eleginoides* in Subarea 48.3 (Part II, paragraph 40).

Marine mammals in longline, trawl and pot fisheries

I.14 There were three southern elephant seal mortalities in longline fisheries (two in Subarea 48.3 and one in Division 58.5.2) in 2006/07 compared to no reports of incidental mortality in 2005/06 (Part II, paragraph 41). There were no marine mammals reported entangled and released alive in longline fisheries this year, down from two in 2005/06 (SC-CAMLR-XXV, Annex 5, paragraph 7.12).

I.15 In 2006/07 there were no marine mammals reported entangled or killed in the krill trawl fisheries (Part II, Table 13). The Working Group noted that this level of mortality is greatly reduced from 2004/05, when 95 Antarctic fur seals were observed caught during krill fishing operations in the same area (Area 48) and reduced from 2005/06, when one Antarctic fur seal was reported killed in this fishery (Part II, Table 14).

I.16 In 2006/07 there were no marine mammals reported entangled or killed in the finfish trawl fisheries, down from one leopard seal caught and killed in the Division 58.5.2 toothfish trawl fishery in 2005/06 (Part II, paragraph 43 and Tables 13 and 14).

I.17 There were again no reports of incidental mortality of marine mammals in pot fisheries (Part II, paragraph 44; WG-FSA-07/9).

Information relating to the implementation of Conservation Measures 26-01, 25-02 and 25-03

I.18 This year the level of reported performance was improved with 100% implementation for nearly all measures, with streamer line design and use, discard of offal and the discard of hooks in offal being the exceptions. With respect to Conservation Measure 25-02, this is summarised as follows:

(i) Line weighting (Spanish system) – 100% reported compliance in all subareas and divisions (Part II, paragraph 48 and Table 16).

(ii) Line weighting (autoline system) – all vessels fishing in Subareas 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b south of 60°S in daylight met the requirement to achieve a consistent minimum line sink rate as described in Conservation Measure 24-02. For 2006/07, the Working Group noted that only one vessel (*Antartic II* in Subareas 88.1 and 88.2), using a variation on the autoline method, used clip-on weights to achieve the sink rate requirements. All autoline vessels are now using IWLs. The Working Group noted that the *Shinsei Maru No. 3*, using a trotline system, met the sink rate requirements in Subarea 48.6 (Part II, paragraph 48).

(iii) Night setting and offal discharge – 100% compliance with night setting, and also for control of offal discharge in all areas where this was required (Subareas 48.3, 48.4, 58.6 and 58.7) (Part II, paragraph 49 and Table 16). In areas where offal retention is required (Subareas 48.6, 88.1 and 88.2, Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b and 58.5.2), all but two vessels complied fully (Table 16). The *Tronio*, fishing in Divisions 58.4.1 and 58.4.3b, discharged offal on seven occasions due to mechanical problems. The *Ross Mar*, fishing in Subarea 88.1, was observed discarding offal during one haul (Part II, paragraph 50).

(iv) Discard of hooks – hooks were present in discards on three of 39 longline cruises; this was reported as a rare event on two of these. However, the observer on board the *Insung No. 22* in Subarea 48.3 reported there was no system in place for removing hooks from discards and the discarding of offal with hooks present was a daily occurrence (Part II, paragraph 52; WG-FSA-07/8 Rev. 1, Table 1).

(v) Streamer lines – the number of cruises complying with streamer line specifications has increased from 80% in 2005/06 to 87% this year (Part II, paragraph 54), although this is not as high as the 92% (34 of 37 cruises) in 2002/03. However, most of the non-compliant vessels had only minor deviations from the requirement. The cruises where streamer lines did not comply failed on streamer lengths (3 cruises), total streamer line length (1 cruise) and branched streamer spacing (1 cruise). One of these vessels, the *Viking Sur*, also failed on two specifications in 2005/06. There was 100% compliance with attachment height (Part II, paragraphs 54 and 55 and Table 16).

(vi) Haul-scaring devices – one vessel in Subarea 48.3 (*Insung No. 22*, 87%), and one vessel in two cruises in Subareas 58.6 and 58.7 (*Ross Mar*, 0%) did not use haul-scaring devices on all hauls. In all other areas there was 100% compliance (Part II, paragraphs 57 and 58 and Table 16).

I.19 The Working Group noted that the small deviations from full compliance with streamer line configuration had not led to any seabird mortalities (Part II, paragraph 56). However, the Working Group expressed concern at the reported discarding of hooks in offal, given the reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses (Part II, paragraph 53).

I.20 The Working Group expressed some concern at the low number of bottle tests for some vessels (Part II, paragraph 48 and Table 17).

I.21 The Working Group noted a reported increase in the discharge of gear debris, which occurred on five vessels and included the discharge of oil from the *Insung No. 1* (Republic of Korea) and *Ross Star* (Uruguay), the discharge of gear debris from the *Insung Ho* (Republic of Korea) and *Antartic II* (Argentina) and the discharge of inorganic garbage from the *Insung Ho* (Republic of Korea), *Ross Mar* (South Africa) and *Antartic II* (Argentina) (Part II, paragraph 47; WG-FSA-07/8 Rev. 1, Table 1). This included fishing gear, small sections of line, snoods and plastics. The Working Group noted that these discharges would have additional negative effects on seabirds and marine mammals which could not be quantified.

I.22 The Working Group reiterated its concern that care was needed to ensure accurate reporting of data by observers because inaccurate reporting may have consequences for reviewing the performance of vessels in fisheries.

I.23 Conservation Measure 26-01 prohibits the use of plastic packaging bands to secure bait boxes. The use of other plastic packaging bands is restricted to those vessels with on-board incineration facilities and all bands must be cut and disposed of using this facility. Information from observer reports again indicated 100% implementation of this measure (100% compliance in 2006) (Part II, paragraph 46).

I.24 With respect to Conservation Measure 25-03, a range of mitigation measures were used on board icefish vessels in Subarea 48.3 and Division 58.5.2 and compliance with Conservation Measure 25-03 was generally good (Part II, paragraph 59).

I.25 Two vessels were reported as having used net sonde cables (*Niitaka Maru* and *Saga Sea*). It was unclear whether these were net sonde cables or paravanes, as had been the case in previous years, and the Working Group requested additional information from scientific observers (Part II, paragraph 60).

INCIDENTAL MORTALITY OF SEABIRDS IN FISHERIES OUTSIDE THE CONVENTION AREA

(see also Part II, paragraphs 61 to 66)

I.26 The Working Group noted that despite requests, no Members provided written reports on longline seabird by-catch from outside the Convention Area. The Working Group encouraged reporting of new information in 2008.

I.27 A verbal report documented high levels of mortality of Convention Area seabirds in pelagic longline fisheries in southern African waters (Part II, paragraphs 62 to 64). The Working Group noted that when coupled with the levels of mortality reported to the group in 2006 for the South African deep-water hake trawl fishery, it is of great concern that many thousands of albatrosses are estimated to be killed annually in these fisheries, including ca. 5 000 (95% CI 3 000–12 500) black-browed albatrosses, thought to predominantly be from the population breeding at South Georgia (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 68).

I.28 Given that considerably greater levels of mortality of Convention Area seabirds occur in areas north of the Convention Area, compared to levels within the Convention Area, the Working Group reminded Members of the importance of the standing request to report on seabird mortality for Convention Area species arising from fisheries conducted outside the Convention Area (Part II, paragraph 66; SC-CAMLR-XXV, Appendix D, Table 20, item 3.2).

INCIDENTAL MORTALITY OF SEABIRDS DURING UNREGULATED LONGLINE FISHING IN THE CONVENTION AREA
(see also Part II, paragraphs 67 to 80)

I.29 The overall estimated total for the whole Convention Area in 2006/07 indicates a potential seabird by-catch in the unregulated fishery of 8 212 (95% CI 6 730–21 926) seabirds (SC-CAMLR-XXVI/BG/32). The values for this and previous years are summarised in respect of different parts of the Convention Area in Part II, Table 18 (Part II, paragraph 72).

I.30 In comparison with estimates for previous years, calculated in identical fashion, the value for 2006/07 is broadly similar to the values estimated for the last three years (SC-CAMLR-XXVI/BG/32). These are the lowest reported values since estimates started in 1996. This presumably reflects a commensurate reduction in toothfish removals and/or changes in the areas from where IUU fishing occurs (Part II, paragraph 73).

I.31 The Working Group noted that grey petrels have comprised between 5 and 16% of the catch in the regulated fishery in Division 58.5.1 over the last three years, and undertook to examine methods of estimating the by-catch of this species by IUU vessels within Division 58.5.1 as an intersessional task with a view to assessing the level of take of grey petrels in future years (Part II, paragraph 75).

I.32 As in previous years, it was emphasised that these are very rough estimates (with potentially large errors). The estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution. In particular, changes in gear type seen in the regulated fishery would undoubtedly have flowed through to IUU vessels. These gear changes, together with the use of gillnets by IUU vessels, will affect the levels of IUU-fisheries-related by-catch, but are not reflected in the assumptions used to develop these estimates (Part II, paragraphs 76 to 78).

I.33 Nevertheless, the Working Group reiterated its conclusions of recent years that even these levels of incidental mortality of seabirds arising from IUU fishing were of substantial concern and likely unsustainable for some of the populations concerned (Part II, paragraph 79). The Commission was encouraged to continue to take action in respect of incidental mortality of seabirds caused by IUU fishing (Part II, paragraph 80).

RESEARCH INTO AND EXPERIENCE WITH MITIGATION MEASURES
(see also Part II, paragraphs 81 to 117)

Longline

I.34 Noting the success to date within the Convention Area in reducing seabird by-catch, the Working Group again recalled that the mitigation measures used continue to require refinement to potentially allow for fishing at any time of day without seasonal closure of fishing grounds (SC-CAMLR-XIX, paragraphs 4.40 and 4.41). Further, as CCAMLR mitigation measures and practices have been held up as a role model outside the Convention Area and successfully exported to some of those fisheries, research into mitigation measure refinement remains a priority to support the export of best-practice mitigation.

I.35 The Working Group noted an increasingly used modification of the Spanish longline system in fisheries outside the Convention Area (trotline longline system). During line setting, the modified system sinks quickly beyond the range of foraging seabirds (Part II, paragraphs 81 and 84). A trotline/net longline system is now in extensive use throughout southern South America (WG-FSA-07/11, 14 and 23). This new trotline/net longline system is reported to eliminate seabird by-catch and significantly reduce whale depredation with no loss in toothfish CPUE when compared to the Spanish longline system. Although at least one vessel has used the trotline system in the Convention Area (*Shinsei Maru No. 3*), the trotline/net system has not as yet been used in the Convention Area (Part II, paragraphs 82 and 84 to 87). The Working Group recommended that this system should comply with all requirements of Conservation Measure 25-02, including line-weighting requirements, to protect seabirds (Part II, paragraph 83).

I.36 The Working Group noted plans to conduct a trial inside the Convention Area to compare the effectiveness of the trotline/net system with the traditional Spanish system in reducing fish loss to toothed whales. The provisions of Conservation Measures 24-02 and 25-02 will be applied during the trial and a three-bird by-catch limit is proposed (Part II, paragraph 88). The Working Group recognised the importance of the proposed trial for vessels operating in the Convention Area and strongly encouraged expanding the trial in 2007/08 to include as many Spanish longline vessels operating in Subarea 48.3 as possible to increase the data acquisition rate on the trotline/net method and enable CCAMLR to quickly understand the comparative effects of the two gear types (Part II, paragraph 89).

I.37 Noting the results of trials that examined the sink rate relationships between traditional Spanish system weights (netting bags of rocks) and elliptical, or torpedo-shaped, steel weights (Part II, paragraph 90), the Working Group recommended that Conservation Measure 25-02 be modified to provide Spanish longline system vessel operators the option of using either traditional weights (netting bags of rocks) under the current two mass/spacing regimes or, steel weights (solid steel and not chain links) under a mass/spacing regime of ≥5 kg mass spaced at intervals of no more than 40 m. The Working Group noted that operators should consider the shape of steel weights and recognise that torpedo-shaped or spherical weights are the most hydrodynamic (Part II, paragraph 91).

I.38 The Working Group expressed concern about reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses and embedded in wandering albatrosses. The Working Group strongly encouraged the UK to present a paper to ad hoc WG-IMAF on its survey work and, in particular, hook ingestion and hook body piercing, to its 2008 meeting (Part II, paragraph 93). There is anecdotal evidence that the increase in hook ingestion may be linked to the increasing use of the trotline/net system outside the Convention Area and the discard of by-catch with embedded hooks from vessels using this gear. In recognition of the severity of the problem and its assessment by the UK (SC-CAMLR-XXVI/BG/18), the Working Group recommended that CCAMLR produce a poster instructing crews to remove hooks from all landed fish and hauled baits. The estimated cost of the production of such posters is AU$5 000 (Part II, paragraph 94).

I.39 The Working Group recommended that (Part II, paragraphs 94 and 95):

(i) CCAMLR produce the A3 poster in colour, in all CCAMLR languages, as well as Indonesian, Korean and Japanese. It should be waterproof and on plastic for display in wet areas on vessels;

(ii) the Secretariat distribute the poster via technical coordinators to all longline vessels operating in the Convention Area early in the 2007/08 season as a priority;

(iii) the Secretariat, via technical coordinators, instruct vessel operators to display a poster in at least four strategic locations on vessels, including in fish processing factories, in line hauling bays in easy view of crews hauling gear, and in areas inboard of hauling areas where crews process hauled baits/hooks;

(iv) scientific observers be instructed to report on whether the poster is displayed on vessels and reminded of the need to monitor hook removal;

(v) Members operating the Spanish method of longlining (both traditional and trotline methods) outside the Convention Area adopt the use of the poster and provide posters to their longline vessels for on-board display.

I.40 Noting the importance of evaluating the effect of seabird mitigation technologies on the catch rates of all taxa (Part II, paragraph 97), with respect to future improvements to Conservation Measures 24-02 and 25-02, the Working Group recommended:

(i) tests of the efficacy of the new trotline/net longline system line-weighting regime as a seabird deterrent and for operational characteristics (Part II, paragraph 87);

(ii) testing the effectiveness of paired streamer lines in Southern Ocean conditions with common seabird assemblages (Part II, paragraph 110).

I.41 Given the continued substantial proportion of seabirds caught during longline haul operations in the Convention Area in 2006/07 (Part II, paragraphs 104 to 107), the Working Group noted two effective mitigation devices – the 'moon pool' and the Brickle curtain (Part II, paragraph 107). The Working Group encouraged technical coordinators to instruct observers to collect information on haul mitigation devices used in the Convention Area (Part II, paragraphs 108 to 109).

Trawl

I.42 Noting trials conducted in New Zealand to determine the effects of mealing, mincing and batching all offal before discharge on seabird abundance around trawlers, the Working Group discussed offal retention and discharge options on trawl vessels recognising the operational constraints on some older and smaller vessels operating in the Convention Area. The Working Group noted that potential options for discharge management, such as underwater discharge and maceration, had not been tested to their full potential either inside or outside the Convention Area (Part II, paragraphs 111 to 115).

I.43 The Working Group noted that three seasons of operational experience indicate net binding is a highly effective and easily accomplished mitigation measure for pelagic trawl fisheries and that there is increasing evidence that in combination with net cleaning, net binding may be responsible for reductions in seabird mortality during setting operations (Part II, paragraph 116).

I.44 Noting the continued success of net binding in Subarea 48.3, the Working Group reiterated the Scientific Committee's recommendation to test its utility as appropriate in other Convention Area pelagic finfish trawl fisheries (Part II, paragraph 117).

OBSERVER REPORTS AND DATA COLLECTION
(see also Part II, paragraphs 118 to 126)

I.45 The Working Group supported the proposal of the Secretariat that Members:

(i) develop a standard set of training and educational standards to augment current domestic training programs;

(ii) consider the feasibility of developing a process whereby national observer programs are accredited to consistent international standards;

(iii) encourage and support national technical coordinators to attend WG-FSA and ad hoc WG-IMAF meetings and consider maximising such opportunities by convening training workshops for coordinators (Part II, paragraphs 118 and 119).

I.46 The Working Group reviewed data collection needs relative to several areas of seabird and marine mammal interaction and mitigation and recommended additions or changes to logbooks and cruise reports, including:

(i) improved reporting on the use of net sonde cables (Part II, paragraph 60);

(ii) net binding (Part II, paragraph 117);

(iii) distinguishing which of the three longline fishing methods, or combination of, was in use on a vessel, either the Spanish system, autoline system or the trotline system (Part II, paragraph 11);

(iv) improved reporting on the warp-strike protocol (Part II, paragraphs 120 and 123 to 125);

(v) information on haul mitigation devices used in the Convention Area (Part II, paragraphs 108 and 109).

I.47 The Working Group was concerned that the reported percentage of hooks observed fell below the recommended minimum of 20% on several vessels in 2006/07 (as low as 0%) and recommended that clarification be sought from the Members which designated the international observers for these cruises (Part II, paragraph 10).

I.48 The Working Group noted that the quality of observer data which had been submitted continued to improve and thanked technical coordinators and observers for their efforts in the last year. However, the Working Group noted that improvements could still be made in the reporting of observer data and encouraged technical coordinators and observers to continue to fully implement the specifications of the various observer protocols and report all required data (Part II, paragraph 126).

RESEARCH INTO THE STATUS AND DISTRIBUTION OF SEABIRDS
(see also Part II, paragraphs 127 to 131)

I.49 The Working Group welcomed a report from the Third Meeting of the ACAP Advisory Committee and was encouraged by the progress on the assessments of ACAP-listed species. Given its comprehensive coverage of Convention Area seabirds at risk from fisheries-related mortality and information on the foraging distribution and interactions with fisheries operating in RFMOS and EEZs, the Working Group agreed that it will be very useful for ad hoc WG-IMAF's work (Part II, paragraphs 127 and 128).

I.50 The Working Group received information on an evaluation of the impact of fisheries on the populations of white-chinned and grey petrels of the Crozet and Kerguelen Islands based on mark–recapture studies, estimation of breeding success, adult survival and population estimation. The Working Group applauded France for its efforts in this area, and looked forward to reviewing the publication that presents these analyses in detail in 2008 (Part II, paragraph 130). France has initiated a three-year study of foraging distribution with the objective to examine the pelagic distribution of seabirds breeding in the French Antarctic and sub-Antarctic areas which will provide important information on the distribution of seabirds both inside and beyond the Convention Area (Part II, paragraph 131).

ASSESSMENT OF RISK IN CCAMLR SUBAREAS AND DIVISIONS
(see also Part II, paragraphs 132 to 153)

I.51 The assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised and provided as advice to the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31). There were no changes to levels of risk this year (Part II, paragraphs 132 to 134).

I.52 The Working Group noted a tabled description of the ad hoc WG-IMAF risk assessment (WG-FSA-07/P2) and recommended that this paper be widely disseminated, including to other RFMOs which could consider the experience of CCAMLR when developing approaches to minimising by-catch in their own fisheries. The Secretariat was asked to assist in this (Part II, paragraphs 135 and 136).

I.53 The risk assessment, originally confined to longline fisheries, was extended to trawl fisheries this year following a request from the Commission to do so (CCAMLR-XXV, paragraphs 5.21 to 5.24). The revised assessments incorporating advice in relation to trawl gear (with changes/additions underlined) have been combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31). The assessments now incorporate advice on operational measures that should be applied to pelagic trawling operations to minimise by-catch. In developing this advice, the Working Group drew upon the considerable observer data that have been collected across CCAMLR trawl fisheries. This shows that the risks to seabirds are strongly gear-dependent, with pelagic trawling for finfish posing the highest risk (Part II, paragraphs 137 to 143).

I.54 The Working Group developed a set of best-practice mitigation measures for pelagic finfish trawling gear and recommended that they be applied for all CCAMLR statistical subareas and divisions. A summary of the assessment of risk to seabirds posed by pelagic finfish trawl fisheries and associated mitigation requirements is provided in Table 19 and SC-CAMLR-XXVI/BG/31 (Part II, paragraph 144).

I.55 The Working Group noted that by-catch in existing finfish fisheries in category 4 and 5 risk areas was minimal despite current conservation measures for fisheries in those areas not containing all elements of the best-practice guidelines and a different suite of mitigation measures being used in each fishery. The Working Group did not consider that there was a need for additional mitigation measures beyond those currently in use in those fisheries, provided the current zero or near-zero by-catch levels are continued or decreased respectively (Part II, paragraph 145).

I.56 With respect to pelagic trawling gear for krill and demersal trawling gear targeting finfish where offal retention occurs, no clear evidence is available to suggest that these methods pose a serious risk to seabirds in the Convention Area at this stage (Part II, paragraphs 146 and 147). For this reason, mitigation measures additional to those required by Conservation Measure 25-03 are not considered necessary at present for these gear types.

I.57 The Working Group reviewed WG-FSA-07/55 which proposed for Subarea 48.3 a relaxation of the limitation of icefish catch that may be taken between 1 March and 31 May and the requirement to undertake research trawls in this period. Ad hoc WG-IMAF agreed that the change is unlikely to lead to an increased risk to seabirds from this fishery, provided that the best-practice mitigation measures are used year-round (Part II, paragraph 148).

I.58 The Working Group reviewed WG-FSA-07/17, a proposal for season extension in Division 58.5.2. In respect of the proposal to include 1 to 30 September as part of the 'core' winter season and to remove the three-seabird by-catch limit presently applied to that period, the Working Group noted that while fishing had occurred in four seasons for the first half of September, there had been fishing in the latter half of September in only one season. For this reason, the Working Group recommended that 1 to 14 September could be included in the core season and not subject to the three-seabird by-catch limit, but that the three-seabird by-catch limit should continue to apply to fishing during the period from 15 to 30 September. The Working Group noted that fishing during October was moving progressively closer to the seasonal period when seabird abundance, especially of white-chinned petrels, increased significantly and that this species was the most likely to interact with fishing operations and the most difficult to mitigate against. The Working Group supported the proposal to trial fishing from 1 to 31 October, and recommended it proceed subject to a three-seabird by-catch limit (Part II, paragraphs 149 to 151).

INCIDENTAL MORTALITY OF SEABIRDS IN RELATION TO NEW AND EXPLORATORY FISHERIES
(see also Part II, paragraphs 154 to 165)

I.59 Of the 41 applications for exploratory longline fisheries for 2006/07, 28 were undertaken (Part II, paragraph 154). No incidental seabird mortality was observed.

I.60 The 44 proposals by 12 Members for exploratory fisheries in seven subareas/divisions of the Convention Area in 2007/08 were addressed in relation to the advice in Part II, Figure 1 and Table 20, and SC-CAMLR-XXVI/BG/31. The results, summarised in Part II, paragraphs 158 to 160, involve two categories: those that provide sufficient information and are assessed as conforming with advice relating to incidental mortality of seabirds (Part II, paragraph 158), and those that contain insufficient information to be certain that they conform with advice relating to incidental mortality of seabirds (Part II, paragraph 159). Applications by the Republic of Korea (CCAMLR-XXVI/16) and Uruguay (CCAMLR-XXVI/24) fall into the latter category. The Working Group noted that, as for last year (SC-CAMLR-XXV, paragraph 5.36(iii)), these inconsistencies should be able to be resolved easily, but suggested this was a task for SCIC (Part II, paragraph 162).

I.61 The Working Group welcomed improvements in notifications this year and requested that Members take greater care in future submissions to ensure that the intent to comply with relevant seabird by-catch measures was clear (Part II, paragraph 161).

I.62 The Working Group was pleased with the number of Members that utilised the checklist and encouraged those that did not do so (Republic of Korea and South Africa), or altered the checklist without explanation (Uruguay), to use the pro forma and checklist in full in future notifications. The Working Group noted that, as the notification from Uruguay (CCAMLR-XXVI/24) had not been translated, it was uncertain whether the relevant information was contained within the document (Part II, paragraph 163).

I.63 The Working Group reiterated its recommendation that any vessel operating under the provisions of Conservation Measure 24-02, and which catches a total of three (3) seabirds, as defined in SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217, shall revert to night setting in accordance with Conservation Measure 25-02 (Part II, paragraph 164).

I.64 The Working Group discussed CCAMLR-XXVI/27, proposing improvements to line sink rate monitoring and reporting and noted that, as the proposal had no technical implications for the work of ad hoc WG-IMAF, it was a matter for SCIC (Part II, paragraph 165).

INTERNATIONAL AND NATIONAL INITIATIVES RELATING TO INCIDENTAL MORTALITY OF SEABIRDS IN RELATION TO LONGLINE FISHING
(see also Part II, paragraphs 166 to 195)

I.65 Information was reported on current international initiatives under the auspices of:

(i) ACAP – items of particular relevance to CCAMLR including ACAP's newly formed Seabird Bycatch Working Group (Part II, paragraphs 166 to 168);

(ii) FAO (IPOA-Seabirds) – noting COFI's agreement (pending cost considerations) to develop best-practice technical guidelines for NPOA-Seabirds and RFMOs, that the guidelines should extend to other relevant fishing gears, and that FAO could undertake this work through an expert consultation and in cooperation with CCAMLR, ACAP and BirdLife International (Part II, paragraph 169);

(iii) Joint meeting of tuna RFMOs – Secretariat-provided information on CCAMLR's processes in developing its seabird by-catch mitigation measures (Part II, paragraphs 171 to 174);

(iv) RFMOs – no responses received to CCAMLR Resolution 22/XXV but updates on WCPFC, ICCAT, CCSBT, IOTC and IATTC (Part II, paragraphs 175 to 187).

I.66 The Working Group noted several ACAP work products (Species Assessments by the Status and Trends Working Group, research plan for pelagic longline mitigation technologies by the Seabird Bycatch Working Group) (Part II, paragraphs 127, 128 and 168) of utility as RFMOs consider seabird assessments and seabird by-catch mitigation measures. The Working Group recommended that the Scientific Committee encourage Members to use and promote these ACAP resources, as appropriate.

I.67 The Working Group reiterated its support for the development of best-practice technical guidelines for the development of NPOA-Seabirds, to be used by countries and RFMOs and to include other relevant gear types (Part II, paragraph 169). This effort is important where RFMOs manage fisheries in waters adjacent to the Convention Area, particularly where seabird species which breed and forage in the Convention Area may be distributed (Part II, paragraph 191).

I.68 The Working Group was encouraged by the progress made at some of the RFMOs toward addressing the issue of seabird by-catch in their fisheries, particularly at WCPFC and ICCAT, including the initiation of risk assessments in both RFMOs to better assess the level of interactions between seabirds and the fisheries within their Convention Areas and the adoption of binding seabird conservation measures at the WCPFC (Part II, paragraphs 189 and 190).

I.69 The Working Group requested that the Scientific Committee extend an offer of technical assistance on conducting seabird risk assessments generally to other RFMOs should they desire such support (Part II, paragraphs 189 and 193), and further recommended that the Scientific Committee stress the need for assessing risk to seabird populations and for mitigating such risks via adaptive and precautionary decision-making, including the use of adequate levels of observer coverage and detailed reporting of implementation of conservation measures to truly achieve reductions in seabird by-catch (Part II, paragraph 192).

I.70 With regard to the effectiveness of Resolution 22/XXV, the Working Group:

(i) expressed concern at the general lack of progress in RFMOs (Part II, paragraph 194);

(ii) reaffirmed that a key to progress is the employment of robust scientific observer programs (Part II, paragraph 194);

(iii) encouraged the Secretariat to continue to contact Flag States whose vessels fish in areas where unregulated fishing takes place or where systematic data reporting has not yet been introduced (Part II, paragraph 195);

(iv) noted the lack of reporting as required under paragraph 5 of Resolution 22/XXV (Part II, paragraph 195);

(v) encouraged Contracting Parties to provide information on this matter in the future (Part II, paragraph 195).

I.71 The Working Group recommended that a standing invitation be extended by the Scientific Committee to ACAP and BirdLife International to participate in future meetings of ad hoc WG-IMAF as invited experts (Part II, paragraph 188).

FISHERY REPORTS
(see also Part II, paragraphs 196 to 198)

I.72 The Working Group recommended that the process of updating Fishery Reports with information relating to the by-catch of seabirds and marine mammals continue and noted that this process provided constructive interaction with WG-FSA and contributed to the streamlining of the work of the Scientific Committee's working groups.

STREAMLINING THE WORK OF THE SCIENTIFIC COMMITTEE
(see also Part II, paragraphs 199 to 211)

I.73 Ad hoc WG-IMAF noted that its revised agenda for this year's meeting was a useful improvement. The Working Group recommended future agenda improvements (Part II, paragraph 199), including:

(i) discontinue the current method for estimation of IUU catches of seabirds but, if feasible, develop alternate methods;

(ii) a review of its agenda to identify those tasks which could be completed on a biennial and triennial basis to allow more time to undertake high-priority tasks.

I.74 Ad hoc WG-IMAF noted the improved interactions with WG-FSA this year on matters of mutual interest (observer and by-catch matters, mitigation measures and impacts on other taxa) and thus enhancing the quality of advice to the Scientific Committee and providing a useful element of peer review during meetings (Part II, paragraph 200).

Future focus of the work of ad hoc WG-IMAF and a workshop proposal

I.75 The Working Group noted the continued very positive results again this year with respect to seabird and marine mammal by-catch throughout the Convention Area and highlighted an increasing need to focus on the by-catch of Convention Area seabirds outside the Convention Area given CCAMLR's responsibility for these Antarctic marine living resources (Convention Article I). Continued vigilance in the monitoring of by-catch and the implementation of conservation measures is needed to continue to strive to minimise seabird and marine mammal by-catch in all Convention Area fisheries and to avoid time delays in responding to changing fishery dynamics and by-catch rates which could have serious consequences for the conservation of seabirds and marine mammals. Noting that a biennial meeting of ad hoc WG-IMAF may mean three-year delays between the recognition of a problem and the development of a solution, the Working Group recommended that annual meetings continue (Part II, paragraphs 202 to 204).

I.76 Based on last year's discussion (SC-CAMLR-XXV, Annex 5, paragraph 7.64) and discussions this year (Part II, paragraphs 202 to 211), the Working Group recommended a one-day workshop immediately prior to ad hoc WG-IMAF in 2008 to address critical medium-term items and the future focus of ad hoc WG-IMAF. The Working Group requested the Scientific Committee's endorsement of the workshop and the following proposed terms of reference:

(i) review and recommend revisions to the terms of reference for ad hoc WG-IMAF;

(ii) develop short- and medium-term work plans for ad hoc WG-IMAF, particularly considering the work plan of WG-FSA for dealing with mitigation of the by-catch of fish and invertebrate by-catch, the work plan of the Scientific Committee and developments in other international bodies concerned with the interaction of fisheries and Convention Area birds or mammals;

(iii) review the frequency of meetings of ad hoc WG-IMAF, in particular:

(a) consider the conditions under which a change in meeting frequency could take place and catalogue the advantages and disadvantages of such change;

(b) examine in detail the consequences of decreasing the frequency of WG-IMAF meetings on the work of WG-IMAF and the advice that it is able to provide WG-FSA, the Scientific Committee and the Commission;

(c) consider mechanisms that could be put in place to minimise the risk of impacting significantly on the work of WG-FSA, the Scientific Committee and Commission were the ad hoc WG-IMAF meeting frequency to be reduced.

OTHER BUSINESS

I.77 Addressing several of the agenda items required the Working Group to attempt to evaluate working papers submitted in languages other than English. These agenda topics include evaluation of: a notification of a new and exploratory fishery (Part II, paragraph 163), the new trotline/net system used to reduce whale depredation and seabird by-catch (Part II, paragraph 85), and efforts in the French EEZs in Subarea 58.6 and Division 58.5.1, the only remaining part of the Convention Area with substantial seabird by-catch levels (Part II, paragraphs 20 and 130). The Working Group's ability to adequately and effectively address these topics was hampered by the lack of translated text. Particularly for future efforts by ad hoc WG-IMAF to assist with seabird by-catch reductions in the French EEZ, the Working Group requested the Scientific Committee to consider, on a case-by-case basis, the translation of key documents.

PART II

REPORT OF THE AD HOC WORKING GROUP ON INCIDENTAL MORTALITY ASSOCIATED WITH FISHING

(Hobart, Australia, 8 to 12 October 2007)

CONTENTS

Please note:
For a List of Participants and List of Documents, please refer to the Report of WG-FSA-07 in Annex 5, Appendix B and C respectively.

PART II

REPORT OF THE AD HOC WORKING GROUP ON INCIDENTAL MORTALITY ASSOCIATED WITH FISHING

(Hobart, Australia, 8 to 12 October 2007)

INTERSESSIONAL WORK OF AD HOC WG-IMAF

II.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMAF according to the agreed plan of intersessional activities for 2006/07 (SC-CAMLR-XXV, Appendix D, Table 20). The report contained records of all activities planned and is available on the ad hoc WG-IMAF page of the CCAMLR website.

II.2 The Working Group thanked the Science Officer for his work on the coordination of ad hoc WG-IMAF intersessional activities and the technical coordinators of national observer programs for their support. The Working Group thanked the Scientific Observer Data Analyst for his work on the processing and analysis of data submitted to the Secretariat by international and national observers during the course of the 2006/07 fishing season.

II.3 The Working Group concluded that most tasks planned for 2006/07 had been successfully implemented. Much of the information requested intersessionally had been presented to the Working Group in papers submitted to the meeting. The list of current intersessional tasks was reviewed and a number of changes were agreed in order to consolidate specific tasks in future plans. The Working Group agreed that the plan of intersessional activities for 2007/08, compiled by the Co-conveners and the Science Officer, be appended to its report (Table 21).

II.4 The Working Group especially welcomed to the meeting Mr C. Marteau (France), Mr N. Walker (New Zealand) and Ms N. LeBoeuf (USA) who were attending the meeting for the first time. The Working Group appreciated Mr M. McNeill’s (New Zealand) continued expert advice on operational aspects of fishing and encouraged analogous input from other Members, including in relation to trawl fisheries. Members were asked to review their representation on ad hoc WG-IMAF intersessionally, to suggest additional members and to facilitate the attendance of their representatives at the meetings.

II.5 The Working Group greatly appreciated the participation of national technical coordinators who provided invaluable experience to the Working Group as it addressed numerous observer-related and data collection issues. In addition to the continued participation of technical coordinators at future meetings, ad hoc WG-IMAF would also welcome the participation of its South American Members.

INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS IN FISHERIES IN THE CONVENTION AREA

Seabirds

II.6 The total extrapolated seabird mortalities due to interactions with fishing gear during longline fishing for *Dissostichus* spp. in the Convention Area, with the exception of the French EEZs in Subarea 58.6 and Division 58.5.1, was estimated to be zero. When seabird mortalities reported from fisheries in the French EEZ within the Convention Area are included, the total seabird mortalities during longline fishing operations in 2006/07 were estimated to be 2 257, all petrels. This estimate includes 313 seabirds in Subarea 58.6 and 1 944 seabirds in Division 58.5.1.

II.7 Observers reported a total of eight seabird mortalities during trawling for finfish in the Convention Area; of these, six seabird mortalities, including four albatrosses and two petrels, occurred during trawling in Subarea 48.3 and two petrels were killed during trawling in Division 58.5.2. No seabird mortalities were reported during trawling for krill or during pot fishing.

Seabirds in longline fisheries

Seabirds in longline fisheries excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1

II.8 Data were available from all longline cruises conducted within the Convention Area, excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1, during the 2006/07 season (Table 1).

II.9 The Working Group noted that the proportions of hooks observed were similar to those observed last year for Subarea 48.3 (27% (range 14–42) compared with 29% (range 18–39)). The proportions of hooks observed were slightly increased for Subareas 88.1 and 88.2 (53% (range 19–96) compared with 45% (range 20–74)); slightly increased for Division 58.5.2 (37% (range 35–39) compared with 33% (range 30–34)); the same for Subarea 48.6 (50% compared with 50%); slightly reduced for Subarea 58.4 (67% (range 0–100) compared with 70% (range 47–100)); and significantly reduced for Subareas 58.6 and 58.7 (17% (three vessels) (range 13–18) compared with 35% (one vessel)) (Table 1).

II.10 The Working Group expressed concern at the reporting of 0% of hooks observed on board the *Jung Woo No. 2* (Republic of Korea) on one cruise to Subarea 48.6, Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, and during another cruise to Subareas 88.1 and 88.2. The Working Group was also concerned that the percentage of hooks observed fell below the recommended minimum of 20% on several vessels. The vessels concerned were the *Argos Georgia* (UK) (Subarea 48.3, 14%), *Yantar* (Russia) (Subareas 88.1 and 88.2, 19%), *Koryo Maru No. 11* (South Africa) (Subareas 58.6 and 58.7, 18%) and *Ross Mar* (South Africa) (Subareas 58.6 and 58.7, 13 and 16%). The Working Group recommended that clarification be sought from the Members which designated the international observers for these cruises. Mr C. Heinecken (South Africa) noted that on both the *Ross Mar* and *Koryo Maru No. 11* fishing in the South African EEZ (Subareas 58.6 and 58.7), only one observer was deployed at a time. The observers reported that due to the low fish catch rates, additional time was spent in the factory to obtain the target number of fish measurements specified in their sampling instructions.

II.11 The Working Group noted that there was a need for observers to distinguish which of the three fishing methods, or combination of, was in use on a vessel, either the Spanish system, autoline system or the trotline system.

II.12 The total number of observed mortalities, excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1, was zero (Table 2). The total extrapolated mortality for 2006/07 excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1 was also zero (Table 2). This compared to two birds estimated killed, excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1, in 2005/06.

II.13 The total number of seabirds observed caught and released uninjured, excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1, was seven (Table 1). The Working Group noted that the incidence of birds being caught injured and uninjured (i.e. birds that are caught on the haul), accounted for 100% of seabird captures in 2006/07. This suggests that a focus on haul mitigation measures remains important for the entire Convention Area.

Seabird mortality in the French EEZs in Subarea 58.6 and Division 58.5.1

II.14 In 2006/07, data were available from 18 cruises in Subarea 58.6 and 22 cruises in Division 58.5.1. The proportion of hooks observed was 25.52 and 25.26% respectively (Table 3). In 2006/07 the total reported seabird mortality from observers for Subarea 58.6 and Division 58.5.1 was 80 and 491 birds respectively (Table 4). The corresponding incidental mortality rates were 0.0650 and 0.0798 birds/thousand hooks (Table 5). The extrapolated total seabird mortalities for Subarea 58.6 and Division 58.5.1 were 313 and 1 944 respectively (Table 5). All vessels in the French EEZs were autoliners using at least 50 g m^{-1} IWLs in 2006/07, compared with one such vessel in the previous season. In Subarea 58.6, 87.5% of the birds were caught by two out of seven vessels, and in Division 58.5.1, 63% of captures were by three out of seven vessels. This may indicate that there are individual vessel effects that need to be examined to further reduce seabird captures in these areas.

II.15 Similar to last year, the Working Group noted that 32% of seabirds observed captured were caught alive, indicating that they were taken on the haul (Table 3). This emphasises a need to focus on haul mitigation measures to further reduce seabird by-catch in these fisheries.

II.16 The Working Group recognised that France has continued to reduce its total seabird by-catch each successive year and noted the efforts made to achieve this result in 2006/07 (a 13% decrease from the combined total estimated by-catch in the previous season for Subarea 58.6 and Division 58.5.1) (Table 6). However, concern was expressed by the Working Group about the current level of seabird captures, noting that white-chinned petrels, which form a substantial proportion of the by-catch (Table 7), are globally threatened.

II.17 The Working Group recommended that France strives to eliminate the incidental mortality of seabirds in accordance with CCAMLR policies and practices (IMAF Terms of Reference, SC-CAMLR-XII, paragraph 10.19; SC-CAMLR-XVII, paragraph 4.71; Conservation Measure 25-02).

II.18 The Working Group noted SC-CAMLR-XXVI/6 which discussed recommendations made by the Scientific Committee in 2006 on seabird by-catch within the French EEZs in Subarea 58.6 and Division 58.5.1. The Working Group noted that France considered a greater level of observer coverage as being problematic to implement. The Working Group suggested that, in addition to improving observed proportions of hooks set, it would be desirable to increase the detail of observer data collection protocols, in order to better analyse factors affecting by-catch of seabirds in these fisheries.

II.19 The Working Group developed specifications of data which could be considered for inclusion into observer protocols, to be gathered across the current 25% of hooks observed, or for a greater proportion of hooks where possible. The Working Group's recommendations for additional data for observers to record are as follows:

(i) TDR measurements of line sink rate representatively across fishing effort;

(ii) specifications of the streamer lines for each set, and any gear failures;

(iii) use of other mitigation devices or practices, including type, frequency of use and detailed specification of these devices;

(iv) offal discharge, including loss of baits or partial baits during any part of the fishing operation;

(v) experience of the vessel master and key crew members (e.g. years of experience and experience on the vessel used that season);

(vi) height of the departure point of of the hookline from the vessel during setting;

(vii) condition of baits at the point of setting (whether they are firm, friable, frozen and bait loss rate etc.).

II.20 The Working Group noted that SC-CAMLR-XXVI/BG/21 and BG/22 were submitted, although these were available in French only. Mr Marteau presented the information contained in these papers, and the Working Group welcomed his offer to submit the full translation of these analyses once they were published, and in time for ad hoc WG-IMAF in 2008. The Working Group recommended that the detailed analyses of the population responses to fisheries and environmental factors be submitted for review to WG-SAM, and that WG-SAM report on the review to WG-IMAF in 2008. The information presented by Mr Marteau showed that France had responded to the 2006 requests of the Scientific Committee to provide:

(i) a thorough analysis of data for the 2003/04 to 2005/06 seasons (SC-CAMLR-XXVI/BG/21);

(ii) additional information on the nature of captures, the factors affecting captures, and details of mitigation devices used (Tables 7 to 9).

II.21 Noting that France had submitted the full suite of data on seabird captures and implementation of conservation measures before the submission deadline for 2007, the Working Group requested that France supply all observer data in the format as specified by SC-CAMLR-XXV (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 17 to 20).

II.22 The summary of the analyses presented by Mr Marteau indicated that area and season were the key variables affecting incidental mortality. Seabirds were caught on the set and haul of longline operations, and most of the captures were of white-chinned petrels, with grey petrels comprising an important, but more minor, component of the by-catch (9–16% of birds caught depending on year) (Tables 7 and 9). The Working Group noted that high capture rates were restricted to a few vessels in both areas of the French EEZ, and were at times linked to operational problems in the fishery (e.g. gear becoming jammed during line setting). The Working Group noted that analyses specifically addressing these factors would be beneficial.

II.23 The Working Group noted that France had put in place measures to reduce incidental mortality, including a fishery closure in Division 58.5.1 around the Kerguelen Islands during mid-February to mid-March to avoid high-risk times of year for incidental mortality of seabirds and use of IWLs and other mitigation measures. Further, France had established a new law (Arrêté no. 2007-99 of 26 July 2007) to enable closure of the fishery in Division 58.5.1 if a by-catch limit of grey petrels was exceeded by the fishery. The limit is to be established based on scientific advice. The reporting of observed effort shows that captures of grey petrels are decreasing through time. In order to examine the impact on the grey petrel population of current and past levels of incidental mortality, the Working Group anticipates submission of the detailed demographic modelling analysis for review in 2008 (paragraph 20).

II.24 The Working Group expressed concern that the grey petrel population at Kerguelen Islands had decreased in recent years (SC-CAMLR-XXVI/BG/22) and that any additional adult mortality could increase the vulnerability of the population.

II.25 Mr Marteau welcomed suggestions from the Working Group for potential improvements to mitigation devices or fishing practices that would aid further reductions in seabird by-catch. The Working Group suggested that France consider broadening the set of mitigation measures used, particularly during the haul (paragraph 107). These measures had been trialled on several vessels fishing in the French EEZs, and expanding their use to other vessels is likely to be beneficial.

II.26 The Working Group suggested the vessels fishing within the French EEZs should follow mitigation practices used by New Zealand's large autoline vessels fishing for ling (*Genypterus blacodes*) within the New Zealand EEZ in order to reduce seabird by-catch. The current fishing practices of these vessels include (many of which it is clear that France is already implementing):

(i) retention of offal during fishing;

(ii) baits lost during setting are retained and not discharged;

(iii) strict use of IWLs;

(iv) streamer lines in strict compliance with the CCAMLR standard, with two used when bird numbers are high;

(v) in addition to the standard streamer line design, a boom and bridle system is used to position the streamer line over the baited hooks, with a 'jiggler' to add movement and give maximum effect to the streamer lines;

(vi) noise cannon, used sparingly if birds begin settling on the water, but this needs to be used unpredictably, rather than set to discharge automatically, as birds will habituate to the noise;

(vii) no stern lighting used when setting at night;

(viii) Brickle curtain in place during the haul – a proven design consists of a string of net-floats at the surface, positioned around the hauling station with two booms and weights preventing tangling with the longline. This prevents the birds approaching the hauling station across the sea surface (Figure 1).

II.27 The Working Group recommended that France work closely with ad hoc WG-IMAF participants to facilitate further research into the nature of seabird captures and to consider experimental trials. In doing so, the Working Group encouraged France to exchange knowledge, experience and collaborative research with other WG-IMAF participants. The Working Group noted that France might consider easing conservation measures, such as night setting, as an element of focused research on mitigation measures during such trials. While this may increase seabird by-catch in the short term on the vessel conducting the research, this approach could save many thousands of seabirds in the long term, as occurred in the USA (Melvin et. al, 2001; NMFS, 2006) and New Zealand (Robertson et al., 2006).

II.28 French by-catch statistics over the last few years have shown continuing reductions of around 50% each year, except that in the last year, only 13% fewer birds were killed than in the previous year. This indicates that the reductions in seabird by-catch resulting from technical advances may be reaching an asymptote for current mitigation practices, and alternative measures may be warranted to make further significant reductions in by-catch in the French EEZs. In research into the current implementation of technical by-catch reduction devices, consideration is needed of whether further improvements to these devices are likely to result in further by-catch reductions.

II.29 The Working Group recommended that France continue to conduct analyses of the factors that lead to seabird by-catch within its EEZs. The results of such analyses should inform which management strategy will contribute to further significant reductions in seabird by-catch. These analyses could lead to direction of management actions, such as fishing restrictions in SSMUs to avoid highest-risk times and areas and using existing fisheries management instruments (such as those that allow for closure of specific small areas and for the redirection of effort by individual vessels to other areas) in order to reduce seabird by-catch.

II.30 Recognising the complex interplay of factors in fishery management that exist in the French EEZs, the Working Group recommended that France urgently submit a strategic plan to eliminate seabird mortality. The Working Group recommended that the strategic plan include:

(i) details of the implementation targets for recommended mitigation devices (including, but not limited to, haul mitigation measures, line weighting, night setting, avoidance of all discharge of offal or used baits, and deployment of streamer lines consistent with the CCAMLR specification in Conservation Measure 25-02);

(ii) establishment of by-catch targets reducing each year to near-zero levels in less than three years;

(iii) the implementation of additional seasonal and area closures if the targets in (ii) above are not met.

II.31 The Working Group requested that France submit a detailed paper describing the full set of regulatory instruments in place to reduce seabird mortality directly or indirectly, such as move-on rules, restrictions on SSMUs, line weighting, streamer lines, and the triggers or thresholds for their implementation in the French EEZ fisheries so that the Working Group can appreciate the scope and extent of the suite of measures available for use by France to manage incidental mortality.

Seabirds in trawl fisheries

II.32 A total of eight seabird mortalities were reported in trawl fisheries in the Convention Area (Table 10). There were six reported in the icefish fishery in Subarea 48.3 and two in the icefish and toothfish trawl fisheries in Division 58.5.2. In addition, three seabirds were released alive in Subarea 48.3 (Table 11). All observers reported the use of various mitigation measures (with different combinations in each fishery) to reduce seabird mortality, including net cleaning, net bindings during sets, streamer lines and water jets. It was suggested that these mitigation measures had been significant contributors to the decrease in seabird mortality in Subarea 48.3 (Table 12).

Subarea 48.3 icefish

II.33 Data were available from all five trawl cruises conducted within Subarea 48.3 during the 2006/07 season (WG-FSA-07/7 Rev. 1). The Working Group noted that there was 100% observer coverage of fishing vessels in this fishery with 89% of tows observed (Table 12).

II.34 For 2006/07, six seabird mortalities (three black-browed albatrosses, two white-chinned petrels and one grey-headed albatross) were reported in the Subarea 48.3 icefish fishery from five vessels; in addition three birds were released alive, uninjured (Table 11). This compares to 33 seabird mortalities (and 89 released alive) in 2006 and 11 seabird mortalities (and 14 entanglements) in 2005. The rate of mortality in this subarea in 2007 was 0.07 birds per trawl compared to 0.07, 0.14 and 0.37 in 2006, 2005 and 2004 respectively (Table 12).

II.35 The Working Group noted that there was a substantial drop in seabird by-catch between 2006 and 2007, continuing the general downward trend in seabird mortality in this fishery in recent years (Table 12).

Division 58.5.2 toothfish/icefish

II.36 Data were available from three of the four trawl cruises conducted within Division 58.5.2 during the 2006/07 season; one of the cruises was still at sea at the time the summary was prepared (WG-FSA-07/7 Rev. 1). The Working Group noted that there was 100% observer coverage of fishing vessels in this fishery with 93% of tows observed (Table 12).

II.37 Two seabird mortalities were recorded in the toothfish demersal trawl fishery in Division 58.5.2, both Cape petrels (Table 11). Observer reports from three cruises on board the *Southern Champion* indicated that no bird-scaring devices were deployed but the mitigation measures used were in full compliance with Conservation Measure 25-03.

Krill

II.38 Data were available from all six trawl cruises conducted within Area 48 during the 2006/07 season (WG-FSA-07/7 Rev. 1). In the krill fishery, 17% of vessels fishing in Subarea 48.1, 20% of vessels fishing in Subarea 48.2 and 50% of vessels fishing in Subarea 48.3 had observers on board at some time during their trips. There were no reported incidents of seabird mortality or entanglements in the krill fishery in Area 48, with two cruises in Subarea 48.1 and 48.2, and four cruises in Subarea 48.3 (Table 10).

II.39 The Working Group noted that no seabird mortality was reported on the *Saga Sea* while fishing with continuous trawls in Subareas 48.1 and 48.2. Similarly, no mortalities were recorded on the *Dalmor II* and *Niitaka Maru* using traditional krill pelagic trawl methods in Subarea 48.3 (Table 10).

Seabirds in pot fisheries

II.40 During pot fishing in 2006/07, no seabird mortalities were recorded during the only cruise targeting *D. eleginoides* in Subarea 48.3 (WG-FSA-07/7 Rev. 1).

Marine mammals

Marine mammals in longline fisheries

II.41 Two southern elephant seal mortalities were reported from Subarea 48.3 (WG-FSA-07/6 Rev. 1), while one southern elephant seal mortality was observed in Division 58.5.2. This is an increase from 2005/06, where there were no cases of marine mammal mortality in longline fishing gear (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 33).

Marine mammals in trawl fisheries

Krill

II.42 No marine mammal mortalities or entanglements were reported in any of the three krill trawl fisheries (Table 13). In 2005/06, one Antarctic fur seal was reported killed in the krill fishery (Table 14).

Finfish

II.43 No marine mammal entanglements were observed in finfish trawl fisheries (Table 13). In 2005/06, one leopard seal was killed in the toothfish trawl fishery (Table 14).

Marine mammals in pot fisheries

II.44 No marine mammal mortalities were reported for pot fisheries in the Convention Area (WG-FSA-07/9). This was also the case for 2005/06 (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 37).

Information relating to the implementation of Conservation Measures 26-01, 25-02, 25-03

II.45 Information from observer reports relating to the implementation of Conservation Measures 26-01, 25-02 and 25-03 in 2006/07 were provided by the Secretariat (Tables 15 to 17). The data reported exclude fishing activity within the French EEZs in Subarea 58.6 and Division 58.5.1.

Conservation Measure 26-01 'General environmental protection during fishing'

Plastic packaging bands

II.46 Conservation Measure 26-01 prohibits the use of plastic packaging bands to secure bait boxes. The use of other plastic packaging bands is restricted to those vessels with on-board incineration facilities and all bands must be cut and disposed of using this facility. Information from observer reports indicated 100% compliance with this measure, the same as in 2006 (WG-FSA-07/8 Rev. 1, Table 1).

Gear debris and garbage

II.47 The Working Group noted the discharge of oil (*Insung No. 1* (Republic of Korea) in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b; *Ross Star* (Uruguay) in Subareas 88.1 and 88.2), the discharge of gear debris (*Insung Ho* (Republic of Korea) in Subarea 48.3; *Antartic II* (Argentina) in Subareas 88.1 and 88.2) and the discharge of inorganic garbage (*Insung Ho* (Republic of Korea) in Subarea 48.3; *Ross Mar* (South Africa) in Subareas 58.6 and 58.7; *Antartic II* (Argentina) in Subareas 88.1 and 88.2) (WG-FSA-07/8 Rev. 1, Table 1). This included fishing gear, small sections of line, snoods and plastics. The Working Group noted that these discharges would have additional negative effects on seabirds and marine mammals which could not be quantified.

Conservation Measure 25-02 'Minimisation of the incidental mortality of seabirds in the course of longline fishing or longline fishing research in the Convention Area'

Line weighting

II.48 For Spanish-system vessels there was 100% reported compliance with the line-weighting regime in all subareas and divisions (Table 16). For autoline vessels, all vessels fishing in Subareas 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b south of 60°S in daylight, met the requirement to achieve a consistent minimum line sink rate as described in Conservation Measure 24-02 (Table 16). As in previous years, this line-weighting requirement has been fully achieved by all vessels. For 2006/07, the Working Group noted that only one vessel (*Antartic II* in Subareas 88.1 and 88.2), using a variation on the autoline method, used clip-on weights to achieve the sink rate requirements. All other autoline vessels were now using IWLs. The Working Group expressed some concern at the low number of bottle tests for some vessels (Table 17), but noted that, with the exception of two vessels, similar sink rates were achieved by all vessels using the Spanish system and also all vessels using IWLs (Table 17). The Working Group noted that the *Shinsei Maru No. 3* again used a trotline system and exceeded the longline sink rate requirements in Subarea 48.6 (Table 17).

Night setting and offal discharge

II.49 There was 100% compliance with night setting, and also for control of offal discharge in all areas where this was required (Subareas 48.3, 48.4, 58.6 and 58.7) (Table 16).

II.50 All but two vessels complied fully with the requirement to retain offal on board in all areas where this was required (Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b and 58.5.2) during the 2006/07 season (Table 16). The *Tronio*, fishing in Divisions 58.4.1 and 58.4.3b, discharged offal on seven occasions due to mechanical problems. The *Ross Mar*, fishing in Subarea 88.1, was observed discarding offal during one haul (WG-FSA-07/8 Rev. 1).

II.51 Vessels fishing in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b and 58.5.2, may set longlines during daylight hours providing they can demonstrate a consistent minimum line sink rate of 0.3 m s^{-1}, or use an IWL of at least 50 g m^{-1} and achieve a sink rate of 0.2 m s^{-1}. All vessels fishing in these areas complied with one or both of these requirements (Table 17).

Discard of hooks

II.52 Observers reported hooks being present in discards on three of 39 longline cruises; in two of these this was reported as a rare event (WG-FSA-07/8 Rev. 1, Table 1). However, the observer on board the *Insung No. 22*, fishing in Subarea 48.3, reported that there was no system in place for removing hooks from discards and that the discarding of offal with hooks present was a daily occurrence.

II.53 The Working Group expressed concern at the discarding of hooks in offal, given the informal reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses (SC-CAMLR-XXVI/BG/18; paragraph 93).

Streamer lines

II.54 Compliance with streamer line design has increased from 80% (29 of 36 cruises) in 2005/06 to 87% (34 of 39 cruises) this year (Table 16), although this is not as high as the 92% (34 of 37 cruises) in 2002/03. Streamer line design compliance in Subareas 48.4, 48.6, 58.6, 58.7 and Division 58.5.2 was 100%, 90% in Subarea 48.3, 93% in Subareas 58.7, 88.1 and 88.2 and 50% in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b. Most of the non-compliant vessels had only minor deviations from the requirement (Table 16).

II.55 The cruises where streamer lines did not comply failed on streamer lengths (three cruises: *Jacqueline* in Subarea 48.3; *Insung No. 1* in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b; and *Viking Sur* in Subareas 88.1 and 88.2), total streamer line length (one cruise: *Antilles Reefer* in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b) and branched streamer spacing (one cruise: *Shinsei Maru No. 3* in Divisions 58.4.3a and 58.4.3b). One of these vessels, the *Viking Sur*, also failed on two specifications in 2005/06. There was 100% compliance with attachment height.

II.56 The Working Group noted that these small deviations from full compliance with streamer line configuration had not led to any bird mortality. Nevertheless, the Working Group encouraged vessels to strive for full compliance.

Haul-scaring devices

II.57 Paragraph 8 of Conservation Measure 25-02 requires that a device designed to discourage birds from accessing baits during the haul of longlines (haul-scaring devices) shall be employed in those areas defined by CCAMLR as average-to-high or high (level of risk 4 or 5) in terms of risk of seabird by-catch. These areas are currently Subareas 48.3, 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2.

II.58 Apart from one vessel (*Insung No. 22*, 87%) on one cruise in Subarea 48.3 and one vessel (*Ross Mar*, 0%) on two cruises in Subareas 58.6 and 58.7 which did not use haul-scaring devices on all hauls, there was full compliance by all other vessels.

Conservation Measure 25-03 'Minimisation of the incidental mortality of seabirds and marine mammals in the course of trawl fishing in the Convention Area'

II.59 A range of mitigation measures were used on board icefish vessels in Subarea 48.3 and Division 58.5.2 and compliance with Conservation Measure 25-03 was generally good (WG-FSA-07/8 Rev. 1; paragraph 32).

Net sonde cables

II.60 There were reports of two vessels, the *Niitaka Maru* and the *Saga Sea*, which used net monitoring cables in the Convention Area during the 2006/07 season (WG-FSA-07/8 Rev. 1). As in 2005/06, the Working Group was unsure whether these were paravane cables or actually net sonde cables (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 48 and 121). The Working Group had provided information for the observer logbook to clarify the distinction between these two cables in 2005/06. If these were indeed net sonde cables, the Working Group noted that this was in contravention of Conservation Measure 25-03.

INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS IN FISHERIES OUTSIDE THE CONVENTION AREA

II.61 The Working Group discussed the incidental mortality of seabirds outside the Convention Area in respect of the CCAMLR standing request to Members to report on the details and magnitude of seabird mortality for species breeding within the Convention Area, but arising from fisheries conducted outside the Convention Area (SC-CAMLR-XXIV/BG/28, item 3.2). Members, non-Contracting Parties, and international organisations are also asked to provide information on longline fishing effort in the Southern Ocean outside the Convention Area and on the use and effectiveness of mitigation measures outside the Convention Area.

II.62 The request was carried forward intersessionally through members of ad hoc WG-IMAF. Although no written reports were provided by CCAMLR Members to the group, Mr B. Baker (ACAP) provided a verbal report of documented high levels of seabird mortality in the waters of Angola, Namibia and South Africa, based on a report recently presented to ACAP (Petersen et al., 2007).

II.63 This report documented that the Benguela Current provides rich foraging for sub-Antarctic seabirds from the Convention Area as well as a number of endemic seabird species. Interactions with longline fishing have been identified as the primary cause of seabird population declines in this area. This study represents the first attempt at quantifying seabird by-catch in the Benguela Current Large Marine Ecosystem. By-catch rates for South African fisheries were 0.2 and 0.04 birds/thousand hooks in the pelagic and demersal longline fishery respectively, totalling an average of 500 seabirds killed per year. Namibian longline fisheries were estimated to kill approximately 0.07 birds/thousand hooks in the pelagic longline fishery and 0.3 birds/thousand hooks in the demersal longline fishery. Together, Namibian longline fisheries are likely to kill approximately 30 850 seabirds per year. Limited data exist for Angolan pelagic longline and artisanal line fisheries, both of which overlap with vulnerable seabird populations. Estimates for the entire region were based on pelagic longline effort from ICCAT which averaged 34.5 million hooks per year. This fishery is likely to be killing approximately 2 900 seabirds per year. Thus a total of 33 850 seabirds are estimated to be killed per year by longline fisheries operating throughout the region.

II.64 This study concluded that five species of seabirds are caught in these fisheries at levels that raise concerns about the sustainability of these populations. Overall impacts by these fisheries on seabirds are estimated to kill >31 903 white-chinned petrels; this species is also being recorded caught as directed catch of the artisanal line fishery for consumption. White-chinned petrels are listed as vulnerable and breed throughout the sub-Antarctic, dispersing widely during the non-breeding season. As a result, they are killed by many fisheries throughout their range and unless such mortality is greatly reduced, their ongoing population decreases are inevitable. More than 1 334 albatrosses are also estimated to be killed each year in these fisheries, most commonly the white-capped albatross (>899 p.a.), a species that only occasionally forages in the Convention Area. For Convention Area species, more than 203 Atlantic yellow-nosed albatrosses, and more than 58 black-browed albatrosses were estimated to be killed each year in this region. Both these species are endangered and undergoing population declines.

II.65 These levels of mortality of Convention Area seabirds in southern African waters were noted with great concern by the Working Group, especially when coupled with the levels of mortality reported to the group in 2006 for the South African deep-water hake trawl fishery. In this fishery, approximately 18 000 (95% CI 8 000–31 000) birds were estimated to be killed annually, including ca. 5 000 (95% CI 3 000–12 500) black-browed albatrosses thought to predominantly be from the population breeding at South Georgia (SC-CAMLR-XXV, Appendix D, paragraph 68).

II.66 Given that considerably greater levels of mortality of Convention Area seabirds occur in areas north of the Convention Area, compared to levels within the Convention Area, the

Working Group reminded Members of the importance of the request to report on seabird mortality for Convention Area species arising from fisheries conducted outside the Convention Area (Resolution 22/XXV, paragraph 3; SC-CAMLR-XXV, Appendix D, Table 20, item 3.2).

INCIDENTAL MORTALITY OF SEABIRDS DURING UNREGULATED LONGLINE FISHING IN THE CONVENTION AREA

II.67 As no information is available on rates of incidental mortality of seabirds from the unregulated fishery, estimation of the incidental mortality of seabirds during IUU fishing within the Convention Area presents a number of difficulties, requiring various assumptions to be made.

II.68 In previous years, the Working Group has prepared estimates using both the average catch rate for all cruises from the appropriate period of the regulated fishery in a particular area and the highest catch rate for any cruise in the regulated fishery for that period. Justification for using the worst catch rate from the regulated fishery is that unregulated vessels accept no obligation to use any of the mitigation measures prescribed in CCAMLR conservation measures. Therefore catch rates, on average, are likely to be considerably higher than in the regulated fishery.

II.69 As no information is available on rates of incidental mortality of seabirds from the unregulated fishery, estimates have been made by bootstrapping the observed catch rates from fishing operations in 1996/97. In 1996/97, the fleet implemented relatively few mitigation measures and has been considered to provide the best estimate the Working Group has of likely catch rates in the unregulated fishery. The method used to prepare estimates of the incidental mortality of seabirds during IUU fishing within the Convention Area is described in full in SC-CAMLR-XXV/BG/27 and in SC-CAMLR-XXII, Annex 5, paragraphs 6.112 to 6.117.

II.70 The Working Group agreed that the following values should be applied to the toothfish removals data to estimate seabird by-catch in IUU *Dissostichus* spp. fisheries in the Convention Area in 2006/07 (SCIC-07/10), and also agreed that these values should be used to generate similar estimates for previous years. The resulting median and 95% confidence intervals for seabird incidental mortality rates (birds/thousand hooks) for the unregulated fishery are shown below. It should be noted that where incidental mortality rates are not available for a regulated fishery within a statistical area, the rate for an adjacent area of similar level of risk (SC-CAMLR-XXV/BG/26) has been used.

Subarea/division	Season	Lower 95%	Median	Upper 95%
48.3	Summer	0.39	0.741	11.641
	Winter	0	0	0.99
58.6, 58.7, 58.5.1, 58.5.2	Summer	0.45	0.55	1.45
	Winter	0.01	0.01	0.07
58.4.2, 58.4.3, 58.4.4	Summer	0.27	0.33	0.87
	Winter	0.006	0.006	0.042
88.1, 88.2	Summer	0.27	0.33	0.87
	Winter	Not applicable, access not possible in winter		

II.71 The estimates of potential unregulated seabird by-catch in the Convention Area in 2004/05 and comparison with estimates for previous years are provided in detail in SC-CAMLR-XXVI/BG/32.

II.72 The overall estimated total for the whole Convention Area in 2006/07 indicates a potential incidental mortality of seabirds in the unregulated fishery of 8 212 (95% CI 6 730–21 926) seabirds. The values for this and previous years are summarised in respect of different parts of the Convention Area in Table 18.

II.73 In comparison with estimates for previous years, calculated in identical fashion, the value for 2006/07 is broadly similar to the values estimated for the last three years. These are the lowest reported values since estimates started in 1996 (see SC-CAMLR-XXVI/BG/32, Table 2). This presumably reflects a commensurate reduction in toothfish removals or changes in the areas from where IUU fishing occurs.

II.74 Based on the data since 1996 (SC-CAMLR-XXIV/BG/27), an estimated total of 193 927 (95% CI 157 917–565 245) seabirds have been killed by these vessels. Of these:

(i) 43 396 (95% CI 35 127–136 275) were albatrosses, including individuals of four species listed as globally threatened using the IUCN threat classification criteria;

(ii) 7 687 (95% CI 6 280–21 474) were giant petrels, including one globally threatened species;

(iii) 121 651 (95% CI 99 213–347 589) were white-chinned petrels, a globally threatened species.

II.75 The Working Group also noted that grey petrels, another globally threatened species, have comprised between 5% and 16% of the catch in the regulated fishery in Division 58.5.1 over the last three years, and that some of the estimated 1 184 to 3 858 birds taken in the IUU fishery this year may have been of this species. The Working Group undertook to examine methods of estimating the by-catch of this species by IUU vessels within Division 58.5.1 as an intersessional task with a view to assessing the level of take of grey petrels in future years.

II.76 As in previous years, it was emphasised that these values are very rough estimates (with potentially large errors). The present estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution.

II.77 In particular, changes in gear type now seen in the regulated fishery, such as the increased use of IWL autoline gear, trotlines and the trotline/net system, would have undoubtedly flowed through to IUU vessels. These gear changes, together with the use of gillnets by IUU vessels, will affect the levels of IUU-fisheries-related by-catch, but are not reflected in the assumptions used to develop these estimates.

II.78 The Working Group discussed how this might be taken into account, however, in the absence of a clear understanding of how these influences affect by-catch rates, the Working Group was reluctant to depart from the established methodology for preparing these IUU seabird by-catch estimates.

II.79 Nevertheless, even taking these methodological issues into account, the Working Group endorsed its conclusions of recent years that:

(i) the levels of loss of seabirds from the populations of these species and species groups are still broadly consistent with such data as exist on the population trends of these taxa, including deterioration in conservation status as measured through the IUCN criteria;

(ii) although considerably reduced from previous years, such levels of mortality probably still continue to be unsustainable for some of the populations of albatrosses and petrels breeding in the Convention Area.

II.80 Because many albatross and petrel species are facing potential extinction as a result of fisheries-related mortality, the Working Group again requested the Commission to continue to take action to prevent further incidental mortality of seabirds by unregulated vessels in the forthcoming fishing season.

RESEARCH INTO AND EXPERIENCE WITH MITIGATION MEASURES

Longlines

Trotline variation of the Spanish longline system and the Chilean trotline/net system

II.81 The Working Group reviewed three papers (WG-FSA-07/11, 07/14 and 07/23) that report the performance of an increasingly used modification of the Spanish longline system in fisheries outside the Convention Area (Annex 5, Figure 7). This trotline longline system retains the floating line of the Spanish longline system, but replaces the horizontal hookline with a series of 15 to 20 m vertical hooklines, each individually weighted with 4 to 8.5 kg and spaced at 20–40 m along the floating line. Clusters of 8–10 hooks are placed within a metre of the weight. During line setting, this modified system sinks quickly (0.8–1.4 m s^{-1}) beyond the range of foraging seabirds. All three papers report no seabird mortality during line setting or line hauling when using the trotline system.

II.82 A trotline/net longline system has been developed in Chile. It is now in extensive use in Chile and throughout southern South America. Although at least one vessel has used the trotline system in the Convention Area (*Shinsei Maru No. 3*), the trotline/net system has not as yet been used in the Convention Area. The adoption of this modified gear is due primarily to the dramatic reduction in sperm whale and killer whale depredation that is realised when used in combination with cone-shaped nets (sleeves) on each of the vertical hooklines. The nets float above the hooks while fishing but encase captured fish in heavy netting as the gear is hauled. This new trotline/net longline system eliminated seabird by-catch and significantly reduced whale depredation with no loss in toothfish CPUE when compared to the Spanish longline system.

II.83 The Working Group noted that by virtue of the rapid sink rates of hooklines, this modified longline system poses significantly reduced risks to seabirds during both hauling and setting compared to the traditional double-line system. However, the Working Group recommended that this system should comply with all requirements of Conservation Measure 25-02, including line-weighting requirements, to protect seabirds. Further, the Working Group noted that use of this gear does not require modification to the sink rate requirement in Conservation Measure 25-02.

