SC-CAMLR-XXVII

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE TWENTY-SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
27–31 OCTOBER 2008

Part I

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Chair of the Scientific Committee
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Abstract

This document presents the adopted report of the Twenty-seventh Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 27 to 31 October 2008. 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, Incidental Mortality Associated with Fishing and Statistics, Assessments and Modelling, are annexed in Part I. The Report of the Joint CCAMLR-IWC Workshop is annexed separately in Part II.

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REPORT OF THE TWENTY-SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE
(Hobart, Australia, 27 to 31 October 2008)

OPENING OF MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met from 27 to 31 October 2008 at the CCAMLR Headquarters in Hobart, Tasmania, Australia. The meeting was chaired by the Scientific Committee's Vice-Chair Dr K. Sullivan (New Zealand).

1.2 The Chair welcomed to the meeting representatives from the following Members: Argentina, Australia, Belgium, Brazil, 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, Poland, Russian Federation, South Africa, Spain, Sweden, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America and Uruguay.

1.3 The Chair welcomed to the meeting observers from Bulgaria, Netherlands, Peru and Vanuatu (Acceding States) and the Marshall Islands (non-Contracting Party), along with observers from ACAP, ASOC, CEP, COLTO, IUCN, IWC, SCAR, SEAFO and WCPFC, and encouraged them to participate in the meeting to the extent possible.

1.4 The Scientific Committee paused in memory of Prof. Edith Fanta, Chair of the Scientific Committee (2005–2007), who passed away in May 2008. Prof. Fanta will always be remembered for her dedication to science-based conservation and management of Antarctic marine resources and her careful, considerate and very successful chairing of the Scientific Committee. She also represented Brazil at SCAR and participated actively in the SCAR Life Sciences Standing Scientific Group, Evolution in the Antarctic, and Evolution and Biodiversity in the Antarctic Program. Prof. Fanta was a much-loved friend who will be remembered for her benevolence, enthusiasm and tenderness. The Scientific Committee felt a deep sense of loss and was confident that through the research initiated by Prof. Fanta and the students she mentored, her legacy will live long into the future[1].

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

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

- Dr A. Constable (Australia) – Advances in statistics, assessments, modelling and survey methods (Advice from WG-SAM) and Bottom fishing in high-seas areas;

- Dr G. Watters (USA) – Advances in statistics, assessments, modelling and survey methods (Advice from SG-ASAM) and Interactions between WG-FSA and WG-EMM;

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[1] Readers are referred to the eulogy in *CCAMLR Science*, 2008, Vol. 15.

- Dr K.-H. Kock (Germany) – Advances in statistics, assessments, modelling and survey methods (Advice from the Joint CCAMLR-IWC Workshop);
- Drs P. Trathan (UK) and C. Southwell (Australia) – Ecosystem monitoring and management (Advice from WG-EMM);
- Drs S. Grant (UK) and P. Penhale (USA) – Management of protected areas;
- Dr S. Nicol (Australia) – Krill resources;
- Drs G. Parkes and R. Mitchell (UK) – Fish resources;
- Dr S. Hanchet (New Zealand) – New and exploratory fisheries, and squid and crab resources;
- Drs R. Mitchell (UK) and D. Welsford (Australia) – Fish and invertebrate by-catch;
- Ms K. Rivera (USA) and Mr N. Smith (New Zealand) – Incidental mortality;
- Prof. C. Moreno (Chile) and Dr D. Welsford (Australia) – CCAMLR Scheme of International Scientific Observation;
- Dr D. Agnew (UK) – 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 R. Holt (USA) – Performance Review;
- Drs D. Ramm (Data Manager) and K. Reid (Science Officer) – all other matters.

Adoption of agenda

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

Chair's report

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

1.8 The following meetings took place in 2008:

(i) The Predator Survey Workshop was held at the CCAMLR Headquarters, Hobart, Australia, from 16 to 20 June 2008, and convened by Dr Southwell.

Eleven participants from three Member countries attended, including an invited expert (Dr R. Fewster, New Zealand) and two experts from SCAR (Ms D. Patterson-Fraser and Dr B. Raymond).

(ii) Three meetings took place in St Petersburg, Russia, in July–August 2008:

- The second meeting of WG-SAM took place from 14 to 22 July. It was convened by Dr Constable. Thirty-three participants from 10 Member countries attended.

- The first meeting of ad hoc TASO was held on 19 and 20 July. It was co-convened by Mr C. Heinecken (South Africa) and Dr Welsford and was attended by 20 participants representing nine Member countries.

- The fourteenth meeting of WG-EMM was held from 23 July to 1 August. It was convened by Dr Watters and was attended by 35 participants representing 10 Members. Discussion of the Focus Topic 'Risk assessment for Stage 1 subdivisions of the precautionary catch limit among small-scale management units in Area 48' was chaired by Dr Trathan. Discussion of the Focus Topic 'Discussion to progress the implementation of spatial management measures that aim to facilitate the conservation of marine biodiversity' was chaired by Dr Penhale.

(iii) The Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models was held at the CCAMLR Headquarters in Hobart, Australia, from 11 to 15 August 2008. The workshop was convened by Drs Constable and N. Gales from the Scientific Committees of CCAMLR and IWC respectively. The workshop was attended by 45 invited experts and participants.

(iv) The meeting of WG-FSA was held from 13 to 24 October in Hobart prior to the Scientific Committee meeting. It was convened by Dr C. Jones (USA).

(v) Ad hoc WG-IMAF conducted its meeting from 13 to 17 October and was preceded by a one-day workshop on 10 October to consider the future work program for ad hoc WG-IMAF. The workshop and the Working Group meeting were co-convened by Ms Rivera and Mr Smith.

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 in 2007/08. Scientific observers have participated in 60 cruises so far this season: 52 cruises on vessels targeting toothfish or icefish and eight cruises on vessels fishing for krill (*Euphausia superba*).

1.10 CCAMLR Member countries participated in 12 fisheries under conservation measures in force during 2007/08, and three other managed fisheries were conducted in national EEZs within the Convention Area in 2007/08 (Table 1).

Scientific Committee representation at meetings of other international organisations

1.11 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 9.

ADVANCES IN STATISTICS, ASSESSMENTS, MODELLING AND SURVEY METHODS

WG-SAM advice

2.1 Dr Constable presented the report of WG-SAM (Annex 7), noting that most of the report was referred to WG-EMM and WG-FSA for consideration. The attention of the Scientific Committee was drawn to the following points for consideration:

(i) Noting the recalculation of seabed areas in Subarea 48.3, a request for Members to consider collating bathymetric data to develop updated bathymetric grids for other areas where recent multi-beam data or single-beam echo soundings exist and trawl surveys are conducted (Annex 7, paragraph 2.10).

(ii) Noting in Annex 7, paragraph 3.21, WG-FSA had given specific guidance on the information that would have to be provided for WG-SAM to adequately review the TISVPA method proposed to be used for assessing toothfish in the Ross Sea (SC-AMLR-XXVI, Annex 5, paragraph 4.27):

(a) 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;

(b) simulated (theoretical) data need to be developed for a number of fishery–stock scenarios and those data need to be analysed using CASAL and the TISVPA in order to compare how the two methods perform using data from known population and fishery attributes;

(c) mathematical and statistical details of how the input data for the TISVPA are generated from the available datasets used in CASAL, including any pooling of the data in space and/or time, need to be provided;

(d) 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;

(e) descriptions are needed on how uncertainty is treated in both the assessments and evaluation of yield.

WG-SAM agreed in paragraph 3.22 of its report (Annex 7) that this had not been carried out and, in the absence of the authors, was therefore unable to complete an evaluation of the TISVPA method. WG-SAM reiterated its advice from last year and recommended that the authors carry out the program of work required for evaluation of the model outlined by WG-FSA (Annex 7, paragraph 3.25).

(iii) WG-SAM reviewed methods for evaluating the quality of data arising from the exploratory toothfish fishery in the Ross Sea (Annex 7, paragraphs 3.26 to 3.29). WG-SAM noted that the methodology would have uses beyond the selection of data for stock assessment (Annex 7, paragraph 3.30). These include the use of fishery data by other working groups, such as WG-EMM, and the performance management and training of observers. WG-SAM also considered that a centralised system of data-quality assessment by the Secretariat may provide both for rapid feedback on the quality of data from individual trips, and simplify the determination of data quality by other working groups. WG-SAM recommended that TASO consider the issues raised in this discussion.

(iv) WG-SAM considered the value of the 10 tonne research limits for *Dissostichus* spp. (Annex 7, paragraphs 4.5 to 4.9) and concluded that interpreting the data from 10-tonne research operations by new vessels in new areas may be difficult, but data from vessels which have a history of several years of fishing and provision of comprehensive and high-quality data in known (assessed) areas may be more readily interpreted (Annex 7, paragraph 4.9).

(v) WG-SAM provided advice on situations in which fishing practices may change and how this should be managed to ensure the data could be used in assessments (Annex 7, paragraph 4.12).

(vi) WG-SAM advised on issues that may need to be considered in utilising BRTs for the purposes of bioregionalisation, and encouraged the authors of the approach to continue developing this approach and suggested that this could best be pursued through a correspondence group involving statistical experts familiar with BRTs (Annex 7, paragraphs 4.13 to 4.19).

(vii) WG-SAM reviewed the new assessment tool, SeaBird, developed in New Zealand for assessing the abundances of seabirds (Annex 7, paragraphs 4.21 to 4.24). It considered this to be a valuable contribution to the work of SC-CAMLR.

(viii) WG-SAM also reviewed an assessment and simulation tool developed in New Zealand to estimate parameters in a spatially structured population model (Annex 7, paragraphs 5.1 to 5.6). It welcomed this new tool and advised on how it may be further developed to assist the work of the Working Group.