II.84 WG-FSA-07/14 reported the development of this gear modification in the Chilean domestic longline fisheries. The novel system was based on the Chilean artisanal longline fishing method. Based on the benefits to seabirds, this method was tested in the industrial longline fishery in 2005 and was adopted by all 11 vessels in the Chilean toothfish fleet in the 2005/06 season. It then quickly spread to other South American fleets. No seabirds were caught in 2005/06, with or without streamer lines, day or night, in areas with a high abundance of black-browed albatross. TDR-measure sink rates of 4–12 kg weighted vertical hooklines averaged 0.8 m s^{-1}. Toothfish depredation was reduced to <0.5% in 2005/06 from over 3% in 2001/02; toothfish CPUE was comparable to the double-line system in previous years. The Working Group noted that the development of this method evolved from the NPOA process initiated by Chile under the leadership of Prof. C. Moreno, and that this collaborative process instigated innovation in the Chilean fishery, which is now spreading quickly to other southern hemisphere fisheries. The Working Group noted that incentives are critical to successful adoption of by-catch mitigation technologies and practices.

II.85 WG-FSA-07/23 reported on comparisons of sperm whale depredation on toothfish using the trotline/net system and the traditional double-line system in the Uruguayan fleet operating at the edge of the Patagonian Shelf. This paper was not available in English; cursory review was based on the abstract and some tables. Sink rates of 1.14 m s^{-1} were recorded for weightings of 8–8.5 kg per vertical hookline using the 10 m bottle-line test. Despite the presence of black-browed albatrosses and Cape petrels, no seabird mortality was observed using the trotline/net system in combination with streamer lines. Seabird by-catch in the traditional system was not reported in the abstract. Sperm whale depredation occurred in 71% of sets using the traditional system versus 27% in the new system. The Working Group welcomed the report from the Uruguayan fleet, but the lack of an English translation limited its ability to evaluate findings.

II.86 WG-FSA-07/11 reported a comparison of fish catch rates between two locations in the South Atlantic region of South America by Ukrainian vessels using the trotline variation of the double-longline system. Gear weighting was 4–6 kg per vertical hookline – sink rate data were not reported. No seabird mortalities were recorded in over 900 000 hooks set. The use of the trotline/net system described in WG-FSA-07/14 successfully reduced sperm whale depredation on toothfish.

II.87 The Working Group welcomed these reports on the trotline/net system and encouraged future reports of the performance of the system, especially those that include details on seabird by-catch, abundance and interactions, weighting scenarios and sink rates, as well as toothfish and fish by-catch CPUE.

II.88 WG-FSA-07/31 reported plans to conduct a trial inside the Convention Area to compare the effectiveness of the trotline/net system with the traditional Spanish system in reducing fish loss to toothed whales. The proposed trial, which will be conducted on a single vessel, follows preliminary testing in the 2006/07 season and is scheduled to occur in Subarea 48.3 in the 2007/08 season. Trotline/net longlines will be configured as described in paragraph 81. Gear configuration will be alternated nightly with the traditional Spanish longline gear. Trials will assess the impact of the modified gear on cetacean, seabird, toothfish, fish by-catch and the benthos, compared to standard (traditional) gear. All the provisions of Conservation Measures 24-02 and 25-02 will be applied during the trial and a three-bird by-catch limit is proposed. If the limit is reached, the vessel will revert to standard Spanish longline gear. It is intended that once shore-based scientists are satisfied that enough information has been acquired on the trotline/net system, that vessels will be given the option of continuing to fish with either gear configuration.

II.89 The Working Group recognised the importance of the proposed trial for vessels operating in the Convention Area. The trial will add further information on the performance of the modified gear to that already acquired by vessels outside the Convention Area (see WG-FSA papers cited above). The Working Group also recognised the difficulty in acquiring statistically robust data on the effects of gear modifications on fish stocks, fish by-catch species and other aspects of the marine environment. With this in mind, the Working Group strongly encouraged expanding the trial in 2007/08 to include as many Spanish longline vessels operating in Subarea 48.3 as possible. This approach would increase the data acquisition rate on the trotline/net method and enable CCAMLR to quickly understand the comparative effects of the two gear types on fish stock, fish by-catch and other aspects of the marine environment.

Steel weights on Spanish longline system and trotlines

II.90 WG-FSA-07/15 reported the results of a designed experiment (on a chartered vessel) that examined the sink rate relationships between traditional Spanish system weights (netting bags of rocks) and elliptical, or torpedo-shaped, steel weights. The purpose of the research was to provide vessel operators with the option of using either weight type while still complying with the sink rates specified in Conservation Measure 25-02. Sink rates of both traditional Spanish system gear and trotline/net gear were examined in the experiment. Traditional method longlines with 8 kg weights 40 m apart (closely approximates the 8.5 kg/40 m requirements in Conservation Measure 25-02) averaged 0.24 m s^{-1} to 2 m depth, which would be equalled or exceeded on average by lines with 5 kg steel weights attached. Sink rates of trotline/net longlines greatly exceeded those of the traditional method, ranging from 0.68 m s^{-1} (4 kg rocks) to 1.41 m s^{-1} (8 kg steel) in the shallow depth ranges. There are both actual and potential benefits to the use of steel weights. Actual benefits include: (i) steel weights maintain their mass throughout the season and require no maintenance, unlike weights made from bags of rocks, which lose rocks with use and require ongoing maintenance; (ii) vessels using steel weights are more likely to remain compliant to the line-weighting requirements of the conservation measure; (iii) steel weights require about one-third the storage space on vessels; and (iv) the total amount of weight hauled by vessels is considerably reduced. The main potential benefit of steel weights is that due to their small size and streamlined shape, the frequency of snagging on the seabed would very likely be reduced. This would result in a reduction in the amount of lost gear, the incidence of ghost fishing (capture of fish that are never landed) and in benthic pollution.

II.91 The Working Group endorsed the use of solid steel (e.g. not chain links) weights and recommended that Conservation Measure 25-02 be modified to provide Spanish longline system vessel operators the option of using either traditional weights under the current two mass/spacing regimes or steel weights under a mass/spacing regime of ≥5 kg mass spaced at intervals of no more than 40 m. The Working Group noted that operators should consider the shape of weights and recognise that torpedo-shaped or spherical weights are the most hydrodynamic.

Hook retention

II.92 WG-FSA-07/20 reported the increased incidence in 2006/07 of demersal fish hooks ingested by South Georgia wandering albatrosses based on observations at breeding colonies and the need to take steps to reduce this cryptic source of seabird injury and mortality. The increase in the occurrence of ingested hooks and its potential contribution to the global decline of wandering albatrosses, and as yet unexplained body piercing by hooks was reported by British Antarctic Survey scientists (SC-CAMLR-XXVI/BG/18), who intend to submit a scientific paper to ad hoc WG-IMAF in 2008.

II.93 The Working Group expressed concern at the reports that nest surveys had found a high and increasing level of hooks around nests of wandering albatrosses and embedded in wandering albatrosses. In addition to the discards referred to in paragraph 52 from within the Convention Area, anecdotal evidence suggests the increase in hook ingestion is associated with the use of the trotline/net method, where non-target species (e.g. grenadiers) may be cut off with embedded hooks. Grenadiers are primarily consumed whole by royal and wandering albatrosses as they are the only birds large enough to take fish of that size. The only currently plausible explanation for body piercing by hooks is that seabirds are caught during longline hauling and snoods break off, or seabirds are landed and set free without hooks being removed. The Working Group strongly encouraged the UK to present a paper to ad hoc WG-IMAF on its survey work and, in particular, hook ingestion and hook body piercing, to its 2008 meeting.

II.94 In recognition of the severity of the problem and its assessment by the UK (SC-CAMLR-XXVI/BG/18), the Working Group strongly supported the proposal that CCAMLR produce a poster instructing crews to remove hooks from all landed fish and hauled baits. A draft version of the poster was presented to the Working Group, and was endorsed. The proposed poster incorporates photographs of fish and baits containing hooks, a photograph of a hook embedded in the mouth of a wandering albatross and appropriate text. The estimated cost of the production of such posters is AU$5 000.

II.95 The Working Group recommended that:

(i) CCAMLR produce the A3 poster in colour, in all CCAMLR languages, as well as Indonesian, Korean and Japanese. It should be waterproof and on plastic for display in wet areas on vessels;

(ii) the Secretariat distribute the poster via technical coordinators to all longline vessels operating in the Convention Area early in the 2007/08 season as a priority;

(iii) the Secretariat via technical coordinators instruct vessel operators to display a poster in at least four strategic locations on vessels, including in fish processing factories, in line hauling bays in easy view of crews hauling gear, and in areas inboard of hauling areas where crews process hauled baits/hooks;

(iv) scientific observers be instructed to report on whether the poster is displayed on vessels and reminded of the need to monitor hook removal.

II.96 The Working Group also strongly encouraged Members operating the Spanish method of longlining (both traditional and trotline methods) outside the Convention Area to adopt the use of the poster and provide them to their longline vessels for on-board display.

Integrated weight longlines

II.97 WG-FSA-07/51 presented a comparison of skate by-catch using 50 g m^{-1} IWLs and UWLs in the Bering Sea fishery for Pacific cod (*Gadus macrocephalus*) using data from WG-FSA-06/52 (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 98 to 102), which described the results of research comparing seabird by-catch and fish catch and by-catch of 50 g m^{-1} IWLs to UWLs both with and without paired streamer lines. The skate by-catch rate (six species) was significantly less (11%) on IWLs than traditional UWLs. The authors note limitations of the analysis: skate by-catch rates could vary by species, demographics, bottom type, depth, region and other factors. This contradicts the preliminary information provided about the trials from Subarea 48.3 in the Convention Area (WG-FSA-07/30). The Working Group noted the importance of evaluating the effect of seabird mitigation technologies on the catch rates of all taxa.

II.98 WG-FSA-07/13 reported the results of a trial to determine the effect on gear sink rates of setting IWLs through a line setter (Mustad Company, Norway). A line setter consists of opposing metal and rubber sheaves through which the longline is pulled at a speed slightly faster than the forward speed of the vessel. Longlines set with a line setter enter the water slack (without tension astern) and with a vertical profile about 0.5 m astern, whereas lines set without a line setter are under tension astern and enter the water several metres astern. The objective of the research was to determine if line setters currently used in the Kerguelen and Crozet *D. eleginoides* fisheries are likely to result in faster sink rates, and therefore, reduced interactions with seabirds. Sink rates were measured with time-depth recorders using a paired experimental approach (both treatments in same sets; alternate magazines with and without the setter). The sink times of lines set with and without the line setter were statistically indistinguishable: longlines reach 2 m depth in 7.9 ± 0.8 (s.e.) and 7.4 ± 0.8 seconds with and without the setter respectively. The results reveal that line setters do not significantly increase the sink rate of IWLs and that their use is unlikely to result in reduced interactions with seabirds in the Kerguelen and Crozet fisheries.

Sink rates

II.99 The Working Group reviewed the sink rate data from 2006/07 (Table 17) for both Spanish gear and autoline vessels to examine sink rates achieved in Convention Area fisheries. All sink rate data were generated using the 10 m bottle line test.

II.100 All but one vessel reported as using autoline used IWLs. The *Shinsei Maru No. 3* fishing in Subarea 48.6 and Divisions 58.4.3a and 58.4.3b was categorised as an autoline vessel as it uses a single topline. However, this vessel utilises the trotline system and achieved an average sink rate of 0.68 m s^{-1}, almost double that of the average sink rate recorded from autoline vessels using IWL.

II.101 The review of sink rate data in 2006 suggested that additional data would be useful to interpret anomalously high sink rates especially with Spanish longline gear. The Working Group then suggested simple additions to the logbook to indicate the placement of the bottle-test attachment on the line relative to added weights, how gear is set relative to the direction of the propeller, and to record if weight spacing during a bottle line test matches the spacing used typically during fishing (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 118).

II.102 These additions were incorporated in the observer logbook and cruise report for the 2006/07 season, and the Working Group noted that the level of precision (a decrease in variation around the mean) in recorded sink rates had improved markedly since 2006 (Table 17).

Longline bait

II.103 WG-FSA-07/18 reported that preliminary testing of potential seabird deterrents in longline fisheries around the Kerguelen Islands showed white-chinned petrel responses to mackerel (*Scomber scombrus*) baits differed depending on whether baits were treated with capsaicin and piperine, or were left untreated. Results are preliminary; however, differences in petrel behaviour towards treated baits suggest this method warrants further investigation, including examining effects on fish.

Haul-scaring devices

II.104 The only Convention Area incidental mortalities of seabirds due to interactions with fishing gear during the haul were observed in Subarea 58.6 and Division 58.5.1 within the French EEZ (Table 3).

II.105 In Subarea 58.6 and Division 58.5.1 within the French EEZ, 253 seabirds were reported caught on the haul. In Subarea 58.6, 79 seabirds were caught uninjured and released alive, while nine were reported caught injured and released alive. In Division 58.5.1, 133 seabirds were caught uninjured and released alive, while 32 were caught injured and released alive. The catch rates (birds/thousand hooks) for Subarea 58.6 and Division 58.5.1 were 0.07 and 0.08 respectively.

II.106 In the rest of the Convention Area, seven birds were observed caught but uninjured. The catch rates (birds/thousand hooks) for Subareas 48.3 and 48.4, and the South Africa EEZ areas (Subareas 58.6 and 58.7) were 0.001, 0 and 0.005 respectively. The Working Group noted the decrease in catch rates from last season which were (birds/thousand hooks): Subarea 48.3 (0.003), Subarea 48.4 (0.005) and the South Africa EEZ (Subareas 58.6 and 58.7) (0.015). The Working Group noted that this was an improvement on the 2005/06 season when 32 seabirds were observed caught and uninjured during the haul.

II.107 Various mitigation devices were reported used during the haul for 14 vessels (13 vessels did not report the use of haul mitigation measures) (WG-FSA-07/6 Rev. 1). These included:

(i) the use of a water cannon/fire hose on four vessels. This was observed to be effective at close range when birds made their way close to the hauling point;

(ii) a single boom with a single attached object/streamer was reportedly used on two vessels;

(iii) a single boom with multiple attached objects/streamers was reported on three vessels;

(iv) a 'Brickle curtain' (multiple booms with attached objects) was used on five vessels (e.g. Figure 1);

(v) two vessels used loud noise as a deterrent when seabirds entered through the boom scaring devices.

II.108 The Working Group noted that the current level of haul by-catch remains a concern, and further efforts need to be made to develop and refine effective mitigation at the hauling station (paragraphs 104 to 107). The Working Group again encouraged technical coordinators to instruct observers to collect detailed information on haul mitigation devices used in the Convention Area to allow the effectiveness of these devices to be assessed, and to provide guidance on the uniform adoption of haul mitigation techniques.

II.109 The Working Group made a request to France to work with its technical coordinator to provide information to observers to encourage the use of, and record the detail of, haul mitigation measures (paragraph 25).

Paired streamer lines

II.110 During discussions about the use of single versus twin streamer lines in the Southern Ocean, Mr I. Hay (Australia) noted that twin streamer lines, which complied with the CCAMLR-prescribed standard, had been used in the Division 58.5.2 longline fishery since part-way through the first season (2002/03). In addition, a boom and bridle system is used whilst setting to adjust the position of the streamer line to maximise aerial coverage over the main fishing line; this is particularly beneficial during periods of crosswinds. No research has been done in this fishery to evaluate the effectiveness of one versus two streamer lines, however, advice from the vessel is that two streamer lines are more effective at times of high bird abundance.

Trawl

Offal management

II.111 WG-FSA-07/42 reported on two trials conducted in New Zealand to determine the effects of mealing, mincing and batching all offal before discharge on seabird abundance around trawlers. To follow current regulations, both trials were conducted with paired streamer lines in place. The first trial occurred on a midwater trawler targeting hoki (*Macruronus novaezelandiae*). Three offal treatments were considered: mincing all offal, discharging unprocessed offal, and mealing all offal and so reducing discharge to sump water. The second vessel was bottom-trawling for squid (*Nototodarus sloanii*). Because there was no meal plant on board, the intention was to replace mealing with a batching treatment, where offal was held and discharged in batches. The response variable was estimated seabird abundance (in species and activity categories) within a defined zone at the vessel stern.

II.112 The results of the first trial show that mincing reduced the numbers of large albatrosses (*Diomedea* spp.) feeding around the vessel, but had no significant effect on other groups of seabirds. In contrast, mealing all waste reduced the abundance of several of the bird groups. In particular, the abundance of small albatrosses (principally *Thalassarche* spp.) within the sample area was reduced to 5% of the number that were there when unprocessed waste was discharged. On-board operational problems constrained the implementation and drawing of conclusions from the second trial. However, preliminary analyses suggest a reduction in the numbers of all albatross within the sampling area.

II.113 While the trials reported here were preliminary, WG-FSA-07/42 concluded that there was not currently sufficient evidence to support mincing as an effective waste management measure for reducing seabird interactions, especially given the current cost of the hardware involved. The Working Group questioned aspects of experimental design in the trials including comparisons of waste treatment alternatives and discharges from different locations on the vessel, and suggested that these may have confounded the results.

II.114 The Working Group discussed offal retention and discharge options on both longline and trawl vessels, while recognising the operational constraints in some older and smaller vessels operating in the Convention Area.

II.115 The Working Group noted that potential options for discharge management, such as underwater discharge and maceration, had not been tested to their full potential either inside or outside the Convention Area.

Net binding

II.116 The Working Group recalled reports of the effective use of net binding to reduce seabird interactions with trawl nets in the *Champsocephalus gunnari* fishery in Subarea 48.3 (SC-CAMLR-XXIV, Annex 5, Appendix O, paragraph 207; SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 58; 2004/05 and 2005/06 cruise reports). While the data are not statistically significant, three seasons of operational experience (2004/05–2006/07) indicate that binding the net is a highly effective and easily accomplished mitigation measure. There is increasing evidence from observer reports and anecdotal information from fishing companies and technical coordinators (Mr Heinecken and Dr D. Agnew (UK)) that in combination with net cleaning, net binding may be responsible for reductions in seabird mortality during setting operations.

II.117 In 2006, the Working Group recommended that to assess the utility and provide guidelines for the uniform uptake of net binding in pelagic trawl fisheries in the Convention Area, pelagic trawl fisheries operating outside Subarea 48.3 also use net binding (SC-CAMLR-XXV, paragraph 5.18). The Working Group reiterated this recommendation to provide better information about the use of net binding in pelagic finfish trawl fisheries.

OBSERVER REPORTS AND DATA COLLECTION

II.118 The Scientific Committee requested that the Secretariat undertake a review of observer education and training (SC-CAMLR-XXV, paragraph 2.11), and this proposal was endorsed by the Commission (CCAMLR-XXV, paragraph 10.8). In order to fulfil this request, the Secretariat contacted Members and requested that they submit information on their procedures to educate and train their observers, together with any training manuals or educational material that they utilise. An overview of the information collected from Members is provided in Appendix 1 of SC-CAMLR-XXVI/BG/9 Rev. 1. It identifies nine main aspects of training and education considered important for scientific observers. The standard training components provided by the respondents are summarised in Appendix 2 of SC-CAMLR-XXVI/BG/9 Rev. 1.

II.119 The Working Group noted that there were several differences in the approach by Members to the education and training of their observers for CCAMLR-specific competencies. It was also noted that this could result in different standards of observer competencies, and that observer data quality could be improved by implementing a range of measures. The Working Group supported the proposal of the Secretariat that Members:

(i) develop a standard set of training and educational standards to augment current domestic training programs;

(ii) consider the feasibility of developing a process whereby national observer programs are accredited to consistent international standards;

(iii) encourage and support national technical coordinators to attend WG-FSA and ad hoc WG-IMAF meetings and consider maximising such opportunities by convening training workshops for coordinators.

Observer data collection

Trawl

II.120 In order to assess seabird mortality reporting during trawl hauls, the Working Group augmented data collection protocols to include reporting of the extent to which the haul was monitored and to record seabirds found on warp cables (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 124). In 2006/07 Convention Area trawl fisheries, only one net haul observation was reported. The Working Group strongly encouraged that these data be recorded in all Convention Area trawl fisheries for trawls regardless of the extent to which seabird mortality is observed.

Progress of a trawl warp cable data collection protocol for inside the Convention Area

II.121 In response to reports of seabird mortality of Convention Area seabirds in trawl fisheries in New Zealand and South Africa and seabird mortalities reported in the *C. gunnari* trawl fishery in Subarea 48.3 in 2006 and past years, the Working Group developed warp-strike forms and a protocol, and recommended that they be implemented in all trawl fisheries in the Convention Area (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 72 to 75). The objective was to assess the extent of seabird interactions with trawl warp cables in Convention Area fisheries. If detected, the Working Group would then examine the nature and extent of seabird mortalities, including the vessel type, seabird species concerned and operational factors of the fishery that may contribute to these interactions and examine mitigation options to reduce mortality of seabirds in these fisheries. The trawl warp-strike protocol was implemented in 2006/07 with the expectation that sampling would take place across a high proportion of vessels and fisheries.

II.122 The Working Group evaluated data collected on seabird warp strikes in Convention Area trawl fisheries in 2006/07. Warp-strike data were collected in 61 of 102 icefish trawls in Subarea 48.3. In all cases, seabirds were present during observations and ranged in number from <50 to >100 birds per observation. No warp strikes were recorded. Factory discharge information was collected inconsistently; however, four instances of factory discharge were recorded. Warp-strike data in accordance with the electronic trawl logbook form T11 protocol were not collected in the trawl fisheries for toothfish and icefish in Division 58.5.2 or in krill trawl fisheries in the Convention Area.

II.123 Noting that warp-strike data were collected in over 50% of the trawls in Subarea 48.3 in the inaugural year of the warp-strike protocol, the Working Group complimented the efforts made by observers and technical coordinators to implement this protocol. The data suggest that, unlike trawl fisheries outside the Convention Area, warp strikes pose minimal risk to seabirds in the Subarea 48.3 icefish trawl fishery. The Working Group encouraged more diligent collection of discharge data to more fully evaluate the relationship between warp strikes and discharge in this fishery. Some confusion may have arisen over the need to collect discharge data in the absence of seabird mortalities and the Working Group suggested that technical coordinators strongly encourage observers to record these data for all warp-strike observations.

II.124 The Working Group reviewed the warp-strike data collection protocol and associated data collection forms and was satisfied with both.

II.125 The Working Group strongly encouraged the full implementation of the warp-strike protocol in all Convention Area trawl fisheries in 2007/08.

General

II.126 The Working Group noted that the quality of observer data which had been submitted continued to improve and thanked technical coordinators and observers for their efforts in the last year. However, the Working Group noted that improvements could still be made in the reporting of observer data (paragraphs 18, 48, 60, 120 and 123) and encouraged technical coordinators and observers to continue to fully implement the specifications of the various observer protocols and report all required data.

RESEARCH INTO THE STATUS AND DISTRIBUTION OF SEABIRDS

II.127 The Working Group noted that ACAP addresses all Procellariiform seabirds occurring in the Convention Area. A report from ACAP (WG-FSA-07/26) documented the major outcomes achieved at the Third Meeting of the ACAP Advisory Committee meeting held in Valdivia, Chile, in June 2007. At that meeting, the Committee noted ACAP Parties' obligations under the Agreement to achieve and maintain a favourable conservation status for albatrosses and petrels. In order to measure progress in achieving this objective, the Committee supported the recommendation of its Status and Trends Working Group that Species Assessments be produced for all 26 species listed under the Agreement. These assessments will include information on population status and trends, as well as foraging distribution and interactions with fisheries operating in RFMOs and EEZs.

II.128 The Species Assessments will be web-based and housed on the ACAP website, and thereby readily available for consideration by CCAMLR Members. It is anticipated that the Species Assessments will be largely completed by the Fourth Meeting of the ACAP Advisory Committee scheduled for August 2008. The Working Group was encouraged by the progress of the Species Assessments and, given their comprehensive coverage of Convention Area seabirds at risk from fisheries-related mortality, agreed that they will be very useful for ad hoc WG-IMAF's work.

II.129 WG-FSA-07/26 also documented that the ACAP Breeding Sites Working Group (BSWG) had made progress against all items listed in its work program. There was agreement for a need for further consideration of how to define threats and threat levels at breeding sites, and of public access to data from the breeding sites database. The BSWG has been requested by the Advisory Committee to reconsider the definition of threats with a view to seeing if the IUCN criteria, that are already widely accepted, were suitable.

II.130 Mr Marteau discussed SC-CAMLR-XXVI/BG/22 which presented a synthesis of the results of research on the evaluation of the impact of fisheries on the populations of white-chinned and grey petrels of the Crozet and Kerguelen Islands, undertaken between 2004 and 2006 (Subarea 58.6 and Division 58.5.1 respectively). Research included mark–recapture studies, estimation of breeding success, adult survival and population estimation. These data, and fishery and environmental data were modelled to examine responses of the populations to a range of factors. The Working Group applauded France for its efforts in this area, and looked forward to reviewing the publication that presents these analyses in detail in 2008.

II.131 Mr Marteau indicated that a foraging distribution research program directed by Dr H. Weimerskirch at the Centre National de la Recherche Scientifique in Chizé, France, has begun. The objective of this program is to examine the pelagic distribution of seabirds breeding in the French Antarctic and sub-Antarctic areas, using both satellite and geolocation loggers. This three-year study will provide important information on the distribution of seabirds both inside and beyond the Convention Area.

ASSESSMENT OF RISK IN CCAMLR SUBAREAS AND DIVISIONS

II.132 As in previous years, the Working Group assessed the numerous proposals for new and exploratory fisheries and the potential for these fisheries to lead to substantial increases in seabird incidental mortality (paragraphs 155 to 164).

II.133 In order to address these concerns, the Working Group reviewed its assessments for relevant subareas and divisions of the Convention Area in relation to the:

(i) timing of fishing seasons
(ii) need to restrict fishing to night time
(iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

II.134 Comprehensive assessments on the potential risk of interaction between seabirds and fisheries for all statistical areas in the Convention Area are carried out each year.

II.135 The Working Group noted a paper presented by Dr S. Waugh (New Zealand) on the risk-assessment processes undertaken in CCAMLR fisheries (WG-FSA-07/P2). This paper was prepared as an intersessional task following discussion at ad hoc WG-IMAF in 2006 on the need to make CCAMLR's methodology and approaches more accessible to groups outside CCAMLR seeking to undertake similar processes (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 135 to 137). The paper documented the CCAMLR system of applying risk assessment to minimise seabird by-catch. A review of the progress of several RFMOs in addressing seabird by-catch clearly shows that CCAMLR has the most advanced system of management among the RFMOs covered in the review, and has made the most demonstrable progress in reducing seabird by-catch levels in its longline fisheries. The Working Group considered the paper to be potentially useful for other fisheries agreements that are currently developing measures to reduce seabird mortality, including risk assessment methods.

II.136 The Working Group recommended that this paper be widely disseminated, including to other RFMOs, which could consider the experience of CCAMLR when developing approaches to minimising by-catch in their own fisheries. The Secretariat was asked to assist in this.

Trawl risk assessment

II.137 The assessments were originally confined to longline fisheries, but were extended to trawl fisheries this year following a request from the Commission to do so (CCAMLR-XXV, paragraphs 5.21 to 5.24).

II.138 The species particularly at risk of mortality from interactions with longline fisheries were considered to be all Convention Area species of albatross, both species of giant petrel, white-chinned petrel, grey petrel, short-tailed shearwater and sooty shearwater. For trawl fisheries, the same species were considered to be at risk, together with the Cape petrel (due to the potential for entanglement and warp strike for this species).

II.139 There was no additional information provided this year on the at-sea distribution of seabirds (paragraphs 127 to 131). However, information on the distribution of Cape petrels has been incorporated into the assessment. The revised assessments, incorporating advice in relation to trawl gear, have been combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31).

II.140 The assessments now incorporate advice on operational measures that should be applied to pelagic trawling operations to minimise by-catch. In developing this advice, the Working Group drew upon the considerable observer data that have been collected across CCAMLR trawl fisheries. This shows that the risks to seabirds are strongly gear-dependent, with pelagic trawling for finfish posing the highest risk.

II.141 Conservation Measure 25-03 sets mandatory practices that include: no net sonde monitor cables; minimising of vessel lighting; no offal discharge during setting and hauling, although full offal retention is also occurring on some vessels; thorough cleaning of the net prior to setting to remove items that might attract birds; and minimising the time during setting and hauling that a net is on the surface with meshes slack. Optional practices that have been used to date include: single streamer lines, Brady bafflers, water jets, net binding, weighting of the net codend and/or wings, and full offal retention.

II.142 The Working Group analysed information on the mitigation measures used by vessels fishing for icefish in Subarea 48.3 from 2004 to 2007. In addition to the mandatory requirements of Conservation Measure 25-03, vessels experimented with a number of other mitigation measures. The lack of a rigorous experimental design, and the fact that vessels have used a combination of different measures in an attempt to reduce their seabird by-catch over this period, meant that none of the effects of mitigation measures on by-catch rates were statistically significant. However, the data did suggest that streamer lines to protect the net were ineffective in mitigating seabird by-catch, confirming reports by observers, and that both cleaning the net and the use of net binding decrease by-catch rates, again confirming previous analyses and observer reports. The results were inconclusive with respect to adding weights to the codend.

II.143 In compiling its advice on best-practice guidelines for seabird by-catch mitigation in finfish pelagic trawl fisheries, the Working Group noted that there are limited data on the individual contributions of different technical practices to achieve mitigation, such as net binding and codend weighting, and that further consideration is needed on other aspects, such as the setting of by-catch limits.

II.144 The Working Group developed a set of best-practice mitigation measures for pelagic finfish trawling gear and recommended that they be applied for all CCAMLR statistical subareas and divisions. These have been incorporated into SC-CAMLR-XXVI/BG/31. A summary of the assessment of risk to seabirds posed by pelagic finfish trawl fisheries and associated mitigation requirements is provided in Table 19.

II.145 The Working Group noted that by-catch in existing finfish fisheries in category 4 and 5 risk areas was minimal despite current conservation measures for fisheries in those areas not containing all elements of the best-practice guidelines and a different suite of mitigation measures being used in each fishery. The Working Group also noted that those mitigation measures have evolved as a set of several elements rather than having been evaluated for their individual effect. The Working Group did not consider that there was a need for additional mitigation measures beyond those currently in use in those fisheries, provided the current zero or near-zero by-catch levels are continued or decreased respectively. It was further noted that there were very low levels of seabird by-catch in the 2006/07 season in finfish pelagic trawl fisheries, which occurred in Subarea 48.3 (six mortalities, three entanglements) and Division 58.5.2 (zero mortalities, zero entanglements) of the Convention Area. The Working Group noted that in different fisheries there may be operational and management considerations that preclude the use of one or more practices and others may need to be used in their place to achieve the same outcome.

II.146 With respect to pelagic trawling gear for krill and demersal trawling gear targeting finfish where offal retention occurs, no clear evidence is available to suggest that these methods pose a serious risk to seabirds in the Convention Area at this stage. For this reason, mitigation measures additional to those required by Conservation Measure 25-03 are not considered necessary at present for these gear types.

II.147 However, it was also noted that with the exception of Subarea 48.3 in 2006/07, observer data on seabird collisions with trawl warps were generally lacking in the Convention Area, even though protocols for the collection of these data have now been established (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 122). This form of trawl-related interaction is widely recognised as a major problem in fisheries outside the Convention Area, and vigilance by CCAMLR observers was requested so that future problems are rapidly identified and managed. Should this problem be identified in the future, trawl-warp protection through the use of streamer lines (Sullivan et al., 2006; WG-FSA-05/40) or other forms of mitigation may need to be considered as a mandatory measure.

Implications of seasonal changes in fishing activity in Subarea 48.3

II.148 The Working Group reviewed WG-FSA-07/55 which proposed a relaxation of the limitation of fish catch that may be taken between 1 March and 31 May and the requirement to undertake research trawls in this period. The paper reported that the original reason for these measures, that icefish were spawning offshore in this season, was no longer supported by the data. Furthermore, vessels fishing in this season have previously reported increased seabird interactions in the times and areas specified for research trawls. The effect of this change would be to increase the proportion of the fish catch that is taken during the period March–May, decreasing the proportion in the period leading up to March, and to allow vessels flexibility to avoid seabird interactions in this period. Ad hoc WG-IMAF agreed that the change is unlikely to lead to an increased risk to seabirds from this fishery, provided that the best-practice mitigation measures are used year-round.

Proposal for season extension in Division 58.5.2

II.149 WG-FSA-07/17 summarised the historic effort and seabird by-catch mitigation measures that have applied to the *D. eleginoides* longline fishery in Division 58.5.2. It suggested that there is now sufficient experience to show that fishing under the current season timing and regime of mitigation measures poses a very low level of risk to seabirds. The paper proposed that the period during which fishing is allowed be extended on a trial basis to include 1–31 October, subject to a three-seabird by-catch limit. It also proposed that the 1–30 September period be included as part of the 'core' winter season and the three-seabird by-catch limit no longer apply in September.

II.150 The Working Group supported the proposal to trial fishing from 1 to 31 October, and recommended it proceed subject to a three-seabird by-catch limit. While supporting the extensive range of proven mitigation measures proposed for the trial, the Working Group noted that fishing during October was moving progressively closer to the seasonal period when seabird abundance, especially of white-chinned petrels, increased significantly and that this species was the most likely to interact with fishing operations and the most difficult to mitigate against. The Working Group noted that, while the paper presented seabird abundance data for seven seasons, which showed relatively low abundance of white-chinned petrels in October, there was a need for some caution due to the longer-term potential for the timing of increased abundance on the fishing grounds to occur earlier in a year.

II.151 In respect of the proposal to include 1–30 September as part of the core winter season and to remove the three-seabird by-catch limit presently applied to that period, the Working Group noted that while fishing had occurred in four seasons for the first half of September, there had been fishing in the latter half of September in only one season. For this reason, the Working Group recommended that 1–14 September could be included in the core season and not subject to the three-seabird by-catch limit, but that the three-seabird by-catch limit should continue to apply to fishing during the period from 15 to 30 September. It agreed to review the latter aspect after further fishing has occurred.

Fine-scale risk assessment

II.152 Information was provided to the Working Group on a risk-assessment approach that established by-catch limits based on the regional, rather than global, conservation status of seabirds (WG-FSA-07/19). The approach was developed for a trial of longline fishing in the Macquarie Island toothfish fishery, which lies just outside the CAMLR Convention Area. Several threatened seabird species which have very small (10 to <100 annual breeding pairs) breeding populations on Macquarie Island are potentially vulnerable to interactions with fishing vessels. Seabird by-catch limits categorised seabirds into three groups of species with a different limit for each group. The groupings reflected the varying conservation status of the seabird populations breeding on Macquarie Island, and their vulnerability to fisheries interactions. The group containing those species with the most critical conservation status and highest risk of interacting with fishing operations had a by-catch limit of one seabird; limits on the other categories were two and three individuals respectively. In addition, if a total of three seabirds from categories 1–3 were killed as a result of interactions with fishing gear, then longline fishing was to cease for the remainder of the season.

II.153 The Working Group supported the concept outlined in WG-FSA-07/19, noting that the inclusion of regional information had merit for areas where populations of threatened species are extremely small. It noted the need for further work before regional conservation status could be included as part of by-catch risk assessment for CCAMLR fisheries.

INCIDENTAL MORTALITY OF SEABIRDS IN RELATION TO NEW AND EXPLORATORY FISHERIES

New and exploratory fisheries operational in 2006/07

II.154 Of the 41 applications for exploratory longline fisheries for 2006/07, 28 were undertaken (WG-FSA-07/4). No incidental seabird mortality was recorded. The strict adherence to the requirements in Conservation Measures 24-02 and 25-02 has proven successful in achieving zero, or extremely low, by-catch of seabirds.

New and exploratory fisheries proposed for 2007/08

II.155 The assessment of the risk to seabirds posed by new and exploratory longline fisheries in the Convention Area is incorporated into SC-CAMLR-XXVI/BG/31, and is summarised in Table 20 and Figure 2, and also includes an assessment of recommended levels of observer coverage.

II.156 Forty-four notifications for exploratory longline fisheries, submitted by 12 countries, were received by CCAMLR in 2007. No notifications for new longline fisheries were received. The areas for which proposals were received are:

Subarea 48.6	Japan, Republic of Korea, New Zealand, South Africa
Division 58.4.1	Australia, Japan, Republic of Korea, Namibia, New Zealand, Spain, Ukraine, Uruguay
Division 58.4.2	Australia, Japan, Republic of Korea, Namibia, New Zealand, South Africa, Spain, Ukraine, Uruguay
Division 58.4.3a	Uruguay
Division 58.4.3b	Australia, Japan, Republic of Korea, Namibia, Spain, Uruguay
Subarea 88.1	Argentina, Republic of Korea, Namibia, New Zealand, Russia, South Africa, Spain, UK, Uruguay
Subarea 88.2	Argentina, New Zealand, Russia, South Africa, Spain, UK, Uruguay.

II.157 The areas listed above were assessed in relation to the risk of seabird incidental mortality according to the approach and criteria set out in SC-CAMLR-XXVI/BG/31.

II.158 Those notifications that provided sufficient information to indicate that the proposals fully comply with relevant seabird by-catch minimisation measures (Conservation Measures 24-02 and 25-02, and the relevant measures in the 41-series) and do not conflict with the IMAF assessment, were:

Argentina	CCAMLR-XXVI/13 – 88.1, 88.2
Australia	CCAMLR-XXVI/14 – 58.4.1, 58.4.2
Japan	CCAMLR-XXVI/15 – 48.6, 58.4.1, 58.4.2, 58.4.3b
Namibia	CCAMLR-XXVI/17 – 58.4.1, 58.4.2, 58.4.3b, 88.1
New Zealand	CCAMLR-XXVI/18 – 48.6, 58.4.1, 58.4.2, 88.1, 88.2
Russia	CCAMLR-XXVI/19 – 88.1, 88.2
South Africa	CCAMLR-XXVI/20 – 48.6, 58.4.2, 88.1, 88.2
Spain	CCAMLR-XXVI/21 – 58.4.1, 58.4.2, 58.4.3b, 88.1, 88.2
UK	CCAMLR-XXVI/22 – 88.1, 88.2
Ukraine	CCAMLR-XXVI/23 – 58.4.1, 58.4.2.

II.159 Those notifications that contained insufficient information to be certain that the proposals fully comply with relevant seabird by-catch minimisation conservation measures, but which express sufficient sentiment to indicate that this is the intention were:

Korea, Republic of	CCAMLR-XXVI/16 – 48.6, 58.4.1, 58.4.2, 58.4.3b, 88.1
Uruguay	CCAMLR-XXVI/24 – 58.4.1, 58.4.2, 58.4.3a, 58.4.3b, 88.1, 88.2.

II.160 Applications in the second category usually state intent to comply with relevant conservation measures, but then indicate elsewhere that their fishing plans do not comply. Typical examples include:

(i) stating an intent to fish during the day without seeking a derogation from paragraph 4 of Conservation Measure 25-02 through implementation of the provisions of Conservation Measure 24-02;

(ii) stating an intent to relax seabird by-catch mitigation measures without clearly seeking relevant derogations.

II.161 The Working Group welcomed the improvements in notifications this year and in particular that only 15% of the notifications were now assessed in the insufficient information category compared with 25% in 2006. Members were requested to take greater care in future submissions to ensure that the intent to comply with relevant seabird by-catch measures was clear.

II.162 Members who have submitted applications falling into the second category should be requested to confirm with SCIC that their proposals fully comply with relevant seabird by-catch minimisation conservation measures and do not conflict with the ad hoc WG-IMAF assessment for the subareas and divisions in which they wish to fish.

II.163 In 2005, the Working Group developed a checklist to assist Members when completing their notifications (SC-CAMLR-XXIV, Annex 5, Appendix O, paragraph 193). The Secretariat used this information in developing a pro forma and checklist to assist Members in fulfilling notification requirements. The Working Group was pleased with the number of Members that utilised the checklist and encouraged those countries that did not do so (Republic of Korea and South Africa), or altered the checklist without explanation (Uruguay), to use the pro forma and checklist in full in future notifications. The Working Group noted that, as the notification from Uruguay (CCAMLR-XXVI/24) had not been translated, it was uncertain whether the relevant information was contained within the document.

II.164 Setting of longlines within the Convention Area during daylight hours or outside normal fishing seasons using currently approved fishing gear still represents a risk for seabirds, even in areas of low to average risk. In all instances where the provisions of Conservation Measure 24-02 are applied, there remains the need for continued review of performance with respect to incidental mortality of seabirds during fishing operations. The Working Group reiterated its recommendation that any vessel operating under the provisions of this conservation measure, and which catches a total of three seabirds, as defined in SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217, shall revert to night setting in accordance with Conservation Measure 25-02. Similar provisions were specified in previous years.

II.165 The Working Group discussed CCAMLR-XXVI/27, submitted by Australia, proposing improvements to line sink rate monitoring and reporting. The Working Group noted that, as the proposal had no technical implications for the work of ad hoc WG-IMAF, this was a matter for SCIC.

INTERNATIONAL AND NATIONAL INITIATIVES RELATING TO INCIDENTAL MORTALITY OF SEABIRDS IN RELATION TO LONGLINE FISHING

ACAP

II.166 The ACAP representative presented a report on the Third Meeting of the ACAP Advisory Committee (WG-FSA-07/26). This meeting was preceded by meetings of ACAP's Status and Trends Working Group and its Seabird Bycatch Working Group. WG-FSA-07/26 provided a summary of the major outcomes of the meeting. The progress of the ACAP Status and Trends Working Group and Breeding Sites Working Group are documented in paragraphs 127 to 129.

II.167 ACAP's Taxonomy Working Group recently applied their decision-making guidelines to six pairs of taxa currently listed under Annex 1 of ACAP. It concluded that available data for the taxa considered did not call for an amendment to the species currently listed under Annex 1 of the Agreement. However, it was recognised that data pertinent to this taxonomic process are sometimes meagre and that new data may be highly influential in future analyses.

II.168 Prior to the Advisory Committee meeting, ACAP's Seabird Bycatch Working Group (WG-FSA-07/P6) assessed the suitability of pelagic mitigation technologies for future research, and reviewed seabird by-catch mitigation measures for pelagic longline fishing to identify knowledge gaps. The products of this work are summarised in two tables (WG-FSA-07/P6, Appendix 4, Tables 1 and 2), which have been endorsed by ACAP as representing the current best scientific advice for pelagic fisheries. In assessing the suitability of mitigation measures for future research, each measure was assigned a priority ranking on a five-point scale, according to criteria on potential effectiveness, practicality and cost. Bird-scaring lines, the bait-setting capsule and side setting were ranked the highest priority for research; weighted branchlines, the bait pod, smart hooks and circle hooks were high priorities; and blue-dyed squid was of moderate priority. Research on technologies such as the underwater setting chute, night setting, line shooters, thawed bait, strategic offal discharge, blue-dyed fish, fish oil, life status of bait and bait-casting machines, were considered a lower priority. The literature review of mitigation measures showed that some of the measures adopted or under consideration by some RFMOs would benefit from further development and testing.

FAO IPOA-Seabirds

II.169 Last year the Working Group recommended that CCAMLR Members support an initiative proposed by BirdLife International to work with FAO and Member States to secure support for FAO's 27th Meeting of COFI, for the development of best-practice guidelines for IPOA-Seabirds (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 156). At the COFI meeting, FAO members advised the Committee on their progress to develop or implement their NPOAs for seabirds. Many Members were of the view that FAO should seek to strengthen the implementation of the IPOA-Seabirds by developing best-practice technical guidelines to support the elaboration of NPOAs. The Committee agreed that, depending on cost and related considerations, the guidelines would be developed through continuing joint work between FAO and relevant bodies and organisations or an expert consultation. It was also agreed that FAO should, in cooperation with relevant bodies, develop best-practice guidelines to assist countries and RFMOs in the implementation of the IPOA-Seabirds and that the best-practice guidelines should be extended to other relevant fishing gears. Many Members expressed the view that CCAMLR, ACAP and BirdLife International were the most relevant bodies in that context.

Other international organisations and initiatives, including non-governmental organisations

II.170 No information was reported under this agenda item.

RFMOs, tuna commissions and international governmental organisations and implementation of Resolution 22/XXIII

Joint meeting of tuna RFMOs

II.171 The First Joint Meeting of Tuna RFMOs was held in Kobe, Japan, in January 2007. The meeting brought together the membership and cooperating non-members of CCSBT, IATTC, ICCAT, IOTC and WCPFC. FAO and the Organization for the Promotion of Responsible Tuna Fisheries also participated.

II.172 The purpose of the meeting was to enhance coordination among the tuna RFMOs to more effectively and comprehensively address issues that cut across oceans and organisations. As requested by the Commission (CCAMLR-XXV, paragraph 5.27), the Secretariat provided a paper to the meeting describing the scientific and fisheries management processes CCAMLR has followed in developing its seabird by-catch mitigation measures. The paper is available at www.tuna-org.org.

II.173 The joint meeting resulted in a Course of Action for Tuna RFMOs, comprising 14 key areas to be urgently addressed through cooperation and coordination among the five tuna RFMOs. This list included implementation of the precautionary approach and an ecosystem-based approach to fisheries management. A description of the latter included improved data collection on incidental by-catch and non-target species and the establishment of measures to minimise the adverse effect of fishing for highly migratory fish species on ecologically related species, particularly sea turtles, seabirds and sharks.

II.174 Progress by tuna RFMOs to implement the Course of Action will be discussed at a meeting of tuna RFMO chairs in January 2008 and at the 2nd Meeting of Tuna RFMOs to be held in 2009.

WCPFC

II.175 Ms LeBoeuf reported on events at recent WCPFC meetings, recalling that WCPFC adopted a binding conservation and management measure (WCPFC-CMM 2006-02) for reducing seabird by-catch in 2006. Implementation of CMM 2006-02 will begin in January 2008 and requires that WCPFC adopt, at its 2007 annual meeting in December, minimum technical specifications for each of the seabird by-catch mitigation methods listed in the measure. Specifications are to be based on advice and recommendations from the WCPFC's Scientific Committee (SC) and the Technical and Compliance Committee (TCC).

II.176 Just prior to the SC's meeting in August 2007, the Secretariat of the Pacific Community's Oceanic Fisheries Programme led an ecological risk assessment workshop, providing information on the results of that workshop at which a proposed methodology and framework for future work on such an assessment by the WCPFC were discussed.

II.177 It also was noted that at the SC meeting, ACAP provided a report of its Seabird Bycatch Working Group, reviewing the effectiveness of a range of seabird by-catch mitigation measures and detailing priorities for further research in pelagic fisheries. ACAP's report and the results of the ecological risk assessment will provide additional scientific information to WCPFC as it implements CMM 2006-02.

II.178 Neither the SC nor the TCC, at their recent meetings, reached consensus regarding the advice to be provided to the Commission on the identification of minimum technical specifications for some of the mitigation measures in CMM 2006-02, although consensus was reached on the specifications for most measures (WCPFC-TCC3-2007/22 and WCPFC-TCC3-2007/37). Both bodies noted that insufficient data had been provided to them regarding proposals to use lightweight streamer lines and a new line-weighting regime. It was reported that the lack of empirical evidence on the use of these technical specifications, coupled with significant differences of opinion regarding the application of mitigation measures in the WCPFC Convention Area, prevented these bodies from conducting a rigorous analysis of those proposed specifications. Both the SC and the TCC requested that the Commission require WCPFC members wishing to propose new specifications to provide to the SC and the TCC more detailed and specified information about their use in the hope of enhancing WCPFC's review process in the future. Documents related to these meetings are on the WCPFC website at: www.wcpfc.int/.

ICCAT

II.179 The ICCAT Sub-committee on Ecosystems met in September 2007. Among other things, the Sub-committee discussed methodology to be used in conducting a risk assessment of the impacts of ICCAT fisheries on seabird species. The Sub-committee adopted a six-stage approach, including the: (i) identification of seabird species most at risk; (ii) collation of available data on at-sea distribution of these species; (iii) analysis of the spatial and temporal overlap between species distribution and ICCAT longline fishing effort; (iv) review of existing by-catch rate estimates for ICCAT longline fisheries; (v) estimation of total annual seabird by-catch in the ICCAT Convention Area; and (vi) assessment of the likely impact of this by-catch on seabird populations. Based on this information, a preliminary risk assessment exercise was undertaken, representing the first stage of the assessment.

II.180 As part of this preliminary assessment, the Sub-committee reviewed available data on seabird by-catch rates in ICCAT fisheries, along with data from studies of remote-tracking, population status and demography for seabird species recorded as by-catch in ICCAT fisheries (SCRS-ECO-29-Rev. 2). Thirty-six seabird species have been recorded as by-catch in ICCAT longline fisheries and five additional ones are considered potential by-catch species. A review of SCRS-2007-129 included updated information on the seabird risk prioritisation exercise. Species with highest-risk score were determined to be six species of albatross from South Georgia and the Tristan da Cunha Islands, black-browed albatross from the Falkland/Malvinas Islands, and six shearwater species. An update on the analysis of seabird distribution and overlap with ICCAT longline fishing effort was also provided, with the Sub-committee noting there may be seabird species identified as high priority for which very few by-catch or distribution data currently exist. The Sub-committee reviewed data of longline effort in the ICCAT Convention Area by flag for the period from 2000 to 2005 and available estimates of seabird by-catch from those fleets with active observer programs, noting that more than 70% of the total longline fishing effort for the period has no associated information about seabird by-catch levels.

II.181 Based on these discussions, the Sub-committee made several recommendations to the ICCAT Scientific Committee regarding the need for increased data collection by Parties, the consideration of an ICCAT regional observer program, greater investment by the ICCAT Secretariat in ecosystem issues, and whether the Commission should consider precautionary management actions for seabird species, such as the introduction of mitigation measures, in advance of complete knowledge of the impact of ICCAT fisheries on seabirds.

II.182 To continue work on the assessment, it was decided that a three-day intersessional ICCAT meeting would be held in early 2008, at which seabird-tracking analysis, by-catch and population modelling would be discussed.

CCSBT

II.183 Mr N. Smith (New Zealand) reported on the outcomes of CCSBT's 7th Meeting of the Ecologically Related Species Working Group, held in July 2007. The meeting was unable to agree on specific recommendations to the CCSBT Commission on seabird by-catch levels or seabird by-catch mitigation. Ad hoc WG-IMAF's discussion of this item was limited, as documents pertaining to this meeting were not yet available on the CCSBT's website for review.

II.184 The Working Group noted the considerable overlap between the distributions of seabirds that are vulnerable to interactions with longline fishing, including species that breed or forage within the CAMLR Convention Area and longline fishing managed by CCSBT. The Working Group noted with serious concern that CCSBT had made little progress in the assessment and mitigation of CAMLR Convention Area seabird by-catch within the CCSBT Convention Area.

IOTC

II.185 Mr Baker provided a report on the Third Session of the IOTC Working Party on Ecosystems and By-catch (WPEB), which was held in the Seychelles in July 2007. The meeting considered recent initiatives by two other RFMOs to adopt a mitigation approach requiring fishers to select two measures, to be used in combination, from a 'menu' of seabird mitigation technical measures. It recommended that IOTC give serious consideration to adopting a similar approach to manage seabird by-catch in its fisheries, and identified a range of technical issues that might be considered in any future revision of IOTC Resolution 06/04 (Seabird by-catch in longline fisheries), based on best-practice advice provided by ACAP. WPEB further noted that the seabird by-catch mitigation measures recommended by ACAP did not include line-throwing devices (line shooters and bait-casting machines) because their effectiveness is not supported by empirical data, and that the use of the 'American longline system' equipped with a line-throwing device by surface longline vessels targeting swordfish (under paragraph 4 of IOTC Resolution 06/04), may not be achieving the desired effect. This fishing method is currently exempt from the provisions of IOTC Resolution 06/04. WPEB agreed that this issue should also be brought to the attention of the IOTC Scientific Committee at its next meeting.

IATTC

II.186 Ms K. Rivera (USA) provided a report on activities of IATTC. Based on discussions at the IATTC By-catch and Stock Assessment Working Groups in February and May 2007 respectively, the IATTC Secretariat tabled a paper regarding seabird interactions with IATTC fisheries and possible mitigation tools to address such interactions in June 2007 (IATTC-75-07c). The mitigation measures discussed within the paper are based largely on those contained within the WCPFC's CMM 2006-02. This document further notes the work of other RFMOs to address seabird by-catch and the need for establishing consistent approaches, such as in the areas of assessments, monitoring incidental catch, and the development and use of effective and practicable mitigation measures, among RFMOs adjacent to the IATTC Convention Area, such as WCPFC.

II.187 No binding mitigation requirements were adopted by the IATTC Commission, although there will be further discussion of doing so at the IATTC's By-catch and Stock Assessment Working Groups in 2008.

General

II.188 The Working Group recommended that a standing invitation be extended to ACAP and BirdLife International to participate in future meetings of ad hoc WG-IMAF as invited expert observers. The Working Group noted that the Scientific Committee has Rules of Procedure for observers, and that its request would have to be approved by the Scientific Committee prior to the issuance of invitations for next year's ad hoc WG-IMAF meeting.

II.189 The Working Group was encouraged by the progress made at some of the RFMOs toward addressing the issue of seabird by-catch in their fisheries. The Working Group discussed with interest recent developments at WCPFC and ICCAT, including the initiation of risk assessments in both RFMOs to better assess the level of interactions between seabirds and the fisheries within their Convention Areas. The Working Group noted its support of risk assessments in evaluating levels of seabird by-catch, recalling the work of some of the Working Group's members to describe the approach used by ad hoc WG-IMAF (WG-FSA-07/P2) (paragraphs 176, 177, 179 and 180).

II.190 The Working Group was also encouraged by WCPFC's progress toward addressing seabird by-catch by adopting binding conservation measures, but noted that there is still no best-practice mitigation strategy that has been rigorously tested and available for widespread uptake by RFMOs with responsibility for managing pelagic longline fisheries. The Working Group also noted with concern the lack thus far of a rigorous review process by which WCPFC and other RFMOs may consider such measures, based on best practices.

II.191 This is especially of concern where RFMOs manage fisheries in waters adjacent to the CAMLR Convention Area, including the WCPFC, particularly where seabird species which breed in the Convention Area may be distributed.

II.192 The Working Group reaffirmed the urgent need to work collaboratively with other RFMOs to address seabird by-catch for shared species and recalled that CCAMLR and WCPFC are in the process of finalising a Memorandum of Understanding to facilitate the sharing of information, in part related to the need to address seabird by-catch (CCAMLR-XXVI/BG/9). The Working Group recommended that the Scientific Committee communicate with WCPFC by encouraging it and its subsidiary bodies to rigorously consider scientific and technical information when evaluating such measures and their application. The Working Group further recommended that the Scientific Committee stress the need for WCPFC and ICCAT to continue their work assessing risk to seabird populations and for mitigating such risks via adaptive and precautionary decision-making, including the use of adequate levels of observer coverage and detailed reporting of implementation of conservation measures to truly achieve reductions in seabird by-catch.

II.193 The Working Group requested that the Scientific Committee extend an offer of technical assistance on conducting seabird risk assessments generally to other RFMOs, and specifically to WCPFC and ICCAT, should they desire such support.

II.194 With regard to the effectiveness of Resolution 22/XXV, the Working Group recalled the progress being made by ICCAT and WCPFC, described in paragraph 1 of this resolution, but expressed concern at the lack of progress in the other RFMOs, where little had been done to assess the risk of their fisheries to seabird species within their Convention Areas. The Working Group reaffirmed that the key to future progress is the employment of robust scientific observer programs that can assist in the development of statistical estimations of incidental seabird mortality and in the targeting of efforts to reduce such mortality. Data derived from such observer programs have been critical to CCAMLR's success in reducing seabird by-catch, and the Working Group believed that such information would be invaluable to similar efforts in other RFMOs and should be a high priority for their work.

II.195 Pursuant to paragraph 2 of Resolution 22/XXV, the Working Group encouraged the Secretariat to continue to contact Flag States whose vessels fish in areas where unregulated fishing takes place or where systematic data reporting has not yet been introduced by the RFMOs listed in Appendix 1 of Resolution 22/XXV. The Working Group applauded Contracting Parties that have requested that the topic of seabird mortality be included on the agenda of relevant RFMO meetings and the active role these Parties have played in advancing the adoption of risk assessment methodology and mitigation measures within these RFMOs. However, the Working Group noted the lack of reporting as required under paragraph 5 of Resolution 22/XXV, encouraging Contracting Parties to provide information on this matter in the future.

FISHERY REPORTS

II.196 The Working Group reviewed the Fishery Reports developed by WG-FSA (Annex 5, Agenda Items 5.1 and 5.2) and the information relating to the by-catch of seabirds and marine mammals contained within the reports.

II.197 The Working Group updated the Fishery Reports based on the information contained in SC-CAMLR-XXV, Annex 5, Appendix D, and the information contained in WG-FSA-07/6 Rev. 1, 07/7 Rev. 1 and 07/8 Rev. 1.

II.198 The Working Group recommended that the process of updating Fishery Reports continue and noted that this process provided constructive interaction with WG-FSA and contributed to the streamlining of the work of the Scientific Committee's working groups.

STREAMLINING THE WORK OF THE SCIENTIFIC COMMITTEE

Streamlining of agenda

II.199 Ad hoc WG-IMAF adopted the agenda streamlining recommended last year (SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 181) and noted that its agenda for this year's meeting was a useful improvement (Appendix A). Based on the experiences at this meeting, the Working Group developed additional recommendations for future agenda improvements, including:

(i) discontinue the current method for estimation of IUU catches of seabirds but, if feasible, develop alternate methods;

(ii) a review of its agenda to identify those tasks which could be completed on a biennial and triennial basis to allow more time to undertake high-priority tasks.

Interaction with WG-FSA

II.200 The Working Group noted improved interactions with WG-FSA this year on observer and by-catch matters had allowed the transfer of useful knowledge on fishing technologies and practices which had been beneficial to both groups. The ongoing dialogue on matters of mutual interest enhances the quality of the advice able to be provided to the Scientific Committee and provides a useful element of peer review during meetings.

II.201 With respect to the development of new mitigation measures, ad hoc WG-IMAF noted the improved dialogue on the consideration of their impact on other taxa (paragraphs 97 and 98). The Working Group recommended continued cooperative efforts to resolve such matters in a timely manner.

Future focus of the work of ad hoc WG-IMAF

II.202 The Scientific Committee established ad hoc WG-IMALF in 1993. In 2001 it decided that its scope should be expanded to cover fishing other than by longlines and the group was renamed ad hoc WG-IMAF. The Working Group noted the very positive results in 2006/07 with respect to seabird and marine mammal by-catch throughout the Convention Area.

II.203 The Working Group agreed that despite the continuing reductions in by-catch in the Convention Area, there was an ongoing need to remain vigilant in the monitoring of by-catch and the implementation of conservation measures, and to continue to strive to minimise seabird and marine mammal by-catch in all Convention Area fisheries.

II.204 Noting that time delays in responding to changing fishery dynamics and by-catch rates could have serious consequences for the conservation of seabirds and marine mammals, and that a biennial meeting of ad hoc WG-IMAF may mean three-year delays between the recognition of a problem and the development of a solution, the Working Group recommended that, for the time being, annual meetings continue.

II.205 The Working Group noted the increasing need to focus on the by-catch of Convention Area seabirds outside the Convention Area given CCAMLR's responsibility for these Antarctic marine living resources (Convention Article I) and the positive results being obtained within the Convention Area. To date, CCAMLR measures and practices have been held up as a role model outside the Convention Area (paragraphs 175 to 182) and the mitigation measures adopted and risk-assessment procedures within the Convention Area have been, or are in the process of being, adopted by neighbouring RFMOs.

II.206 As a result of the discussions detailed in paragraphs 202 to 205, and reflecting on discussions at last year's ad hoc WG-IMAF meeting (SC-CAMLR-XXV, Annex 5, Appendix D, paragraphs 181 to 197), the Working Group undertook a preliminary review of its terms of reference (SC-CAMLR-XII, paragraph 10.19). The Working Group made additional suggestions for consideration during the intersessional period with a view to ad hoc WG-IMAF recommending revised terms of reference in 2008.

Future research plan and duration of the meeting

II.207 The Working Group again discussed the development of a medium-term research plan for ad hoc WG-IMAF and the time required to conduct its core work and noted that at present it still required the allotted five days to conduct its work program.

WG-IMAF 2008 workshop

II.208 The Working Group recalled its proposal in 2006 to conduct short workshops in association with the annual ad hoc WG-IMAF meeting to address critical medium-term items. The use of invited experts at such workshops was highlighted by the Working Group as likely being crucial to their success.

II.209 The Working Group, noting the need to review its terms of reference (paragraph 206), review the duration and frequency of meetings, and develop a medium-term plan for the approval of the Scientific Committee, recommended a one-day workshop to address these issues.

II.210 The proposed terms of reference for the workshop are as follows:

(i) review and recommend revisions to the terms of reference for ad hoc WG-IMAF;

(ii) develop short- and medium-term work plans for ad hoc WG-IMAF, particularly considering the work plan of WG-FSA for dealing with mitigation of the by-catch of fish and invertebrate by-catch, the work plan of the Scientific Committee and developments in other international bodies concerned with the interaction of fisheries and Convention Area birds or mammals;

(iii) review the frequency of meetings of ad hoc WG-IMAF, in particular:

(a) consider the conditions under which a change in meeting frequency could take place and catalogue the advantages and disadvantages of such change;

(b) examine in detail the consequences of decreasing the frequency of WG-IMAF meetings on the work of WG-IMAF and the advice that it is able to provide WG-FSA, the Scientific Committee and the Commission;

(c) consider mechanisms that could be put in place to minimise the risk of impacting significantly on the work of WG-FSA, the Scientific Committee and Commission were the ad hoc WG-IMAF meeting frequency to be reduced.

II.211 The Working Group recommended that the workshop occur for one day in the week immediately prior to ad hoc WG-IMAF in 2008.

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Table 1: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subareas 48.3, 48.4, 58.6, 58.7, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3 and 58.5.2 during the 2006/07 season, including related mitigation information. Sp – Spanish method; A – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); O – opposite side to hauling; S – same side as hauling.

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks observed (thousands)			No. of birds observed caught[1]						Observed seabird mortality (includes injured birds)[1] (birds/thousand hooks)			Streamer line in use %		Offal discharge during	
			N	D	Total	%N	Obs.	Set	% observed	Dead		Injured		Uninjured							Set (%)	Haul (%)
										N	D	N	D	N	D	N	D	Total	N	D		
Subarea 48.3																						
Antarctic Bay	12/6–23/8/07	Sp	205	0	97	100	278.5	1153.6	24	0	0	0	0	0	5	0	0	0	100		(0)	O (100)
Argos Frøyanes	9/5–24/8/07	A	292	0	292	100	385.3	1740.6	22	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Argos Georgia	1/5–24/8/07	A	297	0	297	100	270.9	1848.7	14	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Argos Helena	1/5–24/8/07	A	350	0	350	100	772.9	1826.1	42	0	0	0	0	0	0	0	0	0	100		(0)	O (1)
Insung No. 22	13/5–6/7/07	Sp	106	0	106	100	252.9	1129.5	22	0	0	0	0	0	0	0	0	0	100		(4)	O (48)
Jacqueline	1/5–4/8/07	Sp	247	0	247	100	327.2	1594.8	20	0	0	0	0	0	0	0	0	0	100		(0)	O (100)
Koryo Maru No. 11	3/5–15/8/07	Sp	155	0	155	100	399.3	1728.8	23	0	0	0	0	0	0	0	0	0	100		(0)	O (100)
Punta Ballena	1/5–17/7/07	A	133	0	133	100	256.5	899.0	28	0	0	0	0	0	0	0	0	0	100		(0)	O (1)
San Aspiring	1/5–20/8/07	A	210	0	210	100	733.8	1755.4	41	0	0	0	0	1	0	0	0	0	100		(0)	O (100)
Viking Bay	1/5–24/8/07	Sp	223	0	223	100	334.4	1424.9	23	0	0	0	0	4	0	0	0	0	100		(0)	O (94)
Total						100	4011.7	15101.4	27							0	0	0				
Subarea 48.4																						
San Aspiring	7/4–15/4/07	A	58	0	58	100	160.2	388.0	41	0	0	0	0	0	0	0	0	0	100		(0)	O (100)
Total						100	160.2	388.0	41							0	0	0				
Subarea 48.6																						
Frøyanes	21/3–2/4/07	A	6	13	19	32	33.7	78.2	43	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Shinsei Maru No. 3	29/3–29/6/07	A	116	96	212	55	484.6	963.8	50	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Total						44	518.3	1042.0	50							0	0	0				
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b																						
Tronio	1/12–22/3/07	Sp	0	201	201	0	1098.7	2192.7	50	0	0	0	0	0	0	0	0	0		100	(0)	O (3.5)*
Antillas Reefer	1/1–28/3/07	Sp	14	115	129	11	1413.0	1413.0	100	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Paloma V	1/12–22/3/07	Sp	14	150	164	9	1146.9	1898.9	60	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Insung No. 1	18/12–7/3/07	Sp	11	137	148	7	1040.8	1194.4	87	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Shinsei Maru No. 3	31/12–4/3/07	A	32	132	164	20	216.5	742.1	29	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Jung Woo No. 2[2]	28/2–29/3/07	Sp	5	46	51	10	310.0	336.8	0	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Total						10	5225.9	7777.9	67							0						
Division 58.5.2																						
Janas	27/4–18/6/07	A			143		313.6	796.1	39	0	0	0	0	0	0	0	0	0	100*	100*	(0)	(0)
Janas	15/7–3/9/07	A	69	59	128	54	317.4	892.5	35	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Total						54	631.0	1688.6	37							0	0	0				
Subareas 58.6, 58.7, Area 51																						
Koryo Maru No. 11	10/2–30/3/07	Sp	75	0	75	100	134.6	738.3	18	0	0	0	0	2	0	0	0	0	100		(0)	O (100)
Ross Mar	25/7–24/8/07	A	114	0	114	100	82.5	598.5	13	0	0	0	0	0	0	0	0	0	100		(0)	O (98)
Ross Mar	24/4–12/6/07	A	236	1	237	99	144.1	855.9	16	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Total						100	361.2	2192.7	17							0	0	0				

(continued)

Table 1 (continued):

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks observed (thousands)			No. of birds observed caught[1]						Observed seabird mortality (includes injured birds)[1] (birds/thousand hooks)			Streamer line in use %		Offal discharge during	
			N	D	Total	%N	Obs.	Set	% observed	Dead		Injured		Uninjured							Set (%)	Haul (%)
										N	D	N	D	N	D	N	D	Total	N	D		
Subareas 88.1, 88.2																						
Avro Chieftain	4/12–6/2/07	A	0	101	101	0	252.8	561.8	44	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Insung No. 22	8/12–1/2/07	Sp	0	109	109	0	947.5	983.3	96	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Janas	4/12–5/2/07	A	7	102	109	6	284.4	569.6	49	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Jung Woo No. 2	11/12–1/2/07	Sp	0	87	87	0	580.0	607.0	96	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Ross Mar	31/12–1/2/07	A	0	90	90	0	159.7	344.7	46	0	0	0	0	0	0	0	0	0		100	(0)	(1)
Ross Star	3/1–2/2/07	A	0	61	61	0	118.3	345.6	34	0	0	0	0	0	0	0	0	0		100	(0)	(0)
San Aotea II	1/12–6/2/07	A	0	128	128	0	204.2	561.4	36	0	0	0	0	0	0	0	0	0		100	(0)	(0)
San Aspiring	1/12–1/2/07	A	0	82	82	0	275.8	574.2	48	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Antartic II	2/12–11/2/07	A	0	148	148	0	433.7	728.2	59	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Argos Georgia	1/12–8/2/07	A	58	78	136	43	291.7	535.8	54	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Argos Helena	2/12–14/2/07	A	15	167	182	8	342.5	657.9	52	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Frøyanes	1/12–15/2/07	A	0	219	219	0	398.5	875.7	45	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Viking Sur	4/1–14/2/07	A	0	62	62	0	229.6	372.6	61	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Volna	29/12–2/3/07	Sp			83	0	213.1	641.7	33	0	0	0	0	0	0	0	0	0		100*	(0)	(0)
Yantar	29/12–1/3/07	Sp	0	77	77	0	168.5	851.5	19	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Total						4	4900.3	9211.0	53							0	0	0				

* Information obtained from cruise report.

1 Bird ‘caught’ as defined by the Commission at CCAMLR-XXIII, paragraphs 10.30 and 10.31.

2 *Jung Woo No. 2* also conducted a small amount of fishing in Subarea 48.6 during this cruise.

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 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b and 58.5.2 from 1997 to 2007 (- indicates no fishing occurred).

Subarea/division	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Subarea 48.3											
Extrapolated mortality	5 755	640	210*	21	30	27	8	27	13	0	0
Observed mortality rate	0.23	0.032	0.013*	0.002	0.002	0.0015	0.0003	0.0015	0.0011	0	0
Subarea 48.4											
Extrapolated mortality	-	-	-	-	-	-	-	-	0	0	0
Observed mortality rate	-	-	-	-	-	-	-	-	0	0	0
Subarea 48.6											
Extrapolated mortality	-	-	-	-	-	-	-	0	0	0	0
Observed mortality rate	-	-	-	-	-	-	-	0	0	0	0
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b											
Extrapolated mortality	-	-	-	-	-	-	-	0	8	2	0
Observed mortality rate	-	-	-	-	-	-	-	0	<0.001	0.0002	0
Division 58.5.2											
Extrapolated mortality	-	-	-	-	-	-	0	0	0	0	0
Observed mortality rate	-	-	-	-	-	-	0	0	0	0	0
Subareas 58.6, 58.7											
Extrapolated mortality	834	528	156	516	199	0	7	39	76	0	0
Observed mortality rate	0.52	0.194	0.034	0.046	0.018	0	0.003	0.025	0.149	0	0
Subareas 88.1, 88.2											
Extrapolated mortality	-	0	0	0	0	0	0	1	0	0	0
Observed mortality rate	-	0	0	0	0	0	0	0.0001	0	0	0
Total seabird mortality	6 589	1 168	366	537	229	27	15	67	97	2	0

* Excluding *Argos Helena* line weighting experiment cruise.

Table 3: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2006/07 season (September–August). A – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); NC – not collected; na – not applicable.

Vessel	Dates of fishing	Method	Set deployed				No. of hooks observed (thousands)			Hooks baited (%)	No. of birds observed caught						Observed seabird mortality (includes injured birds) (birds/thousand hooks)			Streamer use %	
											Dead		Injured		Uninjured						
			N	D	Total	%N	Obs.	Set	% observed		N	D	N	D	N	D	N	D	Total	N	D
Subarea 58.6										NC	0	-	0								
Ship 1	23/11–6/12/06	A	31	0	31	100	52.79	213.75	24.70	NC	44	-	5	-	1	-	0.0000	na	0.0000	100	-
Ship 1	16/2–10/3/07	A	17	0	17	100	110.20	420.75	26.19	NC	0	-	0	-	11	-	0.1165	na	0.1165	100	-
Ship 1	16/6–18/6/07	A	10	0	10	100	13.94	56.25	24.78	NC	2	-	1	-	0	-	0.0000	na	0.0000	100	-
Ship 2	5/2–19/2/07	A	58	0	58	100	60.81	242.04	25.12	NC	0	-	0	-	0	-	0.0000	na	0.0000	100	-
Ship 2	14/5–21/5/07	A	16	0	16	100	27.84	117.52	23.69	NC	0	-	0	-	0	-	0.0000	na	0.0000	100	-
Ship 3	9/9–23/9/06	A	51	0	51	100	93.82	359.62	26.09	NC	0	-	0	-	0	-	0.0000	na	0.0000	100	-
Ship 3	17/2–23/2/07	A	7	0	7	100	28.70	42.30	67.85	NC	0	-	0	-	2	-	0.0000	na	0.0000	100	-
Ship 3	28/6–3/8/07	A	84	0	84	100	162.98	609.6	26.74	NC	0	-	0	-	0	-	0.0000	na	0.0000	100	-
Ship 5	14/9–28/9/06	A	35	0	35	100	70.42	292.50	24.08	NC	21	-	0	-	7	-	0.0000	na	0.0000	100	-
Ship 5	17/2–16/3/07	A	74	0	74	100	118.29	477.95	24.75	NC	0	-	0	-	38	-	0.0439	na	0.0439	100	-
Ship 5	8/6–14/6/07	A	17	0	17	100	30.44	119.25	25.53	NC	0		0	-	0	-	0.0000	na	0.0000	100	-
Ship 6	28/11–5/12/06	A	29	0	29	100	31.67	129.00	24.55	NC	0	-	0	-	7	-	0.0000	na	0.0000	100	-
Ship 6	2/7–17/7/07	A	42	0	42	100	78.93	333.75	23.65	NC	1	-	3	-	0	-	0.0000	na	0.0000	100	-
Ship 7	9/11–15/11/06	A	31	0	31	100	43.50	174.00	25.00	NC	0	-	0	-	8	-	0.0230	na	0.0230	100	-
Ship 7	18/2–26/2/07	A	21	0	21	100	34.25	140.62	24.36	NC	2	-	0	-	0	-	0.0000	na	0.0000	100	-
Ship 7	6/4–11/4/07 24/5–10/6/07	A	62	0	62	100	98.97	411.00	24.08					-	0	-	0.0049	na	0.0049	100	-
Ship 8	18/12–28/12/06 7/2–28/2/07	A	86	0	86	100	117.64	462.00	25.46	NC	1	-	0	-	5	-	0.0065	na	0.0065	100	-
Ship 8	11/5–26/5/07	A	42	0	42	0	56.14	223.12	25.16	NC	0	-	0	-	0	-	0.0045	na	0.0045	100	-
			713			100	1 231.33	4 825.02	25.52		71		9		79		0.0650		0.0650		

(continued)

Table 3 (continued)

Vessel	Dates of fishing	Method	Set deployed				No. of hooks observed (thousands)			Hooks baited (%)	No. of birds observed caught						Observed seabird mortality (includes injured birds) (birds/thousand hooks)			Streamer use %	
			N	D	Total	%N	Obs.	Set	% observed		Dead		Injured		Uninjured						
											N	D	N	D	N	D	N	D	Total	N	D
Division 58.5.1																					
Ship 1	13/9–18/11/06	A	145	0	145	100	338.89	1 370.00	24.74	NC	32	-	0	-	18	-	0.0234	-	0.0234	100	-
Ship 1	12/1–14/2/07	A	107	0	107	100	253.40	997.95	25.39	NC	36	-	1	-	4	-	0.0371	-	0.0371	100	-
Ship 1	1/5–13/6/07	A	105	0	105	100	247.55	989.47	25.02	NC	11	-	10	-	1	-	0.0212	-	0.0212	100	-
Ship 2	23/9–6/11/06	A	102	0	102	100	210.20	859.14	24.47	NC	5	-	0	-	1	-	0.0058	-	0.0058	100	-
Ship 2	31/11–2/2/07	A	174	0	174	100	363.15	1 462.54	24.83	NC	10	-	0	-	16	-	0.0068	-	0.0068	100	-
Ship 2	16/3–10/5/07	A	146	0	146	100	343.00	1 369.16	25.05	NC	13	-	1	-	1	-	0.0102	-	0.0102	100	-
Ship 3	26/9–19/11/06	A	123	0	123	100	321.94	1 284.97	25.05	NC	12	-	0	-	2	-	0.0093	-	0.0093	100	-
Ship 3	27/12–14/2/07	A	93	0	93	100	365.18	1 258.17	29.02	NC	14	-	0	-	0	-	0.0111	-	0.0111	100	-
Ship 3	27/3–5/6/07	A	124	0	124	100	447.40	1 670.55	26.78	NC	15	-	0	-	0	-	0.0090	-	0.0090	100	-
Ship 5	2/10–11/12/06	A	183	0	183	100	376.56	1 544.65	24.38	NC	34	-	0	-	10	-	0.0220	-	0.0220	100	-
Ship 5	16/1–14/2/07	A	85	0	85	100	166.57	676.55	24.62	NC	19	-	0	-	11	-	0.0281	-	0.0281	100	-
Ship 5	27/4–5/6/07	A	90	0	90	100	232.35	930.40	24.97	NC	9	-	2	-	3	-	0.0118	-	0.0118	100	-
Ship 6	28/11–5/12/06	A	202	0	202	100	297.15	1 194.00	24.89	NC	18	-	0	-	7	-	0.0151	-	0.0151	100	-
Ship 6	16/1–14/2/07	A	79	0	79	100	175.85	690.37	25.47	NC	50	-	0	-	6	-	0.0724	-	0.0724	100	-
Ship 6	17/3–4/5/07	A	120	0	120	100	297.15	1 194.00	24.89	NC	20	-	0	-	2	-	0.0168	-	0.0168	100	-
Ship 6	2/6–27/6/07	A	55	0	55	100	145.50	600.00	24.25	NC	6	-	1	-	4	-	0.0183	-	0.0183	100	-
Ship 7	9/9–5/11/06	A	126	0	126	100	317.99	1 280.95	24.82	NC	28	-	5	-	21	-	0.0258	-	0.0258	100	-
Ship 7	21/2–14/2/07	A	139	0	139	100	319.82	1 311.00	24.40	NC	12	-	0	-	9	-	0.0092	-	0.0092	100	-
Ship 7	13/4–21/5/07	A	96	0	96	100	203.64	823.15	24.74	NC	1	-	0	-	6	-	0.0012	-	0.0012	100	-
Ship 8	1/9–21/11/06	A	201	0	201	100	355.17	1 357.54	26.16	NC	58	-	1	-	6	-	0.0435	-	0.0435	100	-
Ship 8	1/1–2/2/07	A	71	0	71	100	108.22	430.30	25.15	NC	15	-	1	-	2	-	0.0372	-	0.0372	100	-
Ship 8	27/3–5/5/07 29/5–26/6/07	A	186	0	186	100	263.07	1 054.58	24.95	NC	41	-	10	-	3	-	0.0484	-	0.0484	100	-
			2 752			100	6 149.75	24 349.44	25.26		459		32		133		0.0798		0.0798		

Table 4: Seabird mortalities in Subarea 58.6 and Division 58.5.1 within the French EEZs during the 2006/07 season (September–August).

Vessel	Hooks observed (thousands)	Hooks set (thousands)	Percentage of hook observed	% night sets	Number of seabird mortalities*		
					Night	Day	Total
Subarea 58.6							
Ship 1	52.79	213.75	24.70	100	0	-	0
Ship 1	1 10.20	420.75	26.19	100	49	-	49
Ship 1	13.94	56.25	24.78	100	0	-	0
Ship 2	60.81	242.04	25.12	100	0	-	0
Ship 2	27.84	117.52	23.69	100	0	-	0
Ship 3	93.82	359.62	26.09	100	0	-	0
Ship 3	28.70	42.30	67.85	100	0	-	0
Ship 3	1 62.98	609.6	26.74	100	0	-	0
Ship 5	70.42	292.50	24.08	100	0	-	0
Ship 5	1 18.29	477.95	24.75	100	21	-	21
Ship 5	30.44	119.25	25.53	100	0	-	0
Ship 6	31.67	129.00	24.55	100	0	-	0
Ship 6	78.93	333.75	23.65	100	0	-	0
Ship 7	43.50	174.00	25.00	100	4	-	4
Ship 7	34.25	140.62	24.36	100	0	-	0
Ship 7	98.97	411.00	24.08	100	2	-	2
Ship 8	1 17.64	462.00	25.46	100	3	-	3
Ship 8	56.14	223.12	25.16	100	1	-	1
	1 231.33	4 825.02	25.52		80		80
Division 58.5.1							
Ship 1	338.89	1 370.00	24.74	100	32	-	32
Ship 1	253.40	997.95	25.39	100	37	-	37
Ship 1	247.55	989.47	25.02	100	21	-	21
Ship 2	210.20	859.14	24.47	100	5	-	5
Ship 2	363.15	1 462.54	24.83	100	10	-	10
Ship 2	343.00	1 369.16	25.05	100	14	-	14
Ship 3	321.94	1 284.97	25.05	100	12	-	12
Ship 3	365.18	1 258.17	29.02	100	14	-	14
Ship 3	447.40	1 670.55	26.78	100	15	-	15
Ship 5	376.56	1 544.65	24.38	100	34	-	34
Ship 5	166.57	676.55	24.62	100	19	-	19
Ship 5	232.35	930.40	24.97	100	11	-	11
Ship 6	297.15	1 194.00	24.89	100	18	-	18
Ship 6	175.85	690.37	25.47	100	50	-	50
Ship 6	297.15	1 194.00	24.89	100	20	-	20
Ship 6	145.50	600.00	24.25	100	7	-	7
Ship 7	317.99	1 280.95	24.82	100	33	-	33
Ship 7	319.82	1 311.00	24.40	100	12	-	12
Ship 7	203.64	823.15	24.74	100	1	-	1
Ship 8	355.17	1 357.54	26.16	100	59	-	59
Ship 8	108.22	430.30	25.15	100	16	-	16
Ship 8	263.07	1 054.58	24.95	100	51	-	51
	6 149.75	24 349.44	25.26		491		491

* Includes dead and injured.

Table 5: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subarea 58.6 and Division 58.5.1 within the French EEZs in 2006/07.

	2006/07
Subarea 58.6	
Estimated by-catch	313
By-catch rate	0.0650
Division 58.5.1	
Estimated by-catch	1 944
By-catch rate	0.0798

Table 6: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subarea 58.6 and Division 58.5.1 within the French EEZ from 2000 to 2007.

	Season						
	2000/01*	2001/02*	2002/03*	2003/04*	2004/05	2005/06	2006/07
Subarea 58.6							
Estimated by-catch		1 243	720	343	242	235	313
By-catch rate		0.1672	0.1092	0.0875	0.0490	0.0362	0.0650
Division 58.5.1							
Estimated by-catch	1 917	10 814	13 926	3 666	4 387	2 352	1 944
By-catch rate	0.0920	0.9359	0.5180	0.2054	0.1640	0.0920	0.0798

* The number of observed hooks has not been collected and the values given are from the total number of hooks set.

Table 7: Species composition of birds killed in longline fisheries in Subarea 58.6 and Division 58.5.1 during the 2006/07 season (September–August). N – night-time setting; D – daytime setting (including nautical dawn and dusk); PRO – white-chinned petrel; PCI – grey petrel; MAH – northern giant petrel; MAI – southern giant petrel; PND – petrel not determined.

Vessel	Dates of fishing	No. of birds killed by group								Species composition (%)									
		Albatross		Petrels		Penguins		Total											
		N	D	N	D	N	D	N	D	PRO	%	PCI	%	MAH	%	MAA	%	PND	%
Subarea 58.6																			
Ship 1	23/11–6/12/06	0	0	0	0	0	0	0	0										
Ship 1	16/3–25/3/07	0	0	49	0	0	0	49	0	46	(93.8)			3	(6.2)				
Ship 1	16/6–18/6/07	0	0	0	0	0	0	0	0										
Ship 2	5/2–19/2/07	0	0	0	0	0	0	0	0										
Ship 2	14/5–21/5/07	0	0	0	0	0	0	0	0										
Ship 3	9/9–23/9/06	0	0	0	0	0	0	0	0										
Ship 3	17/2–23/2/07	0	0	0	0	0	0	0	0										
Ship 3	28/6–3/8/07	0	0	0	0	0	0	0	0										
Ship 5	14/9–28/9/06	0	0	0	0	0	0	0	0										
Ship 5	17/2–16/3/07	0	0	21	0	0	0	21	0	21	(100.0)								
Ship 5	8/6–14/6/07	0	0	0	0	0	0	0	0										
Ship 6	28/11–5/12/06	0	0	0	0	0	0	0	0										
Ship 6	2/07–17/7/07	0	0	0	0	0	0	0	0										
Ship 7	9/11–15/11/06	0	0	4	0	0	0	4	0	1	(25)					3	(75)		
Ship 7	18/2–26/2/07	0	0	0	0	0	0	0	0										
Ship 7	6/4–11/4/07 24/5–10/6/07	0	0	2	0	0	0	2	0	2	(100.0)								
Ship 8	18/12–28/12/06 7/2–28/2/07	0	0	3	0	0	0	3	0	2	(66.7)							1	(33.3)
Ship 8	11/5–26/5/07	0	0	1	0	0	0	1	0			1	(100.0)						
		0		80		0		80		72	(90)	1	(1.25)	3	(3.75)	3	(3.75)	1	(1.25)

(continued)

Table 7 (continued)

Vessel	Dates of fishing	No. of birds killed by group								Species composition (%)									
		Albatross		Petrels		Penguins		Total											
		N	D	N	D	N	D	N	D	PRO	%	PCI	%	MAH	%	MAA	%	PND	%
Division 58.5.1																			
Ship 1	13/9–18/11/06	0	0	32	0	0	0	32	0	28	(87.50)	4	(12.5)						
Ship 1	12/1–14/2/07	0	0	37	0	0	0	37	0	36	(97.3)	0		1	(2.7)				
Ship 1	1/5–13/6/07	0	0	21	0	0	0	21	0	1	(4.8)	10	(47.6)	10	(47.6)				
Ship 2	23/9–6/11/06	0	0	5	0	0	0	5	0	5	(100.0)	0							
Ship 2	31/11–2/2/07	0	0	10	0	0	0	10	0	10	(100.0)	0							
Ship 2	16/3–10/5/07	0	0	14	0	0	0	14	0	13	(92.5)	0		1	(7.5)				
Ship 3	26/9–19/11/06	0	0	12	0	0	0	12	0	12	(100.0)	0							
Ship 3	27/12–14/2/07	0	0	14	0	0	0	14	0	14	(100.0)	0							
Ship 3	27/3–5/6/07	0	0	15	0	0	0	15	0	13	(86.7)	2	(13.3)						
Ship 5	2/10–11/12/06	0	0	34	0	0	0	34	0	34	(100.0)	0							
Ship 5	16/1–14/2/07	0	0	19	0	0	0	19	0	19	(100.0)	0							
Ship 5	27/4–5/6/07	0	0	11	0	0	0	11	0			9	(81.8)	2	(18.2)				
Ship 6	28/11–5/12/06	0	0	18	0	0	0	18	0	14	(77.8)	4	(22.2)						
Ship 6	16/1–14/2/07	0	0	50	0	0	0	50	0	50	(100.0)	0							
Ship 6	17/3–4/5/07	0	0	20	0	0	0	20	0	20	(100.0)	0							
Ship 6	2/6–27/6/07	0	0	7	0	0	0	7	0			6	(85.7)	1	(14.3)				
Ship 7	9/9–5/11/06	0	0	33	0	0	0	33	0	23	(69.7)	5	(15.1)	4	(12.2)	1	(3)		
Ship 7	21/2–14/2/07	0	0	12	0	0	0	12	0	12	(100.0)	0							
Ship 7	13/4–21/5/07	0	0	1	0	0	0	1	0	1	(100.0)	0							
Ship 8	1/9–21/11/06	0	0	59	0	0	0	59	0	53	(89.8)	5	(8.5)	1	(1.7)				
Ship 8	1/1–2/2/07	0	0	16	0	0	0	16	0	15	(93.75)			1	(6.25)				
Ship 8	27/3–5/5/07 29/5–26/6/07	0	0	51	0	0	0	51	0	36	(70.6)	5	(9.8)	10	(19.6)				
		0	0	491	0	0	0	491	0	409	(83.3)	50	(10.2)	31	(6.31)	1	(0.2)	0	

Table 8: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2006/07 season (September–August). N – night-time setting; D – daytime setting (including nautical dawn and dusk).

Vessel	Dates of fishing	No. of birds observed caught						Streamer line in use % setting		Attachment height above water (m)	Spacing of streamers per line (m)	No. of streamers per line	No. of lines	Streamer lines			Streamers		
		Dead		Injured		Uninjured								Total length of streamers (m)	Estimated length out of water (m)	Diameter (mm)	Minimal length (m)	Maximal length (m)	Diameter (mm)
		N	D	N	D	N	D	N	D										
Subarea 58.6																			
Ship 1	23/11–6/12/06	0	0	0	0	1	0	100	0	7	1.2	60	6	190	75	14	3.5	7	10
Ship 1	16/3–25/3/07	44	0	5	0	11	0	100	0	7	1.2	60	6	190	75	14	3.5	7	10
Ship 1	16/6–18/6/07	0	0	0	0	0	0	100	0	7	3.2	12	2	200	50	12	1	3	5
Ship 2	5/2–19/2/07	0	0	0	0	0	0	100	0	7	1.4	53	2	250	75	11.5	3	3	10
Ship 2	14/5–21/5/07	0	0	0	0	0	0	100	0	7	1.4	50	2	200	50	11.5	3	3	10
Ship 3	9/9–23/9/06	0	0	0	0	0	0	100	0	6	2	17	?	200	180	12	2	6	30
Ship 3	17/2–23/2/07	0	0	0	0	2	0	100	0										
Ship 3	28/6–3/8/07	0	0	0	0	0	0	100	0	10	1	25	2	150	50	8	2	3	3
Ship 5	14/9–28/9/06	0	0	0	0	7	0	100	0	5.5	4.5	16	6	160	80	13	1.5	3.5	15
																			50
Ship 5	17/2–16/3/07	21	0	0	0	38	0	100	0	8	5	12	1	250	80	11.5	2.5	5	10
Ship 5	8/6–14/6/07	0	0	0	0	0	0	100	0	8	3	66	2	250	40	11.5	2.5	5	250
Ship 6	28/11–5/12/06	0	0	0	0	7	0	100	0	7.5	1.2	120	2	150	36	11.5	60	1.4	50
Ship 6	2/7–17/7/07	0	0	0	0	0	0	100	0										
Ship 7	9/11–15/11/06	1	0	3	0	8	0	100	0	8	2.4	35	2	180	130	11	0.9	3	5
Ship 7	18/2–26/2/07	0	0	0	0	0	0	100	0	8	2.4	35	2	180	130	11	0.9	3	5
Ship 7	6/4–11/4/07 24/5–10/6/07	2	0	0	0	0	0	100	0	8	2.4	15	2	180	130	11	0.9	3	5
Ship 8	18/12–28/12/06 7/2–28/2/07	2	0	1	0	5	0	100	0	7	2.5	2	2	100	25	9	3	7	2
Ship 8	11/5–26/5/07	1	0	0	0	0	0	100	0	7	2.5	2	2	100	25	9	3	7	2
		71		9		79													

(continued)

Table 8 (continued)

Vessel	Dates of fishing	No. of birds observed caught: Dead N	Dead D	Injured N	Injured D	Uninjured N	Uninjured D	Streamer line in use % setting N	Streamer line in use % setting D	Attachment height above water (m)	Spacing of streamers per line (m)	No. of streamers per line	No. of lines	Streamer lines: Total length of streamers (m)	Streamer lines: Estimated length out of water (m)	Streamer lines: Diameter (mm)	Streamers: Minimal length (m)	Streamers: Maximal length (m)	Streamers: Diameter (mm)
Division 58.5.1																			
Ship 1	13/9–18/11/06	32	0	0	0	18	0	100	0	7	1.2	60	6	190	75	14	3.5	7	10
Ship 1	12/1–14/2/07	36	0	1	0	4	0	100	0	7	1.2	60	6	190	75	14	3.5	7	10
Ship 1	1/5–13/6/07	11	0	10	0	1	0	100	0	7	1.2	60	6	190	75	14	3.5	7	5
Ship 2	23/9–6/11/06	5	0	0	0	1	0	100	0	7	1.4	150	2	250	50	12	1	2	9
																			10
Ship 2	31/11–2/2/07	10	0	0	0	16	0	100	0	7	1.4	53	2	250	75	11.5	3	3	10
Ship 2	16/3–10/5/07	13	0	1	0	1	0	100	0	7	1.4	50	2	200	50	11.5	3	3	10
Ship 3	26/9–19/11/06	12	0	0	0	2	0	100	0	6	2	17	2	200	180	12	2	3	30
Ship 3	27/12–14/2/07	14	0	0	0	0	0	100	0	6	2	17	2	200	180	12	2	3	30
Ship 3	27/3–5/6/07	15	0	0	0	0	0	100	0	6	2.5	5	3	200	100	8	2	6	40
Ship 5	2/10–11/12/06	34	0	0	0	10	0	100	0	5.5	4.5	16	6	160	80	13	1.5	3.5	15
																			50
Ship 5	16/1–14/2/07	19	0	0	0	11	0	100	0	8	5	12	1	250	80	11.5	2.5	5	10
Ship 5	27/4–5/6/07	9	0	2	0	3	0	100	0	8	3	66	2	250	40	11.5	2.5	5	250
Ship 6	28/11–5/12/06	18	0	0	0	7	0	100	0	7.5	1.2	120	2	150	36	11.5	0.6	1.4	50
Ship 6	16/1–14/2/07	50	0	0	0	6	0	100	0	7	1.2	76	2	150	45	11.5	0.3	1	?
Ship 6	17/3–4/5/07	20	0	0	0	2	0	100	0	7	1.2	76	2	150	45	11.5	0.3	1	12
Ship 6	2/6–27/6/07	6	0	1	0	4	0	100	0	7	1.2	76	2	150	45	11.5	0.3	1	?
Ship 7	9/9–5/11/06	28	0	5	0	21	0	100	0	8	2.4	35	2	180	130	11	0.9	3	50
Ship 7	21/2–14/2/07	12	0	0	0	9	0	100	0	8	2.4	35	2	180	130	11	0.9	3	50
Ship 7	13/4–21/5/07	1	0	0	0	6	0	100	0	8	2.4	35	2	180	130	11	0.9	3	50
Ship 8	1/9–21/11/06	58	0	1	0	6	0	100	0	7	2	9	2	100	25	9/14	3	7	2
Ship 8	1/1–2/2/07	15	0	1	0	2	0	100	0	7	2.5	2	2	100	25	9	3	7	2
Ship 8	27/3–5/5/07 29/5–26/6/07	41	0	10	0	3	0	100	0	7	2.5	2	2	100	25	9	3	7	2
		459		32		133													

Table 9: Specimens recovered from longline fisheries in Subarea 58.6 and Division 58.5.1 during 2006/07 (September–August) detailing the injury types. N – night-time setting; D – daytime setting (including nautical dawn and dusk); PRO – white-chinned petrel; PCI – grey petrel.

Vessel	Dates of fishing	No. birds killed by group								Species composition (%)				Where the seabirds are hooked					
		Albatross		Petrels		Penguins		Total		PRO	%	PCI	%	Beak	Wing	Foot	Neck	Body	Other or unknown
		N	D	N	D	N	D	N	D										
Subarea 58.6																			
Ship 1	23/11–6/12/06	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 1	16/3–25/3/07	0	0	44	0	0	0	44	0	44	(100.0)			10	28	2	0	1	3
Ship 1	16/6–18/6/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 2	5/2–19/2/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 2	14/5–21/5/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 3	9/9–23/9/06	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 3	17/2–23/2/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 3	28/6–3/8/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 5	14/9–28/9/06	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 5	17/2–16/3/07	0	0	21	0	0	0	21	0	21	(100.0)			5	14	0	2	0	0
Ship 5	8/6–14/6/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 6	28/11–5/12/06	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 6	2/7–17/7/07	0	0	0	0	0	0	0	0	1	(100.0)			0	1	0	0	0	0
Ship 7	9/11–15/11/06	0	0	1	0	0	0	1	0					0	0	0	0	0	0
Ship 7	18/2–26/2/07	0	0	0	0	0	0	0	0					0	0	0	0	0	0
Ship 7	6/4–11/4/07 24/5–10/6/07	0	0	2	0	0	0	2	0	2	(100.0)			0	2	0	0	0	0
Ship 8	18/12–28/12/06 7/2–28/2/07	0	0	2	0	0	0	2	0	2	(100.0)			2	0	0	0	0	0
Ship 8	11/5–26/5/07	0	0	1	0	0	0	1	0			1	(100.0)	1	0	0	0	0	0
		0		71		0		71		70		1		18	45	2	2	1	3

(continued)

Table 9 (continued)

Vessel	Dates of fishing	No. birds killed by group								Species composition (%)				Where the seabirds are hooked					
		Albatross		Petrels		Penguins		Total		PRO	%	PCI	%	Beak	Wing	Foot	Neck	Body	Other or unknown
		N	D	N	D	N	D	N	D										
Division 58.5.1																			
Ship 1	13/9–8/11/06	0	0	32	0	0	0	32	0	28	(87.50)	4	(12.5)	19	0	3	8	0	16
Ship 1	12/1–14/2/07	0	0	36	0	0	0	36	0	36	(100.0)	0		12	22	2	0	0	0
Ship 1	1/5–13/6/07	0	0	11	0	0	0	11	0	1	(9.1)	10	(90.9)	0	9	0	2	0	0
Ship 2	23/9–6/11/06	0	0	5	0	0	0	5	0	5	(100.0)	0		2	2	0	1	0	0
Ship 2	31/11–2/2/07	0	0	10	0	0	0	10	0	10	(100.0)	0		0	10	0	0	0	0
Ship 2	16/3–10/5/07	0	0	13	0	0	0	13	0	13	(100.0)	0		11	2	0	0	0	0
Ship 3	26/9–19/11/06	0	0	12	0	0	0	12	0	12	(100.0)	0		8	3	0	1	0	0
Ship 3	27/12–14/2/07	0	0	14	0	0	0	14	0	14	(100.0)	0		13	1	0	0	0	0
Ship 3	27/3–5/6/07	0	0	15	0	0	0	15	0	13	(86.7)	2	(13.3)	3	12	0	0	0	0
Ship 5	2/10–11/12/06	0	0	34	0	0	0	34	0	34	(100.0)	0		8	17	2	4	0	0
Ship 5	16/1–14/2/07	0	0	19	0	0	0	19	0	19	(100.0)	0		6	13	0	0	0	0
Ship 5	27/4–5/6/07	0	0	9	0	0	0	9	0	9	0	9	(100.0)	3	4	0	2	0	0
Ship 6	28/11–5/12/06	0	0	18	0	0	0	18	0	14	(77.8)	4	(22.2)	0	0	0	0	0	0
Ship 6	16/1–14/2/07	0	0	50	0	0	0	50	0	50	(100.0)	0		16	33	0	1	0	4
Ship 6	17/3–4/5/07	0	0	20	0	0	0	20	0	20	(100.0)	0		10	9	0	1	0	0
Ship 6	2/6–27/6/07	0	0	6	0	0	0	6	0	0		6	(100.0)	2	3	0	1	0	0
Ship 7	9/9–5/11/06	0	0	28	0	0	0	28	0	23	(82.2)	5	(17.8)	11	17	0	0	0	0
Ship 7	21/2–14/2/07	0	0	12	0	0	0	12	0	12	(100.0)	0		2	6	2	0	0	3
Ship 7	13/4–21/5/07	0	0	1	0	0	0	1	0	1	(100.0)	0		1	0	0	0	0	0
Ship 8	1/9–21/11/06	0	0	58	0	0	0	58	0	53	(91.4)	5	(8.6)	22	31	0	5	1	0
Ship 8	1/1–2/2/07	0	0	15	0	0	0	15	0	15	(100.0)	0		8	5	0	2	0	0
Ship 8	27/3–5/5/07 29/5–26/6/07	0	0	41	0	0	0	41	0	36	(87.8)	5	(12.2)	21	16	2	1	0	1
		0	0	459	0	0	0	459	0	409		50		178	214	11	29	1	24

Table 10: Observed incidences of seabird and marine mammal entanglements with trawl gear for the 2006/07 season. DIC – grey-headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; DAC – Cape petrel.

Vessel	Dates of fishing	Subarea/ division	Species	Total observed	
				Mortality (dead or injured)	Released alive (uninjured)
Insung Ho	21/1–24/1/07	48.3	DIC	1	
			DIM		1
			PRO	3	1
New Polar	8/1–31/1/07	48.3	DIM		1
Robin M Lee	5/1–18/1/07	48.3			
Dongsan Ho	9/1–14/1/07	48.3	DIM	2	
Southern Champion	20/4–19/5/07	58.5.2			
Southern Champion	2/2–4/3/07	58.5.2			
Southern Champion	12/6–7/8/07	58.5.2	DAC	2	
Saga Sea	10/12–6/3/07	48.1, 48.2			
Saga Sea	18/7–13/8/07	48.3			
Saga Sea	12/3–21/6/07	48.1, 48.2			
Saga Sea	16/8–28/8/07	48.3			
Niitaka Maru	12/3–21/6/07	48.3			
Dalmor II	12/8–31/8/07	48.3			

Table 11: Seabird mortality totals and rates (BPT: birds/trawl) and species composition, recorded by observers in the CAMLR Convention Area trawl fishery during the 2006/07 season. DIC – grey-headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; DAC – Cape petrel.

Subarea/ division	Vessel (target species)	Cruise dates	Trawls		BPT	Dead				Total dead	Alive (combined)
			Set	Observed		DIC	DIM	PRO	DAC		
48.1, 48.2	*Saga Sea* (KRI)	10/12–6/3/07	131	67	0.00					0	0
	Saga Sea (KRI)	12/3–21/6/07	525	351	0.00					0	2
	Total		656	418	0.00					0	2
48.3	*Insung Ho* (ANI)	21/1–24/1/07	21	20	0.20	1		3		4	2
	New Polar (ANI)	8/1–31/1/07	31	28	0.00					0	1
	Robin M Lee (ANI)	5/1–18/1/07	38	36	0.00					0	0
	Dongsan Ho (ANI)	9/1–14/1/07	12	7	0.29		2			2	0
	Total		102	91	0.07	1	2	3		6	3
48.3	*Saga Sea* (KRI)	18/7–13/8/07	276	57	0.00					0	0
	Saga Sea (KRI)	16/8–28/8/07	19	12	0.00					0	0
	Niitaka Maru (KRI)	12/3–21/6/07	157	48	0.00					0	0
	Dalmor II (KRI)	12/8–31/8/07	128	77	0.00					0	0
	Total		580	194	0.00					0	0
58.5.2	*Southern Champion* (ANI/TOP)	20/4–19/0/07	233	231	0.00					0	0
	Southern Champion (ANI/TOP)	2/2–4/3/07	225	213	0.00					0	0
	Southern Champion (ANI/TOP)	12/6–7/8/07	547	492	<0.01				2	2	0
	Total		1005	936	<0.01				2	2	0

Table 12: Seabird mortality totals and rates (BPT: birds/trawl) and species composition of by-catch, recorded by observers in the CAMLR Convention Area trawl fisheries over the last six seasons. DIC – grey-headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; PWD – Antarctic prion; PTZ – unknown petrel; DAC – Cape petrel; MAI – southern giant petrel; MAH – northern giant petrel.

Season	Area	Target species	Trips observed	Trawls			BPT	Dead								Total dead	Alive
				Set	Observed	(%)		DIC	DIM	PRO	MAH	PWD	PTZ	DAC	MAI		
2001/02	48.3	*E. superba*	5	992	755	76	<0.10									0	0
	48.3	*C. gunnari*	5	460	431	94	0.16		18	49		1				68	52
	58.5.2	*D. eleginoides*	6	904	850	94	<0.10									0	1
		C. gunnari															
2002/03	48.3	*E. superba*	6	1928	1073	56										0	0
	48.3	*C. gunnari*	3	184	182	99	0.20	1	7	28						36	15
	58.5.2	*D. eleginoides*	8	1311	1309	100	<0.105		2	2				2		6	11
		C. gunnari															
2003/04	48	*E. superba*	1	334	258	77	<0.10									0	0
	48.3	*E. superba*	6	1145	829	72	<0.10									0	0
	48.3	*C. gunnari*	6	247	238	96	0.37	1	26	59					1	87	132
	58.5.2	*D. eleginoides*	5	1218	1215	100	<0.10									0	13
		C. gunnari															
2004/05	48.2	*E. superba*	2	391	285	73	<0.10							1		1	0
	48.3	*C. gunnari*	7	337	277	82	<0.14		9	1	1					11	14
	48.3	*E. superba*	5	1451	842	58	<0.10									0	0
	58.5.2	*D. eleginoides*	6	1303	1301	100	<0.11		5	3						8	0
		C. gunnari															
2005/06	48.1	*E. superba*	2	1127	839	74	0.00									0	0
	48.3	*C. gunnari*	5	585	457	78	0.07	1	11	20			1			33	89
	48.3	*E. superba*	2	395	181	46	0.00									0	0
	58.5.2	*D. eleginoides*	3	1086	1086	100	0.00									0	0
		C. gunnari															
2006/07	48.1/2	*E. superba*	2	656	418	64	0.00									0	2
	48.3	*C. gunnari*	4	102	91	89	0.07	1	2	3						6	3
	48.3	*E. superba*	4	580	194	33	0.00									0	0
	58.5.2	*D. eleginoides*	3	1005	936	93	<0.01							2		2	0
		C. gunnari															

Table 13: Seal mortality totals and rates (SPT: seals/trawl) and species composition, recorded by observers in the CAMLR Convention Area trawl fishery during the 2006/07 season. SLP – leopard seal; SEA – Antarctic fur seal.

Subarea/ division	Vessel (target species)	Cruise dates	Trawls		SPT	Dead		Total dead	Alive (combined)
			Set	Observed		SLP	SEA		
48.1, 48.2	*Saga Sea* (KRI)	10/12–6/3/07	131	67	0.00			0	0
	Saga Sea (KRI)	12/3–21/6/07	525	351	0.00			0	0
	Total		656	418	0.00			0	0
48.3	*Insung Ho* (ANI)	21/1–24/1/07	21	20	0.00			0	0
	New Polar (ANI)	8/1–31/1/07	31	28	0.00			0	0
	Robin M Lee (ANI)	5/1–18/1/07	38	36	0.00			0	0
	Dongsan Ho (ANI)	9/1–14/1/07	12	7	0.00			0	0
	Total		102	91	0.00			0	0
48.3	*Saga Sea* (KRI)	18/7–13/8/07	276	57	0.00			0	0
	Saga Sea (KRI)	16/8–28/8/07	19	12	0.00			0	0
	Niitaka Maru (KRI)	12/3–21/6/07	157	48	0.00			0	0
	Dalmor II (KRI)	12/8–31/8/07	128	77	0.00			0	0
	Total		580	194	0.00			0	0
58.5.2	*Southern Champion* (ANI/TOP)	20/4–19/5/07	233	231	0.00			0	0
	Southern Champion (ANI/TOP)	2/2–4/3/07	225	213	0.00			0	0
	Southern Champion (ANI/TOP)	12/6–7/8/07	547	492	0.00			0	0
	Total		1005	936	0.00			0	0

Table 14: Seal mortality totals and rates (SPT: seals/trawl) and species composition of by-catch, recorded by observers in the CAMLR Convention Area trawl fisheries over the last seven seasons. SLP – leopard seal; SEA – Antarctic fur seal; SES – southern elephant seal.

Season	Area	Target species	Trips observed	Trawls		SPT	Dead			Total dead	Alive (combined)
				Set	Observed		SLP	SEA	SES		
2000/01	48.1	*E. superba*	2	485	427	0.00				0	0
	48.3	*C. gunnari*	6	381	350	0.00				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	7	1441	1387	0.001		1		1	2
2001/02	48.3	*E. superba*	5	992	755	0.00				0	0
	48.3	*C. gunnari*	5	460	431	0.00				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	6	904	850	0.001		1		1	0
2002/03	48.3	*E. superba*	6	1928	1073	0.03		27		27	15
	48.3	*C. gunnari*	3	184	182	0.00				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	8	1311	1309	0.003		2	2	4	2
2003/04	48	*E. superba*	1	334	258	0		0		0	0
	48.3	*E. superba*	6	1145	829	0.17		142		142	12
	48.3	*C. gunnari*	6	247	238	0				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	5	1218	1215	0.002		3		3	0
2004/05	48.2	*E. superba*	2	391	285	0.06		16		16	8
	48.3	*C. gunnari*	7	337	277	0.00		0		0	2
	48.3	*E. superba*	5	1451	842	0.006		5		5	64
	58.5.2	*D. eleginoides* *C. gunnari*	6	1303	1301	0.00				0	1
2005/06	48.1	*E. superba*	2	1127	839	0.001		1		1	0
	48.3	*C. gunnari*	5	585	457	0.00				0	0
	48.3	*E. superba*	2	395	181	0.00				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	3	1086	1086	0.00	1			1	0
2006/07	48.1/2	*E. superba*	2	656	418	0.00				0	0
	48.3	*C. gunnari*	4	102	91	0.00				0	0
	48.3	*E. superba*	4	580	194	0.00				0	0
	58.5.2	*D. eleginoides* *C. gunnari*	3	1005	936	0.00				0	0

Table 15: Compliance, as reported by observers, of streamer lines with the minimum specifications set out in Conservation Measure 25-02 (2005) during the 2006/07 season. Sp – Spanish method; A – autoliner; Y – yes; N – no; - – no information; MP – Moon pool; * – conservation measure not applicable in this area.

Vessel name (Nationality)	Dates of fishing	Fishing method	Compliance with CCAMLR specifications	Compliance with details of streamer line specifications				Length of streamers (m)	Streamer line in use % setting		Haul scaring device used %
				Attachment height above water (m)	Total length (m)	No. of streamers per line	Spacing of streamers per line (m)		Night	Day	
Subarea 48.3											
Antarctic Bay	12/6–23/8/07	Sp	Y	Y (8)	Y (150)	7	Y (5)	Y (7)	100		100
Argos Frøyanes	9/5–24/8/07	A	Y	Y (7)	Y (150)	16	Y (5)	Y (8)	100		100
Argos Georgia	1/5–24/8/07	A	Y	Y (7.3)	Y (155)	13	Y (5)	Y (1–8)	100		100
Argos Helena	1/5–24/8/07	A	Y	Y (7.3)	Y (154)	13	Y (5)	Y (1–8)	100		MP
Insung No. 22	13/5–6/7/07	Sp	Y	Y (7)	Y (150)	8	Y (5)	Y (6.8)	100		87
Jacqueline	1/5–4/8/07	Sp	N	Y (7.6)	Y (154)	7	Y (5)	N (1–6)	100		100
Koryo Maru No. 11	3/5–15/8/07	Sp	Y	Y (8)	Y (174)	10	Y (5)	Y (8.5)	100		100
Punta Ballena	1/5–17/7/07	A	Y	Y (7)	Y (150)	7	Y (5)	Y (7)	100		100
San Aspiring	1/5–20/8/07	A	Y	Y (8.2)	Y (213)	24	Y (5)	Y (9.6)	100		100
Viking Bay	1/5–24/8/07	Sp	Y	Y (7)	Y (150)	9	Y (5)	Y (5–6.5)	100		100
Subarea 48.4											
San Aspiring	7/4–15/4/07	A	Y	Y (8.2)	Y (213)	24	Y (5)	Y (9.6)	100		100*
Subarea 48.6											
Frøyanes	21/3–2/4/07	A	Y	Y (7.1)	Y (150)	9	Y (5)	Y (3–7)	100	100	0*
Shinsei Maru No. 3	29/3–29/6/07	A	Y	Y (7.5)	Y (152)	6	Y (5)	Y (4.5–7)	100	100	99*
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b											
Tronio	1/12–22/3/07	Sp	Y	Y (7.2)	Y (160)	12	Y (5)	Y (1–6.5)		100	95*
Antillas Reefer	1/1–28/3/07	Sp	N	Y (7)	N (100)	9	Y (5)	Y (1–6.5)	100	100	0*
Paloma V	1/12–22/3/07	Sp	Y	Y (7)	Y (154)	12	Y (5)	Y (1–6.5)	100	100	0*
Insung No. 1	18/12–7/3/07	Sp	N	Y (7)	Y (150)	10	Y (5)	N (1–4.5)	100	100	100*
Shinsei Maru No. 3	31/12–4/3/07	A	N	Y (10)	Y (160)	6	N (5.4)	Y (5 –7.2)	100	100	85*
Jung Woo No. 2[1]	28/2–29/3/07	Sp	Y	Y (7.8)	Y (150)	10	Y (5)	Y (1–6.5)	100	100	100*
Division 58.5.2											
Janas	27/4–18/6/07	A	Y	Y (7)	Y (170)	17	Y (4)	Y (1.2–7)	100		100
Janas	15/7–3/9/07	A	Y	Y (7)	Y (175)	13	Y (5)	Y (1.2–7)	100	100	100
Subareas 58.6, 58.7											
Koryo Maru No. 11	10/2–30/3/07	Sp	Y	Y (8.2)	Y (150)	10	Y (4.6)	Y (10)	100		100
Ross Mar	25/7–24/8/07	A	Y	Y (7.2)	Y (150)	14	Y (5)	Y (1–6.6)	100		0
Ross Mar	24/4–12/6/07	A	Y	Y (8)	Y (150)	20	Y (5)	Y (8)	100	100	0

(continued)

Table 15 (continued)

Vessel name (Nationality)	Dates of fishing	Fishing method	Compliance with CCAMLR specifications	Compliance with details of streamer line specifications				Length of streamers (m)	Streamer line in use % setting		Haul scaring device used %
				Attachment height above water (m)	Total length (m)	No. of streamers per line	Spacing of streamers per line (m)		Night	Day	
Subareas 88.1, 88.2											
Avro Chieftain	4/12–6/2/07	A	Y	Y (7.5)	Y (160)	38	Y (2.5)	Y (1–85)		100	MP*
Insung No. 22	8/12–1/2/07	Sp	Y	Y (7.5)	Y (200)	40	Y (4)	Y (0.5–6.7)		100	0*
Janas	4/12–5/2/07	A	Y	Y (7)	Y (170)	17	Y (4)	Y (1–8.6)	100	100	0*
Jung Woo No. 2	11/12–1/2/07	Sp	Y	Y (7.8)	Y (150)	10	Y (5)	Y (1–6.5)		100	100*
Ross Mar	31/12–1/2/07	A	Y	Y (7.7)	Y (160)	10	Y (5)	Y (6.5)		100	0*
Ross Star	3/1–2/2/07	A	Y	Y (8.3)	Y (150)	6	Y (5)	Y (1–6.5)		100	0*
San Aotea II	1/12–6/2/07	A	Y	Y (7.7)	Y (213)	11	Y (4.7)	Y (1–8)		100	0*
San Aspiring	1/12–1/2/07	A	Y	Y (8)	Y (250)	22	Y (4.7)	Y (1–9.2)		100	0*
Antartic II	2/12–11/2/07	A	Y	Y (7)	Y (150)	27	Y (4.8)	Y (7.2)		100	0*
Argos Georgia	1/12–8/2/07	A	Y	Y (7.6)	Y (155)	7	Y (5)	-	100	100	0*
Argos Helena	2/12–14/2/07	A	Y	Y (8.4)	Y (165)	13	Y (5)	Y (1–8.4)	100	100	MP*
Frøyanes	1/12–15/2/07	A	Y	Y (7)	Y (150)	16	Y (4.7)	Y (1–7)		100	0*
Viking Sur	4/1–14/2/07	A	N	Y (7.7)	Y (151)	6	Y (4.8)	N (2.5–6)		100	0*
Volna	29/12–2/3/07	Sp	Y	Y (7)	Y (150)	8	Y (5)	Y (1–6.5)		100	0*
Yantar	29/12–1/3/07	Sp	Y	Y (7)	Y (150)	7	Y (5)	Y (1–6.5)		100	0*

[1] *Jung Woo No. 2* also conducted a small amount of fishing in Subarea 48.6 during this cruise.

Table 16: Summary of scientific observations relating to compliance with Conservation Measure 25-02 (2005), based on data from scientific observers from the 1996/97 to the 2006/07 seasons. Values in parentheses are % of observer records that were complete. na – not applicable.

Subarea/season	Line weighting (Spanish system only)				Night setting (% night)	Offal discharge (%) opposite haul		Streamer line compliance (%)										Total catch rate (birds/thousand hooks)	
	Compliance %		Median weight (kg)	Median spacing (m)				Overall		Attached height		Total length		No. of streamers		Distance apart		Night	Day
Subarea 48.3																			
1996/97	0	(91)	5.0	45	81	0	(91)	6	(94)	47	(83)	24	(94)	76	(94)	100	(78)	0.18	0.93
1997/98	0	(100)	6.0	42.5	90	31	(100)	13	(100)	64	(93)	33	(100)	100	(93)	100	(93)	0.03	0.04
1998/99	5	(100)	6.0	43.2	80[1]	71	(100)	0	(95)	84	(90)	26	(90)	76	(81)	94	(86)	0.01	0.08[1]
1999/00	1	(91)	6.0	44	92	76	(100)	31	(94)	100	(65)	25	(71)	100	(65)	85	(76)	<0.01	<0.01
2000/01	21	(95)	6.8	41	95	95	(95)	50	(85)	88	(90)	53	(94)	94	94	82	(94)	<0.01	<0.01
2001/02	63	(100)	8.6	40	99	100	(100)	87	(100)	94	(100)	93	(100)	100	(100)	100	(100)	0.002	0
2002/03	100	(100)	9.0	39	98	100	(100)	87	(100)	91	(100)	96	(100)	100	(100)	100	(100)	<0.001	0
2003/04	87	(100)	9.0	40	98	100	(100)	69	(94)	88	(100)	93	(94)	[7]		100	(100)	0.001	0
2004/05	100	(100)	9.5	45	99	100	(100)	75	(100)	88	(100)	88	(100)	[7]		100	(100)	0.001	0
2005/06	100	(100)	10.0	40	100	100	(100)	100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2006/07	100	(100)	9.8	39	100	100	(100)	90	(100)	100	(100)	100	(100)	[7]		90	(100)	0	0
Subarea 48.4																			
2005/06	Auto only		na	na	100	100	(100)	100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2006/07	Auto only		na	na	100	100	(100)	100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
Subarea 48.6																			
2003/04	100	(100)	7.0	20	41[6]	No discharge		0	(100)	100	(100)	100	(100)	[7]		0	(100)	0	0
2004/05	100	(100)	6.5	19.5	29[6]	No discharge		100	(100)	100	(100)	100	(100)	[7]		0	(100)	0	0
2005/06	Auto only		na	na	36[6]	No discharge		50	(100)	100	(100)	50	(100)			100	(100)	0	0
2006/07	Auto only		na	na	44[6]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b																			
2002/03	Auto only		na	na	24[5]	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2003/04	Auto only		na	na	0[5]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2004/05	33[9]	(100)	7.9	40	26[5]	No discharge		88	(100)	100	(100)	100	(100)	[7]		88	(100)	0	<0.001
2005/06	16[9]	(100)	7.2	48	16[5]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	<0.001
2006/07	20[9]	(100)	7.7	40	10[5]	4% by 1 vessel[10]		50	(100)	100	(100)	83	(100)	[7]		83	(100)	0	0
Division 58.4.4																			
1999/00	0[9]	(100)	5	45	50	0	(100)	0	(100)	100	(100)	0	(100)	100	(100)	100	(100)	0	0
Division 58.5.2																			
2002/03	Auto only		na	na	100	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2003/04	Auto only		na	na	99	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2004/05	Auto only		na	na	50[8]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2005/06	Auto only		na	na	53[8]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0
2006/07	Auto only		na	na	54[8]	No discharge		100	(100)	100	(100)	100	(100)	[7]		100	(100)	0	0

(continued)

Table 16 (continued)

Subarea/season	Line weighting (Spanish system only)			Night setting (% night)	Offal discharge (%) opposite haul	Streamer line compliance (%)					Total catch rate (birds/thousand hooks)	
	Compliance %	Median weight (kg)	Median spacing (m)			Overall	Attached height	Total length	No. of streamers	Distance apart	Night	Day
Subareas 58.6, 58.7												
1996/97	0 (60)	6	35	52	69 (87)	10 (66)	100 (60)	10 (66)	90 (66)	60 (66)	0.52	0.39
1997/98	0 (100)	6	55	93	87 (94)	9 (92)	91 (92)	11 (75)	100 (75)	90 (83)	0.08	0.11
1998/99	0 (100)	8	50	84[2]	100 (89)	0 (100)	100 (90)	10 (100)	100 (90)	100 (90)	0.05	0
1999/00	0 (83)	6	88	72	100 (93)	8 (100)	91 (92)	0 (92)	100 (92)	91 (92)	0.03	0.01
2000/01	18 (100)	5.8	40	78	100 (100)	64 (100)	100 (100)	64 (100)	100 (100)	100 (100)	0.01	0.04
2001/02	66 (100)	6.6	40	99	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2002/03	0 (100)	6.0	41	98	50 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	<0.01	0
2003/04	100 (100)	7.0	20	83	100 (100)	50 (100)	50 (100)	100 (100)	[7]	100 (100)	0.03	0.01
2004/05	100 (100)	6.5	20	100	100 (100)	0 (100)	100 (100)	100 (100)	[7]	0 (100)	0.149	0
2005/06	100 (100)	9.1	40	100	100 (100)	0 (100)	100 (100)	100 (100)	[7]	0 (100)	0	0
2006/07	100 (100)	10.4	40	100	100 (100)	0 (100)	100 (100)	100 (100)	[7]	0 (100)	0	0
Subareas 88.1, 88.2												
1996/97	Auto only	na	na	50	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1997/98	Auto only	na	na	71	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1998/99	Auto only	na	na	1[3]	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1999/00	Auto only	na	na	6[4]	No discharge	67 (100)	100 (100)	67 (100)	100 (100)	100 (100)	0	0
2000/01	1 (100)	12	40	18[4]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2001/02	Auto only	na	na	33[4]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2002/03	100 (100)	9.6	41	21[4]	1 incidence by 1 vessel	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2003/04	89 (100)	9	40	5[4]	24% by 1 vessel	59 (100)	82 (100)	86 (100)	[7]	100 (100)	0	<0.01
2004/05	33[9] (100)	9.0	45	1[4]	1% by 1 vessel	64 (100)	100 (100)	100 (100)	[7]	64 (100)	0	0
2005/06	100[9] (100)	9.2	35	1[4]	No discharge	85 (92)	100 (92)	85 (92)	[7]	100 (92)	0	0
2006/07	100[9] (100)	10	36	4[4]	1% by 1 vessel	93 (100)	100 (100)	100 (100)	[7]	93 (93)	0	0

1 Includes daytime setting – and associated seabird by-catch – as part of line-weighting experiments on *Argos Helena* (WG-FSA-99/5).
2 Includes some daytime setting in conjunction with use of an underwater setting funnel on *Eldfisk* (WG-FSA-99/42).
3 Conservation Measure 169/XVII allowed New Zealand vessels to undertake daytime setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.
4 Conservation Measures 210/XIX, 216/XX and 41-09 (2002, 2003, 2004) permit daytime setting south of 65°S in Subarea 88.1 if able to demonstrate a sink rate of 0.3 m s^{-1}.
5 Conservation Measure 41-05 (2002, 2003, 2004) permits daytime setting in Division 58.4.2 if the vessel can demonstrate a sink rate of 0.3 m s^{-1}.
6 Conservation Measure 41-04 (2003, 2004) permits daytime setting in Subarea 48.6 if the vessel can demonstrate a sink rate of 0.3 m s^{-1}.
7 Conservation Measure 25-02 (2003) was updated and the requirement for a minimum of 5 streamers per line was removed.
8 Conservation Measure 41-08 (2004) permits daylight setting with the use of an integrated weighted line of at least 50 g m^{-1}.
9 Conservation Measure 24-02 (2004) exempts vessels from line weighting requirements if they comply with sink rates or have an UWL of 50 g m^{-1}.
10 The *Tronio* discharged offal on seven occasions due to mechanical problems.

Table 17: Sink rates recorded by observers using bottle tests and TDRs in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b during the 2006/07 season.

Vessel name	Subarea/ division	No. of tests conducted	Sink rate				Line weights	
			Min.	Max.	Average (m/second)	Standard deviation	kg m^{-1}	IWL g m^{-1}
*Frøyanes**	48.6	13	0.29	0.37	0.32	0.03		50
Shinsei Maru No. 3	48.6	103	0.48	0.88	0.65	0.07	11 / 50	
Tronio	58.4.1/3a/3b	92	0.26	1.00	0.42	0.09	7.7 / 40	
*Antillas Reefer**	58.4.1/2/3b	20	0.37	0.50	0.43	0.04	8 / 40	130
Paloma V	58.4.1/3b	116	0.40	1.00	0.69	0.10	7 / 108	
*Insung No. 1**	58.4.1/2	46	0.32	0.40	0.36	0.03	5 / 40	200
Shinsei Maru No. 3	58.4.3a/3b	84	0.56	0.84	0.68	0.06	11 / 50	
Jung Woo No. 2	58.4.2	34	0.34	0.56	0.41	0.05	14 / 37	
*Avro Chieftain**	88.1	123	0.21	0.67	0.27	0.05		50
Insung No. 22	88.1	28	0.31	0.43	0.37	0.03	10 / 69	
*Janas**	88.1	57	0.21	0.71	0.34	0.09		50
Jung Woo No. 2	88.1	32	0.33	0.67	0.43	0.08	14 / 37	
*Ross Mar**	88.1	41	0.24	0.56	0.42	0.08		140
*Ross Star**	88.1	28	0.23	0.63	0.37	0.08		50
*San Aotea II**	88.1	58	0.12	0.77	0.30	0.10		50
*San Aspiring**	88.1	63	0.21	1.06	0.36	0.10		50
*Antartic II**	88.1, 88.2	11	0.43	1.25	0.80	0.30	13.6 / 540	56
*Argos Georgia**	88.1, 88.2	6	0.24	0.31	0.28	0.02		50
*Argos Helena**	88.1, 88.2	57	0.23	0.48	0.26	0.03		50
*Frøyanes**	88.1, 88.2	89	0.22	0.53	0.32	0.05		50
*Viking Sur**	88.1, 88.2	40	0.20	0.83	0.39	0.10		50
Volna	88.1, 88.2	12	0.34	0.48	0.40	0.05	10 / 35	
Yantar	88.1, 88.2	20	0.91	1.43	1.20	0.20	9.8 / 20	

* Vessels operated with an IWL of at least 50 g m^{-1}.

Table 18: Estimated total potential seabird by-catch in unregulated longline fisheries in the Convention Area from 1996 to 2007.

Subarea/ division	Year	Estimated total potential seabird by-catch		
		Lower	Median	Upper
48.3	2007	0	0	0
	1996–2006	1 835	3 486	56 766
58.4.2	2007	509	621	1 658
	1996–2006	972	1 186	3 165
58.4.3	2007	2 981	3 637	9 711
	1996–2006	4 568	5 573	14 882
58.4.4	2007	2 056	2 509	6 699
	1996–2006	3 886	4 741	12 659
58.5.1	2007	1 184	1 445	3 858
	1996–2006	48 781	59 518	158 920
58.5.2	2007	0	0	0
	1996–2006	32 763	39 976	106 739
58.6	2007	0	0	0
	1996–2006	45 029	54 941	146 697
58.7	2007	0	0	0
	1996–2006	12 856	15 686	41 884
88.1	2007	0	0	0
	1996–2006	489	598	1 578
88.2	2007	0	0	0
	1996–2006	9	11	28
Totals	2007	6 730	8 212	21 926
	1996–2006	151 187	185 716	543 319
Total		157 917	193 927	565 245

Table 19: Summary of IMAF assessment of risk posed to seabirds from net entanglements in pelagic finfish trawl fisheries in the Convention Area (see also Figure 2).

Risk level[1]	Mitigation requirements	Recommended observer coverage
1 – low	• Strict compliance with standard seabird by-catch conservation measure[2]. • Vessels that catch a total of three birds in any season shall consider the use of net binding to reduce seabird captures during shooting operations. • No offal discharge during the shooting and hauling of trawl gear. Full offal retention where possible.	20% of sets 50% of hauls
2 – average to low	• Strict compliance with standard seabird by-catch conservation measure[2]. • Vessels that catch a total of three birds in any season shall consider the use of net binding to reduce seabird captures during shooting operations. • No offal discharge during the shooting and hauling of trawl gear. Full offal retention where possible.	25% of sets 75% of hauls
3 – average	• Strict compliance with standard seabird by-catch conservation measure[2]. • Vessels that catch a total of three birds in any season shall consider the use of net binding to reduce seabird captures during shooting operations. • No offal discharge during the shooting and hauling of trawl gear. Full offal retention where possible.	40% of sets 90% of hauls
4 – average to high	• Strict compliance with standard seabird by-catch conservation measure[2]. • Vessels that catch a total of three birds in any season shall use net binding, and consider adding weight to the cod end to reduce seabird captures during shooting operations. • No offal discharge during the shooting and hauling of trawl gear. Full offal retention where possible.	45% of sets 90% of hauls
5 – high	• Strict compliance with standard seabird by-catch conservation measure[2]. • Use net binding, and consider adding weight to the cod end to reduce seabird captures during shooting operations. • No offal discharge during the shooting and hauling of trawl gear. Full offal retention where possible.	50% of sets 90% of hauls

1 Where 'risk' means seabird by-catch risk if no mitigation is used for a given level of seabird abundance.
2 Conservation Measure 25-03.

Table 20: Summary of IMAF assessment of risk to seabirds posed by longline fisheries in the Convention Area (see also Figure 2).

Risk level	Mitigation requirements	Observer coverage
1 – low	• Strict compliance with standard seabird by-catch conservation measure[1]. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirement[2]. • No offal dumping.	20% of hooks hauled 50% of hooks set
2 – average to low	• Strict compliance with standard seabird by-catch conservation measure[1]. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements and seabird by-catch limits. • No offal dumping.	25% of hooks hauled 75% of hooks set
3 – average	• Strict compliance with standard seabird by-catch conservation measure[1]. • Restrict longline fishing to period outside at-risk species breeding season where known/relevant unless line sink rate requirement is met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits. • No offal dumping.	40% of hooks hauled[2] 95% of hooks set
4 – average to high	• Strict compliance with standard seabird by-catch conservation measure[1]. • Restrict longline fishing to the period outside any at risk species breeding season(s). • Strict line sink rate requirements at all times. • No daytime setting permitted. • No offal dumping.	45% of hooks hauled[2] 95% of hooks set
5 – high	• Strict compliance with standard seabird by-catch conservation measure[1]. • Restrict longline fishing to period outside at-risk species breeding season. • Closed areas as identified. • Strict line sink rate requirements at all times. • No daytime setting permitted. • Strict seabird by-catch limits in place. • No offal dumping.	50% of hooks hauled[2] 100% of hooks set

[1] Conservation Measure 25-02 with the possibility of exemption to paragraph 4 as provided by Conservation Measure 24-02.
[2] This is likely to require the presence of two observers.

Table 21: Intersessional work plan for ad hoc WG-IMAF for 2007/08.

The Secretariat will coordinate the intersessional work of the IMAF group. An interim review of work will be conducted in May 2008 and advised to ad hoc WG-IMAF in advance of WG-EMM/WG-SAM (July 2008). The outcome of the intersessional work will be reviewed in September 2008 and reported as a tabled paper to WG-IMAF in October 2008.

[1] In addition to work coordinated by the Science Officer (Secretariat) * SODA: Scientific Observer Data Analyst

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
1.	**Planning and coordination of work:**				
1.1	Circulate materials on IMAF matters as contained in reports of current meetings of CCAMLR.	Standing request		Dec 2007	Place all relevant sections of CCAMLR-XXVI on IMAF page of CCAMLR website and notify IMAF group members, and technical coordinators and (via them) scientific observers.
1.2	Acknowledge work of technical coordinators and scientific observers.	Standing request		Dec 2007	Commend technical coordinators and all observers for their efforts in the 2006/07 fishing season.
1.3	Prepare agenda for WG-IMAF-08.		Science Officer, Co-conveners	Feb 2008/ Jul 2008	Science Officer to forward e-version of last year's annotated agenda to Co-conveners for revision prior to distribution to WG-IMAF for comments on revised structure, final version to be circulated later in year.
1.4	Submission of papers for WG-IMAF-08.		Members, IMAF members, SODA	By 0900 29 Sep 2008	Submit papers specifically relevant to agenda items.
1.5	Allocation of submitted papers to agenda items and assignment of rapporteuring tasks.	Standing request	Co-conveners	Before meeting	Prepare list, circulate to confirmed attendees and post on website.
1.6	WG-IMAF Planning Workshop	II.208–211	Science Officer, SODA, Co-conveners	May 2008 15 Sep 2008 10 Oct 2008	Develop agenda, plan venue, invite participants. Draft and distribute working papers for workshop. Convene one-day workshop in week preceding WG-IMAF-08.

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
2.	**Members' research and development activities:**				
2.1	Request Members provide updated information on national research programs on albatrosses, giant petrels and white-chinned petrels to ACAP in relation to status and trends of populations and foraging range and distribution, genetic profiles and the numbers and nature of by-catch specimens and samples.	Standing request	Members, IMAF members, technical coordinators, nominated scientists	Nov 2007/ Sep 2008	Explicit reminder to IMAF members in March 2008.
2.2	Risk assessment of seabird by-catch in the Convention Area.	Standing request	IMAF members	Nov 2007/ Sep 2008	Further work as appropriate to update SC-CAMLR-XXVI/BG/31 for the Scientific Committee. Circulate any new tabled papers relating to seabird at-sea distributions to Co-conveners and Dr Gales – and to other IMAF members as requested.
2.3	Distribute Waugh et al. paper describing CCAMLR's seabird risk assessment process.	I.52	Science Officer, Co-conveners	Dec 2007/ Feb 2008	Distribute paper to RFMOs, FAO. To WCPFC in time for its Dec 2007 Commission meeting.
2.4	Request BirdLife International to provide summary data on distribution of Southern Ocean seabirds from its tracking database if accumulation of data warrants. Plan with BirdLife for the three-year review of tracking database.	Standing request	Science Officer, BirdLife International, Co-conveners	Jul 2008	Request information. Circulate any new information to WG-IMAF. Co-conveners to liaise with BirdLife International with respect to three-year review.

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
2.5	Information on the development and use of fisheries-related methods of the avoidance of incidental mortality of seabirds. In particular, information is sought on the following: • experiences with trotline or trotline/net systems; • experiences with steel weights; • optimum configuration of line-weighting regimes and equipment; • haul mitigation devices and experiences with their use; • tests of/experiences with streamer lines, especially with respect to paired versus single lines; • trawl haul mitigation and the use of net binding; • review methodology for monitoring link sink rate using bottle tests; • determination of appropriate 'access windows' for Convention Area seabirds and fisheries.	Standing request	Members, IMAF members, technical coordinators	Nov 2007/ Sep 2008	Request information, collate responses for WG-IMAF-08, members to submit papers where possible.
2.6	Produce and distribute a hook discard outreach poster.	I.3, I.39	Australia, SODA	Dec 2007/ Jan 2008	Secretariat distribute hook poster via technical coordinators to all longline vessels operating in the Convention Area.
2.7	Continued experimental trials of mitigation measures in French EEZ.	Standing request and I.9(i–ii)	France, IMAF scientists	As soon as reports available	Report available results to WG-IMAF-08, in particular details on the nature of seabird captures.
2.8	Submit a strategic plan to eliminate seabird mortality.	I.9(iv–v)	France	Sep 2008	See paragraph for details, also include description of the full set of regulatory instruments in place.
2.9	Submit publication of evaluation of the impact of fisheries on the populations of petrels in the French EEZs.	I.50	France		Submit English version for review by WG-IMAF-08.

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
2.10	Request data acquired from observer protocols for: seabird trawl warp strike observation and longline haul.	I.46(iv–v)	Drs S. Waugh and K. Sullivan, Mr E. Melvin, IMAF members	Aug 2008	Review data-to-date from protocols developed at WG-IMAF-06. Extract data in early August to allow paper to be drafted.
3.	**Information from outside the Convention Area:**				
3.1	Information on longline fishing effort in the Southern Ocean outside the Convention Area.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2008	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to the CCAMLR Convention Area (e.g. Argentina, Australia, Brazil, Chile, New Zealand, South Africa, UK and Uruguay; review situation at WG-IMAF-08. Request information from other Parties – Members and non-Contracting Parties (e.g. China, Japan, Republic of Korea) and review at WG-IMAF-08.
3.2	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	Standing request and I.28	Members, IMAF members	Sep 2008	Repeat request to all IMAF members; review at WG-IMAF-08.
3.3	Reports on use and effectiveness of mitigation measures outside the Convention Area.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2008	Request information on use/implementation of mitigating measures, especially provisions in Conservation Measures 24-02, 25-02 and 25-03, as under item 3.1 above; review responses at WG-IMAF-08.
4.	**Cooperation with international organisations:**				
4.1	Cooperation with CCSBT, IATTC, ICCAT, IOTC, SEAFO and WCPFC on specific issues regarding incidental mortality of seabirds. Implementation of CCAMLR Resolution 22/XXV.	Standing request and I.70	Co-conveners, Science Officer	Nov 2007/ Sep 2008	Brief CCAMLR observers on desired feedback on IMAF matters (seabird by-catch levels and mitigating measures).

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
4.2	Collaboration and interaction with all tuna commissions (CCSBT, IATTC, ICCAT, IOTC, SEAFO and WCPFC) and RFMOs with responsibility for fisheries in areas where Convention Area seabirds are killed. Implementation of CCAMLR Resolution 22/XXV.	II.194, II.195	Relevant Members, CCAMLR observers	Nov 2007 and at specific meetings	Request information on: (i) annual data on distribution level of longline fishing effort; (ii) existing data on levels and rates of seabird by-catch; (iii) measures currently in use and whether voluntary or mandatory; (iv) nature and coverage of observer program; (v) scientific information supporting proposed or adopted mitigation measures. Support regulations for use of proposed or adopted mitigating measures at least as effective as Conservation Measure 25-02.
4.3	Support for ACAP attendance at AC/MOP meetings.	Standing request	Members as appropriate; Australia		Support the work of the Advisory Committee, implementation of its Action Plan, and coordinating activities between CCAMLR and ACAP. Report to WG-IMAF-08.
4.4	IUCN Red List: Seabirds	Standing request	Science Officer	Aug 2008	Obtain from BirdLife International, circulate to IMAF members and table for SC-CAMLR-XXVII, any revisions to the conservation status of albatross, *Macronectes* and *Procellaria* species.
4.5	BirdLife International	Standing request	Science Officer, BirdLife International	Sep 2008	Request information from BirdLife International about its activities of relevance to IMAF, in particular its Seabird Program and 'Albatross Task Force'. BLI submission of updated report on RFMO evaluation to WG-IMAF-08.
4.6	Southern Seabird Solutions	Standing request	New Zealand	Sep 2008	Report on progress to WG-IMAF-08.
5.	**Data acquisition and analysis:**				
5.1	Acquisition from EEZs and elsewhere as appropriate, of seabird incidental mortality data for trawl fisheries.	Standing request	Members	Nov 2007/ Sep 2008	Request Members for appropriate data.