(ix) WG-SAM also noted that, in the development of the spatially structured population model, a number of methods were applied to assist with model validation, including unit testing procedures. This is regarded as a useful approach for aiding the development of other models for use by CCAMLR (Annex 7, paragraphs 5.7 and 5.8).

(x) WG-SAM considered that some mechanisms for managing versions of models would be useful (see Annex 7, paragraph 5.31 for details).

(xi) WG-SAM provided preliminary reviews of an empirical ecosystem assessment model. It noted this was a novel approach to using small-scale krill surveys, CEMP data and environmental data in an ecosystem assessment (Annex 7, paragraphs 5.32 to 5.34). It endorsed the continued work on the model and provided advice on its further development.

(xii) WG-SAM reviewed the models to be used in the Stage 1 assessment of the subdivision of the krill catch in Area 48 (Annex 7, paragraphs 6.1 to 6.45). It agreed to adapt a framework for developing management procedures (Annex 7, paragraphs 6.20 and 6.21) to suit the purposes of SC-CAMLR. WG-SAM provided advice on performance measures (Annex 7, paragraphs 6.26 to 6.30) and risk summaries (Annex 7, paragraphs 6.31 to 6.44). It also noted that the current models provide a foundation for evaluation of management procedures for krill in subsequent stages of the SSMU allocation work (Annex 7, paragraph 6.45). The body of this advice was passed on to WG-EMM.

(xiii) WG-SAM considered that a revision control system should be implemented in the work of SC-CAMLR (Annex 7, paragraphs 7.1 to 7.4).

(xiv) WG-SAM highlighted its future work in paragraphs 8.1 to 8.6 of its report (Annex 7).

(xv) WG-SAM included its advice to the working groups and the Scientific Committee in paragraphs 9.1 to 9.9 of its report (Annex 7). The primary advice for consideration by the Scientific Committee is contained in Annex 7, paragraph 9.9.

2.2 Dr Constable thanked the contributions of the Members in WG-SAM, indicating that the diversity of participants enabled great progress in the development and review of new methods. He also thanked Dr Jones for helping convene aspects of the meeting in order to enable him to participate in discussions.

2.3 The Scientific Committee endorsed the report of WG-SAM (Annex 7) including its program of future work, noting that the work program for the coming year will be determined amongst the conveners of the working groups and the Chair of the Scientific Committee.

2.4 The Scientific Committee agreed that:

(i) methodologies to assess data quality should be further developed and implemented (Annex 7, paragraph 9.9(i));

(ii) models that may be used towards understanding ecosystem dynamics and consequences of management approaches for Antarctic resources should continue to be developed and advanced (Annex 7, paragraph 9.9(ii));

(iii) revision (version) control systems which allow the management of multiple revisions of programming code, documents and data files within a central database should be implemented in the work of SC-CAMLR (Annex 7, paragraph 9.9(iii));

(iv) a common set of terminology consistent with that of other international fora with respect to the evaluation of management procedures should be adopted for use in the work of SC-CAMLR (Annex 7, paragraph 9.9(iv)).

SG-ASAM

2.5 The Scientific Committee noted discussions from the meetings of WG-EMM and WG-FSA regarding the holding of a meeting of SG-ASAM during the forthcoming intersessional period and the associated recommendations for issues that this meeting should address (Annex 4, paragraphs 5.114 to 5.116; Annex 5, paragraphs 3.26, 13.20 and Appendix O, paragraph 7).

2.6 The Scientific Committee agreed to hold a fourth meeting of SG-ASAM during 2009. Terms of reference for this meeting, provided in Annex 8, include both general points brought forward from the terms of reference of the third meeting of SG-ASAM in 2007 (SC-CAMLR-XXVI, Annex 8, Appendix A) and a series of specific tasks in response to points raised during the meetings of WG-EMM and WG-FSA.

2.7 The Scientific Committee noted the large number of items to be addressed by SG-ASAM and the need to prioritise the work of the subgroup. The Scientific Committee identified points (ii), (iii) and (iv) in the list of specific tasks in Annex 8 as being of highest priority to the work of the Scientific Committee. Point (iv) of Annex 8 should include analysis of acoustic data from vessels involved in exploratory fisheries.

2.8 The Scientific Committee agreed that the fourth meeting of SG-ASAM should be held close to the time and location of the meeting of ICES WG-FAST in Ancona, Italy (which is from 18 to 22 May 2009), to increase the opportunity for participation by appropriate experts from Members and invited experts. The Scientific Committee accepted with thanks the offer from Dr M. Vacchi (Italy) to hold the meeting at the University of Ancona, Italy, in May 2009.

2.9 The Scientific Committee was advised that Drs J. Watkins (UK) and R. O'Driscoll (New Zealand) have agreed to co-convene the meeting. There is provision for two invited experts, who will be identified through consultation between the co-conveners and other participants in advance of the meeting.

Joint CCAMLR-IWC Workshop

2.10 The Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models was held at CCAMLR Headquarters in Hobart, Australia, from 11 to 15 August 2008. The workshop was co-convened by Drs Constable and Gales from the Scientific Committees of CCAMLR and the IWC respectively.

2.11 A detailed account of the outcome of the workshop is provided in Annex 12. An Executive Summary is given in SC-CAMLR-XXVII/14 on which the presentation of the workshop results by Dr Constable and the deliberations of the Scientific Committee were based.

2.12 Fourteen expert groups had been formed which were tasked to complete review papers on different topics related to the Southern Ocean. These groups were (group conveners in brackets):

- toothed whales (Mr R. Leaper)
- baleen whales (Dr A. Zerbini)
- pack-ice seals (Dr C. Southwell)
- Antarctic fur seal (Dr K. Reid)
- seabirds (Dr B. Wienecke)
- fish (Dr K.-H. Kock)
- squid (Prof. P. Rodhouse)
- krill (Dr S. Nicol)
- primary production (Dr S. Strutton)
- zooplankton (Dr A. Atkinson)
- sea-ice (Dr R. Massom)
- ocean processes (Prof. E. Hofmann)
- exploitation (Dr S. Kawaguchi)
- penguins (Dr P. Trathan).

2.13 Reports delivered by the expert groups to the workshop varied in level of detail. Most were near completion with respect to the distribution and abundance of primary taxa, while others still needed considerable additional input to be completed within the first half of 2009, notably seabirds.

2.14 Dr Holt congratulated the organisers of the workshop on its achievements, especially in bringing together scientists from the IWC and CCAMLR in one meeting.

2.15 The Joint Steering Group of the workshop was tasked with developing a plan to further progress the collation and synthesis of the data and completion of the expert group review papers (SC-CAMLR-XXVII/14, paragraph 44), including broadening participation in the different expert groups. Although the Joint Steering Group has yet to complete this planning exercise, the Scientific Committee agreed that the work should be completed to the extent of a joint publication of all expert group papers and the compilation of data in the metadatabase. It encouraged the co-conveners of the expert groups to correspond with the Members of the respective Scientific Committees to identify mechanism to complete this work.

2.16 Completion of the expert review papers was identified as the primary task in the follow-up to the workshop. The deadline for the submission of final papers from the different expert groups will be the end of June 2009, although the format for the publication has yet to be decided.

2.17 Australia will continue to host the metadatabase and provide support for input of metadata to it. However, there are no resources to further develop the user interface of the database. This should be considered by the Scientific Committee in the future.

2.18 The Scientific Committee noted that the workshop expenditure had been well within the budget. However, it noted that the following items remain to be funded (paragraph 11.3):

(i) translation and publication of the report
(ii) publication of the expert group papers.

2.19 The Scientific Committee particularly welcomed estimates of the distribution and abundance of pack-ice seals resulting from SCAR's APIS Program, recognising that this was an ambitious and very difficult program of work and was of great relevance to CCAMLR's work. The workshop benefitted considerably from the outcome of the APIS Program. The Scientific Committee encouraged SCAR to find ways to undertake the final analyses of the APIS abundance data which remain outstanding.

2.20 The Scientific Committee thanked the workshop conveners, the Joint Steering Group, the expert group coordinators, the participants in the expert groups and the workshop for making such good progress on collating important metadata for modelling in CCAMLR and the IWC. It expressed its satisfaction at what the workshop achieved with respect to the terms of reference, noting that it was important to recognise that it was the beginning of an ambitious process rather than an end point. It encouraged the Joint Steering Group to complete the publication of the papers and the compilation of the metadatabase. It also encouraged the Joint Steering Group to consider what future work might be undertaken jointly between SC-CAMLR and SC-IWC, noting that future work could centre on the synergies between the two committees in ecosystem modelling.

ECOSYSTEM MONITORING AND MANAGEMENT

WG-EMM advice

3.1 The Scientific Committee considered advice from WG-EMM relating to the staged approach to subdivide the precautionary catch limit for krill in Area 48 among SSMUs under the following five headings:

(i) Stage 1 allocation of the precautionary krill catch limit among SSMUs in Subareas 48.1 to 48.3;

(ii) validation and access to models advising on SSMU allocations;

(iii) allocation subsequent to Stage 1;

(iv) SSMUs in Subarea 48.4;

(v) concerns beyond the competency of the Scientific Committee.

3.2 The Scientific Committee asked Dr Watters, as Convener of WG-EMM, to express its gratitude to WG-EMM for its work relating to the staged approach to subdivide the precautionary catch limit for krill in Area 48. The Scientific Committee endorsed its commitment to this work and looked forward to further advice on this subject in 2009.