	Task/Topic	Paragraphs of WG-IMAF report	Members' Assistance[1]	Start/ Completion deadlines	Action
5.2	Acquisition of observer data in CCAMLR logbook format for French EEZs in Subarea 58.6 and Division 58.5.1.	I.8(iii)	France	Aug 2008	Request France to submit reports and data logbooks prepared by national observers for the current and past fishing seasons, using CCAMLR reporting formats. Raw data needed to allow for extrapolation of estimates along with the other fisheries in the Convention Area.
5.3	Acquisition of additional observer data to aid in identification of factors influencing seabird by-catch.	II.19	France	As soon as possible	Request inclusion into observer protocols of specific data elements (see paragraph II.19(i–vii); report to WG-IMAF-08.
5.4	Status report on implementation of WG-IMAF recommendations re: mitigation research programs, observer coverage and implementation of mitigation measures.	Standing request	France, IMAF	Sept 2008	Report to WG-IMAF-08.
5.5	Estimates of IUU take of seabirds.	Standing request and II.75	France, SODA	Before start WG-IMAF 2008	Prepare 2008 estimates of IUU seabird by-catch. Examine methods of estimating the by-catch of grey petrels by IUU vessels within Division 58.5.1.
5.6	Request updated information on ACAP species assessments.	Standing request and I.49	Science Officer	Jul 2008	Request information. Submit paper to WG-IMAF-08 by deadline.
5.7	Request WG-SAM to review French analysis of petrel population responses to fisheries and environmental factors.	I.8(ii)	SAM	Jan 2008	Once SC-CAMLR-XXVI/BG/22 is available in English, request WG-SAM to review analysis and submit report to WG-IMAF-08.
6.	**Scientific observer issues:**				
6.1	Improved reporting on use of net sonde cables.	I.46(i)	Members		Reiterate need for improved reporting to distinguish between paravane cables and net sonde cables.
6.2	Distinguish between three longline fishing methods.	I.46(iii)		Dec 2007/ Jan 2008	Clarify for observers and in logbooks how to accurately report which longline system is being used: Spanish system, autoline system or trotline system.
6.3	Review priorities and protocols for observers in the cruise logbooks, cruise reports and the *Scientific Observers Manual* and address identified issues especially to determine if data collections meet data requirements.	Standing request	IMAF, SODA	Sep 2008	Participate in intersessional FSA task group to review priorities and protocols for observer data collection. Report to WG-IMAF-08.

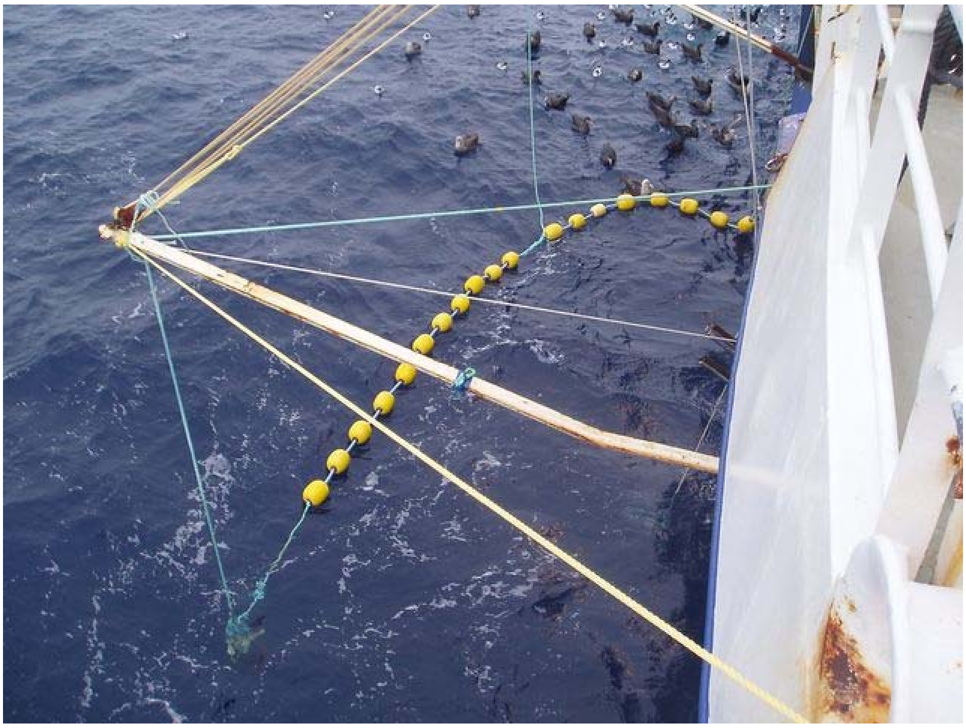

Figure 1: Example of an effective Brickle curtain. (Photo from FV *Janas*)

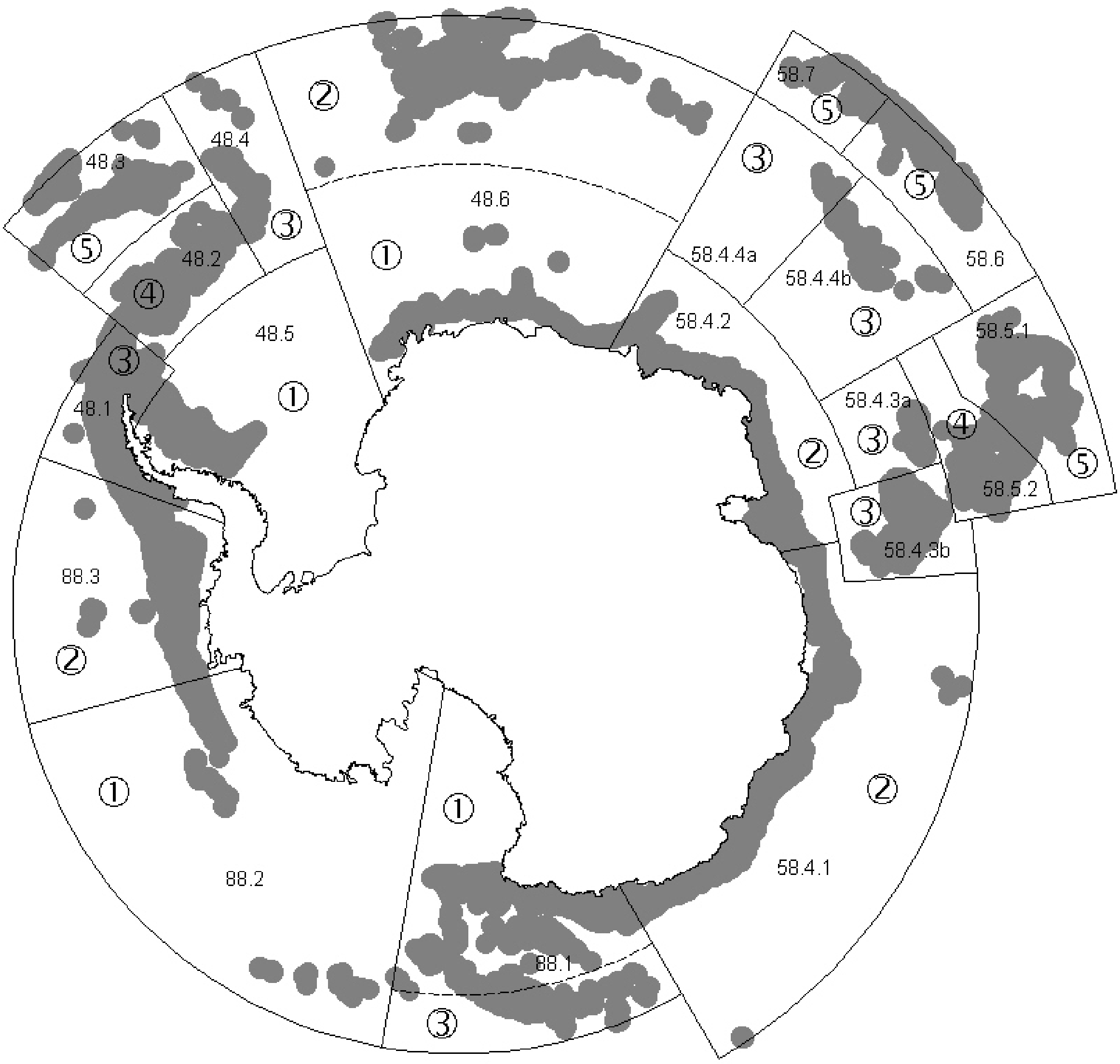

Figure 2: Assessment of the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries within the Convention Area. 1: low, 2: average to low, 3: average, 4: average to high, 5: high. Shaded patches represent seabed areas between 500 and 1 800 m.

APPENDIX A

AGENDA

Ad Hoc Working Group on Incidental Mortality Associated with Fishing
(Hobart, Australia, 8 to 12 October 2007)

Incidental mortality of mammals and seabirds associated with fishing
(ad hoc WG-IMAF report)

- Preliminaries
- Intersessional work of ad hoc WG-IMAF
- Incidental mortality of seabirds and marine mammals in fisheries in the Convention Area
  - Seabirds
    - Longline
    - Trawl
    - Pot
  - Marine mammals
    - Longline
    - Trawl
    - Pot
  - Information relating to the implementation of Conservation Measures 25-02 (2005), 25-03 (2003), 26-01 (2006) and 24-02 (2005)

- Incidental mortality of seabirds and marine mammals in fisheries outside the Convention Area
  - Longline
  - Trawl

- Incidental mortality of seabirds during unregulated longline fishing in the Convention Area

- Research into and experience with mitigation measures
  - Longline
  - Trawl

- Observer reports and data collection

- Research into the status and distribution of seabirds

- Assessments of risk in CCAMLR subareas and divisions

- Incidental mortality of seabirds in relation to new and exploratory fisheries
  - New and exploratory fisheries operational in 2006/07
  - New and exploratory fisheries proposed for 2007/08

International and national initiatives relating to incidental mortality of seabirds in relation to longline fishing

Coordination with ACAP

International initiatives

National initiatives

Fishery reports

Streamlining the work of the Scientific Committee

Other business

Advice

ANNEX 7

REPORT OF THE WORKING GROUP ON STATISTICS, ASSESSMENTS AND MODELLING
(Christchurch, New Zealand, 9 to 13 July 2007)

CONTENTS

REPORT OF THE WORKING GROUP ON STATISTICS, ASSESSMENTS AND MODELLING
(Christchurch, New Zealand, 9 to 13 July 2007)

INTRODUCTION

Opening of the meeting

1.1 The first meeting of WG-SAM was held at the Latimer Hotel, Christchurch, New Zealand, from 9 to 13 July 2007. The meeting was co-convened by Drs C. Jones (USA) and A. Constable (Australia). WG-SAM, which replaces WG-FSA's Subgroup on Assessment Methods, was established by the Scientific Committee in 2006 to serve as a technical group to address quantitative and modelling issues relevant to all Scientific Committee working groups (WG-FSA, WG-EMM and ad hoc WG-IMAF) (SC-CAMLR-XXV, paragraphs 13.12 to 13.16).

1.2 Dr Jones welcomed participants (Appendix A) and thanked New Zealand for hosting the meeting. Miss J. McCabe, on behalf of the New Zealand Ministry for Foreign Affairs and Trade, also welcomed the participants.

Adoption of the agenda and organisation of the meeting

1.3 The provisional agenda was discussed and it was agreed to include consideration of by-catch species under Item 3 (Assessment Methods). It was also agreed that subitems 3.1 (New Methods for CCAMLR Taxa) and 5.1 (Development of Operating Models) would be discussed with respect to the taxa identified in the respective agenda items. As a result, subitems 3.1 and 5.1 were removed from the agenda. The revised agenda was adopted (Appendix B).

1.4 Documents submitted to the meeting are listed in Appendix C.

1.5 The report was prepared by Drs I. Ball (Australia), A. Brandão (South Africa), S. Candy (Australia), Mr A. Dunn (New Zealand), Drs M. Goebel (USA), S. Hanchet (New Zealand), S. Hill (UK), R. Hillary (UK), R. Holt (USA), S. Mormede (New Zealand), É. Plagányi (South Africa), D. Ramm (Data Manager), K. Reid (UK), C. Reiss (USA), G. Watters (USA) and D. Welsford (Australia).

PARAMETER ESTIMATION

Refinements of existing methods

2.1 Mr Dunn presented WG-SAM-07/5, which updated the descriptive analysis of the toothfish tag–release and recapture data for New Zealand vessels for the 2006/07 season in Subareas 88.1 and 88.2.

2.2 The Working Group welcomed the analysis and recommended that similar papers be prepared for WG-FSA-07 that provide a descriptive analysis of the tagging program in Division 58.5.1, and papers that update the descriptive analyses of tagging programs in Division 58.5.2 and Subarea 48.3.

2.3 It was noted that there were disparities between the recapture rates of tags by different vessels across the fishery in Subareas 88.1 and 88.2. The spatial structure of the fishery, with vessels fishing the same areas in successive years, may result in a tendency for vessels to recapture their own tags. It was recommended that these differences be analysed and that a method be developed to describe the spatial pattern of tag recaptures including the vessels which released tagged fish and the vessels recapturing tagged fish.

2.4 The Working Group recommended that a spatial movement model be constructed in order to answer questions about the efficacy of the tagging program and the best manner of interpreting the data. The model could also be used to determine the best way to maximise the information output in a way useful for the integrated assessment method.

2.5 The Working Group was asked whether it had any advice on whether the current level of tagging was reasonable or if it should be increased. Mr Dunn noted that the level of tagging appeared to be a reasonable balance between increasing the number of tagged fish in the population and ensuring that the tagging program remains of high quality. Dr K. Sullivan (New Zealand) noted that: early tags are still being recovered, the number of tagged fish in the population is still increasing, and the amount of information arising from tag recaptures is increasing each year.

2.6 The Working Group noted that the Secretariat would take responsibility for coordinating tagging programs in new and exploratory fisheries starting from the 2007/08 season. It recommended that WG-FSA consider the development of advice on how it should manage the collection of non-toothfish tagging data, particularly from voluntary tagging programs.

2.7 Dr Welsford described the triple tagging of fish in the fishery in Division 58.5.2 using passive integrated transponder (PIT) tags to assist in evaluating external tag observation and shedding rates. The Working Group recommended that a paper be prepared which described this methodology and results.

2.8 Mr Dunn presented WG-SAM-07/6 which reviewed and updated the catch history, CPUE indices, length–weight relationships, catch-at-length and catch-at-age frequencies and included a review of alternative methods for the stratification of length frequencies for *Dissostichus mawsoni* in the Ross Sea.

2.9 It was noted that scientific observer data from a small number of vessels had a large proportion of unsexed fish. The use of an unsexed length–weight relationship resulted in little change to estimated length-frequency distributions. However, an alternative method of scaling length-frequency samples, making use of the number of fish caught instead of the catch weight, resulted in some differences to the estimated distributions. Mr Dunn noted that scaling by catch numbers is preferable as it avoids the need to apply a length–weight relationship to estimate sample weight.

2.10 The Working Group agreed that it would be useful in the future to use samples from recaptured tagged fish to determine the age–length relationship of tagged fish in order to examine differences in the growth rates between tagged and non-tagged fish and determine a suitable value for a tag-related growth retardation parameter.

New methods

2.11 The Working Group welcomed a paper by Dr Candy (WG-SAM-07/7) presenting a new method for the calculation of effective sample size. In discussion on the comparison between the new method and existing methods, some notational errors were discovered in the documentation of existing methods.

2.12 During the meeting the implementation of the existing methods, as given in WG-SAM-07/7, was changed by Dr Candy to reflect the correct notation and the resultant differences between the methods, apart from issues relating to process error, were no longer a significant issue for assessments.

2.13 With respect to the important issue of quantifying the relative contributions of process error and systematic lack of fit, Dr Candy demonstrated a method to detect statistically significant systematic lack of fit of integrated model predictions of catch-at-age or catch-at-length frequencies. The Working Group encouraged the development and documentation of this approach for general use.

2.14 WG-SAM noted the report of the 2007 meeting of SG-ASAM, and the further progress made in developing the methodologies for acoustic surveys of icefish (*Champsocephalus gunnari*) (Annex 8). In particular, WG-SAM noted that further work is required on species classification and target strength before it would be feasible to consider methods for combining trawl and acoustic indices for stock assessment of icefish in Subarea 48.3.

2.15 WG-SAM noted the hierarchical procedures for the collection of acoustic data during CCAMLR-related IPY surveys which had been developed during a joint session of SG-ASAM and the CCAMLR-IPY Steering Committee.

2.16 WG-SAM noted the report of the 2007 planning meeting of the CCAMLR-IPY Steering Committee (SC-CAMLR-XXVI/BG/3) and the CCAMLR-related research.

ASSESSMENT METHODS

Dissostichus spp.

3.1 WG-SAM-07/8 proposed a methodology for a preliminary assessment of toothfish on BANZARE Bank (Division 58.4.3b). Preliminary analysis of non-standardised CPUE data showed evidence of severe depletion in one fishing ground where catch and effort had concentrated from the 2004 to the 2007 seasons. It was suggested that the CPUE time series has some variability and is not necessarily simply decreasing, but that the spatial aggregation in catch and effort would need to be considered as a factor in any overall trends in CPUE seen in this fishery.

3.2 The Working Group agreed that it was important to consider the very high level of IUU catches in this division, which needs to be considered in interpreting the results of a depletion analysis to determine stock biomass.

3.3 A highly spatial relationship between by-catch (rajids and macrourids) and the toothfish fishery, given the figures displayed in the paper, was noted by the Working Group. However, it was also noted that this was not the same relationship for both of these by-catch species.

3.4 The Working Group agreed that a fine-scale standardisation of the CPUE data, to be applicable to such a depletion-type model, would be a good way to proceed so as to obtain a CPUE dataset that can be used in such a Leslie-DeLury depletion analysis. It was noted that what can be seen in the paper is an analysis of the status of the population in the given grounds, i.e. the vulnerable stock, and not the size of the population as a whole. The interpretation of stock in this case could be the summation of the stock sizes in the relevant areas, but it was mentioned that this assumption should be made explicit in further analyses. The Working Group agreed that a Leslie-DeLury depletion analysis could be considered in providing advice on potential yields in exploratory toothfish fisheries depending on broader consideration of the application of CCAMLR's precautionary approach in those fisheries.

3.5 With respect to IUU fishing, the timing of such fishing is very relevant to the potential impact of IUU catches on the results coming from this type of approach. If the IUU catches were taken during the period of the legal fishery, then the rate of decline in CPUE will not be as great as indicated in WG-SAM-07/8. However, if the IUU catches were outside the fishing period, then the rate of decline in CPUE would reflect the rate of decline in the local vulnerable population. The timing and magnitude of IUU fishing is best addressed by SCIC, but it was noted that basic sighting plots of IUU vessels might be informative with respect to the effect of IUU fishing on the patterns of decreasing CPUE, seen at the scale of the grounds as described in WG-SAM-07/8.

3.6 One concern expressed by the Working Group was the lack of small fish seen in this fishery. Knowledge of how these stocks are replenished by recruitment would help the assessment. In particular, it was important to identify the origin of the recruits in order to be confident that fisheries were not over-exploiting the stock through fishing on both the recruits and the adults as if they were separate stocks.

3.7 Further work to consider the links between fished stocks in Subarea 58.4 was agreed to be worthwhile.

3.8 The authors of WG-SAM-07/9 were not present at the meeting but the paper was discussed with respect to the general methodology. It was noted that the general interpretation of both methods and results of any type of model is very difficult without the display of both the data entered into the model, and how well these data are fitted by the proposed assessment model. It was agreed that there are many questions on the applicability of a TSVPA approach, including whether the complexity of these VPA methods was warranted, how tagging data can be included in the model, and the methods by which the input data are calculated. The Working Group agreed that it is very hard to appraise such a paper without the presence of the authors, given the difficulty in understanding the many aspects of the data and methods applied in this paper. The Working Group also agreed that new methods that are suggested as alternatives to assessments that have already been through a review process within WG-FSA (including WG-FSA-SAM, the precursor to WG-SAM) must follow the general guidelines detailed in paragraph 6.3.

Champsocephalus gunnari

3.9 In 2006, WG-FSA identified the following items to further develop the assessment of *C. gunnari* (SC-CAMLR-XXV, Annex 5, paragraphs 12.13 and 12.14):

Fishery in Subarea 48.3:

- investigation of the consequences and solutions to setting catch limits which might result in high harvesting rates on small, unassessed, recruiting year classes;
- further development of the acoustic protocol for assessing biomass;
- continued assessment of accuracy and precision of otolith-based age estimates.

Fishery in Division 58.5.2:

- review of biological parameters and cohort progression based on survey and catch data.

3.10 WG-SAM agreed that it could address some of these items at future meetings and in the light of findings from the forthcoming joint WG-FSA and WG-EMM Workshop on Fisheries and Ecosystem Models in the Antarctic (SC-CAMLR-XXVI/BG/6; Annex 4, paragraphs 7.6 to 7.8).

Euphausia superba

3.11 In 2006, the Scientific Committee requested that the Working Group undertake the following with respect to krill assessments:

(i) contribute to the review of the most appropriate method for estimating B_0 and associated CV from survey data for the B_0 workshop to be held as part of WG-EMM following this meeting (SC-CAMLR-XXV, paragraph 3.27);

(ii) explore whether an integrated assessment approach could be undertaken for krill, similar to that used by WG-FSA for other species (SC-CAMLR-XXV, paragraph 3.15).

3.12 The Working Group noted that the following could be considered in an integrated assessment for krill:

(i) Stock structure –

(a) flows in the region indicate that krill is likely to be transported through the region such that relevant models should include spatial structure;

(b) there is some uncertainty as to whether there are single or multiple stocks of krill;

(c) the assessment should be of the vulnerable (rather than total) population as the system is not closed. An integrated assessment model would thus need to include both emigration and immigration terms.

(ii) Fishery –

(a) there are seasonal differences in the krill fishery, with a winter fishery operating around South Georgia and a summer fishery in other regions;

(b) data for an integrated assessment would need to be provided separately for each fishing subarea (South Shetland Islands, South Orkney Islands and South Georgia), which was considered feasible given that data are available on a haul-by-haul basis.

(iii) Research data –

(a) data for an integrated assessment could be provided by routine surveys undertaken by the British Antarctic Survey in the South Georgia area together with US AMLR surveys in the Antarctic Peninsula region;

(b) it may be worthwhile to examine concordance between different krill survey time series to try and estimate movement rates.

(iv) Assessment –

(a) a move to a finer-scale model requires a much larger and more complex model which, in practice, can be difficult to implement given computational constraints;

(b) at present, this may not be sensible, but it may become increasingly important to divide the region into at least three areas as the fishery starts to approach the catch limit for the entire region;

(c) data currently collected need to be of sufficient quality for future work. It was suggested that it might be useful to construct what an integrated model might look like to advise on data needs. In trying to fit such a model to all different datasets (such as that pertaining to growth dynamics), the Working Group agreed that it would likely be necessary to step back in model complexity and simplify assumptions, for example, by fitting to size-frequency data rather than developing a full growth model;

(d) spatial models were proposed as a tool which could assist by, for example, evaluating in which areas simplifying assumptions matter most;

(e) proposals to develop an integrated assessment should consider what the current limitations of the KYM are;

(f) it was recommended that the MSE approach would be the ideal approach to evaluate the utility and accuracy of an integrated assessment.

3.13 The Working Group agreed that the following were important data considerations in moving towards developing an integrated assessment:

(i) The length-frequency data that are currently available are mostly from surveys, with no obligation for the krill fishery to provide similar data. Given the longevity of krill, there is a need to collect data several years in advance of a model needing such data and hence it was recommended that the fishery start providing length-frequency data, given that coverage by the research surveys is not likely to be sufficient for all regions.

(ii) The collection of high-quality biological data from all commercial vessels is needed. It was noted that there are currently only five to nine trips per year from which such data are reported from commercial vessels.

By-catch species

3.14 Dr Hillary presented a preliminary assessment of rajid populations at South Georgia using a surplus production model implemented in a Bayesian framework (WG-SAM-07/11). First, a catch history for the rajid by-catch was developed, with an adjustment for the survivorship of rajids which had been cut off the lines ('cut-offs'). Then several standardised CPUE analyses were carried out for fleets fishing between 1993 and 2007. A surplus production model was fitted to the catch and CPUE indices. This model was used because there were insufficient tagging data to carry out an alternative modelling approach such as an integrated assessment. Priors were developed for each of the four parameters estimated in the model: *K*, *r*, Spanish longline *q* and autoline *q*. The prior for the carrying capacity *K* was derived from the assumption that the difference in catch rates between toothfish and rajids was directly proportional to the difference in abundance between the two species (i.e. they have the same *q*). The prior for *r* was derived from life-history parameters, and the priors for the two *q* parameters were derived assuming that the level of depletion of the stock at the time of the CPUE data was uniformly likely to be between 60 and 90% of *K*. The paper concluded that current catches were not significantly impacting the rajid population.

3.15 The Working Group noted that there were currently insufficient data to inform the assessment and that the results were strongly dependent on the informative priors for the two catchability parameters, and the intrinsic rate of increase, *r*. However, it also noted that the assessment was likely to be a 'worst-case' scenario, because the *q* for toothfish is likely to be higher than the *q* for rajids. The fits to the CPUE data were generally poor, and the posterior distributions for the two catchability parameters and *r* were very similar to their prior distributions in the base case. When an uninformed prior was used for *K* and the two *q* parameters, the right-hand tail of the posterior distribution of *K* was very wide. Dr Constable questioned why the CPUE indices, in some years, showed a large increase then subsequent decrease and suggested splitting the assessment into two areas for CPUE analysis – Shag Rocks and northern South Georgia. The Working Group considered that the assessment may be improved if the tag data could be included as a tag-based harvest rate in the model.

3.16 Dr Hillary noted that the assessment should be considered as a risk assessment rather than a stock assessment. Dr Constable agreed and noted that it would be desirable to set up appropriate methodologies for a risk assessment consistent with the precautionary approach of CCAMLR but not necessarily undertake an assessment. The Working Group noted that an integrated assessment could be considered in the future once more tag data and catch-at-length data were available.

3.17 Mr Dunn outlined an approach for a preliminary assessment of rajid populations in the Ross Sea using an integrated assessment model in CASAL (WG-SAM-07/4). The assessment combined all rajid species because identification to species level has often not been carried out. The approach used to develop a catch history of rajid removals from the fishery took into account numbers of landed, released and tagged rajids. The numbers of released and tagged rajids were adjusted for survivorship so that the total removals from the population could be obtained. There was considerable uncertainty in the raw age–length data, so these data were fitted in the model allowing this uncertainty to feed through into an MCMC. He also identified several other problems with the data, including the paucity of length samples from the fishery, the uncertain detection rates of tags, and problems associated with the way rajids had been double-tagged.

3.18 As a result of these issues, WG-SAM-07/4 made the following recommendations:

- improve species identification by making good identification guides available to vessel crew and scientific observers;
- improve detection of tagged rajids (and species identification) by bringing rajids up to the roller before cutting them off;
- improve estimates of the catch length frequency by increasing the number of rajids measured and sexed;
- improve and validate the estimates of age and growth (for example, by the use of markers such as oxytetracycline or strontium chloride on tagged rajids, and/or by measuring rajids before release);
- revise rajid tagging protocols to encourage better survival of tagged rajids, including adding protocols for double tagging;
- undertake survivorship experiments, particularly for the different species, covering a wider range of depths, and with longer holding periods than the study of Endicott and Agnew (2004).

3.19 Dr Constable asked whether an assessment based on numbers rather than age-based biomass may be more useful in the short term because of the difficulties in ageing as well as the need for improved data collection by the observers. Dr Hillary noted that harvest rates could be estimated from the rajid recaptures, and did not need estimates of catches or the numbers of scanned fish. Dr Constable also asked about the stock structure. Mr Dunn noted that tagging suggested rajids were quite localised and showed very little movement between release and recapture. Dr Hanchet noted that the bulk of the rajid catches were from SSRUs 881H, I and K, and that rajids from the southern shelf were primarily *Bathyraja* cf. *eatonii*, and that the current SSRU structure appeared suitable for the assessment and management of rajids.

3.20 The Working Group thanked the UK and New Zealand for their progress towards developing preliminary assessments for rajids, which has been an ongoing request by the Commission over the past few years (e.g. CCAMLR-XXV). The Working Group identified several common issues raised by the two papers. These issues related to species identification, catch sampling (the trade-off between sampling rajids for length and sex versus cutting them off the lines), improving estimates of age and growth, improving tagging protocols, and additional survivorship experiments. Several of these issues relate to the work of scientific observers. The Working Group acknowledged the heavy workload of the scientific observers and considered that the priorities for by-catch species may be better met by focusing each year on a particular species group. So that, for example, 2008/09 could be the 'Year of the Rajid', and 2009/10 could be the 'Year of the Macrourid'. The Working Group endorsed the need for further work in each of the areas identified by WG-SAM-07/4 and recommended that these issues be further addressed by WG-FSA.

REVIEW OF PRELIMINARY ASSESSMENTS FOR FINFISH

General

4.1 The Working Group considered fisheries where a preliminary assessment was not available at the meeting. It was suggested that details in previous reports as to how to improve existing assessments should be implemented, and that the ideas of the relevant scientists who are present and those likely to be performing, or assisting in, future assessments would be welcomed.

4.2 It was raised that it is not the purpose of this Working Group to discuss the type of data to be used in any proposed assessments, but rather the methods to be applied to these data, and that WG-FSA was the group that would review data inputs to stock assessment (Agenda Item 6.1).

Subarea 48.3

4.3 With regard to the assessment of Subarea 48.3, the Working Group noted potential plans to be completed between this meeting and WG-FSA-07. These plans will focus on the integration of catch-at-age data, and perhaps the inclusion of the survey data-at-length, as opposed to the CMIX-derived age estimates. The Working Group noted this may aid in estimating recent recruitment trends, as previous attempts have proved unsuccessful with respect to estimating a sensible historical recruitment trend.

Division 58.5.2

4.4 The Working Group was informed that the annual random stratified trawl survey was proceeding in Division 58.5.2, and an updated preliminary assessment would be presented to WG-FSA-07, including the data collected during the 2006/07 fishing season.

4.5 The Working Group noted the recommendations from WG-FSA-06 for the assessment of toothfish used to set catch limits in 2006/07 (SC-CAMLR-XXV, Annex 5, paragraphs 5.103 and 5.104).

4.6 The Working Group discussed the progress on the integrated assessment for toothfish in Division 58.5.2 using the CASAL framework. Dr Candy presented preliminary results from sensitivity tests based on the 2006/07 assessment, investigating the effects of:

(i) including less restriction in fitting selectivity functions to survey data;

(ii) removing strong prior assumptions on the CV of mean recruitment;

(iii) weighting datasets based on effective sample size analyses (described in WG-SAM-07/7) and fitting *q*;

(iv) incorporating tagging data and selectivity on tag releases.

4.7 A detailed technical discussion resulted in a recommendation that the assessment in Division 58.5.2 is likely to be improved through inclusion of ageing data, which would enable better estimation of recruitment and selectivity within the CASAL framework.

4.8 The Working Group affirmed the need for the further development of the assessment model, including further investigation of the sensitivity of the model to assumptions and constraints and some of these results may require further discussion. Dr Hanchet suggested using the tag data as an index of local abundance in comparison with the trawl data to develop an informed prior of the trawl survey *q*.

4.9 The Working Group recommended that a paper describing an updated assessment, based on the model framework provided at WG-FSA-06 and including the 2006/07 survey and fishery data, be prepared for consideration by WG-FSA-07.

Subareas 88.1 and 88.2 preliminary assessments

4.10 Mr Dunn presented WG-SAM-07/6, which described the impacts of changes in assumptions and data on the 2006 base-case model for *D. mawsoni* in the Ross Sea. These were: (i) updated catches for 2007; (ii) inclusion of IUU catch as reported in SC-CAMLR-XXV, Annex 5; (iii) updated CPUE indices for 2007; (iv) revised length–weight relationship for unsexed fish in determining catch-at-length frequencies; (v) revised catch length frequencies using numbers of fish rather than biomass; (vi) revised numbers of fish scanned; (vii) revised tag-related growth retardation parameter *g*; (viii) inclusion of a selectivity on tag–release length frequencies; and (ix) the inclusion of the tag data for 2007 from New Zealand vessels.

4.11 WG-SAM-07/6 also investigated alternative stratification of the Ross Sea fisheries, based on the catch length-frequency distributions. The paper found that the length-frequency distribution of *D. mawsoni* in the Ross Sea had a high degree of both large- and small-scale areal complexity. In general, the models typically split the Ross Sea into strata that were broadly similar to the current shelf, slope and north classifications. However, the resulting stratifications did not produce length frequencies that suggested consistent selectivity patterns over the duration of the fishery, in particular, in the slope or shelf regions. The report concluded that, while the current stratification (shelf, slope and north) had some deficiencies, revised stratifications did not appear to offer much improvement.

4.12 The Working Group noted that, in general, most of the assessment model changes noted in paragraph 4.10 had a negligible effect on the model outputs, with the most significant impacts on the assessment model results being: (i) the inclusion of the 2007 tag–recapture data (in particular the recaptures of 2006 releases in 2007); and (ii) the use of a tag–release selectivity. It noted that the tag data appeared to confirm concerns that the key uncertainty underlying the Ross Sea assessment model is the impact of movements and spatial structure in the *D. mawsoni* population, including the level and nature of the bias from non-homogeneous mixing assumptions of tagged fish.

4.13 The Working Group discussed the TSVPA assessment for *D. mawsoni* in the Ross Sea (WG-SAM-07/9). It noted the concerns raised in paragraph 3.8, and agreed that the model was not currently well enough advanced to provide assessment advice.

4.14 The Working Group recommended that the CASAL model continue to be used to provide the assessment advice for *D. mawsoni* in Subareas 88.1 and 88.2, with the changes identified in paragraph 4.10.

4.15 The Working Group discussed research priorities for the Ross Sea *D. mawsoni* assessment in the medium term. It agreed that:

(i) plausible spatial movement models need to be developed in order to address concerns of the level and nature of the bias that could result from non-homogeneous mixing assumptions of tagged fish;

(ii) methods need to be developed that would allow the evaluation of the sensitivity of the assessments to the inclusion of data of varying quality.

4.16 The Working Group noted that the quality of data arising from different vessels can be quite variable. In the same way that CPUE data needs to be standardised to overcome such variation, a procedure needs to be developed for standardising data from different vessels used in assessments, including data arising from observer programs. It recommended that WG-FSA and the Scientific Committee consider procedures necessary to ensure the provision of consistent high-quality data for assessments in multi-vessel, multi-nation fisheries.

Subareas 58.6/58.7 (Prince Edward and Marion Islands)

4.17 No new assessments were presented to WG-SAM. It is proposed to update the ASPM assessment presented to WG-FSA in 2006 so as to include the most recent data available, and to submit this update to WG-FSA-07. There will be no methodological changes to the assessment of toothfish in Subareas 58.6/58.7.

Division 58.5.1

4.18 WG-SAM recalled the progress made at the last meeting of WG-FSA in developing a fishery report for the fishery for *D. eleginoides* in the French EEZ in Division 58.5.1 (SC-CAMLR-XXV, Annex 5, paragraphs 5.86 to 5.90). A significant amount of fishery and observer data from this fishery had been submitted to the Secretariat, and WG-SAM encouraged France to continue submitting such data to CCAMLR, including the sampling design, data and results from the latest survey of Division 58.5.1.

4.19 WG-SAM encouraged exploration and efforts towards the development of an integrated assessment of *D. eleginoides* in Division 58.5.1 and continued contribution by French scientists to the work of WG-FSA.

EVALUATION OF MANAGEMENT STRATEGIES

Dissostichus spp.

5.1 Dr Ball presented WG-SAM-07/13 describing the work on developing methods for an assessment strategy evaluation (ASE) as a first step towards an MSE. The Working Group thanked Dr Ball for his presentation and noted that considerable progress has been made towards an ASE framework for the fishery for *D. eleginoides* in Division 58.5.2.

5.2 The Working Group noted that the framework described for ASE should provide a suitable basis for investigating a wide range of management strategies, and would allow investigation of sources of potential bias and error in assessments, for example assumptions of homogeneous mixing of tags, functional form of selectivities etc.

5.3 The Working Group suggested that methods to mimic past actions (including catch removals, tag releases and assessment strategies) are an important part of a simulation model, and encouraged the refinement of such methods within Fish Heaven.

5.4 The Working Group noted that there might be some utility in developing methods to allow estimation of parameters within a spatial simulation environment by fitting to fishery observations, for example, methods that allow estimation of movement rates from the observed length–age frequencies in the catch and observed tag movements.

5.5 Dr Brandão presented WG-SAM-07/10. The management procedure (MP) described adjusts the catch limit according to control decisions based on changes in CPUE trend and mean length of the catch. This MP has been evaluated using alternative operating models: ‘Basecase’, ‘Optimistic’, ‘Intermediate’ and ‘Pessimistic’, that reflect different current status of the stock. Dr Hanchet noted that this MP might not be precautionary if a drop in mean length accompanied with an increase in CPUE which, given the control rules, results in an increase in the catch limit even when the increase in CPUE might not be indicative of a greater exploitable biomass. Dr Brandão indicated that the MP suggested is only one of a number of MPs to be explored, and further robustness tests will be applied in order to avoid such false signals. Dr Hanchet also suggested that potential changes in fishing depth should be incorporated in an operating model, since this would potentially affect mean length. Dr Brandão responded that this would be considered, but also suggested that checks outside the MP could be carried out that would show such changes in the fishery, which would trigger a re-evaluation of the MP. Further refinements in the use and evaluation of MPs are planned to be submitted to this Working Group in 2008.

Champsocephalus gunnari

5.6 WG-SAM encouraged Members to develop management strategies suitable for use in the fisheries for *C. gunnari* (see SC-CAMLR-XX, Annex 5, Appendix D). While it was recognised that such strategies may have some elements in common with the strategies being developed for *Dissostichus* spp., strategies for *C. gunnari* would need to take account of the species' short lifespan and highly variable natural mortality and recruitment.

Euphausia superba

5.7 The Working Group noted that the Scientific Committee had requested further consideration and development of approaches to subdivide the catch limit for krill in Area 48 among SSMUs. The Working Group recalled the work of WG-EMM on the development of models to assist with this task, notably through three workshops since 2004:

(i) Siena, Italy (2004 meeting of WG-EMM and the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management) – A broad range of structures and functional relationships were discussed at these meetings, and it was generally apparent that it would be important to explore a variety of model structures that capture the potentially important direct and indirect effects of fishing (SC-CAMLR-XXIII, Annex 4, Appendix D, paragraph 3.16). With regard to developing models to provide advice on the subdivision of the precautionary krill catch limit, it was ultimately agreed (SC-CAMLR-XXIII, Annex 4, Appendix D, paragraph 7.6) that initial exploration of management options could be achieved using spatially structured krill population models that allow exploration of the interaction between:

   (a) the krill population
   (b) spatial catch limits and the fishery
   (c) krill predators
   (d) transport of krill.

(ii) Yokohama, Japan (2005 meeting of WG-EMM and the Workshop on Management Procedures) – Discussions at these meetings were less broad than those in Siena and focused primarily on the first version of KPFM. A number of suggestions were made to include other structural features in KPFM (e.g. predator survival that is dependent on foraging success, predators that can distribute foraging effort, and skewed competition). Ultimately it was agreed that at least three key aspects should be implemented in models for advising on the subdivision of the precautionary krill catch limit:

(a) incorporation of shorter time steps and/or seasonality
(b) incorporation of alternative movement hypotheses
(c) incorporation of a threshold krill density below which a fishery will not operate.

These minimum requirements were endorsed by the Scientific Committee (SC-CAMLR-XXIV, paragraph 3.20).

(iii) Walvis Bay, Namibia (2006 meeting of WG-EMM and the Second Workshop on Management Procedures) – Discussions at these meetings revolved around three models: EPOC, KPFM2 and SMOM. Additional minimum requirements were not specified at these meetings, but new suggestions for structural features did emerge (e.g. metapopulation dynamics for krill and models for fleet dynamics).

5.8 The Working Group also noted a recent workshop by Lenfest Ocean Program on 'Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries', held in Santa Cruz, California, USA, for which a summary letter of outcomes was provided by the conveners of that workshop to the Chair of the Scientific Committee who passed it to WG-SAM for consideration (WG-SAM-07/15).

5.9 The Working Group noted the positive conclusions of the Scientific Committee to significant progress in developing models and approaches to providing advice (SC-CAMLR-XXIV, paragraph 3.25; SC-CAMLR-XXV, paragraphs 3.8 to 3.15) and the recognition by the Commission that advice could be provided soon (CCAMLR-XXIV, paragraph 4.8; CCAMLR-XXV, paragraphs 4.8 to 4.11). It therefore agreed that it was important to progress this work rather than spending too much time discussing past issues. The Working Group reviewed the body of work to date, including further developments in models (WG-SAM-07/12, 07/14), to identify a program of work that could lead to staged advice on a subdivision of the krill catch among SSMUs at the 2008 meeting of WG-EMM.

5.10 The Working Group agreed that such advice and its implementation needed to occur in a staged approach towards subdividing the krill catch among SSMUs, taking account of the requirements of predators. Such an approach would involve, at each stage, an evaluation of the risks to krill, predators and the fisheries of the different options for subdividing the catch given the uncertainties in model structures, our understanding of the dynamics of the krill-based ecosystem and the future interactions of the fishery with the system. Such risks would be evaluated for different levels of maximum aggregate catch across SSMUs. Thus, advice at each stage would be on the strategy for subdividing catch along with the attendant risks at different aggregate catches. This approach will provide the Commission with the best scientific information and advice for subdividing the krill catch at any given time.

5.11 The Working Group agreed that advice for the first stage in this development could be given next year on the basis of the following discussion.

Options for subdividing the catch limit

5.12 The Working Group recalled previous discussions on the options to subdivide the krill catch among SSMUs (SC-CAMLR-XXV, Annex 4, Appendix D, paragraph 1.4), including:

(1) the spatial distribution of catches by the krill fishery;

(2) the spatial distribution of predator demand;

(3) the spatial distribution of krill biomass;

(4) the spatial distribution of krill biomass minus predator demand;

(5) spatially explicit indices of krill availability that may be monitored or estimated on a regular basis;

(6) pulse-fishing strategies in which catches are rotated within and between SSMUs.

5.13 WG-SAM-07/14 outlined how Option 6 could provide for a 'structured fishing' approach as the fishery develops in order to acquire data that could be used to help parameterise models, distinguish between competing hypotheses about how the ecosystem works and to better understand the effect of fishing on krill predators. Dr Constable elaborated this approach in his presentation to the meeting, noting that the design of a structured fishing program could be:

(i) during the development of the fishery, catches would be allocated among SSMUs according to the option for subdivision considered most appropriate for a fully developed fishery, with the expectation that catches could be taken in an individual SSMU at that level;

(ii) some SSMUs are used as controls (closed during the period of the structured fishing) and chosen to enable assessment of large-scale krill movement between SSMUs (flux) as well as interannual variation and climate change trends in the absence of fishing;

(iii) monitoring of krill (abundance) and land-based predators (e.g. diet, reproductive success) would be needed at an appropriate level (across open and closed SSMUs) to identify the effects of fishing on those predators;

(iv) the assignment of open and closed areas may be rotated among SSMUs over time –

  (a) to determine the effects in different locations and under different conditions; and/or

  (b) to appropriately randomise the effects; as well as

  (c) to enable focused study on particular process/management issues.

5.14 The Working Group agreed that this structured approach to fishing could be useful for providing feedback into the assessment process and management during the developmental phase.

5.15 In further consideration of these options, the Working Group noted that the maximum catch to be subdivided among SSMUs at present should only be the aggregate catches for Subareas 48.1, 48.2 and 48.3, i.e. 3.168 million tonnes of the 4 million tonnes allowed from Area 48 as a whole, as this is what is provided for those areas in Conservation Measure 51-01. There are currently no SSMUs identified for Subarea 48.4.

5.16 The Working Group noted that Stage 1 of a subdivision could be an initial subdivision based primarily on Options 2 to 4, noting that Option 1 was found to achieve the poorest balance of ecosystem and fishery objectives amongst the options considered at the 2006 workshop (SC-CAMLR-XXV, Annex 4, Appendix D). It also noted that development of approaches under Options 5 and 6 should be accorded a high priority starting in 2009, as the implementation of these approaches will help in the assessment processes in the future.

Use of empirical data in models

5.17 The Working Group agreed that data should be used to provide the foundation for the ecosystem models used in this work. Such data can be used to parameterise and/or initialise the models (inputs) in order to appropriately scale the behaviours in each model SSMU. Alternatively, time series of data can be used to estimate parameters of the models as inputs, or used to validate the models by comparing outputs from trials with either time series of abundances or quantitative attributes expected of the system, e.g. krill biomass variability.

5.18 In considering all aspects of data for use in the development of ecosystem models, the Working Group recognised that although Area 48 was probably the most intensively studied region in the Convention Area it was, by comparison to other marine systems, data-sparse. In recognising this, the Working Group agreed that advice should be sought on the best data available for initialising and validating models along with an appropriate evaluation of the uncertainties or qualities inherent in those data.

5.19 The Working Group considered that the newly formed WG-SAM needs to remain actively engaged with WG-EMM so that modellers continue to interact with data holders who understand the quality of data and parameters, the relationships between the data and the ecosystems from which they are derived, and who are likely to collect new data. The Working Group agreed to produce a focused and prioritised list of key data and model uncertainties and to pass this list to WG-EMM in order to receive advice on the process and likely time scale involved in providing new and/or refined parameter estimates.

5.20 In discussion of the need for a common dataset with which to initialise models, it was clear that different models will need to use different parameters in the initialisation process. Models might use empirically derived estimates of predator abundance and/or demand. Alternatively, these estimates may be derived using a model-based approach. The Working Group agreed that in both cases it was essential that values used were reconcilable with a plausible representation of the state and operation of the ecosystem. For example, it is important to avoid a situation where a model provides outputs that appear plausible, while using initial values for some parameter values that are biologically implausible.

5.21 The Working Group agreed that a model should provide a sufficiently realistic representation of the ecosystem. This should be checked by testing the outputs of the model against existing data. The Working Group agreed to request advice from WG-EMM on a key (benchmark) set of attributes and data series that would be used to appropriately benchmark any ecosystem model of the southwest Atlantic sector of the Southern Ocean being used to examine the effects of krill fishing on dependent species in SSMUs. It was also agreed that a defensible justification is required if model inputs, structure or outputs do not meet an individual benchmark. The Working Group agreed that the parameter values in Hill et al. (2007) could provide the foundation for developing these benchmarks.

5.22 With respect to time series of key aspects of the system, such as krill density, predator population and reproductive performance, three levels of specification were suggested where the model reproduces:

- the general characteristics (i.e variance/distribution) of the time series
- specific aspects of the time series
- relative magnitude of changes represented by the time series.

5.23 It was agreed that an iterative process was required for assessing whether models sufficiently reflect these attributes. Agreement on an *a priori* set of benchmarks, whereby a model is considered sufficiently realistic for the provision of advice, should be a high priority in the short term.

5.24 On the basis of these discussions, the Working Group developed an initial list of potential benchmark datasets for consideration by WG-EMM. In this respect, the Working Group drafted a 'calendar' of known or suspected changes in the ecosystem that could provide a set of reference observations for validating and tuning models used to provide risk assessments about the effects of distributing krill catches among SSMUs during a staged development of the fishery in Area 48. This calendar covers the period 1970 to the present and is provided, by subarea and species group, in the list below. Reference observations highlighted with an asterisk were considered to be less certain and, therefore, likely to be of secondary importance in model validation and tuning.

(i) Subareas 48.1 and 48.2 –

(a) krill

- near-step change in total biomass and interannual variability in biomass in about 1986 (biomass was greater and less variable prior to the change point);

- interannual variability in biomass is concordant with that in Subarea 48.3;

(b) penguins

- increase in abundance of about 5–10% per year during 1970 to about 1977;
- overall decline in abundance of 60–70% during the period from about 1977 to 2000 (this decline should not be explained by changes in breeding success that are related to changes in food availability during the breeding season);
- *continued, possibly steeper, decline after 2000 (this decline may be explained by changes in breeding success that are related to predation on chicks and fledglings);

(c) seals

- increase in abundance of about 10–15% per year during 1970 to about 1995;
- no significant trend in abundance after about 1995;

(d) whales

- increase in abundance of about 4–5% per year since about 1980;

(ii) Subarea 48.3 –

(a) krill

- biomass was greater and less variable prior to about 1980 than after about 2000;
- *smoother (than in Subareas 48.1 and 48.2) change in biomass and interannual variability during the period from about 1980 to 2000;
- interannual variability in biomass is concordant with that in Subareas 48.1 and 48.2;

(b) penguins

- *possibly no significant trend in abundance from 1970 to about 1980;
- overall decline in abundance of 40–50% during the period from about 1980 to the present;

(c) seals

- increase in abundance of about 10–15% per year during the period from 1970 to about 1988;
- *possibly slower rate of increase in abundance after about 1988;

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* Reference observations considered to be less certain and, therefore, likely to be of secondary importance in model validation and tuning.

(d) whales

- increase in abundance of about 4–5% per year since about 1980.

5.25 The Working Group noted a number of points about the calendar outlined above. Firstly, rates and timings of changes are only approximate. Secondly, levels of abundance and variability are not provided. Finally, no reference observations are provided for fish.

5.26 The Working Group agreed that WG-EMM be requested to review and, as necessary, revise this calendar. Furthermore, WG-EMM was strongly encouraged to complete this process during its 2007 meeting, providing, if appropriate, a revised calendar in its report, noting that if this is not possible, the calendar provided above will serve as a default and modelling should proceed using it. It was also agreed that, for the purposes of the ensuing risk assessment, the calendar would be considered fixed after the 2007 meeting of the Scientific Committee.

5.27 The Working Group noted that models could be continually improved in terms of their realism. However, consistent with the advice from the Lenfest workshop (WG-SAM-07/15), it was noted that improved realism may not necessarily give rise to improved advice on this issue. Furthermore, a process that continually requests modifying models before advice is given could result in no advice being given. The Working Group agreed that model uncertainties can be included in a risk assessment and that the process defined here is likely to result in staged advice on subdividing the krill catch among SSMUs that can be considered the best scientific information available.

Models

5.28 Three models relevant to the evaluation of options for subdividing the precautionary krill catch limit in Area 48 among SSMUs were available to the Working Group. These models, and the relevant documents, were EPOC (WG-SAM-07/14), SMOM (WG-SAM-07/12) and KPFM2 (renamed FOOSA and described in papers presented to WG-EMM in previous years – WG-EMM-06/22). The Working Group summarised the current state of model structure and functionality as follows:

(i) the minimum requirements specified in SC-CAMLR-XXIV, paragraph 3.20, have been achieved within FOOSA and SMOM;

(ii) many structural features have been added to the existing models but, to date, this additional functionality has not been fully explored;

(iii) additional structural features could be developed, but it is not clear whether these are necessary in the short term.

5.29 With specific regard to the last point in this list, the Working Group recalled the guidance that the conveners of the Lenfest workshop provided to the Chair of the Scientific Committee (WG-SAM-07/15) that recognised ‘that not every feature of the krill–predator–fishery system needs to be captured’ in models that may be used to provide management advice.

5.30 A summary was presented by Dr Plagányi of a recent FAO workshop on 'Modelling Ecosystem Interactions for Informing an Ecosystem Approach to Fisheries: Best Practices in Ecosystem Modelling', held in Tivoli, Italy, in July 2007. The summary focused on the key attributes to be considered in ecosystem model development together with the current best practice for handling each of these. This provided some useful guidelines for modelling and a means of evaluating the CCAMLR models being developed against the best practices. It was noted that there is a continuum in ecosystem model applications ranging from: (i) basic understanding that provides an underlying context but is not used explicitly in decision-making; (ii) strategic decisions that are fairly long term and broad based and linked to policy goals; to (iii) short-term tactical decisions that typically take the form of a precise quantitative set of instructions based on data and assessments. It was also noted that most ecosystem models considered at the workshop are strategic but not tactical.

5.31 A summary of the models developed for WG-EMM and updates were provided by the model authors to the meeting.

5.32 The krill–predator–fishery model (FOOSA) was presented by Dr Watters. The model has not been changed since the last meeting of WG-EMM, and the most up-to-date documentation for the model is contained in WG-EMM-06/22. The presentation was therefore brief, highlighting structural aspects that may be new to WG-SAM participants. FOOSA is structured with both a generic time step (that includes seasonality) and a generic spatial structure (that can resolve SSMUs). The population dynamics of krill and predators (up to four predators per SSMU) are described by delay-difference models that account for changes in abundance. The parameterisation of these delay-difference equations is sufficiently flexible to allow for the exploration of a wide range of hypotheses regarding the structure and function of the ecosystem. For example, alternative movement rates for krill, functional responses for predators (e.g. Holling Type II or Type III responses), predator–prey interaction terms (e.g. the degree to which predator breeding is influenced by per-capita consumption of krill), competition coefficients among predators and the fishery (e.g. whether predators or the fishery are better able to capture krill when krill are a limiting factor), and stock-recruitment relationship for predators and krill can all be specified. Process error is added to this relationship, and FOOSA uses Monte Carlo simulations to quantify uncertainty. FOOSA produces a large suite of performance measures and graphical output.

5.33 Dr Plagányi presented SMOM, which was first presented at WG-EMM-06. Updates to SMOM are described in WG-SAM-07/12. SMOM has been updated to explicitly model four generic predators (penguin, seal, fish, whale) and has addressed the recommendation to include a shorter time step/seasonality. An option for modelling movement in an analogous manner to that used by FOOSA has also been included in the model. Uncertainty in the values of the parameters leads to the production of an 'envelope' of future states that are considered likely to bound the true state, and it was highlighted how data could be used to narrow the range of uncertainty in outputs. An example was provided of how an MSE approach using a subdivision control rule could be used to manage the allocation of krill catch in Area 48 among SSMUs.

5.34 Dr Constable presented the EPOC modelling framework, which was first presented at WG-EMM-05. WG-SAM-07/14 described the latest version of the EPOC framework. EPOC is based around a highly flexible framework written in the R statistical language. The model is made up of a central controller, which integrates separate modules on the biota, environment, and human/management activities. Each component may be described at a level of spatial, temporal and structural complexity deemed appropriate. EPOC then combines the elements in these modules to model the spatially explicit dynamics of the system. The set of templates for elements has been updated in order to configure EPOC to evaluate the different options for subdividing the krill catch including Options 5 and 6. These templates now include complex options for representing, as required, the primary production, krill, predator and fishery system of the southwest Atlantic.

5.35 The Working Group noted the past and present developments in models to evaluate the SSMU options. It agreed that FOOSA and SMOM were sufficiently advanced to undertake the work required to lead to advice for a first stage in the implementation of a subdivision strategy. Although not as advanced as FOOSA or SMOM, EPOC was noted to have been advanced to have the potential to explore the options for subdividing the krill catch among SSMUs. The Working Group agreed that the process outlined below for developing advice next year should not preclude the development of new models, provided that the development and use of such models satisfactorily participated in the process below.

5.36 The Working Group noted that catch limits are managed in the model as a harvest rate, γ, of a model estimate of biomass. This means that the overall catch limit of 4 million tonnes would be modelled as $1.0 \cdot \gamma \cdot$ [estimate of biomass]. The proportion of γ that would be consistent with the trigger level of 620 000 tonnes would be about 0.15. Similarly, the proportion of γ that would be consistent with the aggregate catch in Subareas 48.1, 48.2 and 48.3 of 3.168 million tonnes would be about 0.8.

Stage 1 scenarios

5.37 The Working Group agreed that the following constituted an essential set of model scenarios when evaluating the different SSMU options:

(i) the initial conditions set in the model need to be defensible, ideally by using available data;

(ii) the baseline model period needs to be consistent with management strategy or simulation requirements;

(iii) simulations should include a 20-year period with fishing followed by a 20-year recovery period with no fishing. This is considered adequate for the staged approach, but one of the questions that remain outstanding is how long this period should be to fully capture potential declines and recovery of long-lived species;

(iv) model outputs during the next stage should focus on comparing SSMU Options 2, 3 and 4;

(v) simulations should be run for the following levels of harvest rate (here expressed as fractions of γ): 0.0, 0.15, 0.25, 0.5, 0.75, 1.0 so as to provide advice on the risks, given the attendant model and ecosystem uncertainties of the aggregate catches and subdivision strategy causing problems for krill, predators or the fishery at different stages in the development of the fishery;

(vi) the role of flux in krill dynamics needs to be considered, with alternative representations shown, such as scenarios with flux bounded by the seasonal movement matrices based on OCCAM output and no movement;

(vii) a range of interaction functions should be investigated to represent uncertainty in the relationship between krill availability and predator population responses;

(viii) the following scenarios are considered desirable but optional:

(a) scenarios capturing the uncertainty in predator survival rate estimates
(b) scenarios including climate change effects
(c) consideration of fleet dynamics (depending on flexibility within options).

5.38 Model validation, as described above, and evaluation of the performance of different scenarios (see below) could be undertaken by either comparing model outputs from trials with no fishing or using a model history phase prior to fishing.

Performance measures

5.39 The ecosystem models were developed to compare, through simulation, the performance of candidate options for allocating the precautionary krill catch limit in Area 48 among SSMUs, where relative performance is judged according to how well they meet the objectives of Article II of CCAMLR. Performance measures are derived from the status of krill, predator populations and the fishery over relevant time scales.

5.40 Performance of the krill population has been defined according to the decision rules of the precautionary approach for calculating yield of krill, where the objectives for the krill stock are given in operational terms (SC-CAMLR-XXIV, Annex 4, Appendix D, paragraph 4.1):

(i) the probability of krill spawning stock falling below 20% of the median pre-exploitation spawning stock abundance is less than or equal to 0.1;

(ii) the median escapement of the spawning stock after 20 years is 0.75 of the median pre-exploitation spawning biomass.

5.41 Article II states the requirement that fishery impacts on species that are dependent on, or related to, harvested species should be ‘potentially reversible’ within two to three decades of the cessation of fishing. The Working Group noted that the concept of ‘reversible’ will need more theoretical work to suggest operational definitions and, thereby, be able to test the performance of options against this criterion.

5.42 The Working Group recalled considerations in the past of performance measures for predators (SC-CAMLR-XXIV, Annex 4, Appendix D, paragraphs 4.2 and 4.3) and at the recent Lenfest workshop (WG-SAM-07/15) and that there are two main types of such measures: (i) assessment of the conservation status of local populations based on rates of decline and recovery that are scaled to generation times, and (ii) status of populations relative to some historical level or a benchmark level. The latter include a probability of being above or below such levels rather than specific states.

5.43 The above performance measures for krill and predators consider population status relative to its status before the onset of fishing. As indicated above, it might be useful to consider the status of predator populations relative to that expected in the absence of fishing in order to account for trends in the ecosystem that are not a result of fishing.

5.44 Performance measures for the fishery can include global and local (SSMU) aggregate catches over the period of fishing, deviations from allocated catch and the variability in catches and catch rates. Other measures might include how often fishing vessels may need to move between SSMUs in order to maintain catch rates.

5.45 The Working Group noted that the code for FOOSA includes methods for calculating 50 performance measures related to the quantities described here.

5.46 In 2006, WG-EMM considered that some form of aggregation of performance measures is desirable in order to convey complex results. Such aggregate performance measures should, *inter alia*: (i) take into account, and appropriately combine, all model outputs considered to be valuable; (ii) take into account correlations between various measures; (iii) provide sufficient information to enable performance to be assessed relative to Article II; (iv) aim to be value-free (e.g. 'high versus low' rather than 'good versus bad' or 'acceptable versus not acceptable') (SC-CAMLR-XXV, Annex 4, Appendix D, paragraphs 2.12, 4.4 and 4.5).

5.47 The Working Group noted that care needs to be taken in developing aggregate performance measures because they will be sensitive to the choice of measures in the aggregate, the weighting applied to each and the method of aggregation. The Working Group noted that a consistent form for presenting performance measures and the trade-offs between different SSMU options needs to be decided by WG-EMM, noting the substantial progress at previous meetings.

Risk assessment of Stage 1 scenarios

5.48 The Working Group agreed that the provision of advice next year could be based on a risk assessment using elements of the performance measures but noting that some performance measures will be most useful in the subsequent stages of the development of management strategies for krill. It was agreed that the following elements will be considered in a risk assessment:

(i) Suitable fishery performance measures could be selected from those currently used by FOOSA or could be model specific, provided they represented long-term performance and variability. It was agreed that fishery performance would no longer be evaluated relative to the historical fishing distribution (Fishing Option 1).

(ii) Suitable predator performance measures should be shown:

- relative to benchmark levels of both the pre-exploitation state and relative to comparable no-fishing trials;

- for two times in the simulation periods (the end of the fishing period and the end of the recovery period);

- together with an indication of the impact and likelihood of risk, by reflecting the probability of change in the populations at the two times and at the following levels relative to the benchmark levels: ≥1.0, 0.75, 0.5, 0.25.

(iii) Performance measures for krill should be based on the existing decision rules.

(iv) A risk matrix of the performance of different options relative to these measures should be presented.

Process for providing advice on Stage 1

5.49 The Working Group recognised that to make progress towards developing management advice to allocate krill catch limits to SSMUs during 2008, it would be necessary to follow an agreed intersessional plan. The plan would include the development and use of benchmark scenarios and data as discussed above that could be investigated in all viable models, so that comparisons could be made by the Working Group and advice provided to WG-EMM. It was recognised that models vary in structure and form, so it will be necessary during the coming intersessional period to identify a basic set of benchmark specifications to be used by the Working Group to verify the appropriateness of models for use in this work.

5.50 Intersessionally model developers should distribute, via the newsgroup, results of model validation and verification using agreed datasets, following review by WG-EMM at its 2007 meeting and subsequently archived at the Secretariat. The Working Group had reviewed results from FOOSA and SMOM and was aware of the continued development of an ecosystem model in EPOC. These are candidate models for this process. This intersessional process will also aim to identify important issues to be considered and their relative impacts on the risk assessment.

5.51 The Working Group agreed to review the available submission of models and results to provide a technical commentary to WG-EMM on the adequacy of the models and approaches for use in the risk assessment. It would then be expected that WG-EMM will be able to comment on the realism of the models and results and to complete the risk assessment in order to provide advice to the Scientific Committee on a subdivision of the krill catch limit among SSMUs and the implementation risks for different catch levels. It is envisaged that the Commission should be able to subdivide the krill catch limit among SSMUs next year and set a threshold catch level below which the subdivision should not pose substantial risks to krill, predators and the fishery. In the absence of such advice, the Working Group agreed that there was no basis at present on which to judge that the 620 000 tonne trigger level does not pose a risk to predators.

FUTURE WORK

6.1 This first meeting of WG-SAM was a transition meeting, focusing on the tasks of WG-FSA as well as on the methods for subdividing the krill catch limit among SSMUs (SC-CAMLR-XXV, paragraph 13.12). The Working Group aims to provide technical advice to the Scientific Committee and its working groups based on an agenda developed by all the conveners of working groups and the Chair of the Scientific Committee (SC-CAMLR-XXV, paragraph 13.13).

Terms of reference

6.2 During the intersessional period, the conveners of the working groups, the Chair of the Scientific Committee and the Secretariat consulted as to the terms of reference and name of this Working Group (SC CIRC 06/47). The Working Group agreed that the name 'Working Group on Statistics, Assessments and Modelling' is appropriate. It also agreed that the following terms of reference could be used to define the work of this group:

To provide advice to the Scientific Committee and its working groups on:

(i) quantitative assessment methods, statistical procedures and modelling approaches for the conservation of Antarctic marine living resources;

(ii) the implementation and data requirements of such methods, procedures and approaches.

6.3 The Working Group noted that one of its roles was to provide expert review of methods and procedures that leads to advice, such as estimates of yield, to the Scientific Committee. It agreed that not all methods, procedures and approaches would need to be reviewed by WG-SAM. The Working Group agreed that where a working group is not able to judge the utility or the implementation of a method, procedure or approach, the following process should be followed:

(i) the method, procedure or approach be submitted to WG-SAM with sufficient information to enable replication of the model. This includes, but is not limited to, the software package or code and the input data;

(ii) the method, procedure or approach be tested against previously documented and appropriate scenarios, simulated data or other ecological models;

(iii) the realism and suitability of the method, procedure or approach be reviewed by the relevant working group (WG-EMM, WG-FSA or ad hoc WG-IMAF).

6.4 The Working Group also noted that there should be no undue delay in the process as a result of the above requirements.

6.5 In applying this process, the Working Group noted that the process of verifying that computer programs and the underlying models operate as intended need not involve detailed examination of the program code, but would require adequate testing of the programs against appropriate datasets or scenarios or by comparison with the results of other programs and/or models. It was also noted that the degree to which outputs of such models had to match such data or scenarios would be dependent on the application intended for the models. The Working Group agreed that the importance of testing methods, procedures and approaches is to assure the Working Group that they work as intended and that no errors are evident in the operation of the program that could impact on results required by the Scientific Committee and its working groups.

Long-term work plan

6.6 The Working Group agreed it should have a long-term work program while maintaining sufficient flexibility to address topical issues. It was noted that the priorities for long-term work are to evaluate management strategies for *Dissostichus* spp. and krill, and these topics will require substantial work over the next few years. Other topics requiring attention include the development of spatially structured assessment models and of assessment models for by-catch species (e.g. rajids). Flexibility can be maintained by allowing for a relatively open agenda that is annually agreed by the conveners of all working groups and subject to review and agreement by the Scientific Committee. Along these lines, the Working Group recalled paragraph 13.13 of SC-CAMLR-XXV, which calls on the conveners to jointly submit papers indicating forthcoming priorities for WG-SAM at annual meetings of the Scientific Committee.

6.7 In developing annual agendas for WG-SAM, the Co-conveners were requested to consider structuring them around topics (e.g. the evaluation and use of observer data) rather than structuring them around species and statistical areas (as was the case this year).

6.8 It was further advised that time should be provided to:

(i) continue the priority work items necessary to support each working group (e.g. the review of assessment models and the evaluation of management strategies);

(ii) allow for review and discussion of new papers that might be submitted to WG-SAM;

(iii) allow for focused discussion on one or two technical issues that are identified in advance and that are common to all working groups.

This type of time budget would likely provide both continuity and adaptability.

6.9 Discussions on common technical issues will facilitate increased dialogue between participants who normally focus their attention on particular topics (e.g. single-species stock assessments versus ecosystem modelling). These discussions can be motivated by scoping papers that are submitted by and through individual working groups to the joint group of conveners. Such scoping papers should identify the topic nominated for technical discussion, provide reasons why the topic is relevant and important, and suggest how a technical discussion might proceed to successful conclusion. The conveners could set up a rotating list of such scoping papers, selecting items from the list as time allows and when they are particularly relevant.

6.10 Ultimately, it was acknowledged that WG-SAM, as will all the other working groups, will likely be responsible for completing a large volume of work in a limited amount of time. The workload will have to be managed by carefully considering short- and long-term priorities and flexibly adjusting the annual agenda. It will be important for the Scientific Committee to provide clear guidance on its priorities.

Other issues

Assessments at multi-year intervals

6.11 The Working Group discussed a request from the Scientific Committee to provide advice on conducting assessments at multi-year intervals (SC-CAMLR-XXV, paragraphs 4.55 to 4.59).

6.12 The Working Group agreed that multi-year intervals between assessments should be considered in the sense of a trade-off between the risk of gross errors in an assessment, and the considerable saving of time both in the working groups and intersessionally. Such savings would provide time to address other high-priority issues, such as evaluations of the efficacy of assessments and MSEs for achieving the objectives of the Convention.

6.13 Mr Dunn presented work undertaken in the meeting that evaluated the additional risk to the stock of an over-catch in one year, i.e. simulating a year that did not have an assessment, but for which there should have been a downward adjustment to the catch, using the 2006 base-case assessment models for the Ross Sea (Subareas 88.1 and 88.2) and South Georgia (Subarea 48.3) *Dissostichus* spp. fisheries. The results for trials of an over-catch of two- and three-times the estimated yields for one and two years in a row showed only a small increase in the risk (0.5–1.0%). However, in the model, the catch limit is not reassessed and returns to the level set at the beginning of the projection period. In reality, the increased risk would not be sustained, as the reassessment after the period of over-catch would result in a reduced catch limit, and reduce the additional risk to near zero.

6.14 The Working Group noted that the need for annual assessments would need to be decided by WG-FSA for each fishery, and that trials such as those described above could be undertaken for new model scenarios or species to evaluate the risks of different frequencies of assessments.

6.15 The Working Group noted that the frequency of assessments should be considered part of the management strategy and could be evaluated within an MSE framework.

6.16 The Working Group noted that an MSE approach also provides an opportunity for considering how to use signals of stock stress to trigger assessment updates, such as using changes in size or age distributions of catch, rates of catch and rates of recapture of tagged fish. Exploration of suitable indicators from the data inputs in an MSE would ensure the robustness of such trigger points.

6.17 The Working Group noted the general guidelines provided by CCAMLR-XXV (paragraph 4.51) that WG-FSA retain the option to undertake an assessment in any given year if new or refined methods of assessment become available or parameters used in the assessment are revised significantly.

6.18 On the basis of the simulated results and ensuing discussions, the Working Group agreed that, where a toothfish stock is at or above target levels and where assessments have been stable, assessments of toothfish could be performed on a biennial cycle without incurring significant additional risk. The Working Group encouraged further work to evaluate the risks and determine robust indicators to trigger assessment updates.

OTHER BUSINESS

7.1 WG-SAM noted that the authors of two of the meeting documents had indicated that they wished their papers to be considered for publication in *CCAMLR Science*. Both of these papers had been discussed adequately during the meeting, and WG-SAM had no further advice and feedback to the authors or the Editorial Board.

GENERAL ADVICE

Advice to WG-EMM

8.1 The Working Group indicated that an integrated assessment of krill could be progressed with:

(i) the assembly of data from different krill survey time series to try and estimate movement rates (paragraph 3.12(iii)(b));

(ii) the collection of high-quality biological data from all commercial vessels (paragraph 3.13(ii)).

8.2 The Working Group identified a program of work that could lead to advice on a subdivision of the krill catch limit among SSMUs at the 2008 meeting of WG-EMM (paragraphs 5.49 to 5.51) and recommended that a staged development of the fishery be adopted (paragraph 5.24).

8.3 The Working Group agreed to request advice from WG-EMM on a key (benchmark) set of attributes and data series (calendar) that would be used to appropriately benchmark any ecosystem model of the southwest Atlantic sector of the Southern Ocean being used to examine the effects of krill fishing on dependent species (paragraphs 5.21 to 5.24).

8.4 The Working Group agreed that WG-EMM be requested to review and, as necessary, revise the calendar in paragraph 5.24. Furthermore, WG-EMM was strongly encouraged to complete this process during its 2007 meeting, providing, if appropriate, a revised calendar in its report, noting that if this is not possible, the calendar will serve as a default and modelling should proceed using it. It was also agreed that, for the purposes of the ensuing risk assessment, the calendar would be considered fixed after the 2007 meeting of the Scientific Committee (paragraph 5.26).

8.5 The Working Group noted that the development of aggregate performance measures is an important issue for WG-EMM. It also noted that a consistent form for presenting performance measures and the trade-offs between different SSMU options needs to be decided on by WG-EMM, noting the substantial progress at previous meetings (paragraphs 5.46 and 5.47).

8.6 The Working Group developed a process that will lead to advice on a subdivision of the krill catch limit among SSMUs in 2008 and requested that WG-EMM endorse and participate in this process (paragraphs 5.49 to 5.51).

Advice to WG-FSA

8.7 The Working Group recommended that Members provide the following contributions to the next WG-FSA meeting:

(i) a descriptive analysis of the tagging program in Division 58.5.1, and updates of descriptive analyses of tagging programs in Division 58.5.2 and Subarea 48.3 (paragraph 2.2), including an update on the method for triple tagging of fish in the Division 58.5.2 fishery using PIT tags to assist in evaluating external tag observation and shedding rates (paragraph 2.7);

(ii) an updated assessment for *D. eleginoides* in Division 58.5.2, based on the model framework provided at WG-FSA-06 and including the 2006/07 survey and fishery data (paragraph 4.9);

(iii) an update of the ASPM assessment for *D. eleginoides* in Subareas 58.6/58.7, as presented to WG-FSA-06, to include the most recent available data (paragraph 4.17);

(iv) the development of an integrated assessment of *D. eleginoides* in Division 58.5.1 (paragraph 4.19);

(v) the development of management strategies suitable for use in the fisheries for *C. gunnari* (paragraph 5.6).

8.8 The Working Group noted that the Secretariat would take responsibility for coordinating tagging programs in new and exploratory fisheries starting from the 2007/08 season. It recommended that WG-FSA consider the development of advice on how it should manage the collection of non-toothfish tagging data, particularly from voluntary tagging programs (paragraph 2.6).

8.9 The Working Group recommended several improvements in rajid data collection methods and that survivorship experiments for different species, a wider range of depths and with longer holding periods, be undertaken (paragraph 3.18).

8.10 The Working Group identified several issues related to species identification, catch sampling (the trade-off between sampling rajids for length and sex versus cutting them off the lines), improving estimates of age and growth, improving tagging protocols, and additional survivorship experiments, which would improve data relative to by-catch species, but would also affect the workload of scientific observers. The Working Group acknowledged the heavy workload of scientific observers and considered that the priorities for by-catch species may be better met by focusing each year on a particular species group. So that, for example, 2008/09 could be the Year of the Rajid, and 2009/10 could be the Year of the Macrourid. The Working Group endorsed the need for further work in each of the areas identified by WG-SAM-07/4 and recommended that these issues be further addressed by WG-FSA (paragraph 3.20).

8.11 The Working Group recommended that for toothfish in Division 58.5.2:

- the assessment is likely to be improved through inclusion of ageing data, which would enable better estimation of recruitment and selectivity within the CASAL framework (paragraph 4.7);

- the assessment model needs further development, including further investigation of the sensitivity of the model to assumptions and constraints (paragraph 4.8).

8.12 On the basis of the simulated results and ensuing discussions, the Working Group agreed that, where a toothfish stock is at or above target levels and where assessments have been stable, assessments of toothfish could be performed on a biennial cycle without incurring significant additional risk. The Working Group encouraged further work to evaluate the risks and determine robust indicators to trigger assessment updates (paragraph 6.18).

8.13 The Working Group agreed that a Leslie-DeLury depletion analysis could be considered in providing advice on potential yields in exploratory toothfish fisheries, depending on broader consideration of the application of CCAMLR's precautionary approach in those fisheries (paragraph 3.4).

8.14 The Working Group recommended that the CASAL model continue to be used to provide the assessment advice for *D. mawsoni* in Subareas 88.1 and 88.2, with the changes identified in paragraph 4.10 (paragraph 4.14).

8.15 The Working Group recommended that WG-FSA and the Scientific Committee consider procedures necessary to ensure the provision of consistent high-quality data for assessments in multi-vessel, multi-nation fisheries (paragraph 4.16).

Advice to ad hoc WG-IMAF

8.16 WG-SAM did not consider any matter directly related to the work of ad hoc WG-IMAF during its first meeting. However, the Working Group wished to communicate its terms of reference and general approach to WG-IMAF (see paragraphs 8.18 and 8.19), and looked forward to collaborating on matters of interest to both working groups.

Future work of WG-SAM

8.17 The Working Group agreed to medium-term research priorities for toothfish assessments (paragraphs 4.15(i) and (ii)):

(i) plausible spatial movement models need to be developed in order to address concerns about the level and nature of the bias that could result from non-homogeneous mixing assumptions of tagged fish;

(ii) methods need to be developed that would allow the evaluation of the sensitivity of the assessments to the inclusion of data of varying quality.

Scientific Committee

8.18 During the intersessional period, the conveners of the working groups, the Chair of the Scientific Committee and the Secretariat consulted as to the terms of reference and name of this Working Group (SC CIRC 06/47) (paragraph 6.2). The Working Group agreed that the name 'Working Group on Statistics, Assessments and Modelling' is appropriate. It also agreed that the following terms of reference could be used to define the work of this group:

To provide advice to the Scientific Committee and its working groups on:

(i) quantitative assessment methods, statistical procedures, and modelling approaches for the conservation of Antarctic marine living resources; and

(ii) the implementation and data requirements of such methods, procedures and approaches.

8.19 The Working Group noted that one of its roles was to provide expert review of methods and procedures that leads to advice, such as estimates of yield, to the Scientific Committee. It agreed that not all methods, procedures and approaches would need to be reviewed by WG-SAM. The Working Group agreed that where a working group is not able to judge the utility or the implementation of a method, procedure or approach, the following process should be followed (paragraph 6.3):

(i) the method, procedure or approach be submitted to WG-SAM with sufficient information to enable replication of the model. This includes, but is not limited to, the software package or code and the input data;

(ii) the method, procedure or approach be tested against previously documented and appropriate scenarios, simulated data or other ecological models;

(iii) the realism and suitability of the method, procedure or approach be reviewed by the relevant working group (WG-EMM, WG-FSA or ad hoc WG-IMAF).

8.20 The Working Group noted that KPFM2 has been renamed FOOSA (paragraph 5.28).

8.21 The Working Group requested the Scientific Committee consider the proposed approach for structuring the future work program for WG-SAM in paragraphs 6.6 to 6.10.

8.22 The Working Group recommended that multi-year intervals between assessments is tractable as a reasonable trade-off between the risk of gross errors in an assessment and the management of workloads for other high-priority issues, noting the special consideration of this issue in paragraphs 6.12 to 6.18.

ADOPTION OF REPORT AND CLOSE OF MEETING

9.1 The report of the meeting was adopted.

9.2 Drs Jones and Constable thanked all participants and contributors to the work of WG-SAM for a very successful first meeting. They also thanked the New Zealand hosts for their warm hospitality, and the Secretariat for its support.

9.3 On behalf of the Working Group, Dr Holt thanked the Co-conveners for their excellent work in preparing for, and running of, the meeting. He also thanked Dr Jones for his previous role as Convener of WG-FSA-SAM which had paved the way to WG-SAM. The first meeting of WG-SAM had established the Working Group's role in the work of the Scientific Committee and its working groups, and had resulted in further advances in the assessment and management of fisheries for toothfish and krill.

9.4 WG-SAM looked forward to future work under the leadership of Dr Constable, and wished Dr Jones success in his forthcoming role as Convener of WG-FSA starting in 2008.

REFERENCES

Endicott, M. and D.J. Agnew. 2004. The survivorship of rays discarded from the South Georgia longline fishery. *CCAMLR Science*, 11: 155–164.

Hill, S.L., K. Reid, S.E. Thorpe, J. Hinke and G.M. Watters. 2007. A compilation of parameters for ecosystem dynamics models of the Scotia Sea – Antarctic Peninsula region. *CCAMLR Science*, 14: 1–25.

APPENDIX A

LIST OF PARTICIPANTS

Working Group on Statistics, Assessments and Modelling
(Christchurch, New Zealand, 9 to 13 July 2007)

BALL, Ian (Dr)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia ian.ball@aad.gov.au
BRANDÃO, Anabela (Dr)	Department of Mathematics and Applied Mathematics University of Cape Town Private Bag 7001 Rondebosch South Africa anabela.brandao@uct.ac.za
CANDY, Steve (Dr)	Australian Antarctic Division Department of Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia steve.candy@aad.gov.au
CONSTABLE, Andrew (Dr) (Co-convener)	Australian Antarctic Division Department of Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia andrew.constable@aad.gov.au
DUNN, Alistair (Mr)	National Institute of Water and Atmospheric Research (NIWA) Private Bag 14-901 Kilbirnie Wellington New Zealand a.dunn@niwa.co.nz

GOEBEL, Michael (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA mike.goebel@noaa.gov
HANCHET, Stuart (Dr) (WG-FSA Convener)	National Institute of Water and Atmospheric Research (NIWA) PO Box 893 Nelson New Zealand s.hanchet@niwa.co.nz
HILL, Simeon (Dr)	British Antarctic Survey Natural Environment Research Council High Cross, Madingley Road Cambridge CB3 0ET United Kingdom sih@bas.ac.uk
HILLARY, Richard (Dr)	Department of Biology Imperial College Prince Consort Road London SW7 2BP United Kingdom r.hillary@imperial.ac.uk
HINKE, Jefferson (Mr) (from 11th)	US AMLR Program Southwest Fisheries Science Center 1352 Lighthouse Avenue Pacific Grove, CA 93950-2097 USA jefferson.hinke@noaa.gov
HOLT, Rennie (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA rennie.holt@noaa.gov
JONES, Christopher (Dr) (Co-convener)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA chris.d.jones@noaa.gov

MARTINEZ, Patricia (Dr)	Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) Paseo Victoria Ocampo No. 1 7600 Mar del Plata Argentina martinez@inidep.edu.ar
MIDDLETON, David (Dr)	NZ Seafood Industry Council (‘SeaFIC’) Private Bag 24-901 Wellington New Zealand middletond@seafood.co.nz
MORMEDE, Sophie (Dr)	Ministry of Fisheries PO Box 1020 Wellington New Zealand sophie.mormede@fish.govt.nz
PLAGÁNYI, Éva (Dr) (from 10th)	Department of Mathematics and Applied Mathematics University of Cape Town Private Bag 7701 Rondebosch South Africa eva.plaganyi-lloyd@uct.ac.za
REID, Keith (Dr) (WG-EMM Convener) (from 10th)	British Antarctic Survey Natural Environment Research Council High Cross, Madingley Road Cambridge CB3 0ET United Kingdom k.reid@bas.ac.uk
REISS, Christian (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA christian.reiss@noaa.gov
SULLIVAN, Kevin (Dr) (9th and 10th)	Ministry of Fisheries PO Box 1020 Wellington New Zealand sullivak@fish.govt.nz

TRIVELPIECE, Wayne (Dr)
US AMLR Program
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, CA 92037
USA
wayne.trivelpiece@noaa.gov

WATTERS, George (Dr)
Southwest Fisheries Science Center
Protected Resources Division
1352 Lighthouse Avenue
Pacific Grove, CA 93950-2097
USA
george.watters@noaa.gov

WELSFORD, Dirk (Dr)
Australian Antarctic Division
Department of the Environment and Water Resources
Channel Highway
Kingston Tasmania 7050
Australia
dirk.welsford@aad.gov.au

Secretariat:
David RAMM (Data Manager)
Doro FORCK (Publications and Website Assistant)
CCAMLR
PO Box 213
North Hobart 7002
Tasmania Australia
ccamlr@ccamlr.org

APPENDIX B

AGENDA

Working Group on Statistics, Assessments and Modelling
(Christchurch, New Zealand, 9 to 13 July 2007)

1. Introduction
   1.1 Opening of the meeting
   1.2 Adoption of the agenda and organisation of the meeting

2. Parameter estimation
   2.1 Refinements of existing methods
   2.2 New methods

3. Assessment methods
   3.1 *Dissostichus* spp.
   3.2 *Champsocephalus gunnari*
   3.3 *Euphausia superba*
   3.4 By-catch species

4. Review of preliminary assessments for finfish
   4.1 Subarea 48.3
   4.2 Division 58.5.2
   4.3 Subareas 88.1 and 88.2
   4.4 Subareas 58.6/58.7 (Prince Edward and Marion Islands)
   4.5 Division 58.5.1 (Kerguelen Islands)

5. Evaluation of management strategies
   5.1 *Dissostichus* spp.
   5.2 *Champsocephalus gunnari*
   5.3 *Euphausia superba*

6. Future work
   6.1 Terms of reference
   6.2 Long-term work plan
   6.3 Other issues

7. Other business

8. Advice to the Scientific Committee
   8.1 WG-EMM
   8.2 WG-FSA
   8.3 Ad hoc WG-IMAF
   8.4 General

9. Adoption of report and close of meeting.

APPENDIX C

LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling
(Christchurch, New Zealand, 9 to 13 July 2007)

WG-SAM-07/1	Preliminary Agenda and Annotated Preliminary Agenda for the 2007 Meeting of the Subgroup on Assessment Methods
WG-SAM-07/2	List of participants
WG- SAM-07/3 Rev. 1	List of documents
WG-SAM-07/4	Preliminary investigations of an assessment model for skates and rays in the Ross Sea A. Dunn, S.M. Hanchet, S.L. Ballara and M.P. Francis (New Zealand)
WG-SAM-07/5	An updated descriptive analysis of the toothfish (*Dissostichus* spp.) tagging program in Subareas 88.1 and 88.2 for 2006/07 A. Dunn, S.M. Hanchet and S.L. Ballara (New Zealand)
WG-SAM-07/6	Revised input parameters and implications for the Antarctic toothfish (*Dissostichus mawsoni*) stock assessment in Subareas 88.1 and 88.2 A. Dunn and S.M. Hanchet (New Zealand)
WG-SAM-07/7	Comparison of estimators of effective sample size for catch-at-age and catch-at-length data using simulated data from the Dirichlet-multinomial Distribution S.G. Candy (Australia)
WG-SAM-07/8	Proposed methodology for the assessment of the exploratory fishery for *Dissostichus* spp. on BANZARE Bank (Division 58.4.3b) D.C. Welsford, A.J. Constable and G.B. Nowara (Australia)
WG-SAM-07/9	Update of the Antarctic toothfish stock assessment for the Ross Sea by means of the TSVPA separable cohort model D. Vasilyev, K. Shust, V. Babayan and T. Bulgakova (Russia)
WG-SAM-07/10	Extension of the development of a management procedure for the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity A. Brandão and D.S. Butterworth (South Africa)

WG-SAM-07/11	Preliminary assessment of the South Georgia ray populations D.J. Agnew, R. Mitchell, T. Carruthers, J. Roberts, R. Hillary and J. Pearce (United Kingdom)
WG-SAM-07/12	A spatial multi-species operating model of the Antarctic Peninsula krill fishery and its impacts on land-breeding predators É.E. Plagányi and D.S. Butterworth (South Africa)
WG-SAM-07/13	An assessment strategy evaluation framework for testing the application of a CASAL based management system to the HIMI fishery I.R. Ball and S.G. Candy (Australia)
WG-SAM-07/14	Rationale, structure and current templates of the Ecosystem, Productivity, Ocean, Climate (EPOC) modelling framework to support evaluation of strategies to subdivide the Area 48 krill catch limit amongst small-scale management units A. Constable (Australia)
WG-SAM-07/15	Lenfest Ocean Program Workshop 'Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries'

Other documents

SC-CAMLR-XXVI/BG/2	Report of the Third Meeting of the Subgroup on Acoustic Survey and Analysis Methods (Cambridge, UK, 30 April to 2 May 2007)
SC-CAMLR-XXVI/BG/3	Report of the Planning Meeting of the CCAMLR-IPY Steering Committee (Cambridge, UK, 2 to 4 May 2007)

ANNEX 8

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

(Cambridge, UK, 30 April to 2 May 2007)

CONTENTS

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

(Cambridge, UK, 30 April to 2 May 2007)

INTRODUCTION

The third meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was held from 30 April to 2 May 2007. The meeting was convened by Drs R. O'Driscoll (New Zealand) and M. Collins (UK) and was held at the British Antarctic Survey in Cambridge, UK.

2. Dr Collins welcomed participants on behalf of the host institute and outlined local arrangements for the meeting.

3. Dr O'Driscoll reviewed the background to the meeting and the terms of reference recommended by the Scientific Committee (SC-CAMLR-XXV, paragraph 13.39, Annex 5, paragraphs 13.16 to 13.19 and Annex 4, paragraph 6.50; given here in Appendix A). The meeting focused on the development of methodologies for acoustic surveys of icefish (*Champsocephalus gunnari*) and the review of the acoustic sampling protocols for krill (*Euphausia superba*) for use by CCAMLR-IPY projects. Discussion of acoustic protocols for krill in IPY surveys was carried out on 2 May 2007 in conjunction with members of the CCAMLR-IPY Steering Committee which met in Cambridge from 2 to 4 May 2007. A provisional agenda was introduced, discussed and adopted (Appendix B).

4. The list of participants is included as Appendix C and the list of documents submitted to the meeting is included as Appendix D.

5. This report was prepared by the participants.

REVIEW OF THE FINDINGS OF TWO PREVIOUS MEETINGS OF SG-ASAM

6. Dr O'Driscoll summarised the major findings and recommendations of the previous two meetings of SG-ASAM.

7. The first meeting of SG-ASAM was held at the Southwest Fisheries Science Center (SWFSC) in La Jolla, USA, from 31 May to 2 June 2005 (SC-CAMLR-XXIV, Annex 6). The terms of reference for this meeting were restricted to two issues relating to hydroacoustic surveys of krill, namely: (i) models of krill target strength (TS); and (ii) classification of volume backscattering strength (S_v).

8. With respect to these two issues, SG-ASAM recommended for CCAMLR hydroacoustic surveys to estimate krill B_0 that:

- the simplified SDWBA model with constrained parameters be used to define krill TS as a function of length at a given frequency;

- the minimum and maximum TS values from the subgroup's agreed run of the simplified SDWBA (SC-CAMLR-XXIV, Annex 6, Figure 4) should be used as a first estimate of the error associated with krill TS;

- the classification of S_v to filter out non-krill targets should be undertaken using the ΔS_v technique, with the ΔS_v windows constrained for the appropriate size range of krill.

9. The subgroup made two further recommendations for further research relating to TS models and S_v classification of krill:

- The subgroup emphasised the importance of understanding the orientation distribution, sound-speed contrast, density contrast and animal shape for krill under the surveying vessel. The subgroup encouraged further work on these topics as a high priority.

- The subgroup recognised that the use of 70 kHz transducers should improve krill detection, classification and estimation of B_0 and recommended their use during krill surveys whenever possible.

10. The second meeting of SG-ASAM was held at the CCAMLR Secretariat, Hobart, Australia, on 23 and 24 March 2006 (SC-CAMLR-XXV, Annex 6). The terms of reference for this meeting were focused on issues with respect to surveys of icefish, namely: (i) frequency-specific definition of icefish target strength; and (ii) classification of volume backscattering strength attributed to icefish versus other taxa. The Scientific Committee also requested more general advice on the conduct of acoustic surveys, namely: (i) survey design; (ii) documentation of survey methods; (iii) presentation of results; and (iv) protocols for archiving data.

11. The subgroup made the following recommendations to the Scientific Committee, that:

(i) multiple frequencies, including 38, 70 and 120 kHz, be used in acoustic surveys of icefish and krill whenever possible to improve mark classification. The utility of higher and lower frequencies should also be investigated;

(ii) the efficiency of the current Δ120–38 kHz S_v dB difference method of taxa delineation be further evaluated in relation to discrimination of icefish from associated species;

(iii) the TS of icefish and associated species continues to be studied using a variety of methods including *in situ* measurements, *ex situ* experiments on individuals and aggregations, and physics-based and empirical models;

(iv) data be collected on icefish orientation, including changes in orientation due to vertical migration or in response to survey vessels;

(v) icefish behaviour should be further investigated, including vertical distribution and response to survey vessels, as they impact on survey design, fish orientation, target strength determination and species delineation;

(vi) a library of echograms with associated TS, catch and biological data for icefish and associated species should be available from CCAMLR. This library should be incorporated into the existing CCAMLR acoustic database;

(vii) the Secretariat investigate the feasibility of archiving data in the HAC[1] (or other suitable) format, and that other types of data, such as calibration parameters, should be archived by the Secretariat.

NEW INFORMATION ON ICEFISH ACOUSTICS

12. Dr S. Fielding (UK) presented the results of the preliminary analyses of acoustic data obtained from a research survey and a commercial icefish fishing vessel at South Georgia (Subarea 48.3) in January 2006 and January 2007 respectively (SG-ASAM-07/5).

13. Dr Fielding first presented uncalibrated ES60 38 kHz echosounder data collected opportunistically from the fishing vessel *New Polar* during January 2007. The NASC (m^2 n $mile^{-2}$) was calculated for the depth layer fished by the *New Polar* (115–180 m), where the catch data confirmed the presence of icefish. Highest NASC values were observed within the fishing layer around dawn and in water depths between 200 and 250 m. Both echograms and the catch data from the *New Polar* show that icefish were present midwater during the day. Food availability was suggested as a cue for their presence, and echograms were shown of icefish schools occurring midwater below krill swarms. However, comparison of surface (10–50 m) and fishing depth NASC did not show a relationship.

14. Identification of mackerel icefish marks was investigated using EK500 38 and 120 kHz, collected from the FPV *Dorada* during the South Georgian groundfish survey. A Δ120–38 kHz S_v dB difference of between 0 and 14 dB was observed consistently in trawl-verified icefish acoustic marks and suggested as a means to identify them. A schools analysis was performed on the echograms to identify krill and icefish marks; these could be separated using a combination of depth within the water column and different thresholds. Krill swarms occurred in the surface 0–100 m and were identified by a threshold greater than –60 dB, whereas icefish schools were only observed below 50 m depth and S_v ranged between –85 and –60 dB. A tentative estimate of TS at 38 kHz for icefish was presented, calculated from measurements of icefish density from bottom trawl data (11 trawls where more than 80% of the total catch biomass was icefish) compared with mean S_v within the region of the trawl.

15. SG-ASAM noted that the study had provided a considerable amount of new information on the distribution of icefish in the water column and had gone some way to providing reliable information for the morphological identification of icefish acoustic marks. Dr Fielding indicated that simple thresholding using the Echoview's schools detection algorithm could be employed to identify icefish marks from krill. Dr T. Jarvis (Australia) noted that in scenarios of low krill densities the discrimination of such marks might not be straightforward.

16. SG-ASAM also noted that, broadly speaking, there was little apparent depth overlap between krill and icefish marks with icefish generally located below 100 m and krill above

[1] A global standard being developed for the storage of hydroacoustic data.

50 m. However, icefish feed predominantly on krill and therefore must, at some time, have an overlapping depth distribution. Further fishing effort is required in the depths between 50 and 100 m to investigate the krill and icefish overlap.

17. Dr O'Driscoll expressed concern that mark identification based on the presence of 'clean' commercial catches that comprise overwhelmingly the target species may not be appropriate if fishing gear selectivity leads to catch composition not being representative of the composition of the mark. However, SG-ASAM noted that icefish had dominated catches when a finer-meshed research trawl had been deployed to fish targets on previous research surveys at South Georgia and as such the species composition of commercial trawl catches were likely to accurately represent the composition of acoustic marks.

18. SG-ASAM noted that considerable uncertainty exists around the estimation of the relationship between TS and fish length for icefish. Several participants highlighted the difficulties associated with efforts to accurately match net and acoustic data, and it was agreed that TS estimation, using the methods outlined in SG-ASAM-07/5, was likely to be unreliable.

19. It was pointed out that it was difficult to collect *in situ* data on icefish TS with the current ship-mounted acoustic devices because of the depth distribution of the fish. There was also concern about previous *in situ* estimates of icefish TS (WG-FSA-SAM-04/9) because of uncertainty about target identification. Alternative technologies may be required to estimate TS *in situ*. Dr R. Korneliussen (Invited Expert) indicated that Norway planned to use a three-frequency 'drop TS' system during the forthcoming IPY survey of the Scotia Sea scheduled for 2008 from which more reliable estimates of TS might be made.

RECOMMENDATIONS FOR FUTURE WORK ON ICEFISH

20. SG-ASAM noted that questions relating to species classification and target strength need to be further resolved before it could consider the terms of reference relating to the combination of trawl and acoustic indices for a stock assessment of icefish in Subarea 48.3 (SC-CAMLR-XXV, Annex 5, paragraph 13.19).

Mark identification

21. SG-ASAM noted that acoustic scattering was a function of multiple properties of the target and of interplay with acoustic wavelength. Information on frequency response was required not only for fish of different lengths but for fish located at different depths, from different mark structures, of different composition (e.g. variable reproductive state) and at different orientations to further evaluate the discrimination of icefish from associated species.

22. Dr D. Demer (USA) suggested that the optically assisted acoustic survey technique developed at the NOAA SWFSC for surveying rockfishes in the Southern California Bight could be used to survey icefish (SG-ASAM-07/7). Similar to icefish, rockfish reside over thousands of n miles^2 on or near the sea floor at depths of 80–350+ m, are found in low densities and their habitats are largely uncharacterised. Succinctly, the method uses multiple-frequency echosounders to map the scattering from demersal fish, and cameras deployed from

a remotely operated vehicle to quantify the mixture of species and estimate their length probability distribution functions. This information, coupled with appropriate TS models can be used to derive estimates of fish abundance, by species, in a non-lethal manner.

TS estimation

23. Dr G. Macaulay (Invited Expert) informed the subgroup that attempts to model the TS of icefish using computed tomography (CT) scanning methods had not been possible during the last year. Transfer of CT scan data between the UK (where frozen icefish samples were located) and New Zealand had proved impossible as the scanning facility was not able to provide a file format that contained the necessary scan data. However, it was noted that it was now possible for icefish samples collected by the Australian Antarctic Division to be CT-scanned in Hobart and for data to be sent to New Zealand's National Institute of Water and Atmospheric Research (NIWA) for subsequent analysis. It is expected that the scanning will occur in May 2008. Modelling of target strength at a range of frequencies will then follow.

24. A new technique has been developed for measuring the broad bandwidth sound scatter of live animals in highly reverberant tanks in a laboratory or on board vessels (Demer et al., 2003; Demer and Conti, 2003; Conti and Demer, 2003; Conti et al., 2005). The data are used to validate scattering models for harvested and cohabitant species. The models are used to improve acoustical identification of species and sizes, and improve estimates of TS – thus improving the accuracy and precision of survey estimates. The method has been used to measure the sound-scattering spectra of many species such as anchovy and sardine, Antarctic krill, northern krill, mysids, shrimp, bocaccio rockfish and even humans. Dr Demer proposed that the multiscattering technique could be used for measuring the broad bandwidth sound scatter from mackerel icefish and coexisting species *ex situ* (SG-ASAM-07/7).

25. In 2002, the multiscattering technique was used to measure the total target strengths (TTS) of *E. superba*, *Electrona antarctica* and a squid of unknown species. TTS is the total scattering cross-sectional area (m^2) averaged over all angles of incidence. The preliminary results, documented in the report of the US AMLR 2001–2002 Survey, show that TTS from 38 to 202 kHz ranged roughly from –85 to –75 dB for *E. superba*, –65 to –55 dB for *E. antarctica*, and –60 to –50 dB for the squid species. The fish and squid lengths were not provided, their sample sizes were 6 and 1 respectively, and the TTS below about 50 kHz had a low signal-to-noise ratio. The data were presented to illustrate the potential of the multi-scattering method and to give an indication of the relative TTS between these taxa. TTS and TS are similar when the wavelength is large compared to the animal size and vice-versa.

26. SG-ASAM thanked Dr Demer for this presentation and agreed that the broadband reverberation method had considerable potential for estimating TTS of mackerel icefish and other Antarctic species. Dr Collins pointed out that icefish were often moribund when caught in trawls, but some may be in suitable condition to allow *ex situ* TS measurements on the research vessel.

27. Dr Macaulay noted the TS models are still required to allow for the conversion of TTS measurements to estimates of backscattering TS.

28. There are currently few data available on the density values of mackerel icefish, which are required for TS modelling. SG-ASAM recommended that further work be undertaken to obtain density and sound-speed measurements for a range of Antarctic fish species, including icefish and myctophids.

OTHER ACOUSTIC SURVEYS IN CCAMLR WATERS

29. Dr O'Driscoll presented results from acoustic data collected opportunistically from New Zealand longline vessels participating in the exploratory fishery for toothfish in the Ross Sea (SG-ASAM-07/8). Fishing vessels were equipped with Simrad ES60 echosounders with 12 or 38 kHz transducers, but were not calibrated. Additional data were collected by the RV *Tangaroa* during a research cruise from February to March 2006 using an EA500 with 12, 38 and 120 kHz transducers.

30. Acoustic data were used to study the distribution of mesopelagic prey species in the Ross Sea. Total acoustic backscatter in the upper 1 000 m and the variety of mark types decreased from north to south. Common marks north of 67°S included a surface layer at less than 50 m depth, schools and layers centred on about 200 and 400 m depth, and a diffuse deep scattering layer centred at 750 m depth. South of 70ºS, average acoustic density was much lower and most of the backscatter was from schools and layers shallower than 100 m. Near-bottom marks were associated with areas shallower than 1 000 m on the Ross Sea shelf edge. In general, the amount of backscatter observed in the Ross Sea was much lower than that observed in shelf areas off New Zealand.

31. Little direct information is available on the species composition of different mark types in the Ross Sea. However, different marks exhibited different acoustic responses across the three frequencies examined which provided some clues about the likely identity of the key scatterers. Marks shallower than 100 m depth were stronger on 120 kHz than on 38 kHz, and weak on 12 kHz. This type of acoustic response is typical of krill or other large zooplankton. Schools and layers at 200–400 m depth showed a more consistent response across all three frequencies and may have been associated with small fish.

32. This study identified key areas and mark types for further research, including directed sampling, and showed how fishing vessels could be used to opportunistically collect acoustic data for ecosystem studies.

33. Dr O'Driscoll questioned whether Members had validated echograms of *Pleuragramma* spp. Dr Jarvis indicated that Australia had some echograms which it believed were most likely to be *Pleuragramma* spp., based on their geographical location and the absence of krill in RMT catches. He agreed to make these available.

34. Dr Fielding described the British Antarctic Survey's cruise program in the Scotia Sea. Three cruises (spring, summer and autumn) are planned as part of the Discovery 2010 science program, the first of which took place in October–December 2006 (austral spring). The cruises are designed to investigate seasonal variability in food-web structure across latitudinal and productivity gradients, with a main transect running from the ice-edge (south of the South

Orkney Islands) to the Polar Front (north of South Georgia). Acoustic data will be collected along transect, with mesoscale acoustic transects undertaken at each of approximately eight main stations.

35. Dr Collins presented details of a cruise (*James Clark Ross* cruise 100) undertaken to the northwest of South Georgia in March 2004 to investigate the distribution and ecology of mesopelagic fish (SG-ASAM-07/8). Data on the vertical distribution (day and night) of the nine most abundant myctophid species were presented. Echograms attributed to *E. carlsbergi*, *Protomyctophum choriodon* and the notothenid *Patagonotothen guntheri* were displayed and discussed.

36. SG-ASAM noted the prevalence of myctophids in Antarctic waters and the importance for acoustic estimation of knowing which myctophid species possessed swim bladders. Dr Collins prepared Table 1 to provide preliminary information on the size and swim bladder characteristics of abundant myctophids in the Scotia Sea. The subgroup was also referred to an early report on swim bladder form by Marshall (1960).

GENERAL ISSUES RELEVANT TO ACOUSTIC SURVEYS IN CCAMLR WATERS

Collection of acoustic data from commercial vessels

37. SG-ASAM recognised an increasing interest from Members in the collection of acoustic data from commercial vessels (e.g. SG-ASAM-07/5, 07/7).

38. In 2003, ICES established a Study Group on the Collection of Acoustic Data from Fishing Vessels (SGAFV) to evaluate the collection of acoustic data from fishing vessels and provide appropriate recommendations. Experts from 12 countries participated in the work of the study group during its three-year term. SGAFV prepared a written report during its three annual meetings and by correspondence between meetings which will be published as an *ICES Cooperative Research Report* in July 2007. Dr O'Driscoll described the contents of this report and referred interested Members to it.

Data archiving

39. At its 2006 meeting, SG-ASAM requested that the Secretariat:

(i) develop a library of echograms with target strength, catch and biological data for icefish and associated species (SC-CAMLR-XXV, Annex 6, paragraph 50);

(ii) develop an archive of calibration and configuration parameters to allow detailed analysis (and reanalysis) of acoustic survey data (SC-CAMLR-XXV, Annex 6, paragraph 62);

(iii) investigate the feasibility of archiving data in the HAC format, and obtain documentation on SonarData's ek5 and Echoview EV formats (SC-CAMLR-XXV, Annex 6, paragraph 61).

Dr Ramm presented SG-ASAM-07/4 which reported on progress with these tasks.

40. The existing database model has been expanded to include a new module which contains a prototype echogram library. The prototype library was based on the framework adopted by the EU project on Species Identification Methods from Acoustic Multifrequency Information (SIMFAMI, EU project Q5RS-2001-02054, Final Report 2005). The prototype library may be linked to CCAMLR's existing acoustic database, and contains two primary tables: Echogram – a description of the characteristics of a species' typical echogram; and Echotrace – photographic examples of echotraces.

41. SG-ASAM noted the importance of validation of echograms included in the library and the need to include catch composition information and other metadata (gear type, fishing depth etc.). These might be added as a further linked table.

42. Dr Macaulay suggested including the slope and intercept of the TS-to-length relationship instead of B20 in the Echogram table as many species have been demonstrated to have TS-to-length relationships with slopes different to 20.

43. The Secretariat requested some example data to help develop the prototype library and Dr Fielding agreed to provide some echograms.

44. The existing database model was further expanded to include a new module which contains prototype tables to archive data on transducer configuration, echosounder configuration and calibration parameters. The Secretariat sought advice on which calibration parameters should be included in the database table. SG-ASAM suggested that the parameters given in Table 2 be included.

45. SonarData has provided information to the Secretariat on the SonarData ek5 file format specification and the feasibility of archiving Echoview data in the HAC format (I. Higginbottom, Director, SonarData, pers. comm., April 2007).

46. SG-ASAM noted that there are two possible levels of archiving existing data: raw data files (which contain variables such as position, S_v and phase) and processed data (such as bottom definition lines and regions).

47. The conversion of data files to the HAC format is relatively straightforward, but may not be necessary as long as the format of the archived data files is well documented. Some current file formats (such as EK60 raw files) have appropriate documentation and SG-ASAM recommended that this should be archived along with the data files.

48. Archiving of processed data is more problematic. For example, there is information in EV files which is not supported by HAC files, and cannot be written to HAC or other files. SG-ASAM agreed that the post-processing software and file structure should be documented along with the processed data. Where adequate documentation is not available (e.g. proprietary software), the version of the software used for processing should be archived along with the processed data file. This may have financial implications for the Secretariat, but SG-ASAM noted that read-only (demonstration) versions of software were freely available from some manufacturers (e.g. SonarData Echoview).

49. SG-ASAM urged that standard well-documented file structures and procedures for exporting and archiving of processed data (such as ASCII data strings defining the bottom definition line and regions) should be considered by software manufacturers.

Calibration

50. At the 2007 meeting of ICES WG-FAST, the issue of consistency of calibration between different users was raised, particularly in reference to the Simrad EK60 echosounder system and the calibration protocols described in the Simrad manual. A topic group was established to collate the current calibration protocols employed by users, and to prepare a report to ICES providing guidelines for EK60 calibration procedures within the next two years. Dr Jarvis is one of the co-chairs of the topic group and will keep SG-ASAM informed on its progress.

NEW INFORMATION AVAILABLE ON KRILL ACOUSTICS

51. Dr Jarvis presented the methods and results of Australia's 2006 BROKE-West acoustic krill-biomass survey of Division 58.4.2 as a follow-up to WG-EMM-06/16 (SG-ASAM-07/9). CCAMLR-agreed protocols for the steps required to report on and produce an estimate of B_0 from acoustic data were highlighted (e.g. SC-CAMLR-XV, Annex 4, Appendix D; SC-CAMLR-XIX, Annex 4, Appendix G, paragraphs 3.1 to 3.6). Dr Jarvis also pointed out that: (i) while there are numerous discussions of acoustic methods throughout the CCAMLR literature, no single document exists for ease of reference, and (ii) recent methodological advances have also been discussed by CCAMLR since this time (e.g. SC-CAMLR-XXIV, Annex 4, paragraphs 4.55 to 4.60, 4.66 and 4.67).

52. It was agreed that many acoustic protocols and guidelines have been discussed by CCAMLR working groups over the years. Collation of all such information into a single source would be extremely valuable. As a step in this direction, Dr Jarvis presented a flowchart which attempts to summarise and illustrate the general steps involved from acoustic data collection to krill biomass estimation. This flowchart is reproduced here (Figure 1) on the recommendations of the subgroup.

53. The BROKE-West acoustic survey methodology adhered to the protocols of the BROKE (Pauly et al., 2000) and the CCAMLR-2000 Survey (Hewitt et al., 2004) surveys wherever possible. This included application of the same length:weight (*L:W*) and target strength (TS) models, and similar application of a modified version of the Jolly and Hampton (1990) method for estimating B_0 and its associated variance.

54. Calibration of the echosounder system during BROKE-West revealed transducer gain (TS gain) differences of up to ~0.5 dB when using Simrad versus Echoview processing routines. The Simrad 'EK model' results were subsequently used during post-processing of the survey data. Some discussion was held on the differences in quality between the 120 kHz transducer model used during BROKE-West (Simrad ES120-7) and Simrad's newer composite model (ES120-7C). It was reiterated that calibration protocols for the EK60 echosounder are currently being addressed by an ICES topic group, co-chaired by Drs G. Pedersen (Norway) and Jarvis, the results of which will be communicated to SG-ASAM in due course. WG-EMM-96 lists some information to be documented for calibrations from each survey (SC-CAMLR-XV, Annex 4, Appendix D; SC-CAMLR-XIX, Annex 4, Appendix G, paragraphs 3.1 to 3.6). The subgroup agreed to revisit this table and update it as necessary.

55. The post-processing steps for the BROKE-West acoustic data included: (i) removal of surface noise, transducer ring-down and spikes; and (ii) species ID using dB differences (2–16 dB for Δ120–38 kHz S_v). The weighted mean density of krill for the survey was thus estimated as 9.48 g m^{-2}; B_0 = 14.85 million tonnes; with a CV = 15.15%. The CV reported in WG-EMM-06/16 was erroneous, and will be revised and reported to CCAMLR.

56. The BROKE-West acoustic krill densities have been characterised thus far using cumulative density functions, and distributions of densities further described relative to the 1 000 m contour. Results indicated that much of the krill was found in very low densities (<1 g m^{-2}), and much of the cumulative density was found in association with the 1 000 m contour (shelf break). Also, 90% of the krill resided in the top 100 m, as noted in the CCAMLR-2000 Survey. These analyses were part of a larger ongoing investigation of covariations in biotic and abiotic components of the ecosystem.

57. There was some discussion about survey area definition. Dr J. Watkins (UK) noted that the area of interest is generally defined *a priori*, and sampling design follows that decision. Dr Demer agreed that the area definition could be defined on the basis of a management area (e.g. FAO statistical area), or the area defining a stock. The choice depends on the objective of the survey. Dr Jarvis noted that during the BROKE-West survey, real-time decisions were also required on how close to the coast to survey in order to cover the krill stock.

58. Dr Jarvis noted that survey designs can be optimised for biomass estimation or stock dispersion, but compromises are generally necessary when the survey has multiple objectives.

59. The subgroup recalled that in 2005, SG-ASAM recommended using smaller ranges of dB-differences as suggested by the krill length-frequency distributions in the sub-survey areas during the times of those surveys.

60. It was noted that the echo-energy to density conversion factor derived from the ratio of the mass per krill and the TS per krill should be derived by weighting both the numerator and the denominator by the length-frequency distributions prior to calculating the ratio.

RECOMMENDATIONS FOR FUTURE WORK ON KRILL

61. SG-ASAM discussed its terms of reference from WG-EMM (SC-CAMLR-XXV, Annex 4, paragraph 6.50). The subgroup was asked to review the method for estimating the CV for the biomass estimate provided by Demer and Conti (2005) and consider whether this is sufficient to determine the uncertainty in B_0 more generally. SG-ASAM believed that the correct reference is Demer (2004), where a multiple-frequency Monte Carlo simulation was used to estimate total random error.

62. Demer (2004) concluded that the random component of the measurement error was negligible compared to the sampling error. However, many sources of bias are appreciable, and vary on time and space scales. Dr O'Driscoll noted that if biases are consistent in time and space then the data can be considered relative and used as indices.

63. SG-ASAM noted that mark identification, TS, length–weight model and sampling are the biggest four sources of uncertainty determined by Demer (2004), and each of these, and

possibly other sources, need to be quantified, compared and minimised. The subgroup identified that quantifying these errors was perhaps more important than the methods with which the errors were combined.

64. SG-ASAM identified that the Monte Carlo method for estimating total error has now been used by multiple investigators and appears to be a reasonable way to account for combining uncertainty. SG-ASAM recommended that a list of potential sources of error be created and that an accompanying list of protocols be provided to help resolve these errors.

65. SG-ASAM was also asked by WG-EMM to consider 'what is the most appropriate method for estimating B_0 from survey data, considering design-based versus model-based estimation methods?' (SC-CAMLR-XXV, Annex 4, paragraph 6.50). SG-ASAM recognised that the necessary expertise was not present to discuss the validity of the various data- or model-based estimation schemes (e.g. maximum entropy, kriging, Jolly and Hampton (1990) methods etc.), and that ICES and other groups have been discussing this for years. There may be more statistical expertise at the B_0 workshop associated with WG-EMM's 2007 meeting (Christchurch, New Zealand) to deal with this issue.

66. SG-ASAM discussed its previous recommendations regarding the use of the SDWBA for krill biomass estimations. The subgroup noted that these recommendations have not been applied consistently in recent surveys. The subgroup acknowledged that analysis using the new method complicates comparison with historic data.

67. SG-ASAM further discussed whether generic parameter values could be used for the SDWBA. Dr Demer identified that a sensitivity analysis of the model to these parameters was undertaken as part of SG-ASAM-05 (SC-CAMLR-XXIV, Annex 6), where it was identified that further constraints of the model parameters would be highly beneficial. Dr Jarvis reported that several of these parameters had been constrained during the BROKE-West survey (SG-ASAM-07/9).

68. The various methods available for the measurement of density and speed of sound contrasts were discussed. Rather than constraining the community to one method, several papers pertaining to these measurements were suggested for reference (e.g. Chu and Wiebe, 2005; WG-EMM-05/36). SG-ASAM recommended that Members be encouraged to undertake density and sound-speed measurements during IPY surveys.

69. Dr T. Knutsen (Norway) suggested examining the methods for delineating between plankton groups, i.e. identifying other components of the ecosystem using acoustics. This resulted in a discussion as to whether the Δ120–38 kHz S_v difference of 2–16 dB identified in the CCAMLR-2000 Survey was justified. Dr Jarvis identified that it covered the range of krill sizes (10–60 mm) typically observed during the Australian krill surveys. Dr Collins noted that this range was very broad and could represent all the acoustic biomass in some areas. Dr Demer commented that SG-ASAM-05 (SC-CAMLR-XXIV, Annex 6) had agreed to a recommendation that the Δ120–38 kHz S_v range was constrained based on net-sampled information of the krill sizes present. Drs Watkins and Jarvis identified the need to sample a representation of the populations, indicating the difference between stratified and targeted hauls for length-frequency estimation.

70. SG-ASAM suggested that a calculation of biomass is undertaken on total backscattering as well as the component of backscatter attributed to krill by the dB difference method to check what proportion of the total backscatter is attributed to krill.

71. SG-ASAM then discussed diurnal variations in acoustic estimates of krill resulting from either the variation in TS with tilt angle (or the variation of tilt angle over a diurnal cycle) or the removal of krill to the near-surface 'blind zone'. Dr Korneliussen suggested that future surveys should include measurements from upward-looking or side-looking sonar.

JOINT SESSION REVIEW OF THE ACOUSTIC SAMPLING PROTOCOLS FOR KRILL FOR USE BY CCAMLR-IPY PROJECTS

72. Mr S. Iversen (Co-convener, CCAMLR-IPY Steering Committee) welcomed participants to the joint session held on 2 May 2007 and outlined the background behind the formation of the CCAMLR-IPY Steering Committee.

73. At the start of the meeting, four Members (Germany, Japan, New Zealand and Norway) had notified the CCAMLR-IPY Steering Committee of their intention to undertake surveys during IPY. Other Members (Argentina, Brazil, India, Italy) and Peru have previously expressed an interest in participation in CCAMLR-IPY surveys. In addition, Dr Watkins indicated that the UK will be undertaking acoustic survey work which will have relevance to IPY programs.

74. The joint session noted that these IPY surveys will have varied objectives under CAML, ICED and national programs and will not be part of a dedicated CCAMLR research program such as the CCAMLR-2000 Survey. Therefore, acoustic protocols cannot be too rigorous and prescriptive.

75. Dr Watkins proposed hierarchical protocols to be inclusive of all IPY participants. He pointed out that even opportunistic acoustic observations may be valuable, especially in areas where there is little previous information (e.g. Bellingshausen Sea). The joint session agreed with this proposal.

76. The joint session noted that it is important to match the level of protocols with the study requirements. For example, qualitative description of mark types requires a lower level of equipment and protocols than quantitative analysis of backscatter. The most rigorous protocols are required for acoustic data used for biomass estimation and stock assessment.

77. The joint session agreed to a protocol framework that defined the minimum, desirable and optimal requirements for acoustic data collected during IPY surveys (Table 3). These categories correspond to the study requirements for descriptive analysis, quantitative analysis of backscatter and biomass estimation.

78. The joint session recommended that Members carrying out IPY surveys refer to, and follow, the acoustic protocols in Table 3. Protocols should be matched to the particular study requirements of the acoustic data. There may also be opportunities for collection of acoustic data from fishing vessels in CCAMLR waters and the joint session encouraged this collaboration. The joint session recognised that these protocols may be useful for other groups undertaking IPY surveys.

79. The joint session emphasised the need for centralised data archiving of raw acoustic data and metadata collected during IPY surveys. The joint session recommended that protocols and arrangements for data archiving be discussed and agreed between relevant IPY parties (e.g. CAML, CCAMLR, ICED).

80. The joint session did not specifically address protocols for acoustic data processing from IPY surveys. It recommended that a future workshop be held with all interested parties to discuss processing of data from IPY surveys in general, as well as specific CCAMLR study requirements (e.g. krill biomass estimates).

SUGGESTIONS FOR TIMING/VENUE OF NEXT MEETING

81. SG-ASAM agreed that this meeting had benefited from being held in conjunction with a meeting of ICES's WG-FAST in Dublin, Ireland, from 23 to 27 April 2007. It was agreed that SG-ASAM meetings would be more likely to be attended by acoustic experts if the meetings continue to be held in conjunction with WG-FAST meetings.

82. SG-ASAM agreed that future meetings would be required to consider the results of ongoing acoustic research and new surveys, particularly those associated with IPY activities.

83. ICES is sponsoring a Symposium on the Ecosystem Approach with Fisheries Acoustics and Complimentary Technologies (SEAFACTs), to be held in Bergen, Norway, from 16 to 20 June 2008. WG-FAST is meeting for one day following this symposium (probably 23 June 2008). Dr O'Driscoll noted that there were already ICES subgroups planning meetings before and after SEAFACTs, and pointed out that it may be difficult to schedule an associated meeting of SG-ASAM in 2008.

84. SG-ASAM therefore recommended that its next meeting be held close to the time and location of the WG-FAST meeting in April 2009. The terms of reference should include evaluation of acoustic results from IPY surveys in 2008, development in TS modelling and other new observations. The suggested timing would allow Members additional time to analyse results from IPY surveys. Dr Demer indicated that the WG-FAST meeting in 2009 would likely be held in Sicily, Italy.

85. Notwithstanding the above recommendation, SG-ASAM would be willing to meet in 2008 if directed to do so by the Scientific Committee.

86. SG-ASAM recommended that the Data Manager attend future meetings of SG-ASAM, and that the Secretariat cost associated with attending meetings away from Hobart be included in the Scientific Committee's budget.

RECOMMENDATIONS TO THE SCIENTIFIC COMMITTEE

87. SG-ASAM recommended that the acoustic frequency response of icefish be investigated in relation to school structure, depth, time of day and other variables to further evaluate the discrimination of icefish from associated species (paragraphs 21 and 22).

88. SG-ASAM recommended that the TS of icefish and associated species continue to be studied using a variety of methods including *in situ* measurements, *ex situ* experiments on individuals and aggregations, and physics-based and empirical models (paragraphs 23 to 26).

89. SG-ASAM recommended that further work be undertaken to obtain density and sound-speed measurements for a range of Antarctic fish species, including icefish and myctophids, for input into TS models (paragraph 28).

90. SG-ASAM noted that icefish behaviour will impact on survey design, fish orientation, target strength determination and species delineation, and recommended further research on icefish behaviour using a range of technologies and observation methods (paragraphs 15 to 19).

91. SG-ASAM requested that Members provide validated echograms with associated TS, catch and biological data for icefish and associated species for inclusion in the CCAMLR acoustic database library (paragraph 43).

92. SG-ASAM re-emphasised the need for appropriate documentation and archiving of acoustic survey data, including raw and processed data. Where adequate documentation is not available (e.g. proprietary software), the version of the software used for processing should be archived along with the processed data files (paragraphs 46 to 49).

93. SG-ASAM recommended collation of all acoustic protocols and guidelines for krill surveys previously discussed by CCAMLR working groups into a single document (paragraph 52).

94. SG-ASAM recommended that measurements of density, speed of sound contrast and tilt angle be undertaken where possible during future krill surveys to further constrain these parameters for the SDWBA model, and that the taking of these measurements be a goal for those Members undertaking IPY studies to generate typical variability in these measurements (paragraph 68).

95. SG-ASAM recommended continued investigation into the diel variability in krill biomass – caused either by variations in TS with tilt angle and diel cycle or removal of krill to the near-surface zone within the blind zone of hull-mounted echosounders (paragraph 71).

96. SG-ASAM recommended that protocols be reviewed and developed to resolve the major sources of uncertainty in krill surveys. These uncertainties should then be routinely quantified, compared over space and time and minimised (paragraph 63).

97. SG-ASAM recommended that a fourth meeting of the subgroup be held in conjunction with the ICES WG-FAST meeting in 2009 to consider acoustic results from IPY surveys, development in TS modelling and other new observations (paragraph 84).

98. SG-ASAM recommended that the Data Manager attend future meetings of SG-ASAM, and that the Secretariat cost associated with attending meetings away from Hobart be included in the Scientific Committee's budget (paragraph 86).

99. The joint session (SG-ASAM and the CCAMLR-IPY Steering Committee) recommended that Members carrying out IPY surveys refer to, and follow, the acoustic protocols for data collection provided by the subgroup (Table 3). Protocols should be matched to the particular study requirements of the acoustic data (paragraph 78).

100. The joint session recommended that protocols and arrangements for archiving acoustic data from IPY surveys be discussed and agreed between relevant IPY parties (e.g. CAML, CCAMLR, ICED) (paragraph 79).

101. The joint session recommended that a future workshop be held with all interested parties to discuss acoustic and other data processing from IPY surveys (paragraphs 80 and 82).

ADOPTION OF THE REPORT

102. This report was adopted by SG-ASAM at the meeting.

CLOSE OF MEETING

103. Dr O'Driscoll thanked participants for their contribution and closed the meeting.

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Table 1: Size ranges (standard length) and swim bladder form for myctophid fish caught in the Scotia Sea (JR161: Oct–Nov 2006) and South Georgia (JR100: Mar 2004) regions. Maximum reported size from Hulley (1990) or Collins (unpublished); Scotia Sea size ranges from Collins (unpublished); swim-bladder data from Marshall (1960) and Collins (unpublished); PF – Polar Front; SACCF – Southern Antarctic Circumpolar Front.

Species name	Max. rep. size	Min. SL (mm)	Max. SL (mm)	Distribution (Scotia Sea/NW South Georgia)	Swim bladder form
Electrona antarctica	113	30	113	Abundant ice-edge to PF; surface–1 000 m	Gas-filled swim bladder; relatively smaller in adults
Electrona carlsbergi	96	48	93	Abundant north of SACCF; 200–400 m	Gas-filled swim bladder
Electrona subaspera	127	107	107	Rare	Gas-filled swim bladder
Gymnoscopelus bolini	280	106	231	Large species; abundant near South Georgia	Residual swim bladder in juvenile fish; absent in adults
Gymnoscopelus braueri	139	30	139	Abundant ice-edge to PF; surface–800 m	Swim bladder highly reduced or absent in adult fish
Gymnoscopelus fraseri	115	60	115	Abundant north of SACCF	Swim bladder highly reduced or absent in adult fish
Gymnoscopelus microlampus	117	70	70	Rare	No data
Gymnoscopelus nicholsi	165	34	165	Abundant ice-edge to PF; surface–1 000 m	Residual swim bladder in juvenile fish; absent in adults
Gymnoscopelus opisthopterus	168	52	168	Rare	No data
Gymnoscopelus piabilis	155	80	155	Rare	No data
Krefftichthys anderssoni	74	25	74	Abundant north of SACCF	Gas-filled swim bladder
Lampanyctus achirus	153	43	155	Abundant 400–1 000 m	No data
Protomyctophum andreyeshevi	52	44	52	Rare	No data
Protomyctophum bolini	67	25	66	Abundant 200–400 m	Gas-filled swim bladder
Protomyctophum choriodon	95	43	85	Seasonally abundant (March) north of SACCF; surface to 400 m	Gas-filled swim bladder
Protomyctophum gemmatum	86	54	62	Infrequently caught	No data
Protomyctophum luciferum	61	33	33	Infrequently caught	No data
Protomyctophum parallelum	53	24	53	Infrequently caught	No data
Protomyctophum tenisoni	55	39	55	Common	Gas-filled swim bladder

Table 2: Suggested calibration parameters to be included as data fields on the CCAMLR acoustic database.

Category/name	Units and comments	Suggested min. precision
Transceiver:		
Manufacturer		
Model number		
Serial number		
Pulse duration	μs	1
Transmit power	W	10
Ping rate	Hz	0.1
Firmware version		
Software name		
Software version		
Operating frequency	Hz	100
Transceiver bandwidth	Hz	100
Transducer (values at main resonance):		
Fore/aft beam angle (3 dB)	degrees	0.1
Port/stbd beam angle (3 dB)	degrees	0.1
Equivalent 2-way beam angle (ψ)	dB re 1 steradian	0.1
Transmitting current response	dB re 1 μPa/A at 1 m (or TCR)	0.1
Transmitting voltage response	dB re 1 μPa/V at 1 m (or TVR)	0.1
Receive voltage response	dB re 1 V/μPa	0.1
Angle sensitivity	dimensionless	0.1
Bandwidth	Hz	100
Q factor	dimensionless	1
Main resonance frequency	Hz	100
Transducer aperature area	m^2	1.0e-5
Transducer efficiency at resonance	%	1
Calibration inputs:		
Sphere material	material (e.g. Cu,WC with 6% Co)	
Sphere diameter	mm	0.1
Sphere TS (estimated)	dB re 1 m^2	0.1
Sphere target frequency(ies)	Hz	100
Sphere target bandwidths	Hz	100
Transducer depth	m	0.1
Range to centre of calibration sphere	m	0.1
Transducer temperature	°C	0.5
Water temperature	°C	0.5
Water salinity	psu	0.1
Sound speed	m/s	1.0
Sound-speed method	(e.g. estimated from CTD)	
Acoustic absorption	dB/m	1.0e-4
Calibration data filename(s)		
Description of apparatus	(e.g. rigging of sphere and weight)	

(continued)

Table 2 (continued)

Category/name	Units and comments	Suggested min. precision
Ancillary data:		
Calibration start date/time	UTC	minute
Calibration end date/time	UTC	minute
Calibration location (lat/long)	degrees	0.1
Vessel rigging	(e.g. drifting, forward anchor only, fore/aft anchor etc.)	
Wave height	m	0.5
Average wind speed	knots	5
General weather description		
System-specific calibration outputs:		
TS_Gain (EK500 only)	dB	0.1
Std. TS_Gain (EK500 only)	dB	0.1
Sv_Gain (EK500 only)	dB	0.1
Std. Sv_Gain (EK500 only)	dB	0.1
G_0 (EK60 only)	dB	0.1
Std of G_0 (EK60 only)	dB	0.2
Sa_corr (EK60 only)	dB	0.1
Std of Sa_corr (EK60 only)	dB	0.2
Passive noise	dB	1.0

Table 3: Recommended protocols for acoustic surveys in CCAMLR-IPY projects.

Study requirements	Descriptive	Quantitative analysis of backscatter	Biomass estimations
Frequency	Any, single	Single or multiple; preferably 38 and 120 kHz with 70, 200, 18 or others.	38 and 120 kHz essential; others (e.g. 70, 200, 18) desirable
Calibration*[1]	Instrument recently calibrated	Calibrated within survey period; record raw calibration files and data.	Multiple calibrations in survey period; history of stable performance
Echosounder settings	Documented	Power*[2] (25 kW m^{-2}) Pulse length 1 ms Ping interval ≤4 sec	Power*[2] (25 kW m^{-2}) Pulse length 1 ms*[3] Ping interval optimised for study requirements
Data depth	Sea floor or minimum of 1 000 m	Sea floor or minimum of 1 000 m	Sea floor or minimum of 1 000 m
Noise		<90% good pings triggers remedial action (e.g. slowing speed, locating and eliminating source of noise)	Minimise noise. Noise recordings required
Ancillary data	GPS	GPS Meteorological data	GPS Transducer motion Meteorological data Record relative (3-D) position of transducers
System integration	Time synchronised	Synchronised acoustic systems or turning off interfering equipment	Synchronised acoustic systems or turning off interfering equipment
Data format	Raw, un-thresholded ping-by-ping sample data	Raw, un-thresholded ping-by-ping sample data	Raw, un-thresholded ping-by-ping sample data
Survey type	Opportunistic	Transect(s)	Designed survey
Additional acoustic-related data			*In situ* and/or *ex situ* TS measurements; parameters required for TS model (e.g. observations on tilt; density and sound-speed measurements)
Biological sampling		Target and/or stratified net hauls	Target net hauls with opening and closing nets
Biological sample processing		Species composition	Species composition; length-frequency data for target species; length–weight relationship for target species
Oceanographic data	Typical salinity and temperature data required for calibration	Observations of temperature and salinity to sampling depth during cruise	Multiple, on-transect measurements of temperature and salinity to sampling depths
Vessel speed		Constant speed if possible	Constant (optimised for survey coverage and to minimise noise)

*[1] Calibration should be undertaken using standard methods (Foote et al., 1987) with sphere at a depth of 15–25 m below transducer and be fully documented.
*[2] Maximum power should not exceed 25 kW m^{-2}. Recommended power settings: 18 kHz with 11° beam angle (2 kW); 38 kHz (2 kW); 70 kHz (750 W); 120 kHz (250 W); 200 kHz (110 W); 333 kHz (40 W) all with 7° beam angle. Source Korneliussen et al. (2004).
*[3] A shorter pulse length will be necessary for *in situ* target strength measurements.

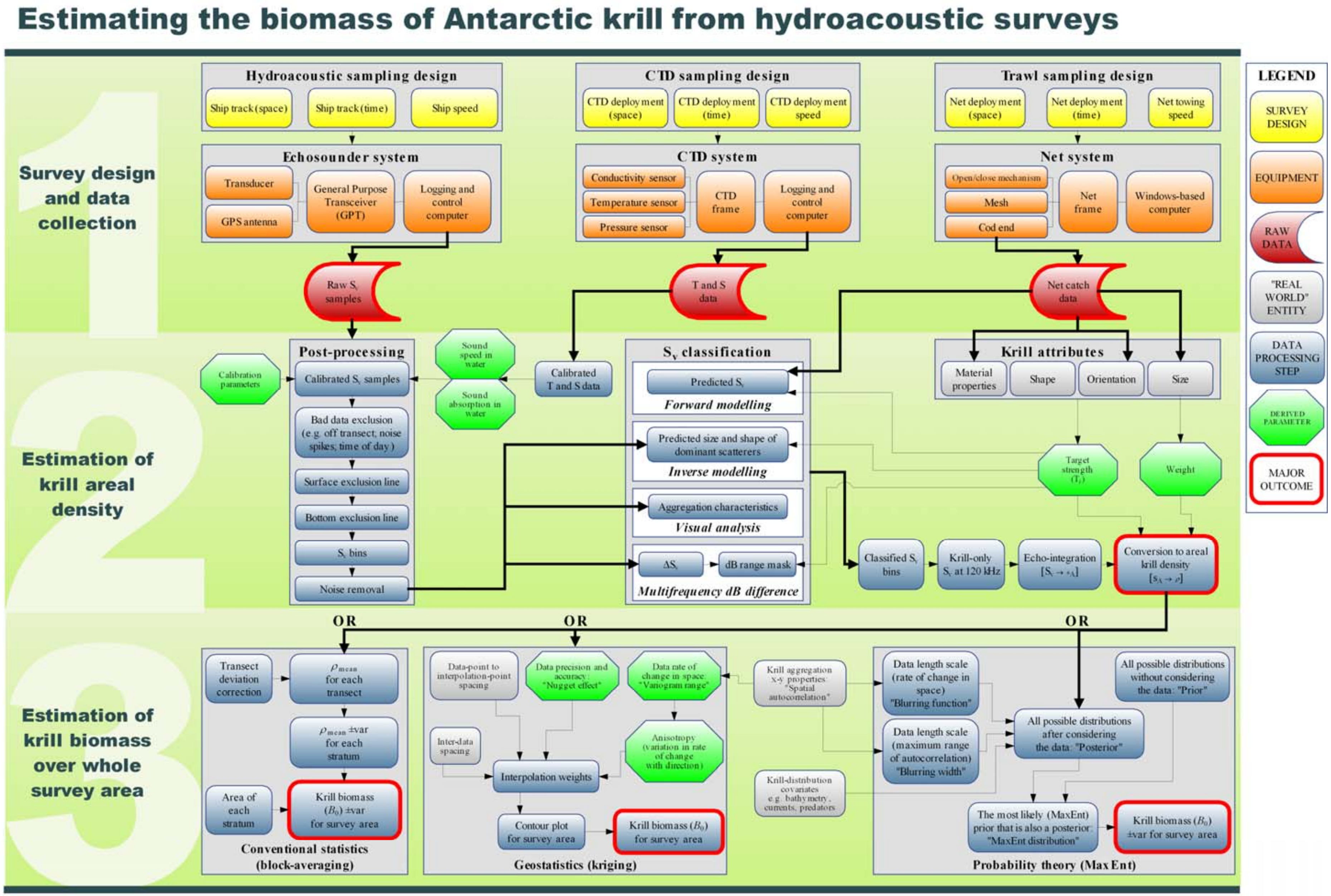

Figure 1: Flow chart outlining typical steps for acoustic data collection and analysis of krill surveys.

APPENDIX A

TERMS OF REFERENCE

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)
(Cambridge, UK, 30 April to 2 May 2007)

WG-FSA recommended the following terms of reference for SG-ASAM (SC-CAMLR-XXV, Annex 5, paragraphs 13.16 to 13.19):

(i) to develop, review and update as necessary, protocols on:

(a) the design of acoustic surveys to estimate the abundance index of nominated species;

(b) the analysis of acoustic survey data to estimate the biomass of nominated species, including estimation of uncertainty (bias and variance) in those estimates;

(c) the archiving of acoustic data, including data collected during acoustic surveys, acoustic observations during trawl stations, and *in situ* target strength measurements;

(ii) to evaluate results of acoustic surveys carried out in the CCAMLR Convention Area in previous years;

(iii) to estimate target strength and its statistical characteristics for key species in the CCAMLR Convention Area;

(iv) to use data from acoustic surveys to investigate ecological interactions and produce information for ecosystem monitoring and management.

2. WG-FSA noted that the focus of SG-ASAM regarding the work of WG-FSA should remain with resolving difficulties identified with the estimation of icefish abundance. However, it also recognised that estimates of the abundance and distribution of pelagic species are needed (namely, *Pleuragramma* spp., myctophid spp.), when developing ecosystem models (SC-CAMLR-XXIII, Annex 4, paragraph 6; SC-CAMLR-XXIV, Annex 4, Appendix D).

3. WG-FSA recommended that an immediate issue for WG-FSA to be further addressed by SG-ASAM is the acoustic protocol for assessing *C. gunnari* in Subarea 48.3, including:

(i) classification of volume backscattering strength attributed to *C. gunnari* versus other taxa with special attention to multiple-frequency acoustic methods;

(ii) further improvements in target strength estimates for *C. gunnari* using a variety of methods including physic-based and empirical models, *in situ* measurements and *ex situ* measurements;

(iii) combination of trawl and acoustic indices for stock assessment;

(iv) uncertainty assessment for *C. gunnari* biomass and abundance indices from combining trawl and acoustic surveys;

(v) protocols for archiving data.

4. WG-FSA recommended that the issues relevant to application of acoustic methods for pelagic finfish estimates should be addressed to SG-ASAM, including:

(i) frequency-specific definition of myctophid spp. target strength;

(ii) classification of volume backscattering strength of myctophid spp. versus other taxa with special attention to multiple frequency acoustics methods.

5. The Scientific Committee agreed to extend the above terms of reference for SG-ASAM to include the development of acoustic sampling protocols for the CCAMLR-IPY projects, and agreed that the CCAMLR-IPY steering group hold a planning meeting in association with SG-ASAM (SC-CAMLR-XXV, paragraph 13.39).

6. WG-EMM also requested SG-ASAM to provide input to its krill workshop on what is the most appropriate method for estimating B_0 from survey data, considering design-based versus model-based estimation methods. It also requested SG-ASAM to review the method for estimating CV for the biomass estimate provided by Demer and Conti (2005) and consider whether this is sufficient to determine the uncertainty in B_0 more generally (SC-CAMLR-XXV, Annex 4, paragraph 6.50).

APPENDIX B

AGENDA

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)
(Cambridge, UK, 30 April to 2 May 2007)

1. Introduction
   1.1 Opening of meeting
   1.2 Meeting terms of reference and adoption of the agenda
   1.3 Review of the findings and recommendations of previous meetings of SG-ASAM

2. New information available on icefish acoustics

3. Recommendations for future work on icefish

4. Presentations on other acoustic surveys in the CCAMLR area

5. General issues relevant to acoustic surveys in CCAMLR waters

6. New information available on krill acoustics

7. Recommendations for future work on krill

8. Suggestions for timing/venue of next meeting

9. Preparation and adoption of report (part 1)

10. Joint session review of the acoustic sampling protocols for krill for use by CCAMLR-IPY projects, including: (i) survey design; (ii) documentation of survey methods; (iii) presentation of results; and (iv) protocols for archiving data

11. Preparation and adoption of joint session report (part 2)

12. Close of the meeting.

APPENDIX C

LIST OF PARTICIPANTS

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)
(Cambridge, UK, 30 April to 2 May 2007)

BELCHIER, Mark (Dr)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom markb@bas.ac.uk
COLLINS, Martin (Dr) (Co-convener)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom macol@bas.ac.uk
DEMER, David (Dr)	National Marine Fisheries Service Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla , CA 92037 USA david.demer@noaa.gov
FIELDING, Sophie (Dr)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom sof@bas.ac.uk
IVERSEN, Svein (Mr)	Institute of Marine Research Pelagic Fish Group Nordnesgaten 50 PB Box 1870 Nordnes 5817 Bergen Norway sveini@imr.no

JARVIS, Toby (Dr)	Australian Antarctic Division Department of the Environment and Water Resources Channel Highway Kingston Tasmania 7050 Australia toby.jarvis@aad.gov.au
KORNELIUSSEN, Rolf (Dr) (Invited Expert)	Institute of Marine Research Research Group Observation Methodology Nordnesgaten 50 PB Box 1870 Nordnes 5817 Bergen Norway rolf@imr.no
KNUTSEN, Tor (Dr)	Institute of Marine Research Research Group Plankton Nordnesgaten 50 PB Box 1870 Nordnes 5817 Bergen Norway tor.knutsen@imr.no
MACAULAY, Gavin (Dr) (Invited Expert)	National Institute of Water and Atmospheric Research (NIWA) Private Bag 14-901 Kilbirnie Wellington New Zealand g.macaulay@niwa.co.nz
NAGANOBU, Mikio (Dr)	Southern Ocean Living Resources Research Section National Research Institute of Far Seas Fisheries 2-2-14 Fukuura Kanazawa-ku Yokohama, Kanagawa 236-8648 Japan naganobu@affrc.go.jp
O'DRISCOLL, Richard (Dr) (Co-convener)	National Institute of Water and Atmospheric Research (NIWA) Private Bag 14-901 Kilbirnie Wellington New Zealand r.odriscoll@niwa.co.nz

WATKINS, Jon (Dr)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom j.watkins@bas.ac.uk

Secretariat:

David RAMM (Data Manager)	CCAMLR PO Box 213 North Hobart 7002 Tasmania Australia david@ccamlr.org

APPENDIX D

LIST OF DOCUMENTS

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)
(Cambridge, UK, 30 April to 2 May 2007)

SG-ASAM-07/1	Agenda
SG-ASAM-07/2	List of Participants
SG-ASAM-07/3	List of Documents
SG-ASAM-07/4	CCAMLR acoustic database: 2007 update Secretariat
SG-ASAM-07/5	Improved target identification of mackerel icefish using commercial and scientific observations (Powerpoint presentation) S. Fielding, M. Collins, I. Everson and A. Reid (UK)
SG-ASAM-07/6	Collaborative optical-acoustic survey technique (COAST) applied to rockfish in the SCB (Powerpoint presentation) D. Demer, J. Butler, D. Pinkard and K. Franke (USA)
SG-ASAM-07/7	Descriptive analysis of mesopelagic backscatter from acoustic data collected in the Ross Sea (Powerpoint presentation) R. O'Driscoll (New Zealand)
SG-ASAM-07/8	South Georgia myctophid survey, March 2004 (Powerpoint presentation) M. Collins (UK)
SG-ASAM-07/9	The 2006 BROKE-West acoustic survey of krill distribution and abundance in CCAMLR Division 58.4.2 (Powerpoint presentation) T. Jarvis, N. Kelly, E. van Wijk, S. Kawaguchi and S. Nicol (Australia)

Other Documents

SC-CAMLR-XXIV	SC-CAMLR. 2005. Report of the First Meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM). In: *Report of the Twenty-fourth Meeting of the Scientific Committee (SC-CAMLR-XXIV),* Annex 6. CCAMLR, Hobart, Australia: 563–585.