Stage 1 allocation of the precautionary krill catch limit among SSMUs in Subareas 48.1 to 4.83

3.3 The Scientific Committee noted that in order to estimate an SSMU allocation for Stage 1, a number of tasks were necessary (Annex 4, paragraph 2.31).

(i) Use of the best available data to estimate SSMU allocation proportions for:

(a) Option 2: estimates of predator demand in each SSMU from available predator abundance data and consumption rates;

(b) Option 3: estimates of the proportion of krill in each SSMU derived from the CCAMLR-2000 Survey;

(c) Option 4: the difference between estimates of krill standing stock and predator demand.

(ii) Assessment of the relative risks under the different options using the modelling tools available (FOOSA, SMOM, EPOC). The risk assessments were based on yield multipliers that scaled the yield from zero, through the current trigger level, to 1.25 × the precautionary catch limit.

(iii) Calculation of the SSMU allocations using the proportions determined in (i) above, multiplied by the yield multiplier determined in (ii) above, multiplied by the yield (from the GYM).

3.4 The Scientific Committee agreed that considerable progress had been made in assessing the relative risks of the different allocation options, and noted that WG-EMM now considered that this was sufficient for Task 2 (paragraph 3.3(ii)) of the Stage 1 SSMU allocation (Annex 4, paragraph 2.101).

3.5 The Scientific Committee noted that WG-EMM had advised (Annex 4, paragraph 2.95) that the overall conclusions drawn from the risk assessment were:

(i) Option 4 performs significantly worse than Options 2 and 3 across all (fishery, predator and krill) performance indicators;

(ii) Options 2 and 3 appeared to perform equally well under a number of scenarios, with differences in performance of Options 2 and 3 between models being due to differences in model structure;

(iii) under Options 2 and 3 the risk of negative impacts on predators was negligible at yield multipliers of 0.15 (the harvest rate consistent with the trigger level);

(iv) under Options 2 and 3 the risk of negative impacts on predators increased at yield multipliers greater than 0.25 to 0.5 with penguins and fish being most significantly affected, seals affected to a minor degree and whales unaffected;

(v) evaluation of Options 2 and 3 with the available models included allocations of 70 and 62% respectively of the total catch to pelagic SSMUs, where fishery performance will be significantly negatively impacted.

3.6 The Scientific Committee noted that WG-EMM advised that the risk assessment was drawn from results that:

(i) predicted that the krill fishery (Annex 4, paragraphs 2.70 to 2.74) –

(a) may be forced to change its behaviour in pelagic areas where total krill biomasses are relatively high but where average densities are relatively low;

(b) may not be able to catch its allocated catch limit in some SSMUs due to the assumed nature of competition between itself and krill predators;

(c) may be prohibited from fishing in some SSMUs because the model simulates the estimation of krill biomass or predator demand to represent the process that would be undertaken in reality (but may provide results that are different to those that would be obtained in reality);

(ii) may be negatively biased and lead to advice on SSMU allocations that was not as precautionary as intended, in which case the risk assessment should be considered as indicating minimum risks to the ecosystem for any given harvest rate (Annex 4, paragraphs 2.54 and 2.55);

(iii) were conditioned on a calendar of events which specifies a step-change in krill abundance that was likely to have occurred with an uncertain magnitude and does not describe the dynamics of fish populations whose role in the ecosystem is an important source of uncertainty (Annex 4, paragraphs 2.76 to 2.83);

(iv) were initialised by extrapolating results from the CCAMLR-2000 Survey (Annex 4, paragraphs 2.84 and 2.85).

3.7 The Scientific Committee also noted that there were a number of uncertainties in the risk assessment (Annex 4, paragraphs 2.54 and 2.102).

3.8 The Scientific Committee noted WG-EMM's advice that:

(i) should the allocations appropriate to Options 2 to 4 be applied to the current fishery, the present catch in a number of SSMUs would be constrained even though the total annual catch is only 17% of the trigger level (Annex 4, paragraph 2.92);

(ii) decisions regarding the current trigger level are matters for the Commission (Annex 4, paragraph 2.93).

3.9 The Scientific Committee noted that the current spatial distribution of catches more closely reflects that under Option 1, the historical fishing distribution. The Scientific Committee noted that WG-EMM could not provide explicit advice on the risks associated with distributions of catches under Option 1, which may apply as the total catch approaches the trigger level. However, the Scientific Committee noted that previous advice (SC-CAMLR-XXV, paragraph 3.11) had suggested that allocations based on historical fishing distribution would have greater negative impacts on the ecosystem than other options (Annex 4, paragraph 2.99).

3.10 Dr V. Bizikov (Russia) noted that the modelling work completed during WG-EMM this year was a significant step forward. However, he noted that the results should be considered as intermediate and not final. He explained that the work was extremely promising, but needed additional effort in two areas as these constituted areas of considerable uncertainty:

(i) The numerical calendar used for modelling does not include fish. Fish are known to be of considerable importance in the marine ecosystem and this was therefore an area of considerable uncertainty.

(ii) The CCAMLR-2000 Survey covered approximately 50% of the combined aerial extent of Subareas 48.1, 48.2, 48.3 and 48.4. In the WG-EMM modelling exercise, the CCAMLR-2000 Survey results had been scaled to cover the whole of this combined aerial extent. However, as krill is not likely to occur over the whole of this combined area, some attendant uncertainty was present.

3.11 Dr L. Pshenichnov (Ukraine) noted the recent progress made in the assessment of krill predators (Annex 4, paragraphs 5.1 to 5.40). Taking into account that the convener of WG-EMM mentioned in his report several times the word ‘risk’, Dr Pshenichnov thought it would be important to summarise existing data concerning the spatial concentration of krill predators in coastal areas for each SSMU for modelling and/or for the future implementation of interim measures, to protect predators from the direct impacts of krill fishing.

3.12 Mr H. Matsushima (Japan) noted that there were still a number of problems with the models as they were currently formulated. Dr H.-C. Shin (Republic of Korea) also noted that the developed modelling scheme apparently fails to simulate the current krill fishery and its minimal impacts, which has been in stable operation for well over a decade without detectable problems. He indicated that this is contrary to reasonable expectation, and questioned where the further improvement could come from.

3.13 Dr Shin considered that there are considerable uncertainties with the estimates used in the models, and if they were underestimated for krill and overestimated for predators, the similar outcomes from Options 2 and 3 are not surprising but to be expected. This puts him in doubt of the extent of the risks attached to Options 2 and 3 and hence the utilities.

3.14 In response to the concerns raised by some Members, Dr Constable, as Convener of WG-SAM, emphasised that all models are approximations of reality and that all models have attendant uncertainties. He reminded the Scientific Committee that WG-SAM had scrutinised the three models (FOOSA, SMOM, EPOC) and that WG-SAM had considered that the models adequately dealt with uncertainty for the purposes of Stage 1 advice.

3.15 As Convener of WG-SAM, Dr Constable further noted that the advice provided by WG-EMM was well rounded and included a number of caveats, and he considered that the advice was the best possible, given the available data and resources. Dr Constable also noted that the review process had been undertaken according to the expectations of the Scientific Committee.

3.16 The Scientific Committee recalled that the Commission had previously endorsed past advice to follow a staged approach to subdivide the precautionary catch limit for krill in Area 48 among SSMUs (CCAMLR-XXVI, paragraph 4.18). Also, that the subdivision for Stage 1 advice should be based primarily on one of Options 2 (based on the spatial distribution of predator demand), 3 (based on the spatial distribution of krill biomass) and 4 (based on the spatial distribution of krill biomass minus predator demand) (CCAMLR-XXVI, paragraph 4.18).

3.17 The Scientific Committee also noted that the Commission was expecting such advice on Stage 1 in 2008 (CCAMLR-XXVI, paragraph 4.19). The Scientific Committee noted that WG-EMM had advised that Option 4 performs significantly worse than Options 2 and 3 across all (fishery, predator and krill) performance indicators; also that Options 2 and 3 appeared to perform equally well under a number of scenarios, with differences in performance of Options 2 and 3 between models being due to differences in model structure.

3.18 Dr Constable noted that advice from WG-EMM (Annex 4, paragraph 2.90) indicated that failure to choose an allocation option for subdividing the catch of krill amongst the SSMUs would have attendant risks for the ecosystem. He reminded the Scientific Committee that if CCAMLR did not follow the advice from WG-EMM, then it was *de facto* following an allocation strategy equivalent to Option 1, and that this had previously (SC-CAMLR-XXV, paragraph 3.11) been shown as likely to be harmful to the ecosystem. Dr Agnew commented that, should CCAMLR not follow advice from WG-EMM, it would be essential to undertake risk assessments for Option 1, as had been comprehensively undertaken for Options 2, 3 and 4.

3.19 Following detailed discussion of the advice from WG-EMM (paragraphs 3.3 to 3.9) and discussion of the concerns raised about the advice (paragraphs 3.10 to 3.18), the Scientific Committee was unable to reach consensus.

3.20 Although the majority of Members endorsed the advice from WG-EMM, Mr Matsushima and Dr Shin considered that considerable uncertainty still remained in the Stage 1 risk analysis.

3.21 The Scientific Committee noted the generic nature of the concerns raised by Mr Matsushima and Dr Shin and asked that they provide explicit details to the next meetings of WG-SAM and WG-EMM.

Validation and access to models advising on SSMU allocations

3.22 Dr Bizikov noted that the models used for formulating Stage 1 advice were extremely complex as they were trying to capture very complex ecological processes. Consequently, he considered that it was critical that the CCAMLR community had the opportunity to examine the models in detail and to examine the model code.

3.23 Dr Holt reminded the Scientific Committee that the models had been scrutinised over many years and that they had been modified on an annual basis to take into account a number of concerns raised by WG-EMM. Dr Holt reminded the Scientific Committee that no model was able to capture perfectly the operation of an ecosystem and that all models had attendant caveats and assumptions. He noted that the advice from WG-EMM made very explicit a number of such caveats and assumptions, but that WG-EMM had nevertheless concluded that the models were suitable for providing Stage 1 advice. Dr Holt also reminded the Scientific Committee that the code for FOOSA had been available, via the Secretariat, for some time.

3.24 Dr Constable noted that all fisheries models were becoming increasingly complex. As Convener of WG-SAM he asked for advice from the Scientific Committee on what was needed to gain the trust and conviction of the wider community who were not experts in modelling. The Scientific Committee recognised that this was a real concern for CCAMLR as well as for the wider fisheries community.

3.25 At present, there are three models being developed to provide advice on SSMU allocations in Area 48. However, except for the model authors, few people in either the Scientific Committee or WG-EMM are sufficiently familiar with the complex operation of the models, including the preparation of input data, parameterisation of the models, calculations provided by the models and analysis of the results. The Scientific Committee noted that WG-EMM had advised that:

(i) for models to be used in providing advice, they should be sufficiently developed for use by individuals other than the model developers. This would enable wider participation by Members, as needed, in the development, validation and review of results of assessments with respect to SSMU allocation.

(ii) participation by Members in the assessment work is highly desirable and recommended that:

(a) sufficient documentation is provided with a model to guide its use by others;

(b) software, example input files, and test cases are submitted to the Secretariat for access by Members.

3.26 The Scientific Committee noted that all models applied for krill management are complex and their effective implementation requires that an independent and critical approach be taken. The Scientific Committee recognised that this would be ensured through the continuing considerations of WG-SAM in accordance with procedures in SC-CAMLR-XXVI, Annex 7, paragraph 6.3. The Scientific Committee therefore agreed that WG-SAM should continue to review the methodological implementation of models used for SSMU allocation.

Allocation subsequent to Stage 1

3.27 The Scientific Committee noted that:

(i) the development of the models leading to the provision of advice for Stage 1 SSMU allocation had been technically challenging and developing models for advice in subsequent stages would be equally challenging, if not more so. Thus, for allocations subsequent to Stage 1, the Scientific Committee recognised that it would be necessary to allow sufficient time in order to develop models so that they were formulated appropriately (Annex 4, paragraph 2.100);

(ii) a range of alternative climate-change scenarios would need to be considered as part of a broader- and longer-term risk assessment for subsequent stages (Annex 4, paragraph 2.30).

SSMUs in Subarea 48.4

3.28 The Scientific Committee noted that WG-EMM had reviewed information on land-based predators that could be used for subdividing Subarea 48.4 into SSMUs appropriately (Annex 4, paragraph 7.5). The Scientific Committee endorsed the partitioning of Subarea 48.4 with one coastal and one pelagic SSMU (Figure 1). The Scientific Committee noted that such a partitioning was consistent with the approach used for separating pelagic and coastal SSMUs in Subareas 48.1, 48.2 and 48.3.

3.29 The Scientific Committee recognised that future analyses of foraging density and species composition may indicate the need for further subdivision of the coastal SSMU into northern (encompassing the six northern-most islands) and southern (encompassing the remaining islands) areas when additional data become available.

Concerns beyond the competency of the Scientific Committee

3.30 Dr Agnew noted that the advice provided by WG-EMM included a number of associated caveats and that these could be characterised into two categories. Firstly, those that reflected scientific concerns, such as described by paragraphs 3.6(ii), (iii) and (iv); and secondly, other caveats that could be characterised as reflecting issues relating to the behaviour of the krill fishery and therefore of more direct concern to the Commission; these included those described in paragraphs 3.6(i) and 3.8.

3.31 Mr Matsushima stated that the current harvest level of krill was approximately 100 000 tonnes and that this is not impacting the ecosystem. He added that it was therefore not yet necessary to spatially apportion the precautionary catch limit and he would like to wait for the completion of the EPOC and SMOM models so that these models could be compared with FOOSA. Mr Matsushima noted that the current trigger level of 620 000 tonnes was therefore an adequate management tool for the present.

3.32 Dr Agnew noted the possibility that it followed from paragraph 3.9 that the current trigger may not be as precautionary as previously assumed if the distribution of catches continues to follow the historical pattern. He reminded the Scientific Committee of WG-EMM's deliberations on this matter (Annex 4, paragraph 2.90).

3.33 Dr Nicol reminded the Scientific Committee that the existing trigger level of 620 000 tonnes is an aggregate of the highest annual commercial catches from each of the subareas in Area 48. At no point in the history of the krill fishery has a catch as high as 620 000 tonnes ever been taken. Dr Nicol reminded the Scientific Committee that the subdivision process was to ensure that such a large catch could not be taken from a restricted area.

3.34 The Scientific Committee noted that these issues were more appropriately the concern of the Commission rather than the Scientific Committee. The Scientific Committee therefore agreed that it should advise the Commission of these issues.

Advice to Commission

3.35 The Scientific Committee advised the Commission that:

(i) the Scientific Committee maintained its commitment to the staged approach for subdividing the precautionary catch limit for krill in Area 48 (paragraph 3.2);

(ii) detailed advice had been received from WG-EMM about the risk analysis for Stage 1 (paragraphs 3.3 to 3.9), and that considerable progress has been made in assessing the relative risks of the different allocation options. However, the Scientific Committee had been unable to reach consensus over this advice (paragraphs 3.19 and 3.20) and further work was still necessary before calculation of the SSMU allocations could be made (paragraphs 3.3 and 3.4);

(iii) subdividing the precautionary catch limit for krill in Area 48 among SSMUs would affect the behaviour of the krill fishery under the scenarios examined by WG-EMM (paragraphs 3.6(i), 3.8 and 3.30). This would potentially become more pronounced as catches increased such that it would not be feasible for the fishery to take the full catch limit from the current fishing grounds.

3.36 The Scientific Committee wished to bring to the attention of the Commission that some Members considered that it was not yet necessary to spatially apportion the precautionary catch limit and that the current trigger level of 620 000 tonnes was an adequate management tool for the present (paragraph 3.31), while most Members considered the current trigger level of 620 000 tonnes may not be as precautionary as previously assumed (paragraphs 3.32 and 3.33; Annex 4, paragraph 2.90).

3.37 The Scientific Committee asked the Commission to endorse the partitioning of Subarea 48.4 as proposed, with one coastal and one pelagic SSMU (paragraphs 3.28 and 3.29).

Report of WG-EMM-STAPP (Status and Trend Assessment of Predator Populations)

3.38 The Predator Survey Workshop was held at CCAMLR Headquarters, Hobart, Australia, from 16 to 20 June 2008, and was reported in WG-EMM-08/8. The workshop was convened by Dr Southwell. Participants at the workshop included two experts from SCAR (Ms Patterson-Fraser and Dr Raymond) and an independent invited expert (Dr Fewster). A report from Dr Fewster on the workshop was reviewed in Annex 4, paragraph 5.1.

3.39 The workshop provided the following recommendations and advice (Annex 4, paragraph 5.7) at different time scales:

(i) Immediate –

(a) recent survey work in Area 48 provides major improvements in the state of knowledge about the abundance of crabeater seals, fur seal pup production in the South Shetland Islands, macaroni penguins at South Georgia and white-chinned petrels at South Georgia;

(b) aerial surveys of Antarctic fur seals at South Georgia are scheduled for completion in the 2008/09 season;

(c) the continued development of a new database containing existing penguin count data from a number of sources that can serve as a basis for the production of large-scale abundance estimates;

(d) the development of two new methods to account for bias and uncertainty in raw count data when estimating total abundance that provide complimentary utility for estimating SSMU-specific abundance;

(e) a major gap in abundance data for priority species is for flying seabirds throughout Area 48, except for white-chinned petrels at South Georgia. Given the lack of land-based data for this group, the workshop recommended that WG-EMM invite submissions on at-sea data for flying seabirds in Area 48 for consideration at WG-EMM-09. The workshop identified US AMLR summer cruise data, US-LTER summer and winter cruise data, and BAS data at South Georgia and across the Scotia Sea as potential datasets for analysis.

(ii) Short-term (intersessional work for submission to WG-EMM-08) –

The development of SSMU-scale estimates of penguin abundance as an illustration of the compiled database were provided in a document submitted to WG-EMM.

(iii) Medium-term (intersessional work for WG-EMM-09) –

(a) if feasible, production of SSMU-specific crabeater seal abundance estimates based on habitat modelling;

(b) the anticipated completion of the Antarctic fur seal survey at South Georgia in early 2009 will provide an important update to the existing abundance estimates from 1991;

(c) further development and testing of the new estimation procedures for penguins, and implementation of those procedures to quantify bias and uncertainty in adjusting raw counts.

(iv) Long-term work –

(a) recent count data for penguins in the western South Shetland Islands and eastern Antarctic peninsula;

(b) count data for flying seabirds throughout Area 48;

(c) adjustment data for most species in most areas, particularly strategic collection of adjustment data to improve estimation of penguin abundance;

(d) development of alternate survey methods for large penguin colonies.

3.40 The Scientific Committee noted that the work of WG-EMM-STAPP represents a substantial contribution to the work of CCAMLR and for quantifying predator abundance within SSMUs (Annex 4, paragraph 5.8). Notable features of this contribution include:

(i) the combined database of penguin count data, comprising data collected under CEMP, data from the ASI and historical data from the literature (this database will eventually be made available to CCAMLR, and access will then be governed by the Rules for Access and Use of CCAMLR Data) (Annex 4, paragraphs 5.9 and 5.10);

(ii) the analysis of APIS data, by BAS, on crabeater seal distribution and abundance (Annex 4, paragraph 5.11);

(iii) identification of geographic areas with poor coverage, where future survey work can be focused (e.g. the Antarctic Peninsula East SSMU) (Annex 4, paragraph 5.12);

(iv) attempts towards estimating uncertainty in predator abundance estimates that will be particularly useful for modelling (Annex 4, paragraph 5.13).