SC-CAMLR-XXV	SC-CAMLR. 2006. Report of the Second Meeting of the Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM). In: *Report of the Twenty-fifth Meeting of the Scientific Committee (SC-CAMLR-XXV),* Annex 6. CCAMLR, Hobart, Australia: 479–501.
WG-FSA-03/14	Report of the Subgroup on Fisheries Acoustics (British Antarctic Survey, Cambridge, UK, 18 to 22 August 2003)
WG-FSA-SAM-04/9	Application of the bootstrap-method in assessment of target strength regression parameters on the basis of *in situ* measurements P.S. Gasyukov and S.M. Kasatkina (Russia)
WG-EMM-05/36	Preliminary report of sound speed contrast and density of krill measured on board RV *Kaiyo Maru* Y. Takao, H. Yasuma, R. Matsukura and M. Naganobu (Japan)
WG-EMM-06/16	Biomass of Antarctic krill (*Euphausia superba*) off East Antarctica (30–80°E) in January–March 2006 T. Jarvis, E. van Wijk, N. Kelly, S. Kawaguchi and S. Nicol (Australia)

WORKSHOP ON BIOREGIONALISATION OF THE SOUTHERN OCEAN

(Brussels, Belgium, 13 to 17 August 2007)

Executive Summary

Report of the Workshop

EXECUTIVE SUMMARY

(This summary is not a document adopted by the Workshop participants.
It has been prepared by the Co-conveners, Drs P. Penhale and S. Grant.)

CONTENTS

EXECUTIVE SUMMARY*

WORKSHOP ON BIOREGIONALISATION OF THE SOUTHERN OCEAN

(Brussels, Belgium, 13 to 17 August 2007)

INTRODUCTION

The CCAMLR Workshop on Bioregionalisation of the Southern Ocean was held in Brussels, Belgium, from 13 to 17 August 2007. It was co-convened by Drs P. Penhale (USA) and S. Grant (UK).

2. The agenda was prepared based on the Workshop terms of reference as agreed by the Scientific Committee (SC-CAMLR-XXIV, paragraph 3.66) (Appendix A). The Workshop itself was organised around two subgroups considering the benthic and pelagic systems respectively.

3. The Workshop report deals with Data, Methods and Results, focusing separately on benthic and pelagic discussions within each section. It was adopted in full and constitutes advice to the Scientific Committee. This paper summarises the major Workshop outcomes and advice.

WORKSHOP BACKGROUND

4. Paragraphs 7 to 14 of the Workshop Report provide a summary of its background. Particular note should be taken of the Scientific Committee's agreement in 2006 (SC-CAMLR-XXV, paragraph 3.33) that the following components of work should be undertaken in developing a system of MPAs for the Convention Area:

(i) technical development of methods for bioregionalisation of the Southern Ocean
(ii) consideration of methods for selection and designation of MPAs.

5. The primary aim of the Workshop was to advise on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces (SC-CAMLR-XXV, paragraph 3.34; Workshop Report, paragraphs 10 and 11). It essentially focused on component (i) in paragraph 4 above.

6. The importance of ongoing cooperation between CEP and CCAMLR has also been highlighted (Workshop Report, paragraphs 12 and 13) as important in the context of elaborating a 'systematic environmental geographic framework', environmental monitoring and identification of sensitive or vulnerable areas.

7. In planning its work, the Workshop drew on the report of an Experts Workshop on Bioregionalisation of the Southern Ocean conducted in September 2006 in Hobart, Australia,

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* This summary is not a document adopted by the Workshop participants. It has been prepared by the Co-conveners, Drs P. Penhale and S. Grant.

by WWF-Australia and ACE CRC (2006 Hobart Workshop) (Grant et al., 2006). The 2006 Hobart Workshop was aimed at developing a 'proof of concept' for a broad-scale bioregionalisation of the Southern Ocean, using remotely-sensed physical environmental data as the primary inputs.

8. The Workshop noted that the primary end-use of bioregionalisation analysis would be to assist in achieving the conservation of marine biodiversity, which can include the development of representative MPAs.

9. Bioregionalisation may also inform other end-uses, including, *inter alia*, ecological modelling, ecosystem monitoring, a framework for assessing risk and directing further research. Bioregionalisation outputs form one component of systematic conservation planning, which includes consideration of biodiversity patterns and processes, and the definition of conservation targets within a framework of rational use (Workshop Report, paragraph 17).

10. It was agreed that the benthic and pelagic systems should be considered separately, since current knowledge of benthic-pelagic coupling is not sufficient to allow a combined benthic-pelagic bioregionalisation to be produced at this stage (Workshop Report, paragraph 18).

11. The Workshop agreed that, ideally, the definition of appropriate scales should be data-driven, but that often this will need to be supplemented with expert advice (Workshop Report, paragraph 19). It is important that actual heterogeneity of ecosystem processes and biodiversity patterns is still represented at relevant scales.

12. Temporal scales were also seen as important. The Workshop agreed that temporal scales are different in the pelagic compared to the benthic environment, with temporal variability needing to be reflected within an appropriately sized spatial region.

EXISTING CLASSIFICATIONS AND APPROACHES TO BIOREGIONALISATION

13. Several presentations described existing classification systems and approaches to bioregionalisation (Workshop Report, paragraphs 21 to 38). The Workshop agreed to endorse the outcomes of the 2006 Hobart Workshop, and to adopt its primary classification (Workshop Report, paragraph 26).

DATA

Pelagic data

14. Several presentations provided information on the types of data that might be used in a pelagic bioregionalisation analysis (Workshop Report, paragraphs 39 to 61).

15. The Workshop considered available bathymetric, physical oceanographic and biological data for the pelagic bioregionalisation. It noted that the datasets used in the 2006 Hobart Workshop were a useful starting point for any further analyses on the pelagic realm (Workshop Report, paragraph 39).

16. Key discussions (Workshop Report, paragraphs 39 to 64) were on the use of available data for a pelagic bioregionalisation, including the generation of derived datasets, the reflection of key determinants of ecosystem structure and function or specific processes related to biota of interest, and the utility of generating process layers (Workshop Report, paragraphs 157 to 164) for comparison with bioregionalisation outcomes.

17. It was noted that, for most physical datasets, some future work to consider mean state, seasonal variation and interannual variation would be desirable (Workshop Report, paragraph 44).

18. Biological datasets indicating spatial attributes of different areas were considered (Workshop Report, paragraphs 50 to 64). It was determined that some of these datasets might be most appropriately used at the regional scale.

19. The Workshop reaffirmed its understanding that productivity and factors affecting production levels should be taken into account when considering the results of data-driven bioregionalisation, and that this was best carried out by means of expert evaluation (Workshop Report, paragraph 59).

20. The Workshop noted that CPR survey data are likely to be valuable for Southern Ocean bioregionalisation, since methods are standardised across a wide geographical area (Workshop Report, paragraph 62). Other biological data considerations are outlined in the Workshop Report, paragraph 63.

21. The SCAR-MarBIN network allows users to search, display and extract taxonomy and distribution information for many Southern Ocean species. The Workshop welcomed the continuing development of SCAR-MarBIN and recognised that it is of great present and potential value to bioregionalisation (Workshop Report, paragraph 38).

Benthic data

22. WS-BSO-07/10 described recent analyses of biogeographic patterns of benthic invertebrate megafauna on shelf areas of the Southern Ocean Atlantic sector. The Workshop noted that this work highlights the importance of physical features, such as bottom temperature and water mass features, in influencing patterns of benthic communities. Future work of this nature was encouraged, and it was suggested that it may be possible to use water mass features to gain insight into benthic biogeography for other regions where little data is available (Workshop Report, paragraphs 65 to 68).

23. The Workshop considered which datasets would be most useful for a benthic bioregionalisation, the robustness and quality of these datasets, and use of other datasets that could potentially be useful. The Workshop agreed that bathymetric data, sea-floor temperature and current data, geomorphology data, sediment data and sea-ice concentration data are important (Workshop Report, paragraphs 69 to 71).

24. Regarding biological datasets available for benthic bioregionalisation, the Workshop noted that for the most part, biological data are primarily restricted to shelf areas. Although these data are largely patchy, they are considerably better known than data from slope and deep ocean regions (Workshop Report, paragraphs 72 to 73).

25. Given such limitations, the Workshop agreed that biological data to be considered for inclusion for analysis could include data on molluscs, data from SCAR-MarBIN, fine-scale data on invertebrate abundance and composition along the Antarctic Peninsula and presence/absence data for demersal finfish (Workshop Report, paragraph 74).

26. In addition, it was agreed that a finer-scale geomorphic dataset of the East Antarctic margin and adjacent ocean basins from 55°S to the coast and 38°E to 164°E (Geoscience Australia) would be included as soon as feasible (Workshop Report, paragraph 78). It is anticipated that an Antarctic-wide geomorphic map will be available soon.

27. A number of biological datasets used for validation of the benthic bioregional classification are described in the Workshop Report, paragraph 79. The majority of biological data used for validation were extracted from SCAR-MarBIN.

METHODS

Pelagic methods

28. The 2006 Hobart Workshop adopted a mixed non-hierarchical and hierarchical pelagic classification method. The methods, datasets and statistical routines are explained and provided in Grant et al. (2006).

29. The Workshop recognised that there are large amounts of biological data from the Southern Ocean, which are currently available, or are likely to become available in the near future. These data are potentially very useful for bioregionalisation, although each dataset needs to be considered in detail.

30. The Workshop recommended a hierarchical, two-level approach to bioregionalisation of the pelagic domain (Workshop Report, paragraph 89):

(i) broad-scale circumpolar bioregionalisation which provides delineation of approximately 20 regions;

(ii) fine-scale bioregionalisation of each broad-scale region separately.

31. Various other Workshop discussions on the data and analyses involved in a pelagic realm bioregionalisation can be found in the Workshop Report, paragraphs 90 to 93. Key conclusions are that:

(i) circumpolar, spatially-extensive data layers are required to determine broad-scale bioregionalisation;

(ii) biological data are likely to be particularly valuable at the fine scale (Workshop Report, paragraph 91);

(iii) spatial and temporal heterogeneity occurs at a broad range of scales, and fine-scale bioregions should be aimed at scales appropriate to management (Workshop Report, paragraph 92);

(iv) static maps can be used to identify meaningful bioregions in the Southern Ocean that reflect consistent differences between ecological patterns and processes in different areas (Workshop Report, paragraph 93).

32. The Workshop endorsed the general methodology used to provide a broad-scale regionalisation of the Southern Ocean from the 2006 Hobart Workshop. It also agreed that, at the broad scale, the primary bioregionalisation from the 2006 Hobart Workshop was a good working product that could be used to inform spatial management of the Convention Area (Workshop Report, paragraphs 94 and 95).

33. The Workshop agreed that the broad-scale bioregionalisation from the 2006 Hobart Workshop could potentially be enhanced by considering, *inter alia*:

(i) additional data layers representing seasonal variation in environmental conditions;

(ii) additional data layers representing interannual variation in environmental conditions;

(iii) new environmental parameters (e.g. mixed layer depth (MLD), primary production: see Workshop Report, paragraph 49);

(iv) use of biological data to transform and combine environmental data layers;

(v) consideration of spatial variability in data layer quality.

34. Five methods of how biological data could be used to enhance bioregionalisation of the Southern Ocean were discussed (Workshop Report, paragraphs 97 to 121). These included the BRT method for modelling single response variables using several predictors.

35. The Workshop applied biological data and the BRT method to investigate whether the bioregionalisation result from the 2006 Hobart Workshop could be enhanced by the use of spatially extensive biological data layers (Workshop Report, paragraphs 102 to 104). It noted that the use of layers representing the spatial distributions of certain zooplankton species in the Southern Ocean could help to delineate broad-scale bioregions (Workshop Report, paragraph 103).

36. The Workshop was concerned that extrapolation outside the range of the data, both in geographic and environmental space, was potentially unreliable (Workshop Report, paragraph 106). Extrapolation in biological space relies on the assumption that the relationship between biology and environment represented in the training data is consistent across geographic space. This assumption was investigated in relation to CPR zooplankton-derived groupings, and the data were extrapolated through the Southern Ocean by the BRT method (Workshop Report, paragraphs 106 to 108 and Figures 1 and 2).

37. Spatially continuous modelled distributions for four taxa (krill, salps, pteropods and copepods) were added to the broad-scale bioregionalisation from the 2006 Hobart Workshop. The methods and results are described in the Workshop Report, paragraphs 109 to 111 and 132 to 144.

38. The Workshop noted that Species Habitat Modelling may also be a valuable tool for capturing heterogeneity, particularly at finer scales (Workshop Report, paragraphs 114 to 121).

39. The Workshop noted that fine-scale bioregionalisation of the clusters produced from the broad-scale bioregionalisation should use appropriate information on environment, biology and process. Considerable amounts and a variety of data were identified for potential use in the fine-scale bioregionalisation. (See Workshop Report, paragraphs 39 to 64 and paragraphs 157 to 164 for details of data that could be used.) Since the data used in fine-scale bioregionalisation do not have to be circumpolar, nor be measured consistently between broad-scale bioregions, much more information can be used for fine-scale bioregionalisation than can be used for broad-scale (circumpolar) bioregionalisation.

Benthic methods

40. The approach to a benthic bioregionalisation consisted of a three-step process, by which physical regions (Workshop Report, paragraph 77) were first defined using the process employed by the 2006 Hobart Workshop (Workshop Report, paragraph 14). The biological data were then overlaid, and the classification evaluated (Workshop Report, paragraph 79).

41. Further work on this classification was undertaken after the Workshop, under the guidance of the Workshop conveners, using the methods described above (SC-CAMLR-XXVI/BG/23).

42. An additional evaluation was undertaken for the western Antarctic Peninsula by overlaying biological data in this region with the geomorphological provinces map. A range of analyses were undertaken to investigate species richness and numbers of sampling stations per geomorphic polygon. The results are described in the Workshop Report, paragraphs 147 and 148.

RESULTS

Pelagic results

43. The results of the broad-scale primary regionalisation from the 2006 Hobart Workshop were fully reported in Grant et al. (2006). The resulting map is shown in Figure 3 of the Workshop Report, and contains 14 regions summarised in Table 1 of the report . This broad-scale bioregionalisation differentiates between coastal Antarctica (including embayments), the sea-ice zone and northern open-ocean waters. The analysis highlights the different environmental characteristics of large regions, including the continental shelf and slope, frontal features (SAF, PF, SACCF), the deep ocean, banks and basins, island groups and gyre systems.

44. The 2006 Hobart Workshop had included ice and remotely sensed near-surface chl-*a* concentration in a 'secondary' classification displayed with 40 groups (Grant et al., 2006, Figures 21, 23 and 25). It could not achieve consensus regarding plausibility of the spatial patterns shown in this secondary regionalisation.

45. The Workshop endorsed the broad-scale 'primary' regionalisation produced by the 2006 Hobart Workshop. This uses clustering based on four environmental variables (log10 depth, SST, silicate concentration, nitrate concentration) with an agreed display resolution of 14 groups (Workshop Report, Figure 3). The Workshop felt that this classification was a good first-stage bioregionalisation and a potentially valuable tool at the broad circumpolar scale.

46. The Workshop re-displayed the 'secondary' classification from the 2006 Hobart Workshop to show 20 groups (Workshop Report, Figure 4) to be consistent with the chosen display resolution of the classification obtained using biological data layers (Workshop Report, paragraph 143 and Figures 5 and 6).

47. The Workshop agreed that the BRT method for generating biological data layers is a valuable development and that biological layers could be used to enhance the 2006 Hobart Workshop bioregionalisation of the Southern Ocean at the circumpolar scale. The Workshop encouraged further work, also at the species level, to be submitted to the Scientific Committee as working papers. The Workshop also noted there were many approaches to using biological data in a broad-scale bioregionalisation of the Southern Ocean that warrant further investigation.

48. The Workshop agreed that the statistical method (BRT) it had employed for the production of continuous biological species distributions and abundances should be considered for wider use in the future (Workshop Report, paragraph 139).

49. The Workshop was supportive of the potential for the BRT method to produce biological data layers for broad-scale and fine-scale bioregionalisation. Some Workshop participants noted particular enthusiasm for the krill abundance data layer derived from the data of Atkinson et al. (2004). However, the Workshop suggested that the method be written up and submitted for technical review by WG-SAM (Workshop Report, paragraphs 140 and 141).

50. The Workshop noted that WG-EMM and WG-FSA might be asked to review the appropriateness of the datasets to be included as response variables (biological data) and those for inclusion as environmental layers which relate to processes giving rise to the data in the biological datasets.

51. Two outputs (Workshop Report, Figures 5 and 6) were produced for a trial pelagic bioregionalisation using additional biological layers at the circumpolar scale.

52. The Workshop agreed that the approach using physical and biological layers in bioregionalisation is promising and that, subject to addressing the issues in paragraphs 49 and 50, results from this approach will be useful in the future.

Benthic results

53. Initial maps of a physical regionalisation of the benthic environment in the Southern Ocean were developed using the same approach as the 2006 Hobart Workshop to generate a primary regionalisation of the pelagic environment (Workshop Report, paragraph 145).

54. The Workshop was satisfied that the methods outlined in the Workshop Report, paragraphs 125 to 128, were consistent with the 2006 Hobart Workshop, and that they could be used as a basis for an initial benthic physical classification.

55. The results of further work on this benthic classification are presented in SC-CAMLR-XXVI/BG/23.

56. The geomorphic map of the East Antarctic margin (Workshop Report, Figure 10) showed some key features relevant to benthic bioregionalisation, including shelf banks, depressions, steep slope areas, canyons, sediment mounds, seamounts, fracture zones and abyssal plain areas.

57. The identified geomorphic provinces were used to select and classify the biological point data. These data were then analysed by applying the techniques outlined in the Workshop Report, paragraphs 129 to 131 and Figures 11, 12 and 13.

58. These figures demonstrate that there is variation in known species numbers between similar geomorphic provinces. Species distribution is therefore affected by factors additional to geomorphology, such as sampling effort or ice cover. Observed differences in patterns of species distribution and sampling effort show that potential biodiversity hotspots are not necessarily related to sampling effort. These methods could be further applied to validate the benthic physical classification.

Ecological processes

59. The Workshop noted that in providing a framework for understanding spatial structure and function of ecosystems, it is important to consider biodiversity pattern information as well as spatially defined ecological processes (Balmford et al., 1998; Cowling et al., 2003). This can be of assistance to a spatial decision-making framework, which was used in developing the conservation plan for the Prince Edward Islands (WS-BSO-07/P1). The Workshop endorsed the approach to develop maps representing ecological processes and other features that cannot easily be incorporated into an analysis of spatial pattern.

60. Biodiversity patterns are the spatial representation of the distribution of species or habitats at a defined scale, whilst ecological processes are actions or events that shape biodiversity patterns and ecological interactions at different scales (e.g. upwelling events, spawning areas or foraging areas). Ecological processes can be either flexible in time and space (e.g. oceanic fronts) or fixed (e.g. related to a geomorphic feature).

61. Whilst the Workshop's bioregionalisation analysis was successful in capturing the physical and biological patterns of the Southern Oceans, the Workshop felt that this needs to be complemented by mapping of spatially defined processes.

62. The Workshop noted that ecological processes can be mapped spatially in two ways:

(i) flexible processes can be mapped using spatial probability data (e.g. kernels)
(ii) fixed processes can be mapped using fixed features that define the process (e.g. geomorphic features).

63. The Workshop considered available ecological process data as well as other information that could easily be acquired. It noted that some of these datasets can be incorporated within a bioregionalisation analysis, whilst others are best depicted as separate spatial overlays. The results of this discussion are shown in Table 2 of the Workshop Report.

64. Whilst ecological process information should be used at the circumpolar scale considered at this Workshop, it was noted that these data will become more important at a finer-scale regional level. The reasons for this are: (i) many process datasets are regional in scale (e.g. tracking data for top predators); (ii) expert knowledge of spatially defined ecosystem processes can be more easily incorporated at a regional scale. It therefore follows that the best areas to develop further fine-scale bioregionalisation are mostly likely those geographical areas where most information and expert knowledge exists.

65. Some of the spatially defined ecosystem processes considered to be important are shown in Figures 14 to 17 of the Workshop Report.

FUTURE WORK

66. The Workshop agreed that:

(i) the primary pelagic regionalisation described in the Workshop Report, paragraphs 132 and 133 can be regarded as useful for application by CCAMLR and CEP;

(ii) initial regionalisation of the benthic environment should be reviewed and optimised for use by CCAMLR and CEP. The overall Workshop results and data show that there will be a greater heterogeneity in biodiversity and ecosystem structure and function at finer scales;

(iii) refinements of this bioregionalisation could be made in the future as methods are improved and data acquired and analysed. Further finer-scale bioregionalisation work could be undertaken in a number of areas using existing data;

(iv) future work could include efforts to delineate fine-scale provinces, where possible;

(v) workshop participants should submit papers to the Scientific Committee on approaches to fine-scale regionalisation, including on statistical methods and potential data sources;

(vi) WG-SAM should be requested to consider the statistical methods presented in the Workshop Report, paragraphs 140 and 141;

(vii) inclusion of process and species information could be considered further, particularly in the context of systematic conservation planning, and in developing a spatial decision-making framework (Workshop Report, paragraph 157). This may be particularly applicable at finer scales.

Geomorphology

67. The Workshop recognised that the work carried out so far suggests that mapping of sea-floor geomorphology provides additional information that integrates physical data into the bioregionalisation process. Extension of this work to cover the whole CAMLR Convention Area would be valuable. Updated sea-floor sediment maps would also be useful for benthic bioregionalisation.

Fine-scale bioregionalisation data availability

68. The Workshop recognised that biological data existed in some smaller-scale regional areas which might be utilised to further delineate broad-scale bioregionalisation. These would include long-term datasets from the Southern Scotia Sea, Ross Sea, East Antarctic Sea as well as other areas.

69. Specific data sources of potential relevance are described in the Workshop Report, paragraphs 171 to 176. They include finfish data from research surveys, benthic data from scientific bottom trawl surveys and museum collections, krill biomass and distribution data, and fine-scale physical oceanographic data from national research efforts.

70. It was noted that with increasing data entry into the SCAR-MarBIN network and with additional data expected from the CAML-IPY joint research effort, this network will become of great importance for future data access. Currently, many of these data are dispersed widely and stored by individual scientists or institutes and are thus very difficult to access.

71. The Workshop recognised that CCAMLR's efforts to define SSMUs may be useful in fine-scale bioregionalisation efforts because this work investigates relationships among finfish, krill, predator and prey species. The workshop noted it may be possible to include data on other components of the ecosystem and use similar techniques to those employed to define SSMUs.

72. The Workshop considered gaps in the current sets of data, and identified future efforts that are likely to improve data coverage and quality (Workshop Report, paragraphs 178 and 179).

Development of fact sheets

73. The Workshop agreed that the development of a bioregionalisation atlas of fact sheets would be a valuable resource for CCAMLR and CEP. This would provide a standardised approach to reporting and archiving results of bioregionalisation work for the Southern Ocean

in the same manner that Fishery Reports are developed for each fishery in CCAMLR. Since their inception, Fishery Reports have been found to be a useful way to present detailed information for use by CCAMLR during meetings and intersessionally, as well as for the public at large to understand how work in CCAMLR is undertaken.

74. A bioregionalisation atlas could follow the approach illustrated in WS-BSO-07/9, where a hierarchy of sheets are presented showing regional features, and where more detailed features, bioregions and provinces are depicted on finer-scale sections of the Southern Ocean in subsidiary sheets. Fact sheets could include maps of relevant bioregions and provinces as well as maps showing locations of important processes, colonies or aggregations of biota and other summarised details considered important for managing bioregions.

75. This format also provides a means for easily reviewing, refining and updating bioregional information and classification in specific areas without needing to revise the classification for the entire Southern Ocean.

76. The Workshop agreed that such an atlas could be developed based on the results of the primary regionalisation agreed at this Workshop, preliminary results on how finer-scale heterogeneity might exist within those regions, and supplementary information from the ecological process layers and other data layers considered in this report.

Further work on the development of a system of MPAs

77. The workshop noted that bioregionalisation could serve as one component of work to be undertaken towards the development of a system of MPAs for the Convention Area (SC-CAMLR-XXV, paragraph 3.33). Further work on the consideration of methods for the selection and designation of MPAs is required, and the Workshop noted that this work could include the further development of ecological process information, including spatial information on human activities. Intersessional work focusing on systematic conservation planning, possibly for finer-scale areas, could be an important contribution to achieving this goal.

REPORT OF THE WORKSHOP

CONTENTS

REPORT OF THE WORKSHOP ON BIOREGIONALISATION OF THE SOUTHERN OCEAN

(Brussels, Belgium, 13 to 17 August 2007)

INTRODUCTION

Opening of the Meeting

The CCAMLR Workshop on Bioregionalisation of the Southern Ocean was held in Brussels, Belgium, from 13 to 17 August 2007. The Workshop was convened by Drs P. Penhale (USA) and S. Grant (UK).

2. The Co-conveners welcomed all participants and, in particular, the invited experts:

- Dr B. Danis, SCAR-MarBIN, Royal Belgian Institute of Natural Sciences
- Dr G. Hosie, SCAR, Australian Government Antarctic Division
- Dr M. Kahru, Scripps Institution of Oceanography, USA
- Dr M. Vierros, United Nations University, Institute of Advanced Studies, Japan.

3. Special thanks were extended to Belgium, in particular, to Mr A. de Lichtervelde and his team from the Federal Public Service Public Health, Food Chain Security and Environment, for their warm hospitality, financial support and hosting of the Workshop.

Adoption of the agenda and organisation of the meeting

4. The Workshop agenda was prepared based on the Workshop terms of reference as agreed by the Scientific Committee (SC-CAMLR-XXIV, paragraph 3.66):

1. To facilitate collaboration between the CCAMLR Scientific Committee and CEP in this work.

2. To facilitate the involvement of appropriate experts in this work.

3. To coordinate and facilitate:

   (i) collating existing data on coastal provinces, including benthic and pelagic features and processes;

   (ii) collating existing data on oceanic provinces, including benthic and pelagic features and processes;

   (iii) determining the analyses required to facilitate a bioregionalisation, including the use of empirical, model and expert data;

   (iv) developing a broad-scale bioregionalisation based on existing datasets and other datasets possibly available prior to the Workshop;

   (v) delineating fine-scale provinces within regions, where possible;

(vi) establishing a procedure for identifying areas for protection to further the conservation objectives of CCAMLR.

4. To organise a Workshop to establish a bioregionalisation for the CCAMLR Convention Area and to consolidate advice on a system of protected areas (SC-CAMLR-XXIV, Annex 7, paragraph 144).

The adopted agenda is in Appendix A.

5. The Workshop participants are listed in Appendix B. The documents submitted to the Workshop are listed in Appendix C.

6. The report of the meeting was prepared by Workshop participants. The report includes sections on Data, Methods and Results, focusing separately on benthic and pelagic discussions within each section.

WORKSHOP BACKGROUND

7. Participants recalled the 2005 CCAMLR Workshop on MPAs (2005 MPA Workshop) as background for the present bioregionalisation effort. In 2005, the Scientific Committee endorsed the advice from the Workshop that conservation outcomes appropriate for achieving the objectives of CCAMLR Article II would include the maintenance of biological diversity, as well as the maintenance of ecosystem processes (SC-CAMLR-XXIV, paragraph 3.54(iii)). The Scientific Committee also endorsed the advice of the 2005 MPA Workshop that attention may need to be given to, *inter alia*, the protection of (SC-CAMLR-XXIV, paragraph 3.54(iv)):

(i) representative areas – a system of representative areas would aim to provide a comprehensive, adequate and representative system of MPAs to contribute to the long-term ecological viability of marine systems, to maintain ecological processes and systems, and to protect the Antarctic marine biological diversity at all levels;

(ii) scientific areas to assist with distinguishing between the effects of harvesting and other activities from natural ecosystem changes as well as providing opportunities for understanding of the Antarctic marine ecosystem without interference;

(iii) areas potentially vulnerable to impacts by human activities, to mitigate those impacts and/or ensure the sustainability of the rational use of marine living resources.

8. The Scientific Committee had also noted the views of the 2005 MPA Workshop on the potential importance of making provision in protected area systems for the protection of spatially predictable features (such as upwellings and fronts) that are critical to the function of local ecosystems (SC-CAMLR-XXIV, paragraph 3.55 and Annex 7, paragraph 131).

9. The Scientific Committee further agreed that key tasks needed, in particular, to consider a system of protected areas to assist CCAMLR in achieving its broader conservation objectives are (SC-CAMLR-XXIV, paragraph 3.64):

(i) a broad-scale bioregionalisation of the Southern Ocean;

(ii) a fine-scale subdivision of biogeographic provinces, which may include hierarchies of spatial characteristics and features within regions, giving particular attention to areas identified in the bioregionalisation;

(iii) identification of areas that might be used to achieve the conservation objectives;

(iv) determination of areas requiring interim protection.

10. In 2006, the following two separate components of work to be undertaken towards the development of a system of MPAs for the Convention Area were identified (SC-CAMLR-XXV, paragraph 3.33):

(i) technical development of methods for bioregionalisation of the Southern Ocean
(ii) consideration of methods for selection and designation of MPAs.

11. The Scientific Committee decided that the focus of the 2007 Bioregionalisation Workshop should be on technical development of methods for bioregionalisation of the Southern Ocean. The aim of the 2007 Bioregionalisation Workshop should be to advise on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces (SC-CAMLR-XXV, paragraph 3.34). Consequently, the Scientific Committee recognised that the 2007 Bioregionalisation Workshop will essentially focus on component (i) in paragraph 10 above. It recognised that work on component (ii) should proceed in parallel, with the submission of relevant papers to either the Scientific Committee or its working groups. The Scientific Committee anticipated that further work towards the development of methods for the selection and designation of MPAs will be progressed by the Scientific Committee.

12. At CEP X (New Delhi, India, 2007), CCAMLR introduced an information paper which updated progress towards the CCAMLR Bioregionalisation Workshop. CCAMLR encouraged CEP participation in this Workshop, and noted the relevance of this work to the Committee, particularly with regard to the elaboration of the ‘systematic environmental geographic framework’, environmental monitoring and identification of sensitive or vulnerable areas. The importance of this work in relation to ongoing cooperation between CEP and CCAMLR was also highlighted.

13. CEP encouraged its Members to work together with their CCAMLR colleagues on this initiative and looked forward to the outcomes of the Workshop (CEP, 2007, paragraph 194).

14. In planning its work on the abovementioned objective, the Workshop noted the report of the Experts Workshop on Bioregionalisation of the Southern Ocean conducted in September 2006 in Hobart, Australia, by WWF-Australia and ACE CRC (2006 Hobart Workshop) (Grant et al., 2006). The aim of this workshop was to develop a ‘proof of concept’ for a broad-scale bioregionalisation of the Southern Ocean, using remotely-sensed physical environmental data as the primary inputs.

15. Dr Grant introduced WS-BSO-07/11 on key questions and considerations for bioregionalisation analysis. The paper highlighted the need to establish a conceptual framework in which the analysis can be undertaken, with clear principles and objectives, focused at appropriate and relevant spatial scales.

16. The Workshop noted that the primary end-use of bioregionalisation analysis would be to assist in achieving the conservation of marine biodiversity, which can include the development of representative MPAs.

17. Bioregionalisation may also inform other end-uses, including, *inter alia*, ecological modelling, ecosystem monitoring, a framework for assessing risk and directing further research. Bioregionalisation outputs form one component of systematic conservation planning, which includes consideration of biodiversity patterns and processes, and the definition of conservation targets within a framework of rational use.

18. It was agreed that the benthic and pelagic systems should be considered separately. Prof. A. Clarke (UK) noted that, although there are some links between the benthic and pelagic systems, current knowledge of benthic–pelagic coupling is not sufficient to allow a combined benthic–pelagic bioregionalisation to be produced at this stage.

19. A range of scales for bioregionalisation can be considered according to available input data and end-user requirements. The Workshop agreed that, ideally, the definition of appropriate scales should be data-driven, but that often this will need to be supplemented with expert advice. It is important that actual heterogeneity of ecosystem processes and biodiversity patterns is still represented at relevant scales.

20. It is also important to consider temporal scales. The Workshop agreed that temporal scales are different in the pelagic environment compared to the benthic environment. It is important to ensure that this variability is captured within an appropriately sized spatial region.

EXISTING CLASSIFICATIONS AND APPROACHES TO BIOREGIONALISATION

21. Dr A. Constable (Australia) presented the results of the 2006 Hobart Workshop, which were presented to, and considered by, the Scientific Committee (SC-CAMLR-XXV, paragraphs 3.44 to 3.52) and the Commission (CCAMLR-XXV, paragraphs 6.1 to 6.6).

22. In introducing the 2006 Hobart Workshop, Dr Constable noted that:

(i) the broad aims of the Workshop were –

  (a) to consider important relationships between taxa, ecological processes and physical characteristics;

  (b) to determine appropriate data for use in the classification (physical data, data transformations, indicator species);

  (c) to group points using synoptic data that are relatively homogenous and different from a neighbouring group, taking account of uncertainties;

(ii) bioregionalisation with perfect and complete data could identify –

  (a) the relationships within and between assemblages of species;

(b) the realised niches (physical and biological environment) of species;

(c) biogeographic differences in species and assemblages, including the nature and uncertainty of transition boundaries arising from spatial clustering;

(iii) conservation of marine biodiversity will need to give consideration to the ranges of organisms and processes in the region, including consideration of the global distribution (relative to circum-Antarctic) and local abundances (relative to fine-scale areas, e.g. a seamount) of species. In that case, the importance of an area to a species might be judged in a relative sense in the following schema for taxa –

(a) globally common (found in most places), locally abundant (when found is often in high abundance): an individual area would be less important to the conservation of the population or species;

(b) globally common (found in most places), locally rare (when found is most often in low abundance): an individual area to these taxa would be considered more important than for those taxa above, but would be less important than the following;

(c) globally rare (found in one or only a few places), locally abundant (when found is often in high abundance): endemic taxa where an individual area would be important to the conservation of the population or species, but the species may be relatively robust compared to the following;

(d) globally rare (found in one or only a few places), locally rare (when found is most often in low abundance): an individual area would be critical to the conservation of the population or species.

23. Dr Constable indicated that the 2006 Hobart Workshop participants had concluded, and the report showed, that a bioregionalisation is possible with sparse data. He noted that a bioregionalisation, for the purposes of conservation of marine biodiversity, with sparse data needs to:

(i) avoid giving undue weight to globally common, locally common species as drivers in the analysis;

(ii) avoid the homogenising effect of temporal variability, e.g. a combined dataset indicates greater spatial coverage of organisms when those organisms are actually associated with specific environmental features that vary over time (e.g. coincidence of organisms with ocean fronts);

(iii) ensure spatial data are unbiased with respect to bioregionalisation classification;

(iv) match scales of data with scales of interest – Southern Ocean data tends to be on large scales (few smaller-scale replicates) and therefore difficult to use for finer-scale subdivisions;

(v) for parameters used in correlations, relate to the same location and same time; if not extrapolation/interpolation errors need to be accounted for in making correlations;

(vi) adopt a process that accounts for statistical Type II errors as well as Type I errors, i.e. avoid concluding there is no heterogeneity when heterogeneity exists, which, in this context, means using available data to identify whether heterogeneity at smaller scales is plausible and to what extent might there be important heterogeneity to account for when using the bioregionalisation.

24. Dr Constable concluded his presentation by noting that, at the 2006 Hobart Workshop:

(i) a statistically rigorous approach had been adopted and used in the physical classification;

(ii) experts verified that outcomes were plausible;

(iii) natural latitudinal and longitudinal differences are evident in results, including spatial subdivision of banks and the continental shelf.

25. Participants noted that in the course of the 2006 Hobart Workshop:

(i) Issues examined included the choice of data and extraction of relevant parameters to best capture ecological properties. The final method involved the use of a clustering procedure to classify individual sites into groups that are similar to one another within a group, and reasonably dissimilar from one group to the next.

(ii) The primary datasets retained by the agreed primary classification and used in the analysis were depth, SST, silicate concentration and nitrate concentration. These highlighted the different environmental characteristics of large regions including the continental shelf and slope, frontal features (SAF, Polar Front (PF) and SACCF), the deep ocean, banks and basins, island groups and gyre systems.

(iii) A secondary analysis added ice concentration and annual mean chlorophyll-*a* (chl-*a*) values. The addition of these datasets suggested smaller-scale spatial heterogeneity within the regions, particularly in the continental shelf and slope areas, and the seasonal ice zone.

(iv) The final stages of the analysis included discussion on how well the defined regions corresponded to our present knowledge of the Southern Ocean. Experts provided information on expected patterns and features according to current observations and understanding, and these largely concurred with the outcomes of the analysis.

26. The Workshop agreed to endorse the outcomes of the 2006 Hobart Workshop, and to adopt the primary classification.

27. Prof. Clarke gave a presentation on the use of biological data in bioregionalisation analysis. He noted that one of the 14 regions identified at the 2006 Hobart Workshop was the

Antarctic shelf region, and described the extent to which this region could be subdivided based on biological data, using the distribution and abundance of molluscs (gastropods and bivalves) from the Southern Ocean Molluscan Database (SOMBASE).

28. A map of the distribution of samples shows that although molluscs have been collected from most areas of the Southern Ocean, three areas have received particular attention. These are the western Antarctic Peninsula and Scotia Sea, the eastern Weddell Sea and the Ross Sea. Areas that have been particularly poorly sampled are the continental slope and the deep sea (though this is being addressed by the Antarctic Benthic Deep-sea Biodiversity (ANDEEP) Program), the Amundsen and Bellingshausen Seas and parts of East Antarctica. Rarefaction analysis suggested that a significant number of species remain to be discovered; recent experience suggested that these will likely prove to be small species, or species identified by molecular methods.

29. Analysis of the SOMBASE data indicated that most Antarctic molluscs are uncommon or rare (or at least rarely sampled), and relatively few have circumpolar distributions. As a result, relatively few areas of the Southern Ocean have a high recorded species richness. An attempt can be made to correct for the effects of this spatial variability in sampling effort by using the residuals around a regression line fitted to the species richness/sampling intensity relationship. However, a map of such corrected data still showed highest diversities in the most-studied regions, indicating that correction for sampling error has been only partially successful.

30. Cluster analysis of presence/absence data can be used to divide the Antarctic Shelf region into a series of biogeographic provinces. These largely match provinces established previously, and suggest that there are important variations in molluscan diversity and assemblage composition around Antarctica that may be used to add a biological layer to the preliminary physical regionalisation established previously.

31. Dr Vierros gave a presentation on approaches to biogeographic classification of the world’s oceans. International policy developments of importance to bioregionalisation include targets established by the World Summit on Sustainable Development and the Convention on Biological Diversity. The presentation noted international expert groups and bodies dealing with bioregionalisation, and global datasets that are available as a result of this work, which might be of interest to similar efforts in the Southern Ocean.

32. Selected global biogeographic classification systems were reviewed, concentrating in particular on two recent efforts developed to support international conservation and management of marine biodiversity. These were the Marine Ecoregions of the World (MEOW) and the deep- and open-ocean biogeographic criteria under development as a result of a recent international workshop hosted by Mexico.

33. The presentation then provided an overview of some common issues encountered in biogeographic classification of marine systems. These included the need for clear objectives for the bioregionalisation, which serve to inform the selection of data, the scale of data and the weighting of data. Additionally, the presentation discussed the types of data (biological, ecological and mixed) commonly used, the methods applied (qualitative, quantitative), scale considerations and classification systems (hierarchical, non-hierarchical). The presentation concluded by highlighting the need for periodic review of bioregion boundaries as a result of new sampling efforts, improved technology, and effects of climate change.

34. Dr B. Sharp (New Zealand) introduced WS-BSO-07/6 which undertook to:

(i) diagram and explain the underlying conceptual premises of the bioregionalisation process. It is important to distinguish environmental space (the environmental and oceanographic conditions at different places), biological space (biological organisms and processes at different places) and geographic space (the location). Bioregionalisation aims to map biological space into geographic space and then simplify it in a meaningful way. The need to determine the relationship between environmental space and biological space arises due to the patchiness of biological data, hence the need for a proxy to inform interpolation and extrapolation;

(ii) review a number of marine environment classifications that have been produced by New Zealand using a variety of methods, and highlight methodological and practical lessons of particular relevance to the CCAMLR bioregionalisation process.

35. Several methods have been used for bioregionalisation in New Zealand (WS-BSO-07/6). The particular strengths and weaknesses of the following three classifications used in New Zealand were presented:

(i) an environmental classification that was optimised to represent a wide variety of both benthic and pelagic taxa;

(ii) an environmental classification that was optimised in particular to represent demersal fish communities;

(iii) a biological classification that used a new hierarchical multiple regression modelling package called Boosted Regression Trees (BRT: see paragraph 99) to generate spatially comprehensive distribution layers for individual species of demersal fish, and then created a spatial classification using these biological layers directly.

36. Dr Sharp noted that CCAMLR could benefit from the following lessons arising from the New Zealand experience (WS-BSO-07/6):

(i) use biological data in bioregionalisation;

(ii) model species individually;

(iii) generate a classification based on abundance, not presence/absence;

(iv) use the most powerful statistical methods available, such as BRT and Generalised Dissimilarity Modelling (GDM);

(v) use a hierarchical clustering algorithm;

(vi) focus on an environment or community of particular interest;

(vii) include information representing uncertainty.

37. He also noted that dynamic aspects of functionally important ecosystem processes will often need to be captured using a separate parallel process.

38. Dr Danis presented information on the ongoing development of the SCAR-MarBIN network. The web-based SCAR-MarBIN system allows users to search, display and extract taxonomy and distribution information for many Southern Ocean species. Access to metadata for interpretation and searching of data is also available. The Workshop welcomed the continuing development of SCAR-MarBIN and recognised that it is of great present and potential value to bioregionalisation.

DATA

Pelagic data

39. The Workshop considered bathymetric, physical oceanographic and biological data available for the pelagic bioregionalisation. It noted that the datasets used in the 2006 Hobart Workshop were a useful starting point for any further analyses on the pelagic realm. The following paragraphs provide important considerations when using available data for a pelagic bioregionalisation.

40. GEBCO data provide a common foundation for bathymetry data layers.

41. Physical oceanographic data for the Southern Ocean are available from a number of sources, including satellites, ocean (WOCE) transects and other CTD and at-sea observations, and model interpolation and outputs:

(i) SST and sea-surface height can be typically obtained and interpolated from satellite data.

(ii) Nutrient data are derived from discrete ocean sampling and contoured as a function of time. A variety of data sources are publicly available, including the WOCE dataset, the Southern Ocean Atlas (Orsi and Whitworth, 2005 compiled at Texas A&M University, USA), and historical data from the US National Ocean Data Center. Certain regions, such as the Antarctic Peninsula, Weddell Sea and Ross Sea, have high-resolution data (in both space and time) and can be obtained for use (e.g. from the Alfred Wegener Institute, Bremerhaven, Germany, and the Center for Coastal Physical Oceanography, Old Dominion University, USA). Also available are model outputs, which can be compared to the observed distributions in space (e.g. output from OCCAM/FRAM).

(iii) Mixed-layer depth (MLD) derived from temperature and salinity data and a preferred mixed-layer definition. Two versions of datasets for MLD based on this approach are the World Ocean Atlas (Levitus et al., 1994; Levitus and Boyer, 1994) and the Southern Ocean Atlas (Orsi and Whitworth, 2004). It was noted that the Southern Ocean Atlas data have been subjected to a fair degree of scrutiny and quality control. Simulated datasets that provide MLD are the OCCAM/FRAM Southern Ocean simulations (available from Southampton via www.noc.soton.ac.uk/JRD/OCCAM/) and regional models such as the Ross Sea and West Antarctic Peninsula circulation models (Hoffman, pers. comm.) and a regional model for the Weddell Sea (Alfred-Wegener Institute). Blended model-data products include the Simple Ocean Data Assimilation reanalysis products (Carton et al., 2000a, 2000b; www.atmos.umd.edu/~ocean/). This provides temperature and salinity from which MLD can be calculated.

42. Additional ocean information is included in some charts, such as the widely used mean front locations by Orsi et al. (1995). The Workshop noted that, rather than using these specifically in a spatial realisation, it would be useful to plot these as a process layer (paragraphs 157 to 164) for comparison with the outcomes of the bioregionalisation.

43. Sea-ice concentration and extent are available from satellite datasets. Ice concentrations and associated parameters (e.g. ice extent and area) are derived using data from the Special Sensor Microwave Imager (SSM/I) on the Defense Meteorological Satellite Program (DMSP) and mapped on a polar stereographic grid at a 25 × 25 km resolution. Ice concentrations are generally derived from satellite passive microwave data using the enhanced bootstrap algorithm used for the Advanced Microwave Scanning Radiometer – Earth Observing System (AMSR-E) data and adapted for SSM/I data (e.g. Comiso et al., 2003; Comiso, 2004). The Workshop noted that these or some derivative dataset, such as average over time, rates of retreat or some transformed dataset, could be used in the bioregionalisation. However, it was also noted that the type of dataset to be used will need to be determined by whether it was to reflect key determinants of ecosystem structure and function or to reflect specific processes related to biota of interest. Care would need to be taken to ensure that some parameters did not become over-represented in the analyses.

44. The Workshop noted that, for most physical datasets, some consideration of mean state, seasonal variation and interannual variation would be desirable in this work in the future.

45. Dr Kahru presented WS-BSO-07/5 on spatial patterns of temporal relationships in the Southern Ocean. He noted that phytoplankton production during the austral summer in the Southern Ocean is known to be limited by iron and light. Distributions of satellite-detected chl-*a* show very complex and time-variable patterns that are hard to explain. Analyses of covariance between several satellite-detected and modelled variables showed that this covariance in time between the MLD, SST and chl-*a* can be used to map areas where different factors control phytoplankton production. Statistically significant spatial patterns in the covariance between MLD, SST and chl-*a* show that the physical factors controlling phytoplankton production in the Southern Ocean change in a predictable manner. Areas where phytoplankton is light-limited in the summer due to insufficient stratification were defined along with other areas where phytoplankton is clearly limited by nutrients (probably iron). The boundary between light limitation and nutrient limitation can be sharp and is sometimes, but not always, associated with the main hydrographic fronts (e.g. SAF). The correlation coefficient between MLD and chl-*a* has a characteristic banded structure.

46. Dr Kahru also showed that similar but opposite banded structure is visible in the correlation structure between SST and chl-*a*. The latter correlation is more reliable as an indicator, as both are actually measured variables (the MLD is based on a model). In the sub-tropics the correlation between MLD and chl-*a* is clearly positive which means that higher chl-*a* is associated with deep MLD and lower chl-*a* is associated with shallow MLD. This is indicative of a regime where nutrients are limiting for phytoplankton growth and the limiting nutrients are provided by vertical mixing. More stratification (with shallow MLD) means less

nutrient input from below and therefore lower chl-*a*. South of about 40°S in the Atlantic and Indian Oceans and about 50°S in the Pacific Ocean is a band of negative correlation between MLD and chl-*a* (positive correlation between SST and chl-*a*) where increased chl-*a* is associated with more stratified conditions. This is the regime where phytoplankton is not generally limited by nutrients but by light due to deep mixing and insufficient vertical stratification. The southern edge of this band coincides often with the mean position of the SAF. Further to the south the banded structure breaks down and the correlation patterns show not only zonal but also more meridional variability. The other major fronts (PF, SACCF and the southern boundary of the ACC (SBDY)) show some relationship with the correlation patterns but the similarity is rather local. For example, around South Georgia the PF and SACCF delineate the area where light limitation (insufficient stratification) is evident. Along the Antarctic Peninsula the nutrient limitation state (between PF and SACCF) changes abruptly to light-limited state near the coast (south of SACCF and SBDY).

47. Dr Kahru noted that the mean surface chl-*a* for the October to March period of 1996 to 1997 was created with a new algorithm (SPGANT) based on Southern Ocean data (Mitchell, 1999) using combined Ocean Colour and Temperature Scanner (OCTS) (1996–1997) and SeaWiFS (1997–2007) data. Some of the high chl-*a* areas are related to the main hydrographic fronts. For example, the high chl-*a* areas of the Scotia Sea and South Georgia area are centred on the SACCF (between the PF to the north and the SBDY to the south) and are supported by eddy mixing through SACCF (Kahru et al., 2007). Mean concentrations in the extreme southern part of the Southern Ocean have to be treated with caution as they are based on only a few measurements. The maximum number of valid monthly measurements using OCTS (October 1996 to March 1997) and SeaWiFS (November 1997 to March 2007) is currently 65. Extensive cloud cover significantly reduces the number of available satellite data. In the Weddell Sea and in some other areas, ice cover during most years reduces the number of available months to only 1 or 2 (dark purple colour in WS-BSO-07/5, Figure 2) during the 11 years of measurements.

48. The Workshop noted that:

(i) the predictability of the mean patterns in satellite-detected chl-*a* is important and useful as it also corresponds to the distribution patterns of zooplankton;

(ii) satellite-derived chl-*a* could be biased in the Weddell Sea due to a lower number of observations and a shorter season than other areas in the time-averaged period. These could bias a regionalisation if the potential for under-sampling is not addressed;

(iii) the use of Empirical Orthogonal Function/Principal Component (EOF/PC) analysis could be difficult because the chl-*a* distributions are very complex and even using EOF/PC analysis does not provide much insight as the EOFs are hard to explain and there are many EOFs. For example, in an analysis of chl-*a* distribution of the Fram Strait/Scotia Sea area, the first three EOFs describe only 26.5% of the total variability;

(iv) chl-*a* patterns can be affected by eddies (Kahru et al., 2007). They are easily detected by satellite altimetry. Most intense eddies are in the PF area but these eddies have a relatively weak influence on chl-*a* distribution as nutrient concentrations change little across PF. The relatively weak eddies in the SACCF have a strong influence on the chl-*a* distribution as described in the cited paper.

49. Primary productivity is significantly correlated with the distribution of sea-surface chl-*a* as measured from satellites, although it was noted that care was needed in defining the time period over which a measure of mean chl-*a* might be derived so as not to inadvertently bias the data from incomplete or poor sampling in some areas, i.e. average over a month was less likely to cause bias than averaging over a six-month period. Other factors that could be important determinants of primary production could be the insolation of an area, the amount of cloud cover, SST and MLD. Photosynthetically active radiation (PAR) may also be important. It was noted that different derivative spatial datasets could be used, such as total production over a season, average seasonal production, length of period in which most production occurs, interannual variability in production, and difference between lowest and highest over the monitoring period.

50. Biological datasets indicating spatial attributes of different areas were considered. These included data from krill net sampling, krill acoustic surveys, CPR sampling, penguin foraging areas, seabird foraging tracking data, and East Antarctic pack-ice seal surveys. It was determined that some of these datasets might be most appropriately used at the regional scale.

51. A multidecadal-scale krill and salp dataset compiled by Atkinson et al. (2004) was considered. This database was assembled from net sampling data from multiple sources at a circumpolar scale. Concerns were raised about data standardisation across methods. Some of these data have been collected using different methods and at different times during the year as well as at varying spatial coverage and locations over the period of sampling. Dr V. Siegel (Germany) offered advice to improve data standardisation.

52. Krill acoustic survey data are available for Subareas 48.1, 48.2, 48.3 and 48.4 and Divisions 58.4.1 and 58.4.2. These data, although collected for estimating biomass of krill, could be used to help with finer-scale regionalisation.

53. Dr P. Trathan (UK) described the process by which WG-EMM had previously delineated the SSMUs for the krill fishery in the southwest Atlantic. He suggested that many of the issues considered by WG-EMM in 2002 had great relevance to the bioregionalisation of the Southern Ocean.

54. Dr Trathan emphasised that the delineation of SSMUs and a bioregionalisation of the Southern Ocean were both complex processes that involved subdivision of geographic, environmental and biological structure in the ecosystem. Environmental structure spanned a broad range of spatial and temporal scales while numerous species and communities were also highly variable in space and/or time.

55. Such a subdivision of the ecosystem would require data-driven analyses, however, not all such analyses could rely on equally comprehensive and robust data. Furthermore, some ecological processes were difficult to delineate in space and time. Consequently, expert opinion was of crucial importance in judging where appropriate boundaries could be developed.

56. Dr K. Shust (Russia) described the role of specific hydrographic features in the Southern Ocean and the impact of bottom topography which influenced the circumpolar distribution of marine organisms to the south of the PF. Such factors led to the creation of localised highly productive areas within gyres and eddies close to continental shelf areas surrounding the sub-Antarctic islands and over submarine banks.

57. Dr Shust identified that of the sub-Antarctic islands, the highest productivity was observed in Subarea 48.3 around South Georgia. This area had supported a high level of commercial harvesting in the past. At present it supports sustainable fisheries for Patagonian toothfish, mackerel icefish and Antarctic krill. Dr Shust suggested that a similar situation occurred in the Ross Sea where productivity was high and where there was a fishery for Antarctic toothfish. In contrast, Dr Shust suggested that in the waters surrounding the Kerguelen Archipelago, productivity was lower and that this was mainly due to the absence of hydrological conditions that would support the formation of large krill concentrations. Consequently, the biomass of local populations of Patagonian toothfish and mackerel icefish were lower than in the South Georgia area. In addition, Dr Shust indicated that toothfish length was also reduced, possibly because of the absence of krill that were likely to be important to toothfish at early stages of development.

58. Dr Shust suggested that these examples demonstrated that the Southern Ocean was spatially heterogenous and that the bioregionalisation should take into account levels of productivity, especially in local areas, as well as associated indicator species. Furthermore, the regionalisation should take into account those environmental conditions that are responsible for maintaining productivity.

59. The Workshop reaffirmed its understanding that productivity and factors affecting production levels should be taken into account when considering the results of data-driven bioregionalisation, and that this was best carried out by means of expert evaluation.

60. Dr W. Smith (USA) presented a summary of the oceanography of the Ross Sea continental shelf, including physical, chemical and biological oceanography. The region has been a focus of study for over a century due to the proximity to the continent's major research and logistics base, McMurdo Station. Because of the extensive investigations, a large dataset is available that may allow the area to be used to test some of the ideas about fine-scale bioregionalisation. Dr Smith noted the following:

(i) The continental shelf break is a delimiter of distributions and processes. A current flows along the shelf break and induces intrusions onto the shelf, which are a source of heat and micronutrients.

(ii) Ice concentrations and distributions are controlled by polynya processes, which result in an ice-free region near the Ross Sea ice shelf that seasonally expands to the north. Substantial interannual variability in ice occurs, and recent iceberg groundings have accentuated this variability (Arrigo et al., 2002; Dinniman et al., 2007).

(iii) Chemical and biological climatologies (long-term means) have been generated for the region (Smith et al., 2003). The seasonal uncoupling of nitrate and silicic acid is clear, as is the dominance in spring by the haptophyte *Phaeocystis* *antarctica*. Climatologies of pigments confirm these spatial patterns. However, significant interannual variations in the distribution of pigments and chemical substances occur (Peloquin and Smith, 2007), in a manner similar to those of ice.

(iv) The food web of the Ross Sea ice shelf is relatively well known and is dominated by ice and seasonal production (Smith et al., 2007). However, notable gaps occur in our knowledge, especially with regard to the middle trophic levels (*Euphausia crystallorophias*, *Pleuragramma antarcticum*) and the large, mobile and migratory species (whales, squid). This food web is in stark contrast to the 'typical' Antarctic krill-based food web that occurs elsewhere.

(v) Away from the coast, the distribution of benthic fauna is largely controlled by sea-floor habitats rather than surface productivity patterns (Barry et al., 2003).

(vi) Significant increases in the ice cover in the Ross Sea have occurred since 1979, nearly balancing the decreases observed in the Amundsen-Bellingshausen sector (Kwok and Comiso, 2002). Based on a bio-optical model, a significant increase in productivity of the entire Southern Ocean has been detected, but this increase cannot be attributed to a change in any one particular region (Smith and Comiso, submitted).

(vii) A list of data sources for the Ross Sea that may be used in addition to those large-scale datasets was compiled and presented.

61. Dr Hosie presented the outcomes and datasets from the Southern Ocean CPR (SO-CPR) Survey collections since 1991. The details of this survey work are clearly provided in WS-BSO-07/P4, 07/P5 and 07/P6. The purpose of this work was to map the biodiversity of zooplankton, variation in biodiversity patterns, and to monitor the health of the region by using the sensitivity of plankton to environmental change as early warning indicators. The survey involves Australia, Germany, Japan, New Zealand and the UK, and is a SCAR program supported by the Action Group on CPR Research. In particular, Dr Hosie noted that:

(i) spatial, seasonal, annual and long-term variability in plankton patterns has been monitored primarily in eastern Antarctica between 60° and 160°E and south of 48°S with some transects in other parts of the Southern Ocean;

(ii) the CPR is towed behind the ships at a depth of about 10 m, sampling in the ship's wash which mixes the top 20 m. Each tow produces approximately 450 n miles (833 km) of continuous plankton data. The SO-CPR dataset comprises abundance data (counts) of zooplankton for 5 n mile sections. Zooplankton species are identified to species or the lowest possible taxon. Developmental stages of euphausiids are included;

(iii) published papers describe the fine-scale distributions of species and assemblages in relation to the frontal and sub-branches, including season variation (Takahashi et al., 2002; Umeda et al., 2002; Hunt and Hosie, 2006a, 2006b; WS-BSO-07/P4, 07/P5, 07/P6).

(iv) the CPR has been used for rapidly and repeatedly surveying plankton on ocean-basin scales, including helping define bioregions and substantial changes in plankton composition in the North Sea and the North Atlantic Ocean;

(v) a zooplankton atlas for the Southern Ocean is being prepared, noting that there is evidence of small and longer temporal variation in spatial composition in the plankton of eastern Antarctica;

(vi) the characteristics of this method are:

- the CPR is towed horizontally so diurnal migration effects need to be considered – higher zooplankton abundances usually occur at night at the surface;
- small aperture of 12.5 x 12.5 mm is suited more for sampling mesozooplankton, although it does catch adult Antarctic krill;
- soft gelatinous zooplankton are poorly sampled, although high numbers of larvaceans are caught;
- some species are difficult to identify, often due to damage in being trapped on the silk mesh, or have not been properly described – some zooplankton are grouped as families or orders;
- the best spatial cover is between 60° and 160°E, although other tows have been done east to the Ross Sea and further west between Drake Passage and south of Africa;
- most of the data have been collected from September to April and most since 1997, although some data extend back to 1991 and some winter tows have been conducted.

62. The Workshop noted that due to standardisation of methods across a wide geographical distribution, these data are likely to be valuable for bioregionalisation.

63. For other biological datasets, the Workshop noted that:

(i) fish survey data could be used in some areas, although pelagic survey data are very limited geographically. Typically, commercial species can be mapped by topographic features. Other species might be more locally distributed and habitat dependent;

(ii) considerable data exist on Antarctic pack-ice seal distribution and abundance in East Antarctica taken with a rigorous methodology (Southwell et al., 2007);

(iii) with respect to whaling records and fisheries data, such data are confounded by both biological and commercial factors influencing where activities occurred. While data for some species have been standardised, this has not been done for many species, particularly by-catch. For these reasons, it was considered that these data were not able to be used by the Workshop;

(iv) the predicted marine mammal distributions (University of British Columbia) were derived using expert knowledge combined with physical parameters to infer distributions globally. As yet, these distributions have not been validated;

(v) seabird sightings-at-sea data have the potential for inconsistency in the implementation of the methods between observers and therefore make these data difficult to use for the purposes of the bioregionalisation.

64. The Workshop noted that a spatial dataset should preferably comprise data using a standard methodology. This is most important for analyses within regions but may not be as necessary between regions if the within-region classification is most important. However, if there is reason to have a between-region comparison of the classification on the same scales, then data would need to be sampled in a consistent way across regions.

Benthic data

Background

65. WS-BSO-07/10 was introduced by Dr C. Jones (USA). In this study, benthic invertebrate megafaunal communities of five shelf habitats within the Atlantic sector of the Southern Ocean from scientific survey trawl catches were quantitatively analysed in order to identify and characterise such communities for comparative purposes at a fine spatial scale. The region for which the greatest complexity of data was available, the northern Antarctic Peninsula and the South Shetland Islands, revealed a two-layered pattern based on standardised invertebrate biomass density data and the composition of phyla that contributed to that biomass. Relative to biomass, the shelf area adjacent to the northern Antarctic Peninsula is comprised of regions with extremely high levels of invertebrate biomass (particularly hexactinellid sponge dominated communities) compared to the relatively sparse South Shetland Island shelf. The situation is reversed at each region’s easternmost shelves. In terms of composition, the demarcation occurs where the sponge dominated communities most frequently encountered on both shelf systems rather abruptly decline westwards on the shelf north of the South Shetland Islands off western King George Island. By referencing average sea-bottom temperatures for the region, the influence of the ACC and Weddell water masses was shown to capture the pattern of shelf faunal zonation.

66. The benthic invertebrate communities on the northern shelves of the South Shetland Islands and the northern Antarctic Peninsula can apparently be separated into two zoogeographic zones based on the physical properties of the ACC and the Weddell water masses that meet and mix in this region. Superimposed on this geographic pattern are the effects of disturbance regimes, whether by iceberg scouring or commercial bottom trawling, which work at smaller spatial scales.

67. Patterns of benthic invertebrate biomass are also described for the South Orkney Islands, as well as general patterns of composition at the level of phyla for South Georgia, the South Sandwich Islands and Bouvet Island. These latter regions are generally echinoderm dominated, relative to the hexactinellid sponge dominated northern Antarctic Peninsula region.

68. The Workshop welcomed this work, and agreed that this sort of high-resolution benthic data provides insight into benthic biogeographic patterns. The Workshop noted that this work highlights the importance of physical features, such as bottom temperature and water mass features, in influencing patterns of benthic communities. Mr H. Griffiths (UK) noted that recent collections around the Shag Rocks region have demonstrated a higher level of benthic diversity than that described in WS-BSO-07/10, and that the area is very patchy. Dr M. Pinkerton (New Zealand) indicated that there are statistical approaches that can be taken that could quantify relationships between position of water mass features and structure of benthic communities. The Workshop encouraged future work of this nature, and suggested that it could be possible to use water mass features to gain insight into benthic biogeography of other regions where little data is available.

Overview of various data sources available for benthic bioregionalisation

69. The Workshop addressed key areas that would lead to the most appropriate benthic bioregionalisation, including which datasets would be most useful, the robustness and quality of these datasets, and use of other datasets that could potentially be useful.

70. The Workshop agreed that optimal benthic bioregionalisation should include both physical and biological datasets.

71. The Workshop agreed that the following physical datasets could be considered for inclusion in the analysis:

(i) Bathymetric data – including information on the position of seamounts, trenches and canyons. The Workshop underscored the importance of identifying known seamounts in the Southern Ocean, as these regions are either known to have, or likely include, unique benthic fauna.

(ii) Sea-floor temperature data – the Workshop recognised the likely influence of sea-floor temperature on benthic biogeographic patterns.

(iii) Geomorphology data interpreted from bathymetry data and seismic reflection data in the SCAR Seismic Data Library System (see WS-BSO-07/8).

(iv) Sediment data – the Workshop noted that the available sediment map dates from 1991 and so should be viewed with caution. The degree to which sediment samples represent the sea floor varies with the horizontal variability of the sea-floor environment. The available map reliably represents the sediment distribution in the deep ocean with its uniformity. The continental shelf and slope, however, will be less reliably represented by the present widely spaced data points because of the complexity of the sea-floor in those regions.

(v) Sea-ice concentration – can provide clues as to food availability for benthos.

(vi) Southern Ocean bottom currents – the Workshop agreed that this information could provide useful information towards regionalisation. However, if this information is not available, the effects of these currents can be observed indirectly through geomorphology data.

72. Regarding biological datasets available for benthic bioregionalisation, the Workshop noted that for the most part, biological data are primarily restricted to shelf areas. Although these data are largely patchy, they are considerably better known than data from slope and deep ocean regions.

73. The Workshop noted that extremely little information is available on benthic fauna from the region between the Antarctic Peninsula and the Ross Sea in the vicinity of the Bellingshausen and Amundsen Seas, as well as the eastern Antarctic Peninsula region/western Weddell Sea.

74. Given these limitations, the Workshop agreed that the following biological datasets could be considered for inclusion in the analysis:

(i) mollusca dataset (SOMBASE);

(ii) data available from SCAR-MarBIN network;

(iii) fine-scale data on abundance and composition of invertebrates along the Antarctic Peninsula (WS-BSO-07/10);

(iv) demersal finfish data. With respect to demersal fish, the Workshop agreed it would be useful to examine data sources from SCAR-MarBIN, FishBase, as well as both scientific survey and fine-scale commercial catch data that are currently available in the CCAMLR database. The latter potentially provides additional insight into species distribution, as well as spatial patterns of finfish diversity and species richness, which the Workshop felt would potentially add to the benthic bioregionalisation effort. This data would not be examined in terms of abundance or catch rates, but in the form of presence/absence only.

75. The Workshop felt that it was important to not restrict the bioregions to any one group of taxa, since no one group is currently known to represent any others well.

76. The Workshop considered the importance of scale with respect to variability, since broad-scale patterns inevitably have some unrepresented small-scale variability. Within this context, the Workshop agreed that the question of consistency between large-scale and smaller-scale patterns should be addressed. The Workshop felt it would further be advantageous to produce maps that describe regions of benthic uncertainty.

Data used in the benthic bioregional classification

Physical data

77. A benthic bioregional classification was undertaken with physical data that were considered to be robust and to have a strong relationship with the distribution of species. All datasets used for the broad-scale classification covered the entire Southern Ocean. The following datasets were used for the initial broad classification:

- bathymetry (gridded (1 min) bathymetry from GEBCO)
- slope (degrees of incline derived from GEBCO)

- sea-floor temperature
- sea-floor sediment types.

Short descriptions of each dataset are available in Appendix D.

78. In addition, it was agreed that a finer-scale geomorphic dataset of the East Antarctic margin and adjacent ocean basins from 55°S to the coast and 38°E to 164°E (Geoscience Australia) would be included as soon as feasible. This dataset consists of a GIS of geomorphic features mapped at a scale of 1 to 1 million. In some shelf areas, the relationships are known between geomorphology, sea-floor processes, seabed type and biological communities. The geomorphic mapping integrates knowledge about physical process and their interaction with the seabed. In particular, it identifies areas likely to be scoured by icebergs and/or currents and identifies features likely to have unusual substrates of significance for biological communities such as seamounts and canyons. The incorporation of these data into statistical analyses has yet to be developed so the geomorphic map is used as a layer for comparison with the other analyses. It is anticipated that an Antarctic-wide geomorphic map will be available soon.

Biological data

79. A number of biological datasets were used for validation of the benthic bioregional classification. These included eight taxonomic groups, 33 000 records, 7 600 stations and 3 000 taxa (species). The data were selected for their robustness, for their quantitative nature and for their good spatial coverage. Combined, these data provided circumpolar coverage, although this was not the case for every individual dataset. The datasets included in the analysis were:

- Antarctic Echinoids
- SOMBASE
- Southern Ocean Sea Stars Biogeography
- Ant'phipoda (a database of amphipods)
- FishBase (benthic fish)
- Hexacorallia
- ZIN Brittlestars
- CCAMLR scientific survey and commercial finfish database (demersal fish – presence/absence only).