3.41 The Scientific Committee noted that the Predator Survey Workshop was the first stage of a multi-stage process with the ultimate goal of regional-scale estimates of predator abundance and consumption, and agreed that future work should also include fish predators.

Advice on estimates of krill B_0

3.42 The Scientific Committee noted the importance of estimating uncertainties and providing measures, such as probability density functions, of confidence in estimates of B_0 (Annex 4, paragraph 5.112). The Scientific Committee considered the implication this may have on the estimate of B_0 and recalled paragraph 2.20(i) of WG-EMM-07 (SC-CAMLR-XXVI, Annex 4) in relation to estimation of B_0, which states:

> '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 in the peer-reviewed literature where appropriate.'

3.43 The Scientific Committee reaffirmed its agreement to this position. The Scientific Committee also noted that this paragraph refers specifically to the use of protocols in setting the precautionary catch limit and indicated that it would welcome submissions on revisions and updates to acoustic protocols so that these could be assessed by SG-ASAM at the earliest opportunity (Annex 4, paragraph 5.113). In doing so the Scientific Committee recognised that protocols for estimating B_0 will continue to be refined and improved into the future.

Climate-change impacts

3.44 Discussion of climate-change impacts was taken under Agenda Item 7.

Revised agenda and long-term work plan for WG-EMM

3.45 The Scientific Committee reviewed a proposal by WG-EMM for revising and structuring WG-EMM's future agenda (Annex 4, paragraphs 8.7 to 8.12). The proposal was recommended to facilitate the achievement of long-term objectives while simultaneously maintaining the flexibility needed to address the annual requirements for scientific review and advice that will be expected by the Scientific Committee and the Commission.

3.46 The Scientific Committee reaffirmed that at least four topics require work over the long term, all of which have previously been endorsed by the Scientific Committee or have been identified as a topic of interest to the Commission:

(i) The development and evaluation of feedback management strategies for the krill fishery, including work to estimate predator abundance and demand and to support the staged development of the krill fishery in Area 48 (e.g. SC-CAMLR-XXVI, paragraph 3.36(vii)).

(ii) The development and application of methods to facilitate the conservation of marine biodiversity in the Convention Area, including work to identify VMEs (e.g. SC-CAMLR-XXVI, paragraph 14.9) and define candidate MPAs (e.g. SC-CAMLR-XXVI, paragraph 3.87) and to achieve a harmonised approach (e.g. SC-CAMLR-XXV, paragraph 3.32) within the Antarctic Treaty System and within CCAMLR.

(iii) Consideration of the ecosystem effects of fishing for finfish (e.g. SC-CAMLR-XXVI, paragraph 3.99), including further collaboration with WG-FSA.

(iv) Consideration of the impacts of climate change on the Antarctic marine ecosystem (e.g. CCAMLR-XXVI, paragraph 15.36).

3.47 The Scientific Committee agreed that focus topics (like those included in WG-EMM's agenda for 2008) provided a mechanism to facilitate requirements for short-term advice, and that long-term work objectives should form the primary items of WG-EMM's future agenda. The Scientific Committee also noted that the topic of climate change was a cross-cutting issue that could be considered under multiple agenda items.

3.48 The Scientific Committee endorsed the proposed structure for the future agenda of the Working Group as follows:

(i) Introduction (opening of the meeting, adoption of the agenda and appointment of rapporteurs, review requirements for advice and interaction with other working groups);

(ii) Focus topic (to be determined on an annual basis with priority given to topics that relate to needs for short-term advice);

(iii) Ecosystem effects of fishing for krill (krill, dependent predators, the fishery and scientific observation, surveys and monitoring, climate impacts and feedback management strategies);

(iv) Ecosystem effects of fishing for finfish (fish, dependent predators, fisheries and scientific observation, surveys and monitoring, climate impacts and collaboration with WG-FSA);

(v) Spatial management to facilitate the conservation of marine biodiversity (VMEs, protected areas, and harmonisation of approaches, both within CCAMLR and across the Antarctic Treaty System);

(vi) Advice to the Scientific Committee and its working groups;

(vii) Future work;

(viii) Other business;

(ix) Adoption of the report and close of the meeting.

3.49 The Scientific Committee noted that a focus topic might not be required every year and that, generally, focus topics should not occupy more than two to three days of WG-EMM's annual meeting. The Scientific Committee also indicated that focus topics should be agreed at the preceding meeting of SC-CAMLR where the conveners of the working groups and the Chair of the Scientific Committee can consult with Members. This would also provide an opportunity for considering the time required for, and timing of, the focus topics.

Management of protected areas

3.50 The WG-EMM Convener summarised the discussion and advice derived from the focus topic 'to progress the implementation of spatial management measures that aim to facilitate the conservation of marine biodiversity' (Annex 4, paragraphs 3.1 to 3.78).

3.51 Some Members expressed concern about the priority areas identified by WG-EMM for further work on the development of MPAs (Annex 4, Figure 12), since the process of secondary bioregionalisation has not been completed (SC-CAMLR-XXVI, Annex 9, Figure 4).

3.52 Dr X. Zhao (China) stated that China is a new Member of the Commission, and was not involved in Scientific Committee's previous work on bioregionalisation; he expressed his sincere appreciation of all the inputs made by those Members actively involved. He further noted that, since there are still some concerns and different views from the floor, he encouraged further work by WG-EMM to consolidate different views on this issue.

3.53 It was noted that Figure 12 in Annex 4 was based on an analysis which had previously been recognised to demonstrate heterogeneity in marine ecosystems (SC-CAMLR-XXV, paragraph 3.48). Figure 12 simply identifies areas which show a high level of heterogeneity and are therefore likely to contain complex biological and environmental characteristics. In order to better utilise limited resources available to CCAMLR, these complex areas were considered by WG-EMM to be appropriate regions in which to focus further work on the development of MPAs.

3.54 It was further noted that focused work on the topic of MPAs began in 2000 and that progress to date has included scientific research and modelling activities, several workshops and discussions within the Scientific Committee and its working groups and the Commission (e.g. CCAMLR-XXVI, paragraph 7.18). The reports of these meetings and workshops were noted as information resources.

3.55 The Scientific Committee:

(i) recalled that recent discussions by CCAMLR and the CEP have concluded that the issues of where and how to establish a system of marine areas for the conservation of biodiversity in the Southern Ocean should be addressed as a matter of priority (CCAMLR-XXIII, paragraph 4.13; CEP IX Final Report, paragraphs 94 to 101) (Annex 4, paragraph 3.71);

(ii) agreed that the existing benthic and pelagic bioregionalisations developed by the 2007 Bioregionalisation Workshop were adequate for use in such work, although further refinement may be undertaken, and encouraged work to further develop the BRT method (Annex 4, paragraph 3.72);

(iii) noted that a number of methods could be used for designing a representative system of MPAs, including, *inter alia*, bioregionalisation and/or systematic conservation planning, and endorsed using MARXAN as one feasible method for undertaking the latter (Annex 4, paragraph 3.76);

(iv) agreed that it should, as a priority, continue the process of consolidating scientific views to maintain a common basis for the development of representative systems of MPAs, as agreed by the Commission (CCAMLR-XXVI, paragraph 7.18). The development of representative systems of MPAs should focus on, but not be limited to, the priority areas identified by WG-EMM in Figure 12 of Annex 4. Therefore, Members were encouraged to use appropriate methodologies to further this work (Annex 4, paragraph 3.77).

Interactions between WG-EMM and WG-FSA

3.56 The Scientific Committee endorsed the commitment to further collaboration between WG-EMM and WG-FSA that is implied by the new agenda agreed for WG-EMM which includes an item entitled ‘Ecosystem effects of fishing for finfish’ (paragraph 3.48).

3.57 Following this endorsement, the Scientific Committee reviewed the background to, and proposed topics for, the Second Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA2).

3.58 The Scientific Committee endorsed the proposal made by the Conveners of WG-EMM and WG-FSA that FEMA2 be structured in a manner that treats fisheries for toothfish in the Ross Sea as a case study of how ecosystem considerations can be used to advise on the management of fisheries that target finfish.

3.59 The Scientific Committee reviewed four topics that the conveners proposed for consideration during FEMA2, and endorsed the view, expressed by both working groups, that FEMA2 should aim to evaluate whether the level of escapement currently espoused in the existing decision rules for toothfish in the Ross Sea is sufficiently precautionary when these fish are viewed as important prey as well as predators (Annex 4, paragraphs 8.3 and 8.5; Annex 5, paragraph 13.15).

3.60 The Scientific Committee agreed to the following terms of reference for FEMA2:

(i) Review existing information on predator species (Weddell seals, toothed whales etc.) in the Ross Sea known to consume *Dissostichus* spp. This may be aided through a comparative analysis of the importance of *Dissostichus* spp. as prey in different regions throughout the Southern Ocean. The review should include:

   (a) abundance of predator species
   (b) temporal and spatial extent of predation foraging ranges
   (c) degree of overlap in vertical distribution with toothfish fishery
   (d) size composition of *Dissostichus* spp. consumed by other predators
   (e) daily consumption of predators
   (f) proportion of predator population eating *Dissostichus* spp.

(ii) Consider the current estimates of biomass, distribution and productivity of *Dissostichus* spp. in the Ross Sea, as well as annual removals by the fishery.

(iii) Review rationale for existing escapement level of 0.5 for *Dissostichus* spp., and determine if 0.5 is an appropriately precautionary level of escapement in the Ross Sea, given the predator requirements, foraging ranges, toothfish stock biomass, distribution and productivity.

(iv) Review other methods or options for mitigating risks in the Ross Sea toothfish fishery, including:

   (a) area closures
   (b) season closures.

(v) Development of methods to monitor changes in predators in the Ross Sea including:

   (a) Weddell seals
   (b) toothed whales
   (c) others?

3.61 The Scientific Committee agreed that, in considering the agreed topic of FEMA2, it would be useful for the workshop to conduct a general discussion about appropriate escapement levels when the age (or size) at which fish recruit to a fishery is contrasted with the age (or size) at which the fish are vulnerable to predation by other predators. It was also suggested that the workshop might benefit from considering previous work conducted by Thomson et al. (2000).

3.62 The Scientific Committee agreed that the Conveners of WG-EMM and WG-FSA should co-convene FEMA2 and that the workshop should be conducted as a focus topic (Annex 4, paragraph 8.11) within the agenda of WG-EMM.

3.63 In preparing for the workshop, the Conveners of WG-EMM and WG-FSA should consider whether technical review of quantitative methods could usefully be provided by WG-SAM. In cases where such review is appropriate and required, discussions with the Convener of WG-SAM will be required to fit such work into the agenda of WG-SAM.

3.64 The Scientific Committee noted that interactions between WG-EMM and WG-FSA are likely to occur on topics related to the by-catch of fish in the krill fishery and the depredation of toothfish by marine mammals.

3.65 With respect to this latter topic, the Scientific Committee noted that an experimental trial using trotlines fitted with a 'cachalotera' yielded mixed results. Although there was some evidence of a successful reduction in cetacean predation, this was offset by the poorer condition of skates and toothfish coming off the line, which may potentially make them unsuitable for tag and release (Annex 5, paragraphs 3.81 to 3.83). The Scientific Committee encouraged further studies using this system.

HARVESTED SPECIES

Krill resources

2007/08 fishing season

4.1 Six vessels from five Member nations had fished for krill during the 2007/08 season.

4.2 The fishing all occurred in Area 48 (Table 1).

4.3 The krill catch in 2007/08 (reported to October 2008) was 125 063 tonnes compared to the total of 104 364 tonnes reported at CCAMLR-XXVI in October 2007 (SC-CAMLR-XXVII/BG/1). The total catch reported to May 2008 was 85 110 tonnes (Annex 4) indicating that a substantial catch (39 953 tonnes) had been taken during the winter months.

Krill fishery notifications in 2008/09

4.4 Nine countries submitted krill fishery notifications for 18 vessels with a total projected catch of 629 000 tonnes. This projected catch level indicated that sufficient vessel capacity exists in the krill fleet to exceed the trigger level for Area 48 and emphasised the need to make rapid progress on SSMU allocation of the krill catch (Annex 4, paragraph 4.14).

4.5 Notifications to fish for krill were received from nine nations: Chile (one vessel), Cook Islands (one vessel), Japan (one vessel), Republic of Korea (three vessels), Norway (four vessels), Poland (one vessel), Russia (five vessels), Ukraine (one vessel) and the USA (one vessel) (Table 3). Four additional notifications from the USA and one notification from Ukraine had been submitted to WG-EMM (SC-CAMLR-XXVII/BG/3) and had subsequently been withdrawn.

4.6 All notifications were for fishing in Area 48 and additionally there was one Russian notification that included krill fishing in Area 58 (SC-CAMLR-XXVII/11). The US and Russian notifications also indicated that their vessels intended to fish for krill in Subarea 48.3 during summer which is a departure from previous practice (Annex 4, paragraph 4.8).

4.7 Chile indicated that its vessel had caught 2 tonnes in the 2007/08 season whilst developing processing and catching techniques. These techniques have now been proved and the vessel will be fully operational from December 2008.

4.8 The Scientific Committee noted that the projected catches contained in the 2007 notifications to enter the krill fishery (689 000 tonnes) had also exceeded the reported catches in 2007/08 (125 063 tonnes). Thus, it was difficult to assess the seriousness of the intent to fish in the majority of notifications, however, it was acknowledged that the notifications still provide an indication of the level of interest in the krill fishery.

4.9 Other indications of commercial interest in harvesting krill is publicly available in the trade press and it might be appropriate for the Scientific Committee to investigate ways in which this information might be provided to inform the deliberations of the working groups.

Gear types

4.10 The notifications for entry into the krill fishery indicated that four gear types would be used: traditional trawling, pumping to clear codend, continuous fishing system and beam trawling (CCAMLR-XXVII/11). Russia clarified that the beam trawling would be used for midwater fishing, in conjunction with a pumping method and would be unlikely to have a greater impact on the benthos or pelagic communities than other pelagic fishing methods.

4.11 The Scientific Committee recommended that the notification pro forma be modified to include information on specific details of gear configuration, including mesh size, mouth opening of the net, as well as the presence and design of any seal exclusion devices, and noted that a proposed modification to Conservation Measure 21-03 had been submitted to achieve this end (CCAMLR-XXVII/36).

4.12 Reports of the scientific observers should also contain information on the gear type and diagrams of the types of gear used.

Estimation of krill catch

4.13 The Scientific Committee noted the large range of conversion factors used to relate the weight of krill products to the catch of krill by fishing vessels (Annex 4, paragraphs 4.34

to 4.39). Data submitted to CCAMLR include no information on the uncertainty associated with the estimation of conversion factors. With the increasing range of products arising from the krill fishery, the range of conversion factors was likely to get larger, therefore the Scientific Committee advised that conversion factors were unlikely to be of use in providing back-estimates of landed catch.

4.14 Information on weight of krill can come from a combination of observer data and information from the fishing vessels. Green weight can be measured effectively from both conventional trawls and from the continuous fishing method using a flow scale meter. Dr S. Iversen (Norway) informed the Scientific Committee that flow scale monitoring of green weight has been implemented on all Norwegian vessels fishing for krill.

4.15 In association with the uncertainty about the actual krill catch derived from the different conversion factors used, the Scientific Committee noted that because of this there is further uncertainty surrounding the extrapolated by-catch of early life-history stages of fish that is being caught in the krill fishery. This concern is also reflected in CCAMLR-XXVII/BG/24.

4.16 The Commission's attention was drawn to the requirement for accurate measurements of the green weight of krill by krill vessels so that the actual amount of krill removals from SSMUs can be calculated. This will be of particular importance as the catch approaches the trigger level in Area 48. Therefore, the Scientific Committee recommended the direct measurement of green weight of krill.

4.17 The Scientific Committee requested that all vessels participating in the krill fishery in the coming season report on the utility of the methods presented by ad hoc TASO (SC-CAMLR-XXVII/BG/6) in estimating green weight during operations. The Scientific Committee requested that Members obtain these reports from their vessels and present them to TASO for consideration at its 2009 meeting.

4.18 There is also continuing value in the notification pro forma containing information on the range of products arising from the fishery.

By-catch of larval and juvenile fish

4.19 The Scientific Committee noted that despite regular reports from the Japanese fishery, there was still uncertainty over the level of by-catch of juvenile and larval fish in the krill catch over all seasons and areas in which the krill fishery was operating, and from different fishing gears.

4.20 It was noted that a Russian guide to larval and juvenile fish had been submitted to CCAMLR and this guide will be translated so that it can be used by scientific observers. The collection of information on fish by-catch should remain a priority task for observers on krill vessels.

Exploratory krill fishery notifications

4.21 The Scientific Committee noted that the notification deadline in Conservation Measure 21-02 could lead to situations in which notifications of Members' intent to participate in an exploratory krill fishery could be provided after the annual meeting of WG-EMM. The Scientific Committee therefore recommended that Conservation Measure 21-02 be modified so that notifications for exploratory krill fisheries can be received prior to the annual meeting of WG-EMM and be brought into line with other conservation measures for new and exploratory fisheries.

4.22 The Scientific Committee thanked Norway for its efforts in submitting the required notification of an exploratory krill fishery in Subarea 48.6 in advance of the meeting of WG-EMM so that it could receive the necessary scrutiny.

4.23 There is no formal estimate of krill biomass or established precautionary catch limit in Subarea 48.6. An estimate of krill biomass (B_0) would need to be calculated from an acoustic survey conducted according to CCAMLR standard protocols. Given the very large size of Subarea 48.6, WG-EMM should consider schemes for subdividing this subarea into ecologically appropriate subdivisions that could be realistically surveyed to produce estimates of krill biomass.

4.24 There is no existing exploratory fishing data collection plan for krill. The Scientific Committee recommended that a generic set of research requirements and a data collection plan be developed for exploratory krill fisheries. This data collection plan is outlined in paragraphs 4.163 to 4.185.

Advice to the Commission

4.25 The Commission's attention was drawn to the fact that for the second year running the notifications for catch levels from the krill fishery exceeded the existing trigger level in Area 48 (paragraph 4.8).

4.26 The Scientific Committee recommended that the krill fishery notification pro forma be modified to include information on specific details of gear configuration, including mesh size, mouth opening of the net, as well as the presence and design of any seal exclusion devices (paragraph 4.11).

4.27 The Scientific Committee recommended direct measurement of green weight of krill (paragraph 4.16).

4.28 The Scientific Committee recommended that Conservation Measure 21-02 be modified so that notifications for exploratory krill fisheries can be received prior to the annual meeting of WG-EMM (paragraph 4.21).

4.29 The Scientific Committee recommended the adoption of the data collection plan for exploratory krill fisheries (paragraph 4.24).