80. The majority of biological data used for validation were extracted from SCAR-MarBIN (www.scarmarbin.be). SCAR-MarBIN contains a total of 47 distribution datasets and 490 000 records. It establishes and supports a distributed system of interoperable databases, forming the Antarctic Regional Ocean Biogeographic Information System (OBIS) Node, under the aegis of SCAR. SCAR-MarBIN gives free and open access to raw data on Antarctic marine biodiversity. The majority of the datasets used in the framework of this exercise were directly downloaded from the SCAR-MarBIN webportal. A short description (metadata) of the datasets is given in Appendix D. The complete metadata record is available either from the SCAR-MarBIN webportal or from the Global Change Master Directory (GCMD) website.

METHODS

Pelagic methods

Summary of methods developed at the 2006 Hobart Workshop

81. The classification method adopted during the 2006 Hobart Workshop was a mixed non-hierarchical and hierarchical approach. Consideration of the methods, datasets and statistical routines are explained and provided in Grant et al. (2006). The classifications were performed on a 1/8th degree grid, covering the marine area from 80° to 40°S. The full set of 720 835 grid cells was subjected to a non-hierarchical clustering to produce 200 clusters. Hierarchical classification was then performed on these 200 clusters to produce a dendrogram and the final clustering at 14 and 40 levels.

82. Sites with missing data were excluded from the analyses. These were principally sites shallower than 200 m depth, for which the chosen nutrient data did not apply. These excluded sites are shown in the maps as white. Future work will need to fill in these missing cells.

83. The broad-scale (primary) regionalisation from the 2006 Hobart Workshop with 14 clusters or regions was derived from the following four environmental data layers:

(i) bathymetry (log10 transformed)
(ii) SST
(iii) nitrate (NOx) concentration
(iv) silicate (Si) concentration.

Descriptions of each of these datasets are provided in Appendix IV of Grant et al. (2006).

84. The ocean water masses combined with topography of the ocean floor were considered likely to define the primary features of the Southern Ocean and coastal Antarctic systems. SST was included as a proxy for the different water masses of the Southern Ocean. Topography (captured by bathymetric data) was included because of the ecological differentiation between shelf, slope and abyssal regions as well as the effect of bathymetry on upwelling, eddying and as a potential source of iron. Bathymetry was transformed (log10) to give increased weight to the areas shallower than 2 500 m. Silicate and nitrate concentrations were included to provide information on nutrient characteristics. Silicate concentration is related to phytoplankton production in some areas of the Southern Ocean. The silicate layer differentiated water masses in deeper water and along the various fronts, which may reflect differences in plankton communities. The nitrate and silicate climatologies at the 200 m depth layer were used, as this is likely to be an indicator of broad-scale long-term (annual) nutrient availability. Surface nutrients are likely to be seasonally depleted in areas of nutrient-limited productivity. However, the use of the 200 m depth layer resulted in missing data in the shelf areas of less than 200 m depth.

85. Two components of a fine-scale (secondary) regionalisation were explored at the 2006 Hobart Workshop. Descriptions of each of these two extra datasets are provided in Appendix IV of Grant et al. (2006), and are summarised below.

86. Sea-ice is known to influence the distribution of biology in the Southern Ocean, including affecting, *inter alia*, primary production, marine mammals and seabirds. The

impact of sea-ice on the environment was explored using a data layer comprising the long-term (more than 10 years) average number of days an area was covered by at least 15% concentration of sea-ice.

87. The concentration of satellite-observed sea-surface chl-*a* was explored using a data layer comprising log transformed chl-*a* densities from ocean colour satellite sensors. The chl-*a* distribution was truncated at 10 mg m^{-3} (where all values greater than 10 were made equal to 10). Near-surface chl-*a* concentration observed by satellite sensors is closely related to rates of primary production in the water column, and was considered to be a suitable proxy for the purposes of exploring spatial heterogeneity in primary production at the large scale.

Pelagic bioregionalisation methods considered at the 2007 Brussels Workshop

88. The Workshop recognised that there are large amounts of biological data of the Southern Ocean which are currently available, or are likely to become available in the near future. These biological data are potentially very useful for bioregionalisation, although each dataset needs to be considered in detail.

89. The Workshop recommended a hierarchical, two-level approach to bioregionalisation of the pelagic domain:

(i) broad-scale circumpolar bioregionalisation which provides delineation of approximately 20 regions;

(ii) fine-scale bioregionalisation of each broad-scale region separately.

90. Circumpolar, spatially extensive data layers are required to determine broad-scale bioregionalisation. There are a limited number of circumpolar data applicable. The Workshop considered how environmental, oceanographic, remotely sensed data and biological data layers can be used within this process (paragraphs 39 to 64), and noted that non-hierarchical clustering methods using these broad-scale data layers should not be used for fine-scale bioregionalisation.

91. The Workshop agreed that each of the broad-scale regions could be divided into fine-scale bioregions using all appropriate data on pattern and process within that broad-scale region. A greater quantity and variety of data will be applicable for fine-scale bioregionalisation than is available for broad-scale bioregionalisation. Biological data is likely to be particularly valuable at the fine scale.

92. The Workshop recognised that spatial and temporal heterogeneity occurs at a broad range of scales and further noted that the fine-scale bioregions should be aimed at scales appropriate to management.

93. Although there are inherent limitations in the use of static maps to represent spatially and temporally dynamic ecosystems, the Workshop agreed that it is possible to identify meaningful bioregions in the Southern Ocean that reflect consistent differences between ecological patterns and processes in different areas.

Broad-scale bioregionalisation method

94. The Workshop endorsed the general methodology used to provide a broad-scale regionalisation of the Southern Ocean from the 2006 Hobart Workshop.

95. The Workshop agreed that, at the broad scale, the primary bioregionalisation result from the 2006 Hobart Workshop was a good working product that could be used to inform spatial management of the Convention Area. This product has 14 bioregions or clusters.

96. The Workshop agreed that the broad-scale bioregionalisation from the 2006 Hobart Workshop could potentially be enhanced by considering, *inter alia*:

(i) additional data layers representing seasonal variation in environmental conditions;

(ii) additional data layers representing interannual variation in environmental conditions;

(iii) new environmental parameters (e.g. MLD, primary production: see paragraph 49);

(iv) use of biological data to transform and combine environmental data layers;

(v) consideration of spatial variability in data layer quality.

97. Five methods of how biological data could be used to enhance bioregionalisation of the Southern Ocean were discussed:

(i) cluster using environmental data layers, and use point biological data retrospectively to test how well the clusters distinguish between different biological properties;

(ii) extrapolate point biological data to the circumpolar domain using the fitted dependence on environmental properties, and use these modelled biological layers in the clustering to produce the bioregionalisation. The BRT approach can be used for this process;

(iii) use GDM to determine how differences in biology between locations depend on environmental variables. Then use circumpolar environmental data to map biological dissimilarity in geographic space and determine bioregions;

(iv) use expert opinion to determine the dependence of selected species on environmental variables (e.g. for marine mammals using the relative environmental suitability approach (Kaschner, 2004));

(v) use Species Habitat Modelling to consider realised ecological niches.

Extrapolation of biological data using environmental data

98. Dr Pinkerton noted that biological datasets, in general, are not circumpolar. Spatially extensive, circumpolar biological data layers can however be estimated by extrapolating point biological data to the whole domain using the relationship to environmental data layers as a proxy for spatially continuous biological coverage. One statistical method that may be used for this purpose is BRT analysis.

99. BRT is a relatively recent statistical method for modelling single-response variables using several predictors (Friedman, 2001; Hastie et al., 2001; Leathwick et al., 2006; Ridgeway, 2006; De'ath, 2007). BRT developed from machine-learning techniques, where the dependence of the response variable on each predictor, and interactions between predictors, are modelled hierarchically. BRT is an ensemble method, meaning that predictions are made not on the basis of a single model, but rather combines an ensemble of several (often thousands) models. At the Workshop, BRTs were applied using the software package R (R Development Core Team, 2007), using the Generalised Boosted Model (GBM) library (Ridgeway, 2006) and scripts developed by Leathwick et al. (2006). Ten-fold cross-validation of the models (Hastie et al., 2001; Leathwick et al., 2006) was used to optimise the trade-off between bias and variance and minimise the risk of over- or under-fitting. The particular advantages of BRT over other regression methods include that it:

(i) accommodates continuous and factor predictors
(ii) automatically fits interactions
(iii) is insensitive to monotone transforms of predictors
(iv) allows missing values in predictors
(v) ignores extraneous predictors.

100. The Workshop noted that it was important to determine how the reliability of the extrapolation could be assessed, and that this would need to be considered in the application of any biological dataset in this process.

101. Dr Pinkerton noted that at the first stage, expert opinion was recognised as being important to assess the quality of the biological point data themselves, and whether the biological data were likely to be representative of, or sensitive to, the biological environmental space. Second, experts considered whether the extrapolated distribution was sensible: did the extrapolated distribution match what is known about the occurrence of the biology, including using knowledge of the biological distribution not included in the training set? These expert-knowledge-based methods of evaluation are necessary but not sufficient for the Workshop to have confidence in the extrapolated biological data layers. More formal methods to investigate the extrapolation reliability are required. Results are less reliable where the method predicts values outside the range of the (environmental) training set than when the environment space for the predictions is well represented in the training data. These formal methods of assessing reliability in extrapolated biological data layers were not available at the Workshop.

102. The Workshop recognised that biological data and the BRT method were available to the Workshop, and applying this method during the Workshop could be used to investigate whether the bioregionalisation result from the 2006 Hobart Workshop could be enhanced by the use of spatially extensive biological data layers.

103. The Workshop noted that biological data available during the Workshop that was most appropriate to investigate the potential utility of biological layers in bioregionalisation was krill and salp distributions derived from net hauls (Atkinson et al., 2004) and zooplankton distributions from SO-CPR surveys (G. Hosie, AAD). The Workshop noted that the use of layers representing the spatial distributions of these zooplankton species in the Southern Ocean could help to delineate broad-scale bioregions.

104. Ten circumpolar environmental variables were used in the spatial extrapolation by BRT. Nine of these were provided by the 2006 Hobart Workshop (bathy, par, logChl, ssh, sst, nox, si, po4, ice), and an extra clear skies insolation data layer (paragraph 49) was also used.

105. Most of the SO-CPR data presented to the Workshop (WS-BSO-07/7) were from the East Antarctica region, although a few transects were available from the Scotia Arc, the area between New Zealand and the Ross Sea, and the southern Indian Ocean. The data consisted of counts of abundance of 220 taxonomic groups of zooplankton from which 11 groups of zooplankton were produced for consideration by the Workshop. Data for these groups are available at nearly 20 000 locations in the Southern Ocean. For the purposes of bioregionalisation, the Workshop considered that the BRT results for two zooplankton groups were most plausible: pteropods and copepods.

106. The Workshop was concerned that extrapolation to outside the range of the data, both in geographic and environmental space, was potentially unreliable. Note that this is different from extrapolation in environmental space discussed in paragraph 34 above. Extrapolation in biological space relies on the assumption that the relationship between biology and environment represented in the training data is consistent across geographic space. Such an assumption underpins the use of environmental data layers in bioregionalisation. During the Workshop this assumption for the CPR zooplankton groups was investigated (Figure 1). Even though most of the CPR data are in East Antarctica, there was no significant difference in the predictive power of the model between this region and the Scotia Arc, between New Zealand and the Ross Sea, and in the southern Indian Ocean.

107. A subset of the circumpolar net haul krill (*E. superba*) and salp (mainly *Salpa thompsoni*) data from Atkinson et al. (2004) was available at the Workshop. After consideration of data characteristics, data taken before 1980 were excluded. A correction for net sampling as suggested by Atkinson et al. (2004) was applied to the krill abundances. These data were extrapolated through the Southern Ocean by the BRT method (Figure 2).

108. Krill experts at the Workshop noted that the patterns of krill abundance predicted by this preliminary extrapolation were broadly consistent with their understanding of krill distribution in the Southern Ocean. It was noted that the extrapolation suggested relatively high abundances of krill off Cape Adare in the Ross Sea, an area measured as having elevated abundances of *E. superba* at some times (e.g. WG-EMM-07/7) but from which the model had no net haul data to inform the prediction.

109. Spatially continuous modelled distributions for four taxa (krill, salps, pteropods and copepods) were added to the broad-scale bioregionalisation from the 2006 Hobart Workshop. The layers were added to the existing four environment variables (bathymetry, SST, nitrate, silicate) in various combinations:

(i) four primary physical variables + krill
(ii) four primary physical variables + krill + salps
(iii) four primary physical variables + krill + salps + copepods
(iv) four primary physical variables + krill + salps + pteropods
(v) four primary physical variables + krill + salps + copepods + pteropods.

110. The process by which different combinations of input variables were used to generate alternate bioregionalisations involved a method exactly analogous to the method employed at the 2006 Hobart Workshop.

111. For each combination of variables the clustering algorithm from the 2006 Hobart Workshop was used to generate 200 spatial clusters. These clusters were then hierarchically re-aggregated to generate a hierarchically nested dendrogram viewable at any user-defined level of resolution from 1 to 200 groups. The Workshop chose to display the classification at the 20-group level (results are described in paragraphs 132 to 144).

Generalised Dissimilarity Modelling

112. Generalised Dissimilarity Modelling is a statistical method which determines how environmental information explains differences in biological communities between locations. It is perhaps the best option for environmental classification where biological data is presence-only rather than presence/absence (see Ferrier et al., 2007). However, the method retains the following disadvantages:

(i) it is designed to assess biological communities in terms of species presence rather than abundance (which may be the more ecologically relevant measure);

(ii) it models the aggregate relationship between community composition and environment, rather than modelling the distributions and abundances of particular species;

(iii) it is not widely available within the statistical community at present, although it may become so in the next few months.

Relative Environmental Suitability

113. Recent work at the University of British Columbia (Kaschner, 2004) has developed a quasi-objective approach to map global geographic ranges of marine mammals using the Relative Environmental Suitability (RES) model for marine mammal species.

Species Habitat Modelling

114. Dr P. Koubbi (France) outlined the principles of Species Habitat Modelling, which provides a means of dealing with information gaps in studied areas. Sampling stations are scattered in space and time, meaning that mapping of raw abundances can be insufficient for

an understanding of species distribution, especially for biogeographic and conservation issues. Each survey is a snapshot of the relation between species and environmental factors because of temporal and spatial variability, but also linked to complex interactions with other species. When combining data from different surveys, one has to be careful of how to deal with information that was obtained with different sampling strategies, spatial or temporal scales, gears or sampling efforts.

115. A species habitat is the manifestation of the realised ecological niche of the species as defined by Hutchinson (1957). This is influenced not only by correlations with the physical environment, but also by species interactions (competition, predation etc.). The species habitat is the combination of environmental factors that explains the distribution of a species. In a specific area, the presence of some individuals is due to suitable conditions for survival. For that reason, habitats can be divided into three components:

(i) the potential habitat where the environmental conditions of the species' presence can be found;

(ii) the realised habitat that can be observed. Some patches of habitats may or may not be occupied permanently by the species according to metapopulation theories because of fragmentation, connectivity etc. Populations can occupy patches of potential or optimal habitat, moving from one to another either by migration or advection processes sometimes without success of recruitment;

(iii) the successful habitat where the species will find the best conditions for its growth and recruitment.

116. Species habitat can be mapped using GIS, based on survey data as a way of assessing the realised niche of the species. Different methods are available for modelling habitats, including habitat suitability index and quantile regressions. Statistical methods such as GAMs (Hastie and Tibshirani, 1990) or GLMs (McCullagh and Nelder, 1989) have also been used. These are more suitable for modelling realised habitat and abundances rather than optimal habitat.

117. Habitat modelling deals with complex species' response to multiple interacting factors. In representing these responses, there is a danger of generating simple models that cannot deal with the complexity of species–habitat relationship. Habitat mapping can be used to model environmental scenarios in unknown areas (Koubbi et al., 2003) or to study spatio–temporal changes (Loots et al., 2007). Among problems, there are some differences in habitat of each developmental stage – spawning grounds, areas of larval development, nurseries and trophic grounds – which indicate that the species–environment relationship changes during the life-cycle (Koubbi et al., 2006). In some cases and for some species, these areas can be geographically separated.

118. However, provided that limitations of the datasets are taken into account, these methods are robust and coherent. A major advantage is that they are data-driven rather than model driven, and the results of modelling can be improved with new datasets, especially when using GAMs.

119. Dr Koubbi noted that these models should only be applied to the environmental ranges that were used to create them. Extrapolation outside environmental ranges is not ecologically reasonable, except when validated by expert knowledge based on ecological or ecophysiological studies that were not considered to do the models.

120. Habitat modelling can also be used to test environmental scenarios in species' habitats and as a tool for modelling species distribution in unknown areas where environmental factors are known. The resolution of habitat maps will depend on the resolution of environmental factors, as spatial variability is better modelled for abiotic factors than for species abundances because of patchiness and sampling errors.

121. The Workshop noted that Species Habitat Modelling may be a valuable tool for capturing heterogeneity, particularly at finer scales.

Fine-scale pelagic bioregionalisation method

122. Fine-scale bioregionalisation of each of the clusters produced from the broad-scale bioregionalisation should use appropriate information on environment, biology and process. The Workshop noted the availability of considerable amounts and variety of data that could be used in the fine-scale bioregionalisation. See 'Pelagic data' (paragraphs 39 to 64) and 'Ecological processes' (paragraphs 157 to 164) for details of data that could be used. Because data used in fine-scale bioregionalisation does not have to be circumpolar, nor be measured consistently between broad-scale bioregions, much more information can be used for fine-scale bioregionalisation than can be used for broad-scale (circumpolar) bioregionalisation.

123. Fine-scale bioregionalisation of the pelagic environment was not conducted at the Workshop due to time constraints.

Benthic methods

124. The approach to a benthic bioregionalisation consisted of a three-step process, by which physical regions (paragraph 77) were first defined using the process employed by the 2006 Hobart Workshop (paragraph 14). The biological data were then overlaid and the classification evaluated (paragraph 79).

Physical benthic classification

125. Dr B. Raymond (Australia) undertook the analysis of the benthic data to provide physical bioregionalisation maps for the benthic environment. The methods he used were identical to those used in the 2006 Hobart Workshop.

126. Benthic data were mapped onto a 0.5° grid because insufficient time was available to do a finer-scale resolution.

127. The following data were used:

- Bathymetry: standard data were used ($\log_{10}(x + 1)$ transform).
- Sea-floor temperature: this was provided on a global 0.125° grid with a linear interpolation from that grid to the 0.5° grid used here.
- Slope was provided as raster data in polar orthographic projection. This was inverse-projected (to get the latitude and longitude coordinates of each pixel in the raster). The data were too large to interpolate directly due to technical constraints, so they were randomly subsampled from one in four pixels and then a linear interpolation was used to convert these data to the 0.5° grid. Note that this data had areas of missing values that were filled in by the interpolation.
- Sediment data was difficult to use in the time available. Most detail from this data layer are applicable to the ocean basin areas. It was agreed that comparisons of the regionalisation for the ocean basin areas with the sediment map would show the expected heterogeneity of the benthic environment in the ocean basin areas.

128. The final clustering analysis was undertaken according to the methods from the 2006 Hobart Workshop. The three layers were collated in a single matrix. Non-hierarchical clustering (the CLARA routine in R) was used to reduce the full set of grid cells down to 200, and then hierarchical clustering (unweighted pair group method with arithmetic mean – UPGMA) was used from there to obtain 40 and 20 groups. A Gower metric was used in the clustering (equivalent to a Manhattan distance with equal weights on the three input variables). (Results are described in paragraphs 145 and 146.)

Evaluation using biological data

129. The biological data were displayed as a gridded 2° by 2° longitude layer for a broad-scale overview. Similar hotspots for sampling locations and for taxa were found. These were generally in shallow areas and in a group of regions consisting of the Antarctic Peninsula, Scotia Arc, sub-Antarctic islands, eastern Weddell Sea and Ross Sea. It should be noted that there were gaps in the data due to the patchiness of sampling.

130. A number of analyses were then performed. Among these was an analysis of relative rarity, which included counting the number of grid squares where species were found. Most of the species were found in less than 10 squares, meaning that most species were rare and found in a small number of areas. Only few were widely distributed. Most species were restricted to one box, indicating that most species would be endemic on this scale. Because this would lead us to expect major differences between small geographic regions, it will not be possible to use assemblage difference as an indicator of biological processes. However, it is possible to concentrate on large-scale patterns of relative species richness and relative endemism.

131. An additional evaluation was undertaken for the western Antarctic Peninsula by overlaying biological data in this region with the geomorphological provinces map. The data were extracted based on where they were located spatially on the geomorphic classification.

A species list per class was extracted. A range of analyses were undertaken to look at species richness and numbers of stations per polygon. (Results are described in paragraphs 147 and 148.)

RESULTS

Pelagic results

Summary of results from the 2006 Hobart Workshop

Primary regionalisation

132. The results of the broad-scale primary regionalisation from the 2006 Hobart Workshop are given in full in Grant et al. (2006). The resulting map is shown in Figure 3, which contains 14 regions as summarised in Table 1. This regionalisation differentiates on the broad scale between coastal Antarctica (including embayments), the sea-ice zone and the northern open-ocean waters. The analysis highlights the different environmental characteristics of large regions including the continental shelf and slope, frontal features (SAF, PF, SACCF), the deep ocean, banks and basins, island groups and gyre systems.

133. A limited analysis at the 2006 Hobart Workshop was undertaken to investigate the uncertainty associated with the primary clustering (see Grant et al., 2006). Uncertainty was computed by first calculating the difference between the environmental characteristics of a grid cell and the average environmental characteristics of the cluster to which it was assigned. A second difference was then computed, this time between the environmental characteristics of a grid cell and the average environmental characteristics of the next-most similar cluster. The first difference value was then divided by the second. Thus, high uncertainty values indicate that a grid cell lies on the environmental boundary between two different clusters, and so its allocation to one or the other is less certain than for a grid cell that is strongly typical of the cluster to which is has been allocated. This uncertainty analysis considers only a specific subset of the possible sources of uncertainty in the regionalisation (specifically, to do with the allocation of grid cells to particular clusters).

Secondary regionalisation

134. The Workshop noted that the 2006 Hobart Workshop had included ice and remotely sensed near-surface chl-*a* concentrations in a ‘secondary’ classification displayed with 40 groups. The results are shown and discussed in Grant et al. (2006, Figures 21, 23 and 25). The secondary regionalisation at the level of 40 groups showed spatial patterns on which the experts at the 2006 Hobart Workshop could not achieve consensus regarding plausibility.

Results from the 2007 Brussels Workshop: pelagic – broad scale

135. The Workshop endorsed the broad-scale ‘primary’ regionalisation produced by the 2006 Hobart Workshop. This bioregionalisation used clustering based on four environmental

variables (log10 depth, SST, silicate concentration, nitrate concentration); the agreed display resolution has 14 groups (see Figure 3). The Workshop felt that this classification was a good first stage bioregionalisation and a potentially valuable tool at the broad circumpolar scale.

136. The Workshop re-displayed the ‘secondary’ classification from the 2006 Hobart Workshop with 20 groups (Figure 4) to be consistent with the chosen display resolution of the classification obtained below (paragraph 143, Figures 5 and 6), which uses biological data layers.

137. The Workshop agreed that the BRT method for generating biological data layers is a valuable development and that biological layers could be used to enhance the 2006 Hobart Workshop bioregionalisation of the Southern Ocean at the circumpolar scale. The Workshop encouraged further work also at the species level to be submitted as a working paper to the Scientific Committee.

138. The Workshop noted that there were many approaches to using biological data in a broad-scale bioregionalisation of the Southern Ocean that warrant further investigation.

139. The Workshop agreed that the statistical method employed at the Workshop for the production of continuous biological species distributions and abundances, known as BRT, be considered for wider use in the future.

140. The Workshop was supportive of the potential for the BRT method to produce biological data layers for broad-scale and fine-scale bioregionalisation. Some Workshop participants noted particular enthusiasm for the krill abundance data layer derived from the data of Atkinson et al. (2004). However, many of the participants did not fully understand the statistical details of the method or felt that some uncertainties remained about the scope for its future application. The Workshop suggested that the method be written up and submitted for technical review by WG-SAM.

141. Dr Constable noted that it would be useful if WG-SAM could consider the degree to which distributions of biota can be extrapolated outside the environmental and geographic spaces of the data, the degree to which sampling error can be accounted for in the BRT method and in how uncertainty in predictions from the BRT method can be incorporated in the final classification. In so doing, it will be useful if WG-FSA and WG-EMM could review the degree to which extrapolation might mask changes in the distribution of taxa with similar characteristics, particularly taxa that are not found within the sampling area.

142. The Workshop noted that WG-EMM and WG-FSA might be asked to review the appropriateness of the datasets to be included as response variables (biological data) and those for inclusion as environmental layers which relate to processes giving rise to the data in the biological datasets.

143. The Workshop reviewed outputs from a trial bioregionalisation using additional biological layers at the circumpolar scale:

(i) four environmental data layers + krill + salps (Figure 5)
(ii) four environmental data layers + krill + salps + copepods + pteropods (Figure 6).

144. The Workshop agreed that the approach using physical and biological layers in bioregionalisation is promising and that, subject to addressing the issues in paragraphs 141 and 142, results from this approach will be useful in the future.

Benthic results

Physical benthic bioregional classification

145. Initial maps of a physical regionalisation of the benthic environment in the Southern Ocean were developed using the same approach as the 2006 Hobart Workshop to generate a primary regionalisation of the pelagic environment. These maps were the result of a cluster analysis undertaken using three data layers: bathymetry, slope and sea-floor temperature at the level of 20 and 40 bioregional classes. The sediment data was left out due to time constraints.

146. The Workshop was satisfied that the methods outlined in the 'Benthic methods' section (paragraphs 125 to 128) were consistent with the 2006 Hobart Workshop, and that they could be used as a basis for an initial benthic physical classification. In particular, inclusion of the sediment data will likely improve the bioregionalisation due to the relationship between sediment type and biota. The initial map using 20 physical classes is displayed in Figure 7. The Workshop noted that the degree of heterogeneity that would arise when the sediment data is included would likely be greatest in the continental slope and near-shore zones. It also noted that increasing the number of classes above 20 would result in greater diversity of physical habitats, particularly in the coastal region.

Evaluation using biological data

147. The map in Figure 8 represents the raw biological data used for evaluation of the benthic physical classification. As detailed in the 'Benthic methods' section (paragraphs 129 to 131), the data incorporates eight taxonomic groups, and approximately 33 000 records, 7 600 stations and 3 000 taxa (species).

148. Figure 9 shows the relative species richness divided into 2° by 2° grid cells. The map shows that the greatest concentrations of known species are found within the 1 000 m contour.

Geomorphology

149. The geomorphic map of the East Antarctic margin (Figure 10) has some key features relevant to benthic bioregionalisation. The features that make up most of the shelf are the shelf banks which are less than 550 m deep. These banks are the main environment that experiences iceberg scouring and, in places, are subject to energetic current activity. Substrates are likely to be hard sediment although mobile sands may be present. Banks are most likely to be colonised by filter-feeder communities.

150. Shelf depressions are sheltered from most iceberg scouring and commonly act as sediment traps for sediment mobilised from the banks and for phytodetritus from the water

column. It is expected that most depressions have low current activity, however some experience fairly energetic flows where bottom water forms. Depressions are the geomorphic features most favoured to accumulate biogenic ooze and so support deposit-feeding communities and abundant infauna. Anoxic sediments may be present in some deep depressions.

151. The continental slope is divided into a steep upper slope and a lower slope. The steep upper slope experiences ice keel scouring at the shelf break and strong flows of the Antarctic Coastal Current. The steep gradients make sediment accumulation less likely, favouring hard-bottom communities. Where bottom water forms, the slope is affected by cascading plumes of dense cold water. The lower slope has a gentler gradient but may still experience strong bottom water flows and episodic turbidity current activity. The lower slope features well defined canyons and, in places, sediment mounds. The canyons tend to have eroding walls and thus hard bottoms. Inactive canyons and sediment mounds have soft sediment beds. Canyons that cut the shelf edge are features of importance for marine communities around other continents. Such canyons are rare around the Antarctic because of the effects of glaciation on the margin. One of the few such canyons is the Oates Canyon at 158°56'36"E 68°44'6"S. Whether it has similar significance to fish and benthos as similar canyons at low latitudes is unknown.

152. True seamounts are found in the eastern part of the study area associated with the rugged, relatively young ocean crust and fracture zones between the Ross Sea and Tasmania and with the Hjort Trench and Macquarie Ridge. Another group of seamounts occurs at around 100°56'E 58°54'38"S. Ridges and seamounts that stand in the order of 500 m above the surrounding ocean floor were also recognised. They are commonly ridges associated with fracture zones but also occur nearer the continent. All seamounts will have hard substrates, however, the seamount ridges that protrude hundreds rather than thousands of metres above the ocean floor may affect the overlying ocean differently to the taller true seamounts, thus affecting their habitat characteristics.

153. The abyssal plain is a broad area of sediment extending north from the margin. It is likely floored by clay and ooze. It thins onto a younger oceanic crust which has been mapped as rough ocean floor. The rough ocean floor is likely to have patches of hard, rocky sea floor but may support pockets of soft sediment. The deepest sea floor in the region is the 6 000 m plus Hjort Trench. Its great depth is likely to influence the habitats within.

154. The identified geomorphological provinces were used to select and classify the biological point data. These data were then analysed by applying the techniques outlined in the 'Benthic methods' section (validation using biological data) (paragraphs 129 to 131). Figure 11 shows the geomorphological provinces of the northern Antarctic Peninsula. Figure 12 shows the number of species per province. Figure 13 shows sampling effort per province (number of stations).

155. The figures demonstrate that there is variation in known species numbers between similar geomorphological provinces. Species distribution is therefore affected by factors additional to geomorphology, such as sampling effort or ice cover. Differences in patterns of species distribution and sampling effort show that potential biodiversity hotspots are not necessarily related to sampling effort.

156. These methods could be further applied to validate the benthic physical classification.

Ecological processes

157. The Workshop noted that in providing a framework for understanding the spatial structure and function of ecosystems, it is important to consider both biodiversity pattern information and spatially defined ecological processes (Balmford et al., 1998; Cowling et al., 2003). This can be of assistance to a spatial decision-making framework, which was used in developing the conservation plan for the Prince Edward Islands (WS-BSO-07/P1). The Workshop endorsed the approach to develop maps representing ecological processes and other features that cannot easily be incorporated into an analysis of spatial pattern.

158. Biodiversity patterns are the spatial representation of the distribution of species or habitats at a defined scale (e.g. habitats or species distributions), whilst ecological processes are actions or events that shape biodiversity patterns and ecological interactions at different scales (e.g. upwelling events, spawning areas or foraging areas).

159. Ecological processes can be either flexible in time and space (e.g. oceanic fronts) or fixed (e.g. related to a geomorphic feature).

160. Whilst the bioregionalisation analysis was successful in capturing the physical and biological patterns of the Southern Ocean, the Workshop felt that this needs to be complemented by the mapping of spatially defined processes.

161. The Workshop noted that ecological processes can be mapped spatially in two ways:

(i) flexible processes can be mapped using spatial probability data (e.g. Kernels)
(ii) fixed processes can be mapped using fixed features that define the process (e.g. geomorphic features).

162. The Workshop considered ecological process data that were available to this Workshop as well as other information that could easily be acquired. The Workshop also noted that some of these datasets can be incorporated within a bioregionalisation analysis, whilst others are best depicted as separate spatial overlays. The results of this discussion are shown in Table 2.

163. The Workshop noted that whilst ecological process information should be used at the circumpolar scale considered at this Workshop, these data will become more important at a finer-scale regional level. The reasons for this are two-fold: (i) many process datasets are regional in scale (e.g. tracking data for top predators); (ii) expert knowledge of spatially defined ecosystem processes can be more easily incorporated at a regional scale. It therefore followed that the best areas to develop further fine-scale bioregionalisation are most likely to be those geographical areas where most information and expert knowledge exists.

164. Some of the spatially defined ecosystem processes that were considered to be important are shown in Figures 14 to 17.

FUTURE WORK

165. The Workshop agreed that the primary regionalisation for the pelagic environment contained in the 'Results' section (paragraphs 132 and 133) can be regarded as useful for

application by CCAMLR and CEP. It was agreed that the initial regionalisation for the benthic environment should be reviewed and optimised for use by CCAMLR and CEP. The Workshop noted that the overall results and data considered at the Workshop show that there will be a greater heterogeneity in biodiversity and ecosystem structure and function at finer scales.

166. The Workshop agreed that refinements to this bioregionalisation could be made in the future as methods are improved and data acquired and analysed. Further finer-scale bioregionalisation work could be undertaken in a number of areas based on existing data.

167. The Workshop agreed that future work could include efforts to delineate fine-scale provinces, where possible. It was recommended that participants should submit papers to the Scientific Committee on approaches to fine-scale regionalisation, including on statistical methods and potential data sources. It was further recommended that WG-SAM should be requested to consider the statistical methods presented in paragraphs 140 and 141.

168. The inclusion of process and species information could also be considered further, particularly in the context of systematic conservation planning, and in developing a spatial decision-making framework (paragraph 157). This may be particularly applicable at finer scales.

Geomorphology

169. The Workshop recognised that the work carried out so far suggests that mapping of sea-floor geomorphology provides additional information that integrates physical data into the bioregionalisation process. Extension of this work to cover the whole CAMLR Convention Area would be valuable. Updated sea-floor sediment maps would also be useful for benthic bioregionalisation.

Fine-scale bioregionalisation data availability

170. The Workshop recognised that biological data existed in some smaller-scale regional areas which might be utilised to further delineate broad-scale bioregionalisation efforts. These would include long-term data collections in the southern Scotia Sea, Ross Sea and East Antarctic Sea as well as other areas.

171. The Workshop suggested that substantial finfish data from research bottom trawl surveys may be available from several national programs. In addition, other finfish data may be available from scientific collection efforts, not currently available to Workshop participants. Data pertaining to rare species may be obtained from museum collections and catalogues.

172. Although several national efforts have collected benthos data during scientific bottom trawling surveys, much of it is not presently available in electronic format. Museum collections may also be a valuable source for defining areas where rare or infrequently caught benthos species have been found.

173. It was noted that with increasing data entry into the SCAR-MarBIN network and with additional data expected from the CAML-IPY joint research effort, this network will become of great importance for future data access. Currently, many of these data are dispersed widely and stored by individual scientists or institutes and thus are very difficult to access.

174. The Workshop recognised that krill biomass and distribution data collected using both nets and acoustic methodology may be useful in these efforts. Some of these data, such as the CCAMLR-2000, BROKE East and BROKE West data, already reside with CCAMLR. The main purpose of these surveys was to gather data on krill abundance for catch limit estimates. The krill, zooplankton and associated protists and oceanographic data can be used for further bioregionalisation. Other data reside with national programs.

175. The Workshop recognised that CCAMLR's efforts to define SSMUs may be useful in fine-scale bioregionalisation efforts because these efforts investigated relationships among finfish, krill, predator and prey species. The Workshop noted it may be possible to include data on other components of the ecosystem and use similar techniques such as those employed to define SSMUs.

176. The Workshop agreed that substantial bottom temperature, salinity, chl-*a*, zooplankton and phytoplankton data exist from many research efforts by national programs in several fine-scale areas. Fine-scale resolution of bathymetry data may also exist. These would be valuable to enhance fine-scale bioregionalisation efforts.

177. The Workshop considered gaps in the current datasets. The SO-CPR Survey has delivered a relatively high density of zooplankton data between 60° and 160°E, with 5 n mile sampling resolution. This dataset can provide sufficient detail of zooplankton patterns for finer bioregionalisation analysis. However, there have been fewer CPR tows outside this region to date, but this is expected to increase during the IPY and afterwards as the survey continues to develop.

178. There is also a substantial gap between the southern tow limits of the CPR and the coast, predominantly over the continental shelf, because of the inability to tow the CPR in pack-ice. CPR tows are only conducted over the shelf during ice-free periods, e.g. January and February. This gap is best covered by surveys using traditional plankton nets, although the resolution between sampling sites is usually much coarser than the CPR, especially in the eastern Antarctic sector between the Weddell and Ross Seas. A number of surveys have been conducted in this area before, during and after the BIOMASS Survey. Various nets were used. Surveys were also intermittent and sporadic. More consistency in sampling has occurred since BIOMASS with the RMT1+8 being a common net system.

179. Sampling of demersal and pelagic fish assemblages, as well as the sampling of benthos, has been less extensive in the eastern Antarctic region. Again, most sampling has been sporadic. There was a more concentrated sampling in the Prydz Bay during the 1990s and there was an attempt to classify the benthic communities in the Mertz Glacier area during a geoscience survey in 2001 using grab samples and multi-beam mapping. A more comprehensive fine-scale fish and benthos survey will be conducted in this region during 2007/08, in a three-ship survey of the plankton, fish, benthos and oceanography for CAML. Other CAML surveys will be conducted around Antarctica, notably in the Ross Sea, Antarctic

Peninsula, Scotia Arc and Lazarev Sea, that will provide additional data for fine-scale bioregionalisation. CAML is also gathering historical benthic data that will contribute to the bioregionalisation. SCAR-MarBIN will be the primary portal to access those data.

Development of fact sheets

180. The Workshop agreed that the development of a bioregionalisation atlas of fact sheets would be a valuable resource for CCAMLR and CEP. This would provide a standardised approach to reporting and archiving of results of bioregionalisation work for the Southern Ocean in the same manner that fishery reports are developed for each fishery in CCAMLR. Since their inception, fishery reports have been found to be a useful way to present detailed information for use by CCAMLR in its deliberations, both during meetings and intersessionally, and for the public at large to understand how work in CCAMLR is undertaken.

181. A bioregionalisation atlas could follow the approach illustrated in WS-BSO-07/9, where a hierarchy of sheets is presented showing regional features in overarching sheets and then, where available, more detailed features of bioregions and provinces on finer-scale sections of the Southern Ocean in subsidiary sheets. Fact sheets could include maps of the relevant bioregions and provinces as well as maps showing locations of important processes, colonies or aggregations of biota and other summarised details considered important for managing bioregions.

182. This format also provides a means for easily reviewing, refining and updating bioregional information and classification in specific areas without needing to revise the classification for the entire Southern Ocean.

183. The Workshop agreed that such an atlas could be developed based on the results of the primary regionalisation agreed at this Workshop, preliminary results on how finer-scale heterogeneity might exist within those regions and supplementary information from the process and other data layers considered in this report.

Further work on the development of a system of MPAs

184. The Workshop noted that bioregionalisation could serve as one component of work to be undertaken towards the development of a system of MPAs for the Convention Area (SC-CAMLR-XXV, paragraph 3.33). Further work on the consideration of methods for the selection and designation of MPAs is required, and it was noted that this work could include the further development of ecological process information, including spatial information on human activities. Intersessional work focusing on systematic conservation planning, possibly for finer-scale areas, could be an important contribution to achieving this goal.

ADVICE TO THE SCIENTIFIC COMMITTEE

185. A summary report will be submitted by the Co-conveners to the Scientific Committee.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

186. The Report of the Workshop on Bioregionalisation of the Southern Ocean was adopted.

187. In closing the meeting, Dr Grant thanked the participants for their contributions to the successful conclusion of the Workshop, and thanked Mr de Lichtervelde for hosting the meeting and providing outstanding support. She extended special thanks to the rapporteurs, and to those who had provided their data for analysis during the Workshop.

188. The participants joined Ms G. Slocum (Australia) in thanking Drs Grant and Penhale for organising and chairing the meeting, and in thanking the CCAMLR Secretariat for their excellent support.

189. The participants also recorded their particular thanks to Dr Raymond, who made an invaluable contribution to the Workshop by undertaking analyses remotely in Hobart throughout the week, undeterred by the eight-hour time difference.

190. The Workshop on Bioregionalisation of the Southern Ocean was closed.

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Table 1: Physical properties (mean and standard deviation of data values) of regions shown in Figure 3 (14 cluster groups based on primary datasets).

Region name	Number of grid cells	Depth mean (m)	Depth SD	SST mean (°C)	SST SD	Si mean (µmol/kg)	Si SD	NOx mean (µmol/kg)	NOx SD
Southern Temperate	110 567	–4 119.952	821.342	8.681	1.854	7.998	2.402	20.919	1.616
Sub-Antarctic Front	40 180	–3 917.738	921.884	5.840	0.791	15.231	2.582	25.158	1.052
Polar Front	83 006	–4 134.095	732.582	3.539	0.999	28.382	6.492	29.236	1.815
Southern ACC Front	108 053	–4 109.261	818.366	0.945	0.872	56.089	9.814	32.370	1.503
Antarctic Open Ocean	136 360	–3 612.533	897.680	–0.682	0.535	79.593	5.804	33.169	1.374
Antarctic Shelves	30 767	–520.048	213.352	–1.149	0.380	82.044	9.211	32.356	1.821
Antarctic Shelf Slope, BANZARE Bank	6 508	–1 455.466	389.636	–1.227	0.434	79.961	2.946	33.599	1.343
Campbell Plateau, Patagonian Shelf, Africana Rise	7 451	–1 034.451	427.437	8.453	1.129	7.876	2.582	20.898	1.735
Inner Patagonian Shelf, Campbell and Crozet Islands	913	–343.482	109.436	7.742	0.827	8.084	2.233	20.857	1.427
Kerguelen, Heard and McDonald Islands	2 294	–1 270.202	734.782	3.360	0.818	25.846	4.024	29.279	1.318
Subtropical Front	94 234	–4 461.472	788.887	11.804	1.511	4.607	1.235	15.257	2.062
Northern Temperate	9 946	–4 163.621	951.003	15.496	0.774	4.336	0.727	10.154	1.667
Weddell Gyre and Ross Sea banks	52 905	–4 466.641	762.290	–0.680	0.333	98.163	5.615	31.965	0.553
Chatham Rise	3 025	–1 568.439	858.953	14.361	0.802	4.112	0.610	12.061	1.453

Table 2: A list of spatially defined ecological processes for which datasets are available and which could be incorporated into a spatial decision-making framework.

Type of process	Effects of processes	Datasets considered for this workshop	Available datasets for future analyses
Physical			
Flexible processes			
Position of oceanic fronts	Enhanced local productivity and other effects	Orsi et al. (1995)	Moore et al. (1997) Probability of position of the APF
Eddies and current variability	Enhanced local productivity and other effects	Average sea-surface height anomaly (Figure 1)	
Iceberg scouring	Benthic disturbance		Probability model to be developed
Fixed Processes			
Sub-Antarctic island effects	Nutrient trapping, upwelling and vertical mixing	SeaWiFS	
Continental shelf effects	Nutrient trapping, upwelling and vertical mixing, ice melts	SeaWiFS, ice extent	
Canyons and other bathymetric irregularities in the shelf break	Deep-water upwelling onto the continental shelf	Developed by Geoscience Australia (Figure 15)	Dinniman et al. (2003). Other regional and large-scale physical models
Seamounts	Taylor columns	Kitchingman and Lai (2004)	
Polynyas	Upwelling and mixing	Arrigo and van Dijken (2003)	
Biological			
Flexible processes			
Procellariform breeding/foraging areas	Areas of high dependence and productivity	BirdLife (2004) probability kernel maps (Figure 16)	
Elephant seal data	Areas of high dependence and productivity		International elephant seal collaboration
Krill recruitment areas	Areas of high dependence for key species		Probability data Hoffman and Husrevoglu (2003)
Cetacean foraging areas	Areas of high dependence and productivity		IWC sightings data
Fixed processes			
Penguin foraging buffers	Areas of high dependence	Adélie, gentoo, macaroni, chinstrap (Figure 17)	

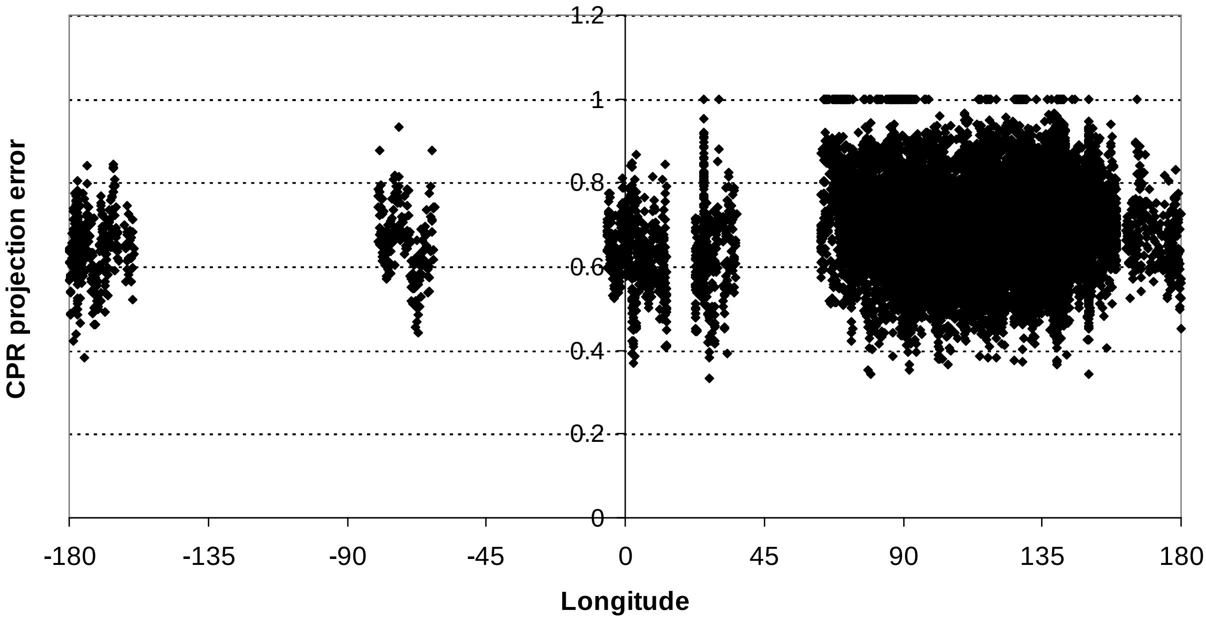

Figure 1: Error in the predicted CPR zooplankton distributions predicted using BRT with longitude. Most of the training data are in East Antarctica (longitude 60–158°E), but there are also CPR data in the Scotia Arc, between New Zealand and the Ross Sea, and in the southern Indian Ocean. This comparison shows that there is no significant difference in model predictive power with region.

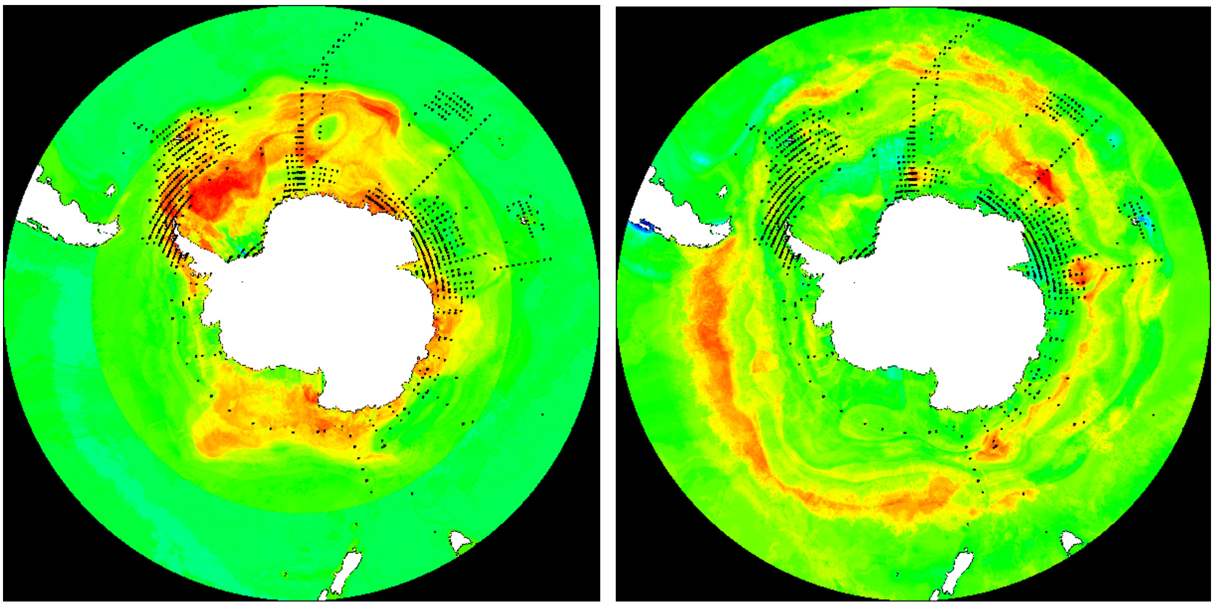

Figure 2*: Predicted krill (left) and salp (right) abundances using a BRT regression based on net-haul measurements. Red indicates higher abundance; blue indicates lower abundance. Black symbols show the location of net haul measurements.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

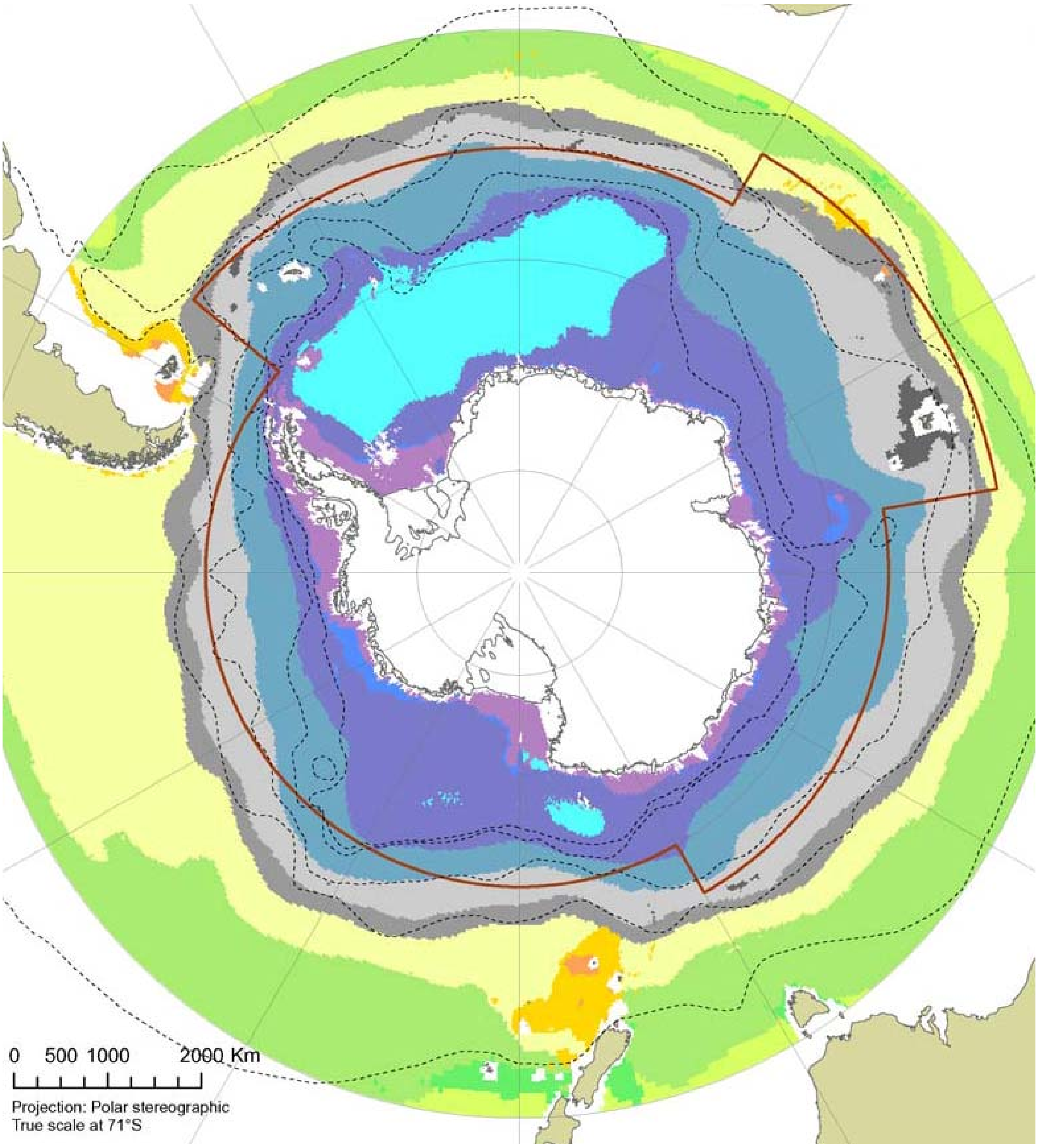

Figure 3*: The primary regionalisation from the 2006 Hobart Workshop. The regionalisation uses four physical environment layers (depth, SST, silicate concentration, nitrate concentration).

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

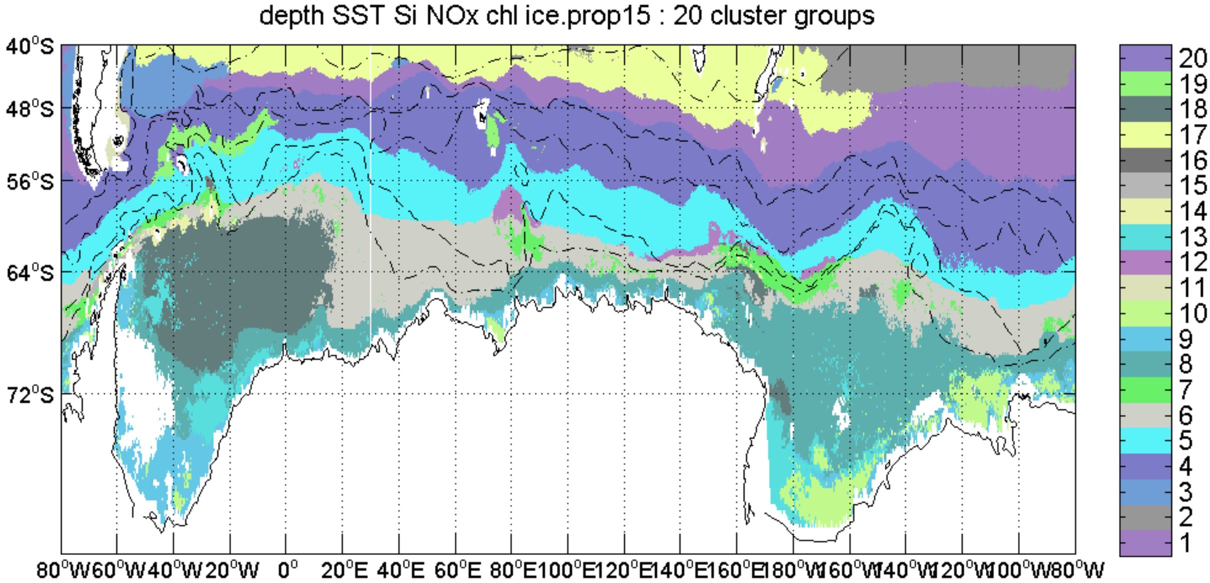

Figure 4*: The secondary regionalisation from the 2006 Hobart Workshop achieved by adding layers representing chl-*a* and ice to the agreed primary regionalisation. That workshop agreed that these two variables were related to heterogeneity at fine scales not captured by the primary classification, and produced the secondary classification at the 40-group level; however the workshop did not achieve consensus as to whether the resulting patterns were plausible. The secondary regionalisation has thus been re-aggregated to 20 groups for comparison with the results of the mixed environment–biological regionalisation, below.

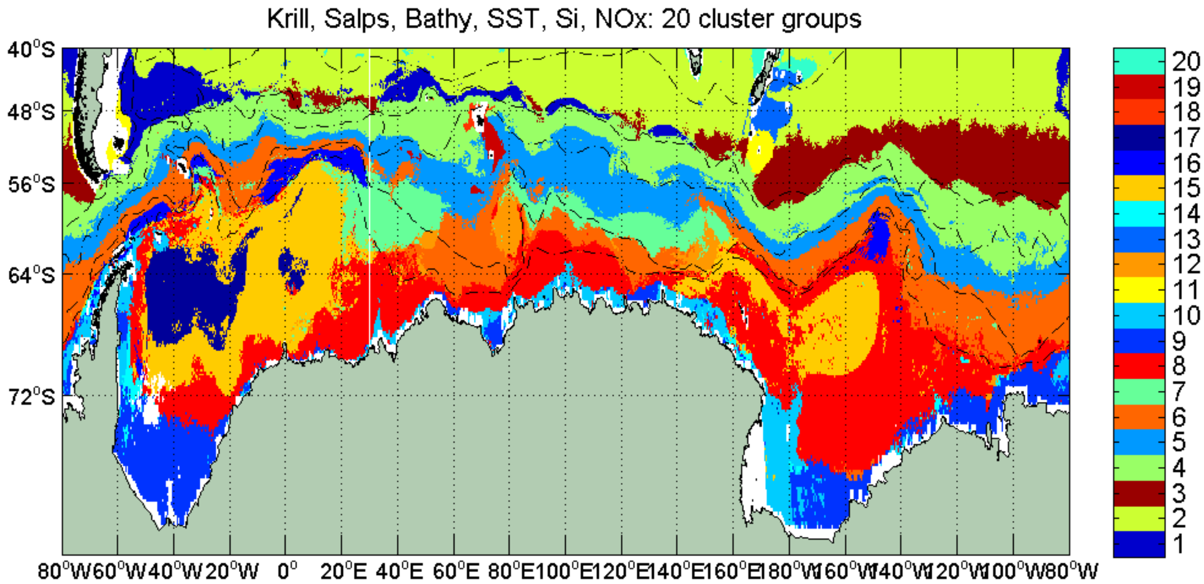

Figure 5*: Bioregionalisation using four primary physical environment layers (depth, SST, nitrate concentration, silicate concentration) plus modelled circumpolar distributions for krill and salps, displayed at the 20-group level.

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* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

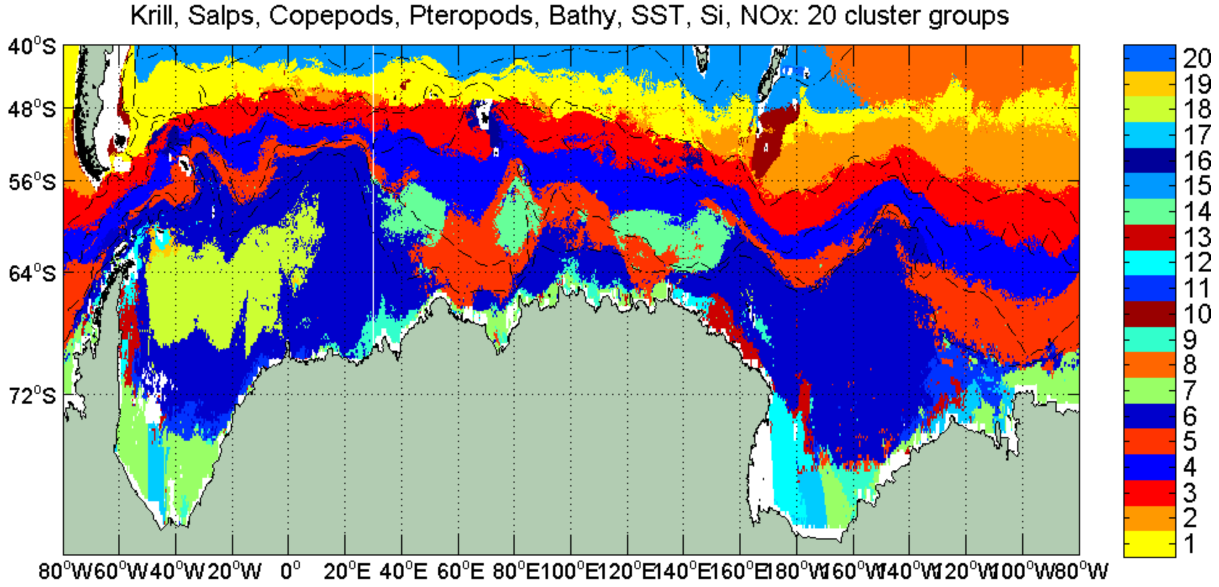

Figure 6*: Bioregionalisation using four primary physical environment layers (depth, SST, nitrate concentration, silicate concentration) plus modelled circumpolar distributions for krill, salps, copepods, and pteropods, displayed at the 20-group level.