Fish resources

Fisheries information

Catch, effort, length and age data reported to CCAMLR

4.30 Fishing took place in 12 fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*E. superba*) under conservation measures in force in 2007/08 (CCAMLR-XXVII/BG/15).

4.31 Three other fisheries were conducted in the Convention Area in 2007/08:

- 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[2].

4.32 Catches of target species by region reported from fisheries conducted in the CAMLR Convention Area in 2007/08 are summarised in Table 1. Catches reported in 2006/07 are summarised in Table 2.

4.33 The Scientific Committee noted the intersessional work completed by the Secretariat on:

- monitoring and closure of fisheries when catch limits were reached;

- implementation of the length–mass parameters used in the assessments and development of an R script to plot the catch-weighted length frequencies;

- plotting of the catch-weighted length frequencies for *D. eleginoides* in Subarea 48.3 in two time series (1984/85 to 1996/97, and 1997/98 to present).

4.34 The Scientific Committee noted the estimates of catch and effort from IUU fishing (Annex 5, Table 2). Catches of toothfish reported in waters outside the Convention Area are considered under Agenda Item 7.

Input for stock assessment

4.35 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

4.36 The Scientific Committee noted that five research surveys were undertaken in 2007/08 (Annex 5, paragraphs 3.24 to 3.44):

[2] Also conducted in Area 51 outside the Convention Area.

(i) 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.

(ii) A bottom trawl survey in the Ross Sea was carried out by New Zealand as part of the IPY. Catch rates by station were presented for the eight most abundant species, along with catch-weighted length frequencies and biomass estimates of those species.

(iii) A bottom trawl survey in Division 58.5.2 was carried out by Australia. The results from the survey were used to update assessments of icefish in this division.

(iv) A stratified random longline survey of Division 58.4.3b was carried out by Australia. The results from this survey were used to provide catch rates, size distribution and size-at-maturity data for toothfish in this division.

(v) A research survey of Division 58.4.4 was carried out by Japan using trotlines with the objective of collecting biological data on toothfish needed for assessing status of stocks in this division.

4.37 The Scientific Committee congratulated Australia, Japan, New Zealand and the UK on completing research surveys and for contributing to the long-term data series.

4.38 Aspects of the research survey carried out by Japan in Division 58.4.4 are considered further under Agenda Item 4(iii).

Tagging studies

4.39 The Scientific Committee noted that several key issues with respect to tagging of toothfish in both exploratory and assessed fisheries were discussed in detail by WG-FSA (Annex 5, paragraphs 3.46 to 3.63), including:

(i) the continuation of the tag-recapture experiment in Subarea 48.4 (Annex 5, paragraphs 3.46 and 3.47);

(ii) difficulties in matching recaptured fish with release records (Annex 5, paragraphs 3.49 to 3.58).

4.40 The Scientific Committee considered that the requirements for photographs, entering of recapture details in logbooks and returning the tags to the Secretariat represented some redundancy, but allows for improved validation. For example, the Scientific Committee recognised that digital images could be manipulated, therefore photographic evidence alone may not be sufficient evidence of a tag return. The Scientific Committee was optimistic that the centralisation of the tagging program in new and exploratory fisheries would go some way to addressing these issues into the future.

Management advice

4.41 The Scientific Committee agreed that Members should be required to return physical tags to the Secretariat. In addition, the Secretariat should check for correct transcription of returned tags, including all alphanumeric characters.

4.42 The Scientific Committee requested that the Secretariat verify the tagging details for all tags recovered, including the following actions:

(i) direct comparison of reported recapture details with data available in the tagging database;

(ii) use of digital photographs and actual tags to verify tag identities;

(iii) correspondence with Members to clarify remaining uncertainty.

Biological parameters

4.43 The Scientific Committee noted consideration of new information on biological parameters set out in Annex 5, paragraphs 3.64 to 3.80, including information on age and growth and maturity for *Dissostichus* spp. and *C. gunnari*.

General biology and ecology

4.44 The Scientific Committee noted the discussions of WG-FSA on biology and ecology which included topics pertaining to *Dissostichus* spp., *C. gunnari*, by-catch species and former target species (*Chaenodraco wilsoni*) (Annex 5, paragraphs 9.1 to 9.23). These topics included:

- distribution and abundance of *D. mawsoni*
- diet and food consumption of several species of finfish
- early-life history
- maturity and fecundity
- age and growth
- further development of species profiles.

4.45 With respect to species profiles, the Scientific Committee noted that the profile for *D. eleginoides* will be updated in the course of 2009, and recommended that the profiles for *D. mawsoni*, *D. eleginoides* and *C. gunnari* be published on the CCAMLR website in early 2010 and updated regularly (Annex 5, paragraph 9.21).

Preparation of assessment and assessment timetables

WG-SAM report

4.46 The Scientific Committee noted that WG-FSA had reviewed the relevant sections of the WG-SAM report and endorsed the recommendations of WG-SAM.

Review of preliminary stock assessment papers

4.47 The Scientific Committee noted two preliminary stock assessments for *C. gunnari* in Subarea 48.3 and Division 58.5.2 that were developed during the intersessional period and reviewed by WG-FSA. The resulting discussions and summaries leading to management advice are provided in Annex 5, paragraphs 4.2 to 4.10.

4.48 In addition, the Scientific Committee noted that WG-FSA had reviewed preliminary assessments for toothfish in Divisions 58.4.1 and 58.4.2 (Annex 5, paragraphs 4.12 to 4.14). The Scientific Committee also noted that in order to provide management advice for the exploratory toothfish fishery in Division 58.4.3a, WG-FSA had drawn on progress toward assessing this fishery presented at WG-SAM (Annex 5, paragraphs 5.44 to 5.46). WG-FSA had also examined indicative estimates of biomass for the macrourid *Macrourus whitsoni* on the continental slope of the Ross Sea (Annex 5, paragraphs 4.16 and 14.17). These assessments are discussed further under Agenda Item 4(iii).

Assessment carried out and assessment timetable

4.49 The Scientific Committee noted that no new assessments were required this year for the fisheries for *Dissostichus* spp. in Subarea 48.3, Division 58.5.2 and in the Ross Sea under the current arrangement for multi-year management.

4.50 Discussion of assessments carried out this year by WG-FSA is provided in Annex 5, paragraphs 5.1 to 5.107. All assessment work was undertaken by primary authors of preliminary assessments and reviewed independently at WG-FSA. The outcomes of the assessments are presented in the Fishery Reports (Annex 5, Appendices D to Q).

Assessments and management advice

Dissostichus eleginoides South Georgia (Subarea 48.3)

4.51 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Annex 5, Appendix J.

4.52 The catch of *D. eleginoides* reported for this subarea in 2008 was 3 856 tonnes, plus 2 tonnes taken during the trawl survey. Of this total, 55 tonnes were taken by pots, the remainder by longlines. Catches in Management Areas A, B and C were 8 tonnes, 1 103 tonnes and 2 744 tonnes respectively. The estimated IUU catch for the 2007/08 season was zero. Following the advice of the Scientific Committee, the assessment was not updated in 2008.

Management advice

4.53 The Scientific Committee recommended that the catch limit for toothfish in Subarea 48.3 (SGSR stock) be set at 3 920 tonnes in the 2008/09 fishing season, the same level as in 2007/08. The Scientific Committee recommended that a new assessment of toothfish in Subarea 48.3 be carried out by WG-FSA in 2009.

4.54 The catch limits for management areas A, B and C should be 0, 1 176 and 2 744 tonnes respectively. By-catch limits for skates/rays and macrourids should remain at 196 and 196 tonnes respectively.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

4.55 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Annex 5, Appendix K.

4.56 The catch of *D. eleginoides* up to 31 August 2008 reported for this division was 2 853 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2007/08 season was zero inside the French EEZ. Some IUU fishing may occur outside the EEZ, as reported in WG-FSA-08/10 Rev. 2.

4.57 The CPUE standardisation for Division 58.5.1 was not updated by WG-FSA.

Management advice

4.58 For Division 58.5.1, the Scientific Committee encouraged the estimation of biological parameters, the development of a stock assessment and continuation of the tagging program undertaken by France. The Scientific Committee 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.

4.59 The Scientific Committee recommended avoidance of fishing in zones of specific high rates of by-catch.

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

4.61 The Scientific Committee noted that France had made significant progress in mitigating seabird by-catch, including area/season closures (SC-CAMLR-XXVI, 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)

4.62 The Fishery Report for *D. eleginoides* in Division 58.5.2 is contained in Annex 5, Appendix L.

4.63 The catch of *D. eleginoides* reported for this division by the time of the WG-FSA meeting was 1 496 tonnes. Of this total, 718 tonnes were taken by bottom trawl and 778 by longlines. The estimated IUU catch for the 2007/08 season was zero.

4.64 Following the recommendation by the Scientific Committee, the toothfish assessment for *D. eleginoides* in Division 58.5.2 was not updated by WG-FSA. The Scientific Committee noted that the *D. eleginoides* stock assessment in this division will be updated in 2009.

Management advice

4.65 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 2008/09 fishing season.

Dissostichus eleginoides Crozet Islands (Subarea 58.6)

4.66 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Annex 5, Appendix M.

4.67 The catch of *D. eleginoides* reported for this subarea to October 2008 was 684 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2007/08 season was zero inside Subarea 58.6 as reported in WG-FSA-08/10 Rev. 2.

4.68 The CPUE series for this fishery was not updated by WG-FSA in 2008.

Management advice

4.69 For this subarea, the Scientific Committee encouraged the estimation of biological parameters, the development of a stock assessment and the continuation of the tagging program undertaken by France.