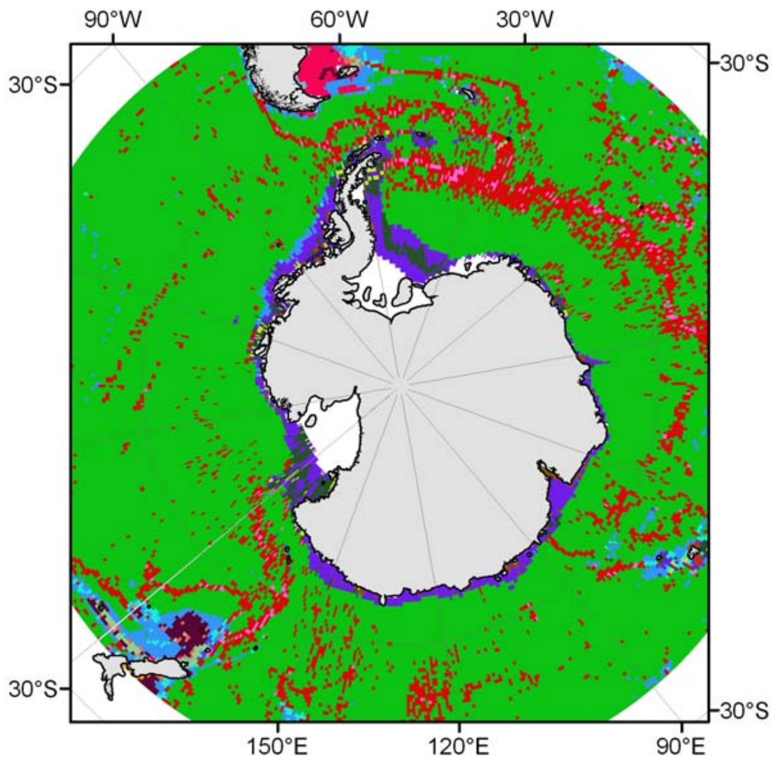

Figure 7*: Initial benthic physical classification using three data layers: bathymetry, slope and sea-floor temperature at the level of 20 bioregional classes.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

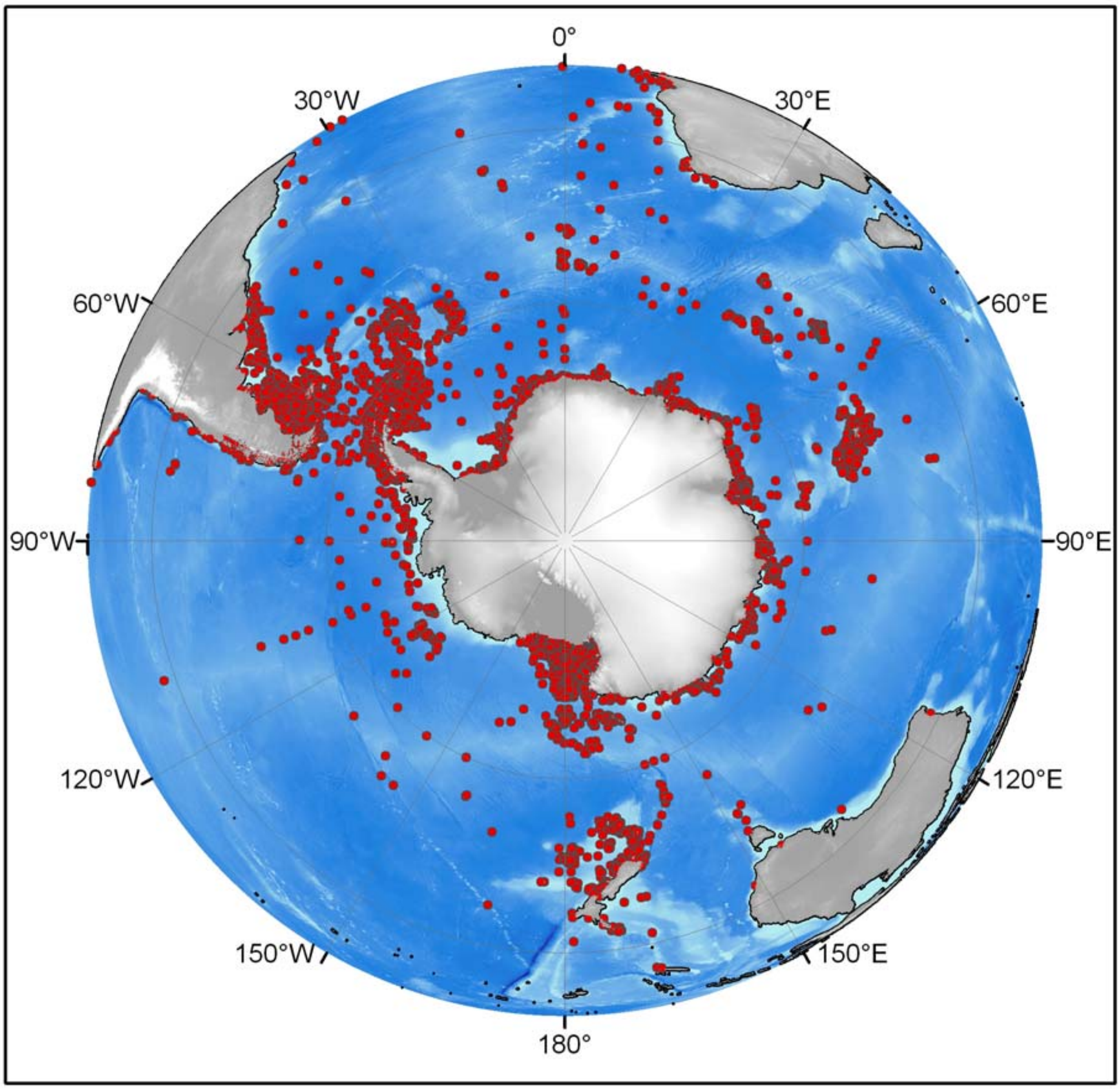

Figure 8*: Map of Southern Ocean showing the distribution of benthic samples for selected taxa.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

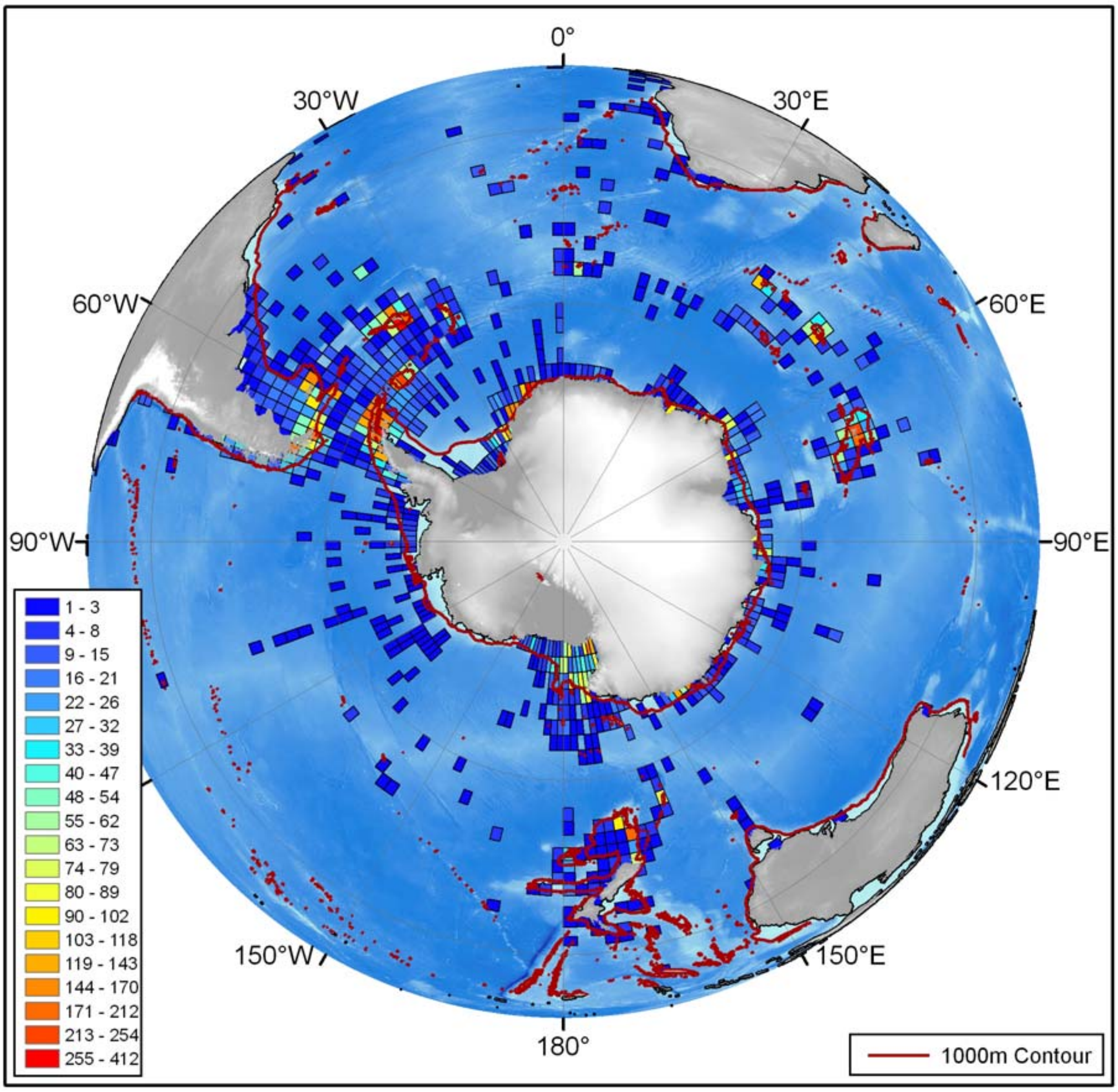

Figure 9*: A 2° x 2° grid showing the total number of species per grid cell.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

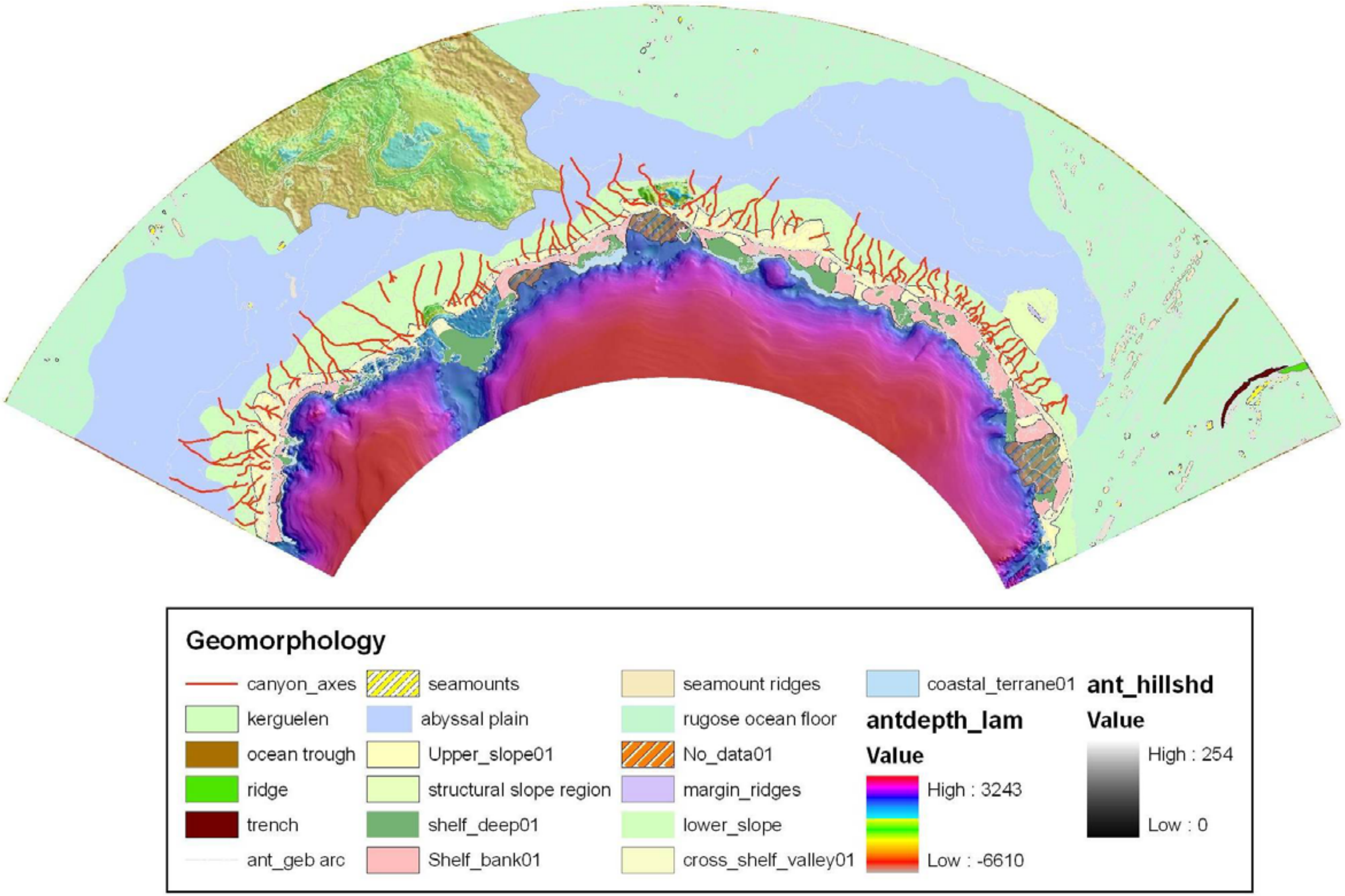

Figure 10*: Geomorphic map of the East Antarctic margin.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

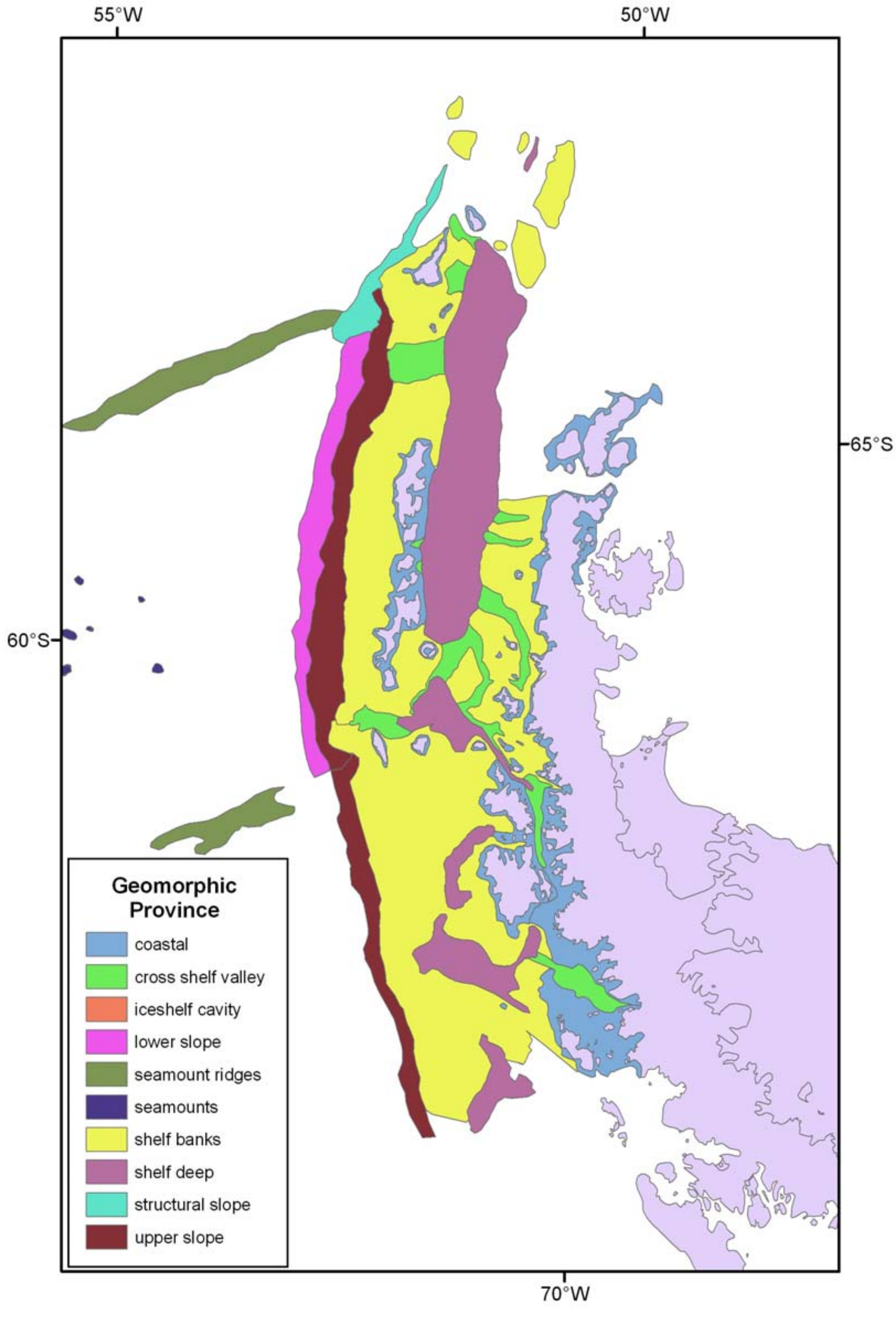

Figure 11*: Geomorphic provinces of the northern Antarctic Peninsula.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

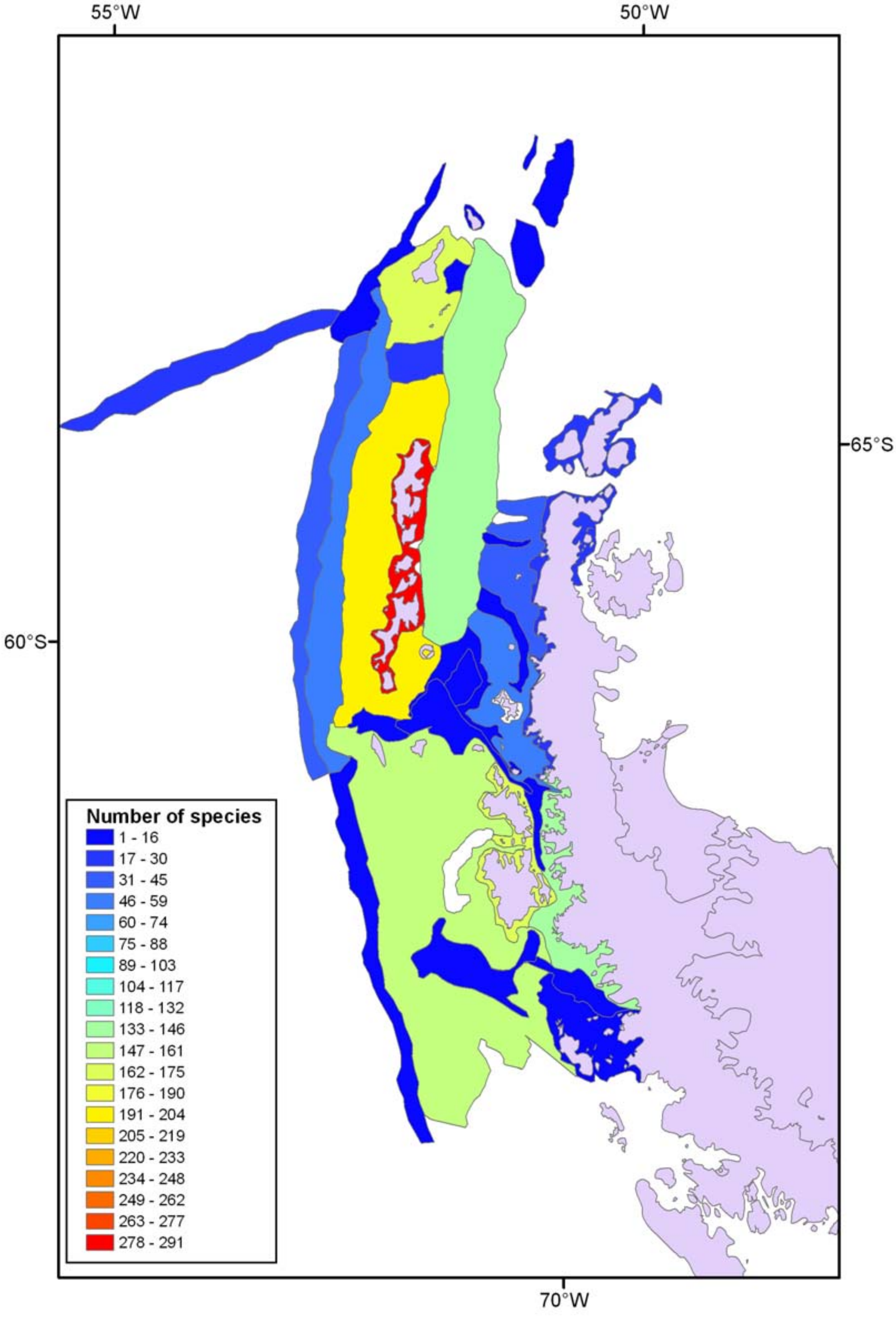

Figure 12*: Number of known species sampled in different geomorphic provinces.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

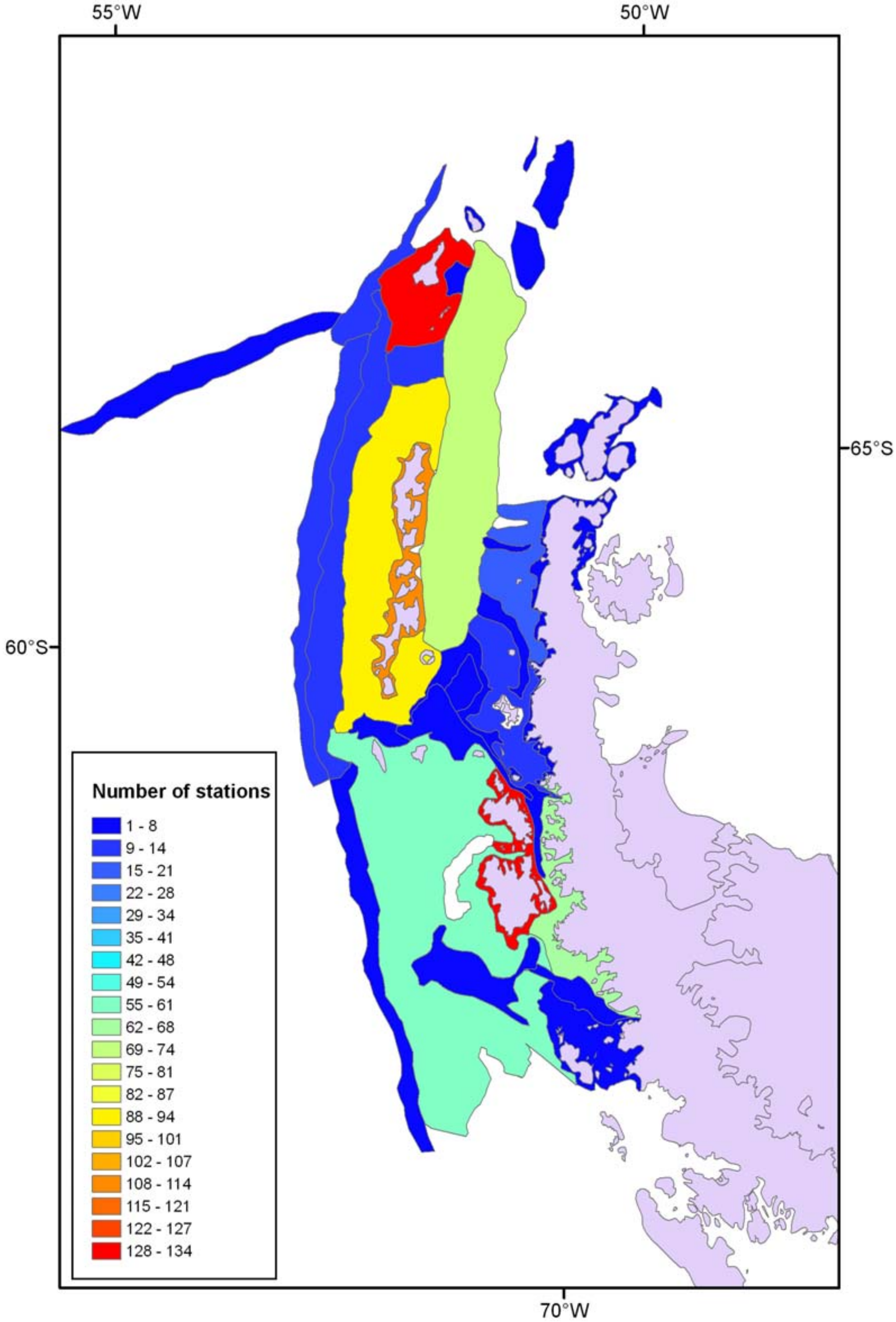

Figure 13*: Concentration of sampling locations in different geomorphic provinces.

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* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

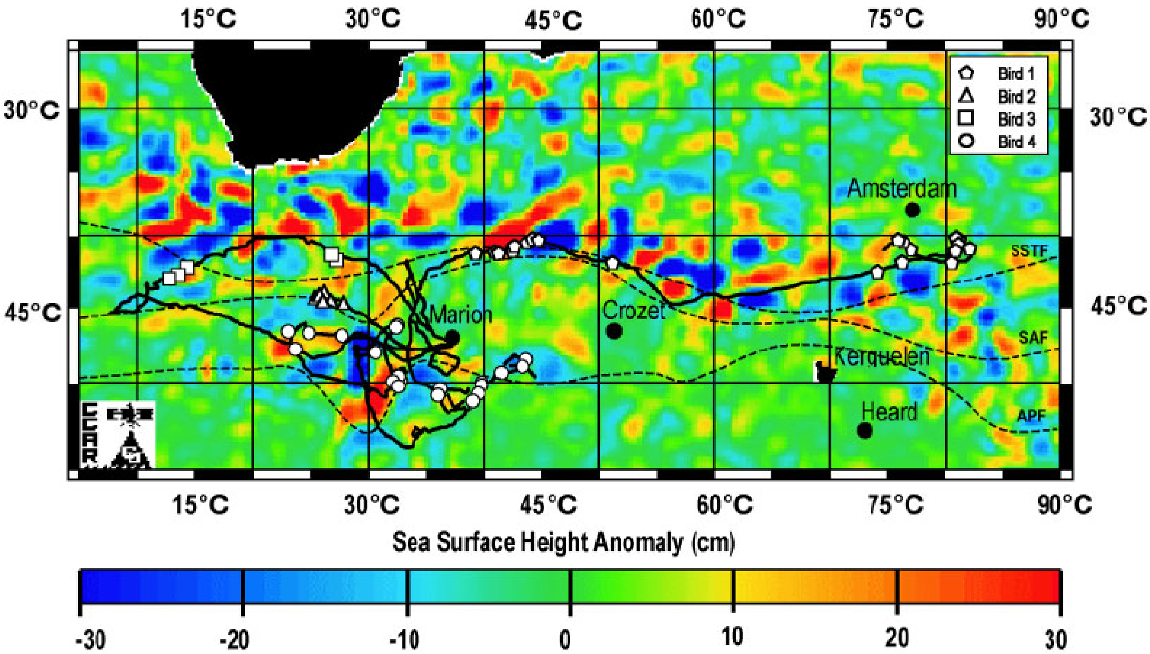

Figure 14*: Position of mesoscale eddies in the southern Indian Ocean as depicted by sea-surface height anomaly data. This figure also depicts the foraging tracks of grey-headed albatrosses which exploit these features. Symbols indicate birds moving at <10 km/h during daytime, probably foraging.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

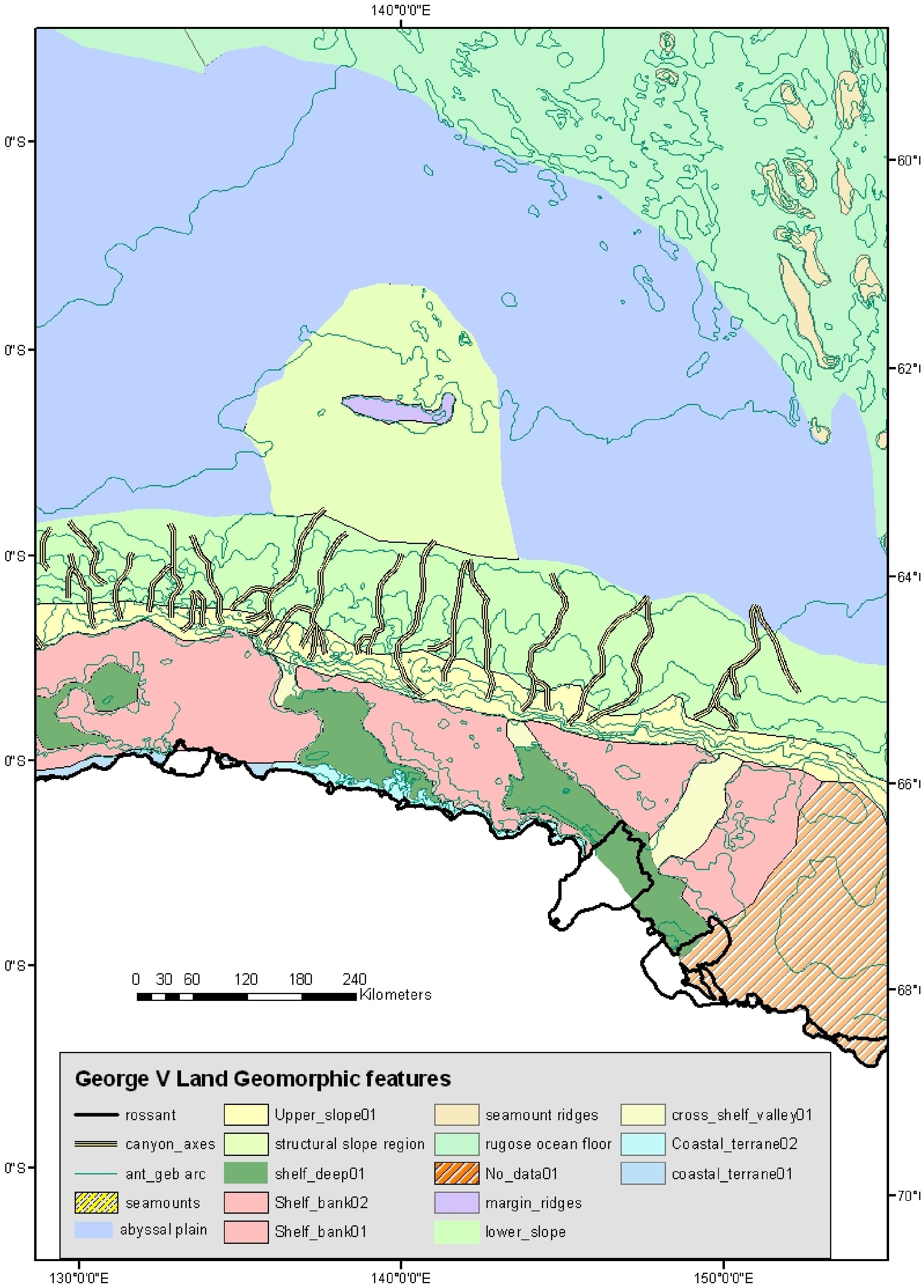

Figure 15*: Position of submarine canyons in the eastern Antarctic region.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

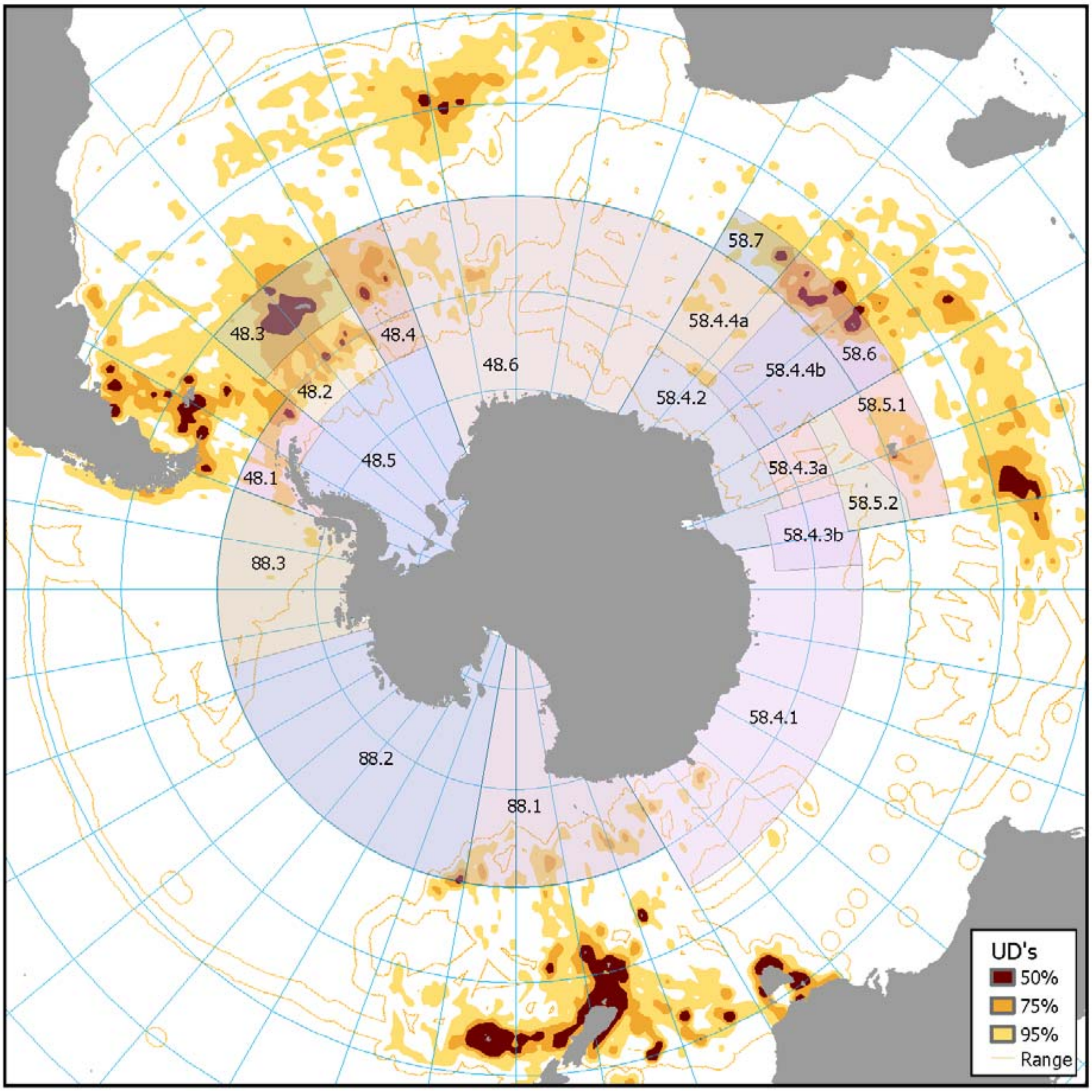

Figure 16*: Combined utilisation distribution map for the breeding distribution of 18 albatross, giant petrel and petrel species represented in the BirdLife International Global Procellariiform Tracking Database. Each species has been given equal weighting.

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

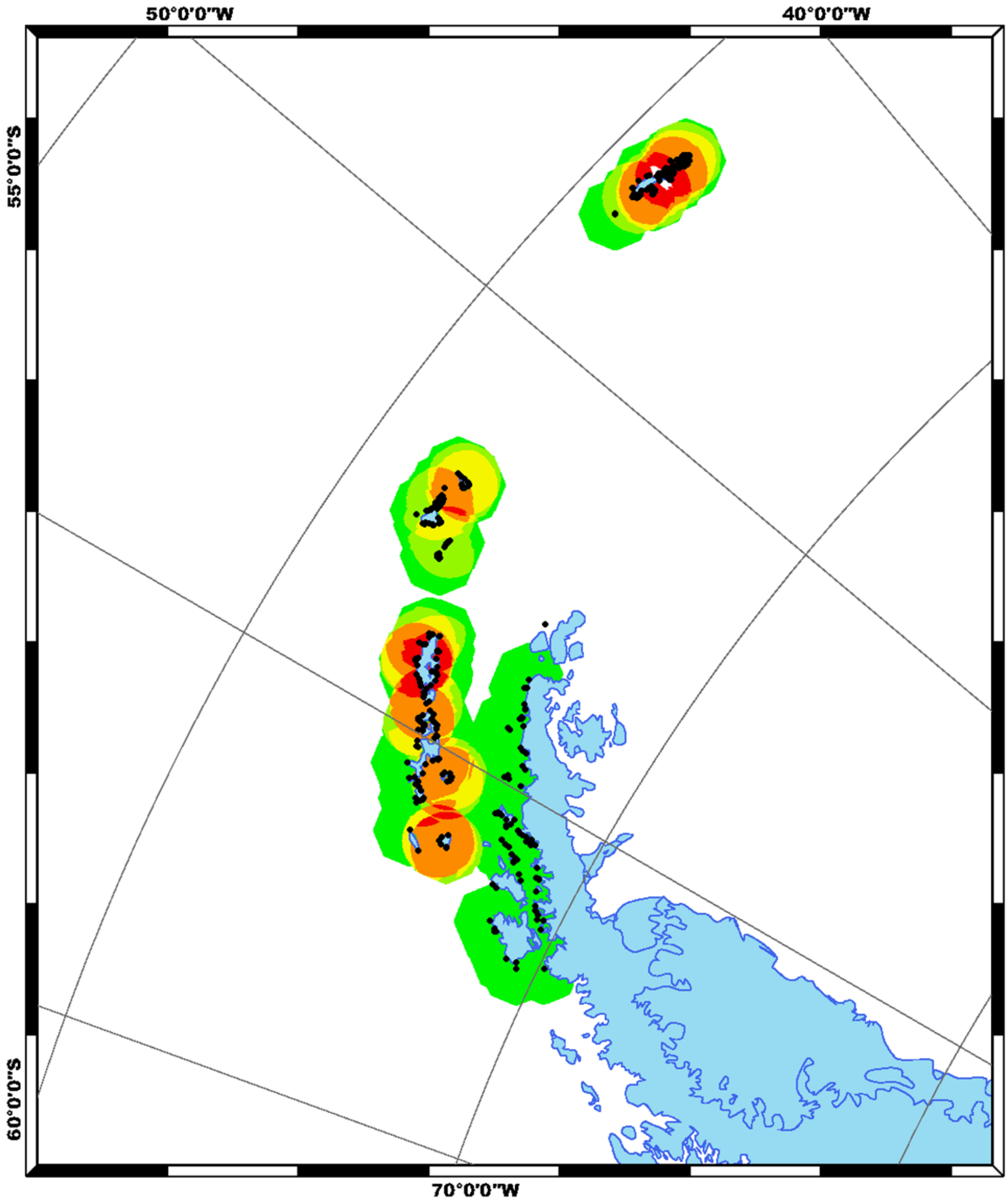

Figure 17*: Relative foraging effort of chinstrap penguin colonies in the west Antarctic Peninsula; foraging effort is scaled to colony size; foraging range is taken from Lynnes et al. (2002).

* This figure is available in colour on the 'Publications' page of the CCAMLR website www.ccamlr.org/pu/e/e_pubs/sr/07/toc.htm.

APPENDIX A

AGENDA

Workshop on Bioregionalisation of the Southern Ocean
(Brussels, Belgium, 13 to 17 August 2007)

Introduction

Adoption of agenda

Workshop objectives:
- To advise on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces.

Introductory presentations

Terms of reference for the Steering Committee
(annotated with key points to be addressed by the Workshop)

(i) Collate existing data on coastal and oceanic provinces, including benthic and pelagic features:

- review collated datasets on coastal and oceanic provinces, including benthic and pelagic features, and physical and biological data;

- consider which datasets would be most useful for (i) broad-scale bioregionalisation analysis, and (ii) fine-scale delineation of provinces.

(ii) Determine the statistical analyses required to facilitate a bioregionalisation, including the use of empirical, model and expert data:

- review approaches to bioregionalisation (including outcomes from 2006 Hobart Workshop and other intersessional work);

- undertake practical (computer-based) analysis to investigate statistical issues and refine methods;

- establish agreed methods for use in (i) broad-scale bioregionalisation analysis, and (ii) fine-scale delineation of provinces.

(iii) Develop a broad-scale bioregionalisation based on existing datasets and other datasets possibly available prior to the workshop.

(iv) Delineate fine-scale provinces within regions, where possible:

- review results from intersessional work (including 2006 Hobart Workshop)

- undertake (i) broad-scale bioregionalisation analysis, and (ii) fine-scale delineation of provinces, using agreed methods and datasets.

(v) Establish a procedure for identifying areas for protection to further the conservation objectives of CCAMLR:

- Preliminary discussion on procedures that might be utilised (with a view to undertaking further work during the next stages of the work program).

Recommendations for future work

Advice to SC-CAMLR

Adoption of workshop report.

APPENDIX B

LIST OF PARTICIPANTS

Workshop on Bioregionalisation of the Southern Ocean
(Brussels, Belgium, 13 to 17 August 2007)

ALDER, Viviana (Dr)	Instituto Antártico Argentino Departmento Ciencias Biológicas Cerrito 1248 C1010AAZ Buenos Aires Argentina viviana@ege.fcen.uba.ar viviana_alder@yahoo.com
BAIVIER, Bertrand (Mr) (Host, local organiser)	Public Health, Food Chain Security and Environment International Affairs (DG5) Place Victor Horta 40, Box 10 1060 Brussels Belgium bertrand.baivier@health.fgov.be
CLARKE, Andrew (Prof.)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom accl@bas.ac.uk
CONSTABLE, Andrew (Dr) (Co-convener, WG-SAM)	Antarctic Climate and Ecosystems Cooperative Research Centre Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia andrew.constable@aad.gov.au
DANIS, Bruno (Dr) (Invited expert)	Royal Belgian Institute of Natural Sciences rue Vautier 29 1000 Brussels Belgium bruno.danis@naturalsciences.be bruno.danis@scarmarbin.be

DE BROYER, Claude (Dr)	Royal Belgian Institute of Natural Sciences rue Vautier 29 1000 Brussels Belgium claude.debroyer@naturalsciences.be
DE LICHTERVELDE, Alexandre (Mr) (Host, local organiser)	Public Health, Food Chain Security and Environment International Affairs (DG5) Place Victor Horta 40, Box 10 1060 Brussels Belgium alexandre.delichtervelde@health.fgov.be
FERNHOLM, Bo (Prof.)	Swedish Museum of Natural History Box 50007 SE-104 05 Stockholm Sweden bo.fernholm@nrm.se
GOFFART, Anne (Dr)	Laboratoire d'Océanologie – MARE Center University of Liège Allée de la Chimie, 3 Bâtiment B6c 4000 Liège Sart-Tilman Belgium a.goffart@ulg.ac.be
GRANT, Susie (Dr) (Co-convener)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom suan@bas.ac.uk
GRIFFITHS, Huw (Mr)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom hjg@bas.ac.uk
HOLT, Rennie (Dr)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA rennie.holt@noaa.gov

HOSIE, Graham (Dr) (Invited expert)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia graham.hosie@aad.gov.au
JONES, Christopher (Dr) (Co-convener, WG-SAM)	US AMLR Program Southwest Fisheries Science Center 8604 La Jolla Shores Drive La Jolla, CA 92037 USA chris.d.jones@noaa.gov
KAHRU, Mati (Dr) (Invited Expert)	Scripps Institute of Oceanography 8604 La Jolla Shores Drive La Jolla, CA 92037-1508 USA mkahru@ucsd.edu
KELLY, Emily (Ms)	National Science Foundation Office of Polar Programs 4201 Wilson Blvd Arlington, VA 22230 USA emkelly@nsf.gov
KOUBBI, Philippe (Dr)	Laboratoire d'Océanographie de Villefranche – UMR 7093 Observatoire Océanologique Université Pierre et Marie Curie – Paris VI BP 28 06234Villefranche-sur-mer France koubbi@obs-vlfr.fr
LOMBARD, Mandy (Dr)	C/- WWF South Africa Millennia Park Private Bag X2 Die Boord 7613 South Africa gemsbok@mweb.co.za

MARSCHOFF, Enrique (Dr)	Instituto Antártico Argentino Cerrito 1248 C1010AAZ Buenos Aires Argentina marschoff@dna.gov.ar
MARTIN-SMITH, Keith (Dr)	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway Kingston Tasmania 7050 Australia keith.martin-smith@aad.gov.au
MEMOLLI, Mariano (Dr)	Dirección Nacional del Antártico Cerrito 1248 C1010AAZ Buenos Aires Argentina drmemolli@gmail.com
NEL, Deon (Dr)	WWF South Africa Millennia Park Private Bag X2 Die Boord 7613 South Africa dnel@wwf.org.za
O'BRIEN, Phil (Dr)	Geoscience Australia GPO Box 378 Canberra ACT 2601 Australia phil.obrien@ga.gov.au
PENHALE, Polly (Dr) (Co-convener)	National Science Foundation Office of Polar Programs 4201 Wilson Blvd Arlington, VA 22230 USA ppenhale@nsf.gov
PINKERTON, Matt (Dr)	National Institute of Water and Atmospheric Research Private Bag 14-901 Kilbirnie Wellington New Zealand m.pinkerton@niwa.co.nz

RAYMOND, Ben (Dr)
(participated remotely from AAD, Australia)

Antarctic Climate and Ecosystems Cooperative Research Centre
Australian Antarctic Division
Department of the Environment and Water Resources
203 Channel Highway
Kingston Tasmania 7050
Australia
ben.raymond@aad.gov.au

SAKAMOTO, Takaaki (Mr)

Fisheries Agency of Japan
1-2-1, Kasumigaseki, Chiyda-ku
Tokyo 100-8907
Japan
takaaki_sakamoto@nm.maff.go.jp

SHARP, Ben (Dr)

Ministry of Fisheries
PO Box 1020
Level 4, GBL House
256 Lambton Quay
Wellington
New Zealand
ben.sharp@vanuatu.com.vu

SHUST, Konstantin (Dr)

VNIRO
17a V. Krasnoselskaya
Moscow 107140
Russia
antarctica@vniro.ru

SIEGEL, Volker (Dr)

Institut für Seefischerei
Bundesforschungsanstalt für Fischerei
Palmaille 9
22767 Hamburg
Germany
volker.siegel@ish.bfa-fisch.de

SLOCUM, Gillian (Ms)

Australian Antarctic Division
Department of the Environment and Water Resources
203 Channel Highway
Kingston Tasmania 7050
Australia
gill.slocum@aad.gov.au

SMITH, Walker (Dr)	Virginia Institute of Marine Science College of William and Mary PO Box 1346 Gloucester Point, VA 23062-1346 USA wos@vims.edu
TRATHAN, Phil (Dr)	British Antarctic Survey High Cross Madingley Road Cambridge CB3 0ET United Kingdom pnt@bas.ac.uk
VAN DE PUTTE, Anton (Mr)	Laboratory of Animal Diversity and Systematics Katholieke Universiteit Leuven (KUL) Charles Deberiotstraat 32 3000 Leuven Belgium anton.vandeputte@bio.kuleuven.be
VIERROS, Marjo (Dr) (Invited Expert)	United Nations University Institute of Advanced Studies 6F International Organizations Center Pacifico-Yokohama 1-1-1 Minato Mirai, Nishi-ku Yokohama 220-8502 Japan vierros@ias.unu.edu

Secretariat:

Denzil MILLER (Executive Secretary) Eugene SABOURENKOV (Science/Compliance Officer) Genevieve TANNER (Communications Officer)	CCAMLR PO Box 213 Tasmania Australia ccamlr@ccamlr.org

APPENDIX C

LIST OF DOCUMENTS

Workshop on Bioregionalisation of the Southern Ocean
(Brussels, Belgium, 13 to 17 August 2007)

WS-BSO-07/1	Draft Agenda
WS-BSO-07/2	List of Participants
WS-BSO-07/3	List of Documents
WS-BSO-07/4	Southern Ocean continuous plankton recorder survey: spatial and temporal patterns of variation in zooplankton abundance, distribution and diversity G.W. Hosie (Australia)
WS-BSO-07/5	Spatial patterns of temporal relationships in the Southern Ocean M. Kahru and B.G. Mitchell (USA)
WS-BSO-07/6	Marine classification: lessons from the New Zealand experience B. Sharp, M. Pinkerton and J. Leathwick (New Zealand)
WS-BSO-07/7	Use of biological data to inform bioregionalisation of the Southern Ocean M. Pinkerton, B. Sharp and J. Leathwick (New Zealand)
WS-BSO-07/8	A scheme for mapping Antarctic seafloor geomorphology to aid benthic bioregionalisation P. O'Brien (Australia)
WS-BSO-07/9	Summary fact sheets for bioregionalisation of the Southern Ocean – examples from the Indian Ocean sector (Area 58) K. Martin-Smith, P. O'Brien, B. Raymond and A. Constable (Australia)
WS-BSO-07/10	On biogeographic patterns of benthic invertebrate mega fauna on shelf areas of the Southern Ocean Atlantic sector S.J. Lockhart and C.D. Jones (USA) (*CCAMLR Science*, submitted)
WS-BSO-07/11	Bioregionalisation: some key questions and considerations S. Grant, A. Clarke, P.N. Trathan and H.J. Griffiths (UK)

WS-BSO-07/12	Spatial disposition of euphausiid larvae in relation with the Weddell-Scotia Confluence E. Marschoff, D. Gallotti, G. Donnini and N. Alescio (Argentina)

Other Documents

WS-BSO-07/P1	Conserving pattern and process in the Southern Ocean: designing a Marine Protected Area for the Prince Edward Islands (Lombard, A.T., B. Reyers, L.Y. Schonegevel, J. Cooper, L.B. Smith-Adao, D.C. Nel, P.W. Froneman, I.J. Ansorge, M.N. Bester, C.A. Tosh, T. Strauss, T. Akkers, O. Gon, R.W. Leslie and S.L. Chown (2007) *Ant. Sci.*, 19 (1): 39–54)
WS-BSO-07/P2	Vacant
WS-BSO-07/P3	A new approach to selecting Marine Protected Areas (MPAs) in the Southern Ocean (Harris, J., M. Haward, J. Jabour and E.J. Woehler (2007) *Ant. Sci.*, 19 (2): 189–194, doi: 10.1017/S0954102007000260)
WS-BSO-07/P4	Development of the Southern Ocean Continuous Plankton Recorder survey (Hosie, G., M. Fukuchi and S. Kawaguchi (2003) *Progr. Oceanogr.*, 58: 263–283)
WS-BSO-07/P5	The Continuous Plankton Recorder in the Southern Ocean: a comparative analysis of zooplankton communities sampled by the CPR and vertical net hauls along 140°E (Hunt, B.P.V and G. Hosie (2003) *J. Plankton Res.*, 25 (12): 1561–1579)
WS-BSO-07/P6	Zonal structure of zooplankton communities in the Southern Ocean south of Australia: results from a 2150 km continuous plankton recorder transect (Hunt, B.P.V. and G. Hosie (2005) *Deep-Sea Res.*, I, 52 (7): 1241–1271)
WG-EMM-07/7	Interactions between oceanography, krill and baleen whales in the Ross Sea and adjacent waters in 2004/05 M. Naganobu, S. Nishiwaki, H. Yasuma, R. Matsukura, Y. Takao, K. Taki, T. Hayashi, Y. Watanabe, T. Yabuki, Y. Yoda, Y. Noiri, M. Kuga, K. Yoshikawa, N. Kokubun, H. Murase, K. Matsuoka and K. Ito (Japan)
SC-CAMLR-XXV/BG/18	To the question for bioregionalisation of the Antarctic waters with ecosystem approach Delegation of Russia

DESCRIPTIONS OF THE DATASETS USED IN BENTHIC BIOREGIONAL CLASSIFICATION

1. Physical data

Bathymetry – Depth data were obtained from the GEBCO digital atlas (IOC, IHO and BODC, 2003). These data give water depth in metres and are provided on a one-minute global grid. Centenary Edition of the GEBCO Digital Atlas, published on CD-ROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization (IHO) as part of the General Bathymetric Chart of the Oceans, British Oceanographic Data Centre, Liverpool, UK.
See www.gebco.net and www.bodc.ac.uk/projects/international/gebco.
A metadata record for the bathymetry polygons can be obtained from: http://data.aad.gov.au/aadc/metadata/metadata_redirect.cfm?md=AMD/AU/geb.
In addition to the GEBCO bathymetry, geomorphic mapping used the ETOPO2 topography grid (www.ngdc.noaa.gov/mgg/fliers/01mgg04.html) which includes satellite-derived bathymetry. These data are particularly useful for identifying seamounts.

Slope – Slope (degrees of incline) are derived from the GEBCO bathymetry dataset (see above for details) using the 'slope' function in ArcGIS (version 9) Spatial Analyst.

Sea-floor sediment type – A map of surficial sediment distributions was digitised from McCoy (1991). This map is a compilation of published and unpublished data, including historical records such as from the Challenger and Discovery cruises, and more recent drilling projects. All information was compared to a regional framework of sediment data from core analyses. The map depicts unconsolidated sediments recovered primarily by coring, but also by grab samplers, dredges, and other types of sediment samplers.
McCoy, FW. (1991). Southern Ocean Sediments: circum-Antarctic to 30°S. In: Hayes, D.E. (Ed.). Marine Geological and Geophysical Atlas of the Circum-Antarctic to 30°S. *Ant. Res. Ser.*, 34.

Sea-floor temperature – Mean sea temperature by depth sourced from the US National Oceanic and Atmospheric Administration (NOAA – www.nodc.noaa.gov). Created by H. Griffiths (British Antarctic Survey, UK).

Geomorphology – Geomorphology was mapped by visual inspection of the combined bathymetry datasets and polygons digitised directly into ACRGIS. The different geomorphic features were mapped using criteria set out in WS-BSO-07/8. In addition, seismic lines from the SCAR Seismic Data Library System were used to give a profile view of the sea floor and give insight into the likely character of the sea floor (hard versus soft).

2. Biological data

Antarctic Echinoids
Metadata page:
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=Ant_Echinoids_SCARMarBIN&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creators: B. David, University of Burgundy, France; C. De Ridder, Free University of Brussels, Belgium
Short description: 'Antarctic Echinoids' is an interactive database synthesising the results of more than 100 years of Antarctic expeditions. It comprises information about 81 echinoid species present south of the Antarctic convergence. It includes illustrated keys for the determination of the species, and information about their morphology and ecology (text, illustrations and glossary), their distribution (maps and histograms of bathymetrical distribution); the sources of the information (bibliography, collections and expeditions) are also provided. Antarctic Echinoids is part of the Belgian BIANZO consortium, which constitutes the kernel of SCAR-MarBIN.

Southern Ocean Mollusc Database (SOMBASE)
Metadata
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=scarmarbin_SOMBASE&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creators: A. Clarke and H. Griffiths, British Antarctic Survey, UK
Short description: SOMBASE contains comprehensive distribution records of Antarctic, Magellanic, and sub-Antarctic gastropods and bivalves as well as records for many other species from the southern hemisphere. Based on published records and British Antarctic Survey data, these distribution maps form part of a biogeographic database, which also includes taxonomic, ecological and habitat data. The database contains information on over 1 400 species from more than 3 350 locations.

Southern Ocean Sea Stars Biogeography
Metadata page (not complete):
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=scarmarbin_Asteroids_stampanato&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creator: B. Danis, Free University of Brussels, Belgium
Short description: This dataset is an extension of the 'Antarctic and Sub-Antarctic Asteroid Zoogeography [SCAR-MarBIN]' datasets, which is available on SCAR-MarBIN. The version of the datasets used in the framework of the present workshop includes data from six expeditions, including 7 308 records, belonging to 147 sea star species, from 331 stations. The complete dataset will soon be made available on SCAR-MarBIN, when primary analysis is completed.

Ant'Phipoda

Metadata page:
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=scarmarbin_AntPhipoda&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creator: C. De Broyer, Royal Belgian Institute of Natural Sciences, Brussels, Belgium
Short description: Ant'phipoda is a specialised database that records and organises the widely scattered information on taxonomy, geographic and bathymetric distribution, ecology and bibliography available on Southern Ocean amphipods. Ant'phipoda is part of the Belgian BIANZO consortium, which constitutes the kernel of SCAR-MarBIN.

FishBase

Metadata page: http://gcmd.nasa.gov/records/01-FishBase-99.html
Dataset creators: R. Froese, Institute of Marine Research, Kiel, Germany; D. Pauly, Fisheries Centre, University of British Columbia, Canada
Short description: A subset of the data described here (7 775 records from Southern Ocean locations) is served by SCAR-MarBIN. FishBase is a global information system covering all aspects of fish biology, ecology, population dynamics, life history and usage by humans. The information is provided in monthly updates at www.fishbase.org. Occurrence data stem mostly from museum collections, less from surveys and the scientific literature; in addition, about 1 000 observation records were reported by the public (fish watchers). Fish were collected with varying gear and deposit of specimens; also trawl surveys and a few individual observations, e.g. by anglers or divers. Habitat coverage includes marine, brackish and freshwater. All classes of fish are represented: Myxini (hagfish), Cephalaspidomorphi (lampreys), Holocephali (chimaeras), Elasmobranchii (sharks and rays), Sarcopterygii (lobe-finned fish) and Actinopterygii (ray-finned fish), with altogether 29 200 of 30 000 estimated species. In the framework of this Workshop, SCAR-MarBIN was queried only for benthic fish species.

Hexacorallia

Metadata page:
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=scarmarbin_HEXACORALLIA&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creator: D. Fautin, University of Kansas, USA
Short description: A subset of the data described here (1 428 Southern Ocean records) is served by SCAR-MarBIN. Hexacorallia is a compilation of publications concerning taxonomy, nomenclature and geographic distribution of extant hexacorallians – members of cnidarian orders Actiniaria (sea anemones in the strict sense), Antipatharia (black corals), Ceriantharia (tube anemones), Corallimorpharia (sea anemones in the loose sense), Ptychodactiaria (sea anemones in the loose sense), Scleractinia (hard or stony corals) and Zoanthidea (sea anemones in the loose sense). More information on the collections and temporal coverage of the data included can be obtained at:
http://hercules.kgs.ku.edu/hexacoral/anemone2/index.cfm

ZIN Brittlestars
Metadata page:
http://gcmd.gsfc.nasa.gov/KeywordSearch/Metadata.do?Portal=scarmarbin&KeywordPath=Locations%7COCEAN%7CSOUTHERN+OCEAN&OrigMetadataNode=GCMD&EntryId=scarmarbin_MANFA&MetadataView=Brief&MetadataType=0&lbnode=gcmd3
Dataset creator: I. Smirnov, Zoological Institute of St Petersburg, Russia
Short description: The Laboratory of Marine Research (Zoological Institute of the Russian Academy of Sciences) has set up a series of databases on Antarctic marine biodiversity. The databases focus on taxonomy, biogeography, phylogeny and ecology of Antarctic marine invertebrates. The collections deposited in the laboratory are the largest in Russia. They contain more than 15 000 species and about 1 700 000 items. The Marine Antarctic Fauna (MANFA) Database is part of CAML which investigates the distribution and abundance of Antarctica's vast biodiversity to develop a benchmark for assessing effects of climate change. MANFA data will be made accessible through SCAR-MarBIN.

CCAMLR Scientific Survey and Commercial Fishery database (not available online)
In order to complete the information available via SCAR-MarBIN, the subgroup on benthos requested a distribution database for benthic fish. The list of taxa making up the data request include: Artedidraconidae, Bathydraconidae, Channichthyidae, Harpagiferidae, Nototheniidae (*Dissostichus*, *Gobionotothen*, *Lepidonotothen*, *Notothenia*, *Nototheniops*, *Paranotothenia*, *Trematomus*), Tripterygiidae and Zoarcidae.

ANNEX 10

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2007/08 INTERSESSIONAL PERIOD

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2007/08 INTERSESSIONAL PERIOD

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
1.	**International Polar Year**				
1.1	Implement sampling protocols for CCAMLR-related activities conducted during IPY (see CCAMLR website).	2.24–2.28	As appropriate	Assist	Implement, as appropriate
1.2	Store data in internationally recognised data repositories, submit metadata records to CCAMLR and SCAR-MarBIN, submit relevant data (raw and processed formats) to CCAMLR.	2.29	As appropriate	Assist	Implement
1.3	Summarise all IPY acoustic data and related metadata submitted to CCAMLR, and report to SG-ASAM.	2.30	Apr 2009	Implement	
1.4	Examine available IPY acoustic data and advise the Scientific Committee on their value for krill biomass estimation.	2.30	2009	Assist	SG-ASAM
2.	**Methods**				
2.1	Undertake tasks identified by WG-SAM and SG-ASAM.		As appropriate	Implement	Implement
2.2	Continue to develop management strategy evaluation.	2.10, 2.13	Ongoing	Assist	Implement
2.3	Keep Scientific Committee informed during intersessional period on progress in subdivision of krill catch limit in Area 48 among SSMUs, in case contingency plans need to be developed.	2.14	Oct 2008	Coordinate	WG-SAM and WG-EMM Conveners
2.4	Develop format for reporting and archiving work to validate and verify software and approaches, and for archiving assessment runs.	2.17	As appropriate	Assist	WG-SAM
2.5	Convene next meeting of SG-ASAM in conjunction with ICES WG-FAST meeting in 2009, to consider acoustic results from IPY surveys, development in TS modelling, and other new observations.	2.21	2009	Assist, participate	SG-ASAM Co-conveners
3	**Ecosystem monitoring and management**				
3.1	Undertake tasks identified by WG-EMM.	Annex 4, Table 3	Jun 2008	Implement	Implement
3.2	Consider information required from exploratory krill fisheries.	3.29, 3.53	As appropriate	Assist	WG-EMM

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
3.3	Examine consequences of not subdividing large statistical areas, or consequences of subdividing these areas using limited data.	3.35	As appropriate	Assist	WG-EMM
3.4	Consider biological data reporting requirements for krill fishery.	3.51	Sep 2008	Assist	WG-EMM
3.5	Develop terms of reference for second joint WG-EMM and WG-FSA workshop to be held in 2009 to consider development of ecosystem models to examine effects of fisheries in fish-based ecosystems.	3.100	Sep 2008	Assist	WG-EMM, WG-FSA
3.6	Conduct intersessional work of WG-EMM Subgroup on the Status and Trend Assessment of Predator Populations (WG-EMM-STAPP).	6.4, 6.5	May 2008	Assist	WG-EMM-STAPP Convener
3.7	Convene workshop on estimation of land-based marine predator abundance in southwest Atlantic.	6.4–6.8	Jun 2008	Assist	WG-EMM-STAPP Convener
3.8	Submit WG-EMM-STAPP report to WG-SAM and WG-EMM.	6.9	Jun 2008	Assist	WG-EMM-STAPP Convener
4.	**Harvested species including by-catch species**				
4.1	Encourage development of management strategy evaluation.	2.10	Ongoing	Assist	Implement
4.2	Submit requested haul-by-haul data from krill fishery and send scientists to WG-EMM to assist with analysis of such data.	4.1	Jun 2008	Assist	Poland
4.3	Examine how effort in krill fishery can best be quantified.	4.17, 4.24	As appropriate	Assist	WG-SAM, WG-EMM, Members
4.4	Send appropriate expertise to WG-EMM and WG-SAM meetings so that information on krill fishing operations can be thoroughly analysed.	4.17	As appropriate	Assist	Implement
4.5	Estimate *D. eleginoides* biological parameters and develop stock assessments for the French EEZs in Division 58.5.1 and Subarea 58.6.	4.64, 4.79	As appropriate	Assist	France, Australia to assist
4.6	Use CCAMLR decision rules in estimating yields for *D. eleginoides* fishery in South African EEZ.	4.88	As appropriate	Assist	South Africa
4.7	Review impact of changes to management of *C. gunnari* fishery in Subarea 48.3 (Conservation Measure 42-01).	4.95	Oct 2008	Assist	WG-FSA
4.8	Conduct further priority work on developing *C. gunnari* management procedure.	4.100	As appropriate	Assist	Members, WG-SAM, WG-FSA

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
4.9	Post protocols on CCAMLR website for tagging and handling very large toothfish (WG-FSA-07/36).	4.39	Feb 2008	Implement	Communicate to technical coordinators
4.10	Produce waterproof template for tag–recapture photos to add to tagging kits.	4.41	Feb 2008	Implement and distribute	Distribute
4.11	Collect and report information to help investigate possible causes of variable tag–recapture rates.	4.43, 12.9	Apr 2008	Coordinate and implement	Implement
4.12	Coordinate formation of subgroup to plan Year of the Skate in 2008/09.	4.181(i)	Jan 2008	Coordinate	Implement
4.13	Develop detailed region-specific skate identification guides.	4.181(ii)	Sep 2008	Coordinate	Implement
4.14	Coordinate skate tagging program in new and exploratory fisheries.	4.41, 4.42, 4.181(v)	Oct 2008	Coordinate and implement	Implement
4.15	Review amendment to Conservation Measure 33-03, particularly with respect to effects of the change on macrourid catches and catch rates.	4.189	Oct 2008	Assist	WG-FSA
4.16	Develop guides for identification of benthic organisms specific to areas in which observers carry out activities.	4.190	As appropriate	Assist	Implement
5.	**New and exploratory fisheries**				
5.1	Identify factors responsible for high variability of data quality arising from different vessels in Subareas 88.1 and 88.2.	2.9	Oct 2008	Assist	WG-FSA
5.2	Develop assessments for all exploratory fisheries, and ensure that appropriate data are collected to enable such assessments to be made as soon as practicable.	4.112	Urgent	Assist	WG-FSA
5.3	Further develop analysis to estimate catch required to estimate stock size accurately from current tagging rates.	4.113	Oct 2008	Assist	WG-FSA
5.4	Undertake methodological work on designing research experiments in exploratory fisheries.	4.114, 4.156	Oct 2008	Assist	WG-SAM, WG-FSA
5.5	Provide full report of research on *Dissostichus* spp. notified under Conservation Measure 24-01, paragraph 4(c), to WG-FSA.	4.115, 9.11	Sep 2008	Assist	Members conducting notified research
5.6	Investigate differences in tag recovery rates from tagging by different Members.	4.116, 12.9	Sep 2008	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
5.7	Ensure that fishery-based research requirements are met and reported.	4.117, 4.118	Ongoing	Assist	Implement
5.8	Undertake preliminary assessment of catch and tagging data from *Dissostichus* spp. fisheries in Subarea 58.4.	4.133, 4.137	Oct 2008	Assist	WG-FSA
5.9	Develop practical guidelines for providing scientific advice to Commission on different components for managing bottom fisheries in high-seas areas of Convention Area.	4.162–4.167, 14.9, 14.10	Dec 2008	Assist	Members, WG-SAM, WG-FSA
5.10	Develop camera gear to be deployed on fishing gears.	4.168	As appropriate	Assist	Australia, Members to collaborate
6.	**Incidental mortality**				
6.1	Undertake tasks identified by ad hoc WG-IMAF intersessional work plan.	5.1, Annex 6, Part II, Table 21	Sep 2008	Implement	Implement
6.2	Consider hook loss in longline fisheries and possible ways to reduce it.	5.16	Sep 2008	Implement	Implement
6.3	Obtain data and details on vessels, gear type, method of deployment and mitigation measures.	5.28	Sep 2008	Implement	Assist
6.4	Produce poster instructing crews to retain all hooks on board vessels.	5.29(vi), 5.31	Jan 2008	Implement	Implement
6.5	Request reports on survey work on hook ingestion and hook body piercing in wandering albatrosses.	5.30	Sep 2008	Implement	Members (UK)
6.6	Develop briefing package for representatives at RFMO meetings, including Resolution 22/XXV and WG-FSA-07/P2.	5.54, 5.55, 10.48	Ongoing	Implement	Ad hoc WG-IMAF Co-conveners to assist
6.7	Members develop standardised training and education standards and support technical coordinator attendance at WG-FSA and ad hoc WG-IMAF meetings.	5.33	Sep 2008	Coordinate	Implement
6.8	Members encouraged to use and promote ACAP resources.	5.52	Ongoing	Assist	Implement
6.9	Provide standing invitation to ACAP and BirdLife International to participate in future meetings of ad hoc WG-IMAF as invited experts.	5.56	Dec 2007	Implement	
7.	**Scheme of International Scientific Observation**				
7.1	Update scientific observer logbooks, instructions and cruise reports and send to technical coordinators for distribution and briefing of observers.	3.3, 4.180, 5.34	Feb 2008	Implement	Distribute to technical coordinators

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
7.2	Revise *Scientific Observers Manual* to include interim fish larvae by-catch protocol (WG-EMM-07/25).	3.3	Feb 2008	Implement	
7.3	Prepare plans to achieve systematic and consistent collection of scientific data from krill fishery and submit to WG-EMM, WG-SAM and ad hoc WG-IMAF.	3.13–3.16	Jul 2008	Assist	Implement
7.4	Assess consequences to data collection effort of different observer coverage in the krill fishery, and recommend required level of coverage to the Scientific Committee.	3.14, 3.15	Oct 2008	Assist	WG-EMM, WG-SAM, ad hoc WG-IMAF
7.5	Prepare modifications to L11 skate form in preparation for 2008/09 Year of the Skate.	4.181(iii)	Sep 2008	Implement	Members (NZ) to assist
7.6	Establish ad hoc Technical Group for At-Sea Operations (TASO), and convene meeting to begin addressing specified issues.	7.5, 7.8–7.12	Jul 2008	Assist	TASO Co-conveners to coordinate
7.7	Review scientific observer program priorities to ensure that expectations of observers and observer workloads remain achievable.	7.5	Ongoing	Assist	TASO
7.8	Prepare summary of data collected by scientific observers on krill fishing vessels during 2006/07 season.	7.17	Jun 2008	Implement	WG-EMM to review
7.9	Investigate krill fishing gear descriptions. Prepare required illustrations and update cruise report form.	7.19	Sep 2008	Implement	Technical coordinators to assist, TASO
7.10	Thank technical coordinators and scientific observers for efforts in 2006/07.	12.19	Dec 2007	Implement	Implement
8.	**Marine Protected Areas**				
8.1	Forward draft management plan for ASMA No. X with CCAMLR comments to the ATCM under Madrid Protocol Annex V.	3.65–3.70, 3.91	Dec 2007	Implement	Note
8.2	Undertake further work on bioregionalisation.	3.85–3.87	Oct 2008	Assist	Members and WG-EMM
9.	**Secretariat supported activities**				
9.1	Consider translation of certain ad hoc WG-IMAF papers, on case-by-case basis, for high priority issues, such as reduction of seabird by-catch in French EEZs.	5.60, 5.61, 5.65(v)	Sep 2008	Consider	Note
9.2	Develop CCAMLR metadata.	10.20, 13.18	As appropriate	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
9.3	Improve quality of STATLANT data.	10.42, 13.9, 13.11	Dec 2007	Implement	Implement
9.4	Modify haul-by-haul catch and effort data forms.	13.12	Nov 2007	Implement	Implement changes
9.5	Scientific Observer Data Analyst to participate in 2009 International Observer Conference.	10.46	As appropriate	Implement	
9.6	Consider proposals and prepare revision of the *CCAMLR Science* publication policy, including procedure for selecting papers.	13.24, 13.25	Oct 2008	Implement	Scientific Committee Chair, Working Group Conveners
9.7	Consider proposals for special issues of *CCAMLR Science*, including publication of CCAMLR Species Profiles and results of CCAMLR-IWC Workshop.	13.23	Oct 2008	Prepare draft	SC to consider
10.	**Intersessional meetings of working groups and other groups**				
10.1	Support Scientific Committee intersessional activities and facilitate participation of specialists at working group meetings.	1.8, 2.14, 5.2, 14.13	As appropriate	Assist	Implement
10.2	Contribute to, and participate in, joint CCAMLR-IWC Workshop.	14.16–14.20	As appropriate	Assist	Implement, Steering Committee
11.	**Other tasks**				
11.1	Delegate consideration of marine debris to ad hoc WG-IMAF, and remove the ‘Marine Debris’ item from the Scientific Committee’s agenda.	6.2	Sep 2008	Assist	Members, ad hoc WG-IMAF
11.2	Consider joint CEP-Scientific Committee workshop.	10.8	As appropriate	Assist	Implement
11.3	Science Officer to periodically attend CEP meetings to provide continuity in CEP–Scientific Committee relationship, particularly when changeover of the Scientific Committee Chair.	10.10	As appropriate	Implement	
11.4	Continue participation in, and cooperation with, SCAR activities.	10.11–10.13, 10.16	As appropriate	Implement	Implement
11.5	Further develop international cooperation.	10.47	As appropriate	Implement	Implement
11.6	Develop and implement long-term science plan.	14.1–14.7	As appropriate	Implement	Implement, Working Groups

No.	Task	Reference to paragraphs in SC-CAMLR-XXVI	Deadline	Action required	
				Secretariat	Members
11.7	In consultation with Members, develop list of achievable priority tasks for each working group, including consideration of other tasks identified in working group reports.	14.8	Jun 2008	Assist	Scientific Committee Chair, Working Group Conveners

ANNEX 11

**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
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)
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
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced Very High Resolution Radiometry
BAS	British Antarctic Survey
BED	Bird Excluder Device
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
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 *Dissostichus* spp.
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CF	Conversion Factor
CircAntCML	Circum-Antarctic Census of Antarctic Marine Life
CITES	Convention on International Trade in Endangered Species
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
CWP	Coordinating Working Party on Fishery Statistics (FAO)
DCD	*Dissostichus* Catch Document
DMSP	Defense Meteorological Satellite Program
DPM	Dynamic Production Model
DPOI	Drake Passage Oscillation Index
DVM	Diel vertical migration
DWBA	Distorted wave Born approximation model
EAF	Ecosystem Approaches to Fishing
EASIZ	Ecology of the Antarctic Sea-Ice Zone
E-CDS	Electronic Web-based Catch Documentation Scheme for *Dissostichus* spp.
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
ECOSIM	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
EEZ	Exclusive Economic Zone
EIV	Ecologically Important Value
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
EPOS	European *Polarstern* Study

EPROM	Erasable Programmable Read-Only Memory
eSB	Electronic version of CCAMLR's *Statistical Bulletin*
FAO	Food and Agriculture Organization of the United Nations
FEMA	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)
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
GBM	Generalised Boosted Model
GCMD	Global Change Master Directory
GDM	Generalised Dissimilarity Modelling
GEBCO	General Bathymetric Chart of the Oceans
GIS	Geographic Information System
GIWA	Global International Waters Assessment (SCAR)
GLM	Generalised Linear Model
GLMM	Generalised Linear Mixed Model
GLOBEC	Global Ocean Ecosystems Dynamics Research
GLOCHANT	Global Change in the Antarctic (SCAR)
GMT	Greenwich Mean Time
GOOS	Global Ocean Observing System (SCOR)

GOSEAC	Group of Specialists on Environmental Affairs and Conservation (SCAR)
GOSSOE	Group of Specialists on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
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
HIMI	Heard Island and McDonald Islands
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
ICES WGFAST	ICES Working Group on Fisheries Acoustics Science and Technology
ICFA	International Coalition of Fisheries Associations
ICSEAF	International Commission for the Southeast Atlantic Fisheries
ICSU	International Council for Science
IDCR	International Decade of Cetacean Research
IFF	International Fishers' Forum
IGBP	International Geosphere-Biosphere Programme
IGR	Instantaneous Growth Rate
IHO	International Hydrographic Organisation
IKMT	Isaacs-Kidd Midwater Trawl

IMAF	Incidental Mortality Associated with Fishing
IMALF	Incidental Mortality Arising from Longline Fishing
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research (IGBP)
IMO	International Maritime Organization
IMP	Inter-moult Period
IOC	Intergovernmental Oceanographic Commission
IOCSOC	IOC Regional Committee for the Southern Ocean
IOFC	Indian Ocean Fisheries Commission
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
IPOA	International Plan of Action
IPOA-Seabirds	FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries
IPY	International Polar Year
IRCS	International Radio Call Sign
ISO	International Organization for Standardization
ISR	Integrated Study Region
ITLOS	International Tribunal for the Law of the Sea
IUCN	International Union for the Conservation of Nature and Natural Resources – the World Conservation Union
IUU	Illegal, Unreported and Unregulated
IW	Integrated Weight
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
IWL	Integrated Weighted Line
IYGPT	International Young Gadoids Pelagic Trawl
JAG	Joint Assessment Group
JARPA	Japanese Whale Research Program under special permit in the Antarctic

JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
KPFM	Krill–Predatory–Fishery Model (used in 2005)
KPFM2	Krill–Predatory–Fishery Model (used in 2006) – renamed FOOSA
KYM	Krill Yield Model
LADCP	Lowered Acoustic Doppler Current Profiler (lowered through the water column)
LMM	Linear Mixed Model
LMR	Living Marine Resources Module (GOOS)
LTER	Long-term Ecological Research (USA)
MARPOL Convention	International Convention for the Prevention of Pollution from Ships
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)
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
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	Antarctic Regional 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
PAR	Photosynthetically Active Radiation
PBR	Permitted Biological Removal
PCA	Principal Component Analysis

PCR	Per Capita Recruitment
pdf	Portable Document Format
PDF	Probability Density Function
PF	Polar Front
PFZ	Polar Frontal Zone
PIT	Passive Integrated Transponder
PS	Paired Streamer Line
PTT	Platform Terminal Transmitter
RES	Relative Environmental Suitability
RFB	Regional Fishery Body
RFMO	Regional Fishery Management Organisation
RMT	Research Midwater Trawl
ROV	Remotely-Operated Vehicle
RPO	Realised Potential Overlap
RTMP	Real-Time Monitoring Program
RV	Research Vessel
RVA	Register of Vulnerable Areas
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 WG-Biology	SCAR Working Group on Biology
SC-CAMLR	Scientific Committee for CCAMLR
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
SOOS	Southern Ocean Observing System
SOW	South Orkney West (SSMU)
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Specially Protected Area
SPC	Secretariat of the Pacific Community
SPGANT	Ocean Colour Chlorophyll-*a* algorithm for the Southern Ocean
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

ToR	Term of Reference
TrawlCI	Estimation of Abundance from Trawl Surveys
TS	Target Strength
TSVPA	Triple Instantaneous Separable VPA
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
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-IMALF	ad hoc Working Group on Incidental Mortality Arising from Longline Fishing (CCAMLR)
WG-IMAF	ad hoc Working Group on Incidental Mortality Associated with Fishing (CCAMLR)
WG-Krill	Working Group on Krill (CCAMLR)
WG-SAM	Working Group on Statistics, Assessments and Modelling
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WSC	Weddell–Scotia Confluence
WS-Flux	Workshop on Evaluating Krill Flux Factors (CCAMLR)
WS-MAD	Workshop on Methods for the Assessment of *D. eleginoides* (CCAMLR)
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable Bathythermograph
XML	Extensible Mark-up Language
Y2K	Year 2000