4.70 The Scientific Committee recommended the avoidance of zones of high rates of by-catch.

4.71 No new information was available on the state of fish stocks in Subarea 58.6 outside areas of national jurisdiction. The Scientific Committee therefore recommended that the prohibition of directed fishing for *D. eleginoides*, described in Conservation Measure 32-13, remain in force.

4.72 The Scientific Committee noted that France had made significant progress in mitigating seabird by-catch, including area/season closures (SC-CAMLR-XXVI, 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 Islands (Subareas 58.6 and 58.7)

4.73 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 inside the South African EEZ is contained in Annex 5, Appendix N.

4.74 The catch limit of *D. eleginoides* in the South African EEZ for the 2007/08 season was 450 tonnes for the period from 1 December 2007 to 30 November 2008. The catch reported for Subareas 58.6 and 58.7 as of 5 October 2008 was 61 tonnes, all of which was taken by longlines. The IUU catch for the 2007/08 season was assumed to be equal to the IUU catch in 2004/05 at 156 tonnes.

4.75 The CPUE series was not updated by WG-FSA in 2008.

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

4.76 The Scientific Committee reiterated its advice from previous years that the advice on appropriate future catch levels 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 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 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

4.77 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*, described in Conservation Measures 32-10, 32-11 and 32-12, remain in force.

Champsocephalus gunnari South Georgia (Subarea 48.3)

4.78 The Fishery Report for *C. gunnari* in Subarea 48.3 is contained in Annex 5, Appendix O.

4.79 In the 2007/08 fishing season the catch limit set for *C. gunnari* in Subarea 48.3 was 2 462 tonnes. Up to the time of the WG-FSA meeting, the fishery caught 1 326 tonnes. The fishery was subsequently closed on 25 October 2008 with a total catch of 2 366 tonnes having been taken up to 23 October.

4.80 In April 2008 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves, reported in WG-FSA-08/28. The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

4.81 A short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2008 survey. All other input parameters for the assessment were the same as in 2007.

Management advice

4.82 The Scientific Committee recommended that the catch limit for *C. gunnari* should be set at 3 834 tonnes in 2008/09 and 2 631 tonnes in 2009/10 based on the outcome of the short-term assessment.

Champsocephalus gunnari Heard Island (Division 58.5.2)

4.83 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Annex 5, Appendix P.

4.84 The catch limit of *C. gunnari* in Division 58.5.2 for the 2007/08 season was 220 tonnes for the period from 1 December 2007 to 30 November 2008. The catch reported for this division as of 5 October 2008 was 199 tonnes.

4.85 A large 2+ 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 2008.

4.86 The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2008 survey. All other parameters were the same as in previous years.

Management advice

4.87 The Scientific Committee recommended that the catch limit for *C. gunnari* in 2008/09 should be set at 102 tonnes.

4.88 The Scientific Committee recommended that other measures for this fishery remain the same.

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

4.89 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 have previously demonstrated that the condition of fish stocks has improved to the extent that would allow commercial harvesting.

4.90 The Scientific Committee noted that the results from the three most recent surveys in these subareas indicate that fish biomass has not increased to the extent that a reopening of the fishery should be considered.

4.91 A new trawl survey will be undertaken in Subarea 48.2 by the US AMLR Program with international participation in February–March 2009.

Management advice

4.92 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)

4.93 The Scientific Committee noted the results of the three-year mark–recapture experiment conducted in the Northern Area of Subarea 48.4 (Conservation Measure 41-03). The experiment has allowed a preliminary assessment of *D. eleginoides* in the Northern Area, and the vulnerable biomass was estimated to be between 1 000 and 2 000 tonnes (Annex 5, paragraph 5.166).

4.94 The Scientific Committee also noted WG-FSA's consideration of the UK's proposal to continue the mark–recapture experiment in Subarea 48.4 in 2008/09 so as to allow for a full assessment of *D. eleginoides* in the Northern Area in 2009. Additionally, the UK proposed to commence a mark–recapture experiment in the Southern Area of Subarea 48.4 (Annex 5, Appendix Q, Figure 3), with the aim of collecting data required for assessments of the population structure, size, movement and growth of both *D. eleginoides* and *D. mawsoni* in the Southern Area of Subarea 48.4.

4.95 The main elements of the proposal are described in Annex 5, paragraph 5.168. Included in the proposal is a catch limit of 75 tonnes each for the Northern Area and the Southern Area.

4.96 The Scientific Committee congratulated the UK on this initiative, noting that the three-year mark–recapture experiment and the new proposal for 2008/09 provide a staged approach to the assessment of *Dissostichus* spp. in Subarea 48.4. This approach illustrates how new data may be added to existing information to develop assessments in areas where the status of stocks was previously unknown.

Management advice

4.97 The Scientific Committee endorsed the proposed extension to the mark–recapture experiment and agreed that the catch limit should be 75 tonnes in the Northern Area and 75 tonnes in the Southern Area for the 2008/09 season (Annex 5, paragraph 5.171 and Appendix Q).

4.98 In addition, the Scientific Committee endorsed the recommendation made by WG-IMAF to amend Conservation Measure 41-03 in order to align the seabird by-catch mitigation requirements for Subarea 48.4 with the IMAF risk assessment (Annex 6, paragraph 9.10), and the fishing season be extended to run from 1 December to 30 November.

New and exploratory fisheries in 2007/08 and notifications for 2008/09

4.99 In 2007 the Commission agreed to seven exploratory longline fisheries for *Dissostichus* spp. in the 2007/08 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, Tables 5 and 6.

4.100 Notifications for exploratory fisheries in 2008/09 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, for an exploratory trawl fishery for *E. superba* in Subarea 48.6, and for new pot fisheries for crab in Subareas 48.2 and 48.4.

Notification for new fisheries for crabs in Subareas 48.2 and 48.4

4.101 One Member (Russia) and one vessel notified their intention to conduct new pot fisheries for crabs in Subareas 48.2 and 48.4 in the 2008/09 season.

4.102 The Scientific Committee noted that no crab fishery has ever been attempted in Subareas 48.2 and 48.4. Noting the issues to be considered in addition to the requirements for the crab fishery discussed below, the Scientific Committee considered that the existing Conservation Measures 52-01 and 52-02 for the crab fishery in Subarea 48.3 could be used as a template to develop an experimental harvest regime for crabs in Subareas 48.2 and 48.4 should they proceed. All aspects of Conservation Measures 52-01 and 52-02 should be applied to conservation measures developed for Subareas 48.2 and 48.4 with the exception of modifications suggested below:

(i) two scientific observers should be present, including at least one international scientific observer;

(ii) the 2008/09 season should be defined as the period from 1 December 2008 to 30 November 2009, or until the catch limit is reached, whichever is sooner.

4.103 The Scientific Committee recommended that all by-catch of finfish during the experimental fishing regime shall be recorded for length, identified to species and then released with the least possible handling. Before the release, all specimens of *Dissostichus* spp. shall be measured and tagged. Full biological data should be taken from dead finfish by-catch and they should be returned to the sea.

4.104 The following paragraphs outline the Scientific Committee's considerations for the proposed crab fishery in each subarea.

Subarea 48.2

4.105 The Scientific Committee noted that there is no information on which to determine a catch limit for crabs in Subarea 48.2 as there is no information on the types of species or abundances that might form the basis of a sustainable fishery. The Scientific Committee considered that an approach consistent with assigning catch limits in exploratory toothfish fisheries would be appropriate, i.e. the catch should be at a nominally low level to provide for doing research on stock distribution and abundance and for helping determine strategies that will lead to an assessment of stock status and sustainable harvest strategies. It agreed that, should the crab fishery proceed in this subarea in the 2008/09 season, the experimental regime specified in the WG-FSA report (Annex 5, paragraphs 5.13 to 5.16) would be appropriate with a catch limit in the order of 250 tonnes.

Subarea 48.4

4.106 The Scientific Committee recommended that every vessel participating in the crab fishery in Subarea 48.4 in the 2008/09 season should conduct fishing operations in accordance with an experimental harvesting regime as defined in the WG-FSA report (Annex 5, paragraphs 5.17 to 5.20). The Scientific Committee agreed that, should the crab fishery proceed in this subarea, the experimental regime would be appropriate with a precautionary catch limit of 10 tonnes.

Progress towards assessments of new and exploratory toothfish fisheries

4.107 The Scientific Committee noted that WG-FSA had made further progress towards developing methods to assess exploratory fisheries (Annex 5, paragraphs 5.75 to 5.87). It further noted that they had considered two key aspects: (i) data requirements for assessing exploratory fisheries, and (ii) research designs in exploratory toothfish fisheries. The

Scientific Committee acknowledged the importance of understanding stock structure, productivity and abundance, and agreed that estimation of stock abundance in many of the exploratory fisheries remains a key problem.

4.108 The Scientific Committee recognised the importance of tagging studies for acquiring information necessary for assessments, and agreed on the factors identified by WG-FSA that are important for tagging programs to be successful (Annex 5, paragraph 5.77). The Scientific Committee agreed on the need for good spatial overlap of tags and subsequent fishing effort and that the tagging rate had to be sufficiently high to ensure reasonable recovery of tags. The Scientific Committee noted that WG-FSA had examined the requirement of a constant tagging rate, as well as the required spreading of tags throughout the area (Annex 5, paragraph 5.81). The Scientific Committee noted that plots of tagging rate per vessel demonstrated high variability, and recommended that this issue be referred to SCIC, noting that the attention of Members might need to be drawn to its recommendations last year (SC-CAMLR-XXVI, paragraph 4.117) and the associated changes made last year to Conservation Measure 41-01 (Annex 41-01/C, paragraph 2(i)) to address this issue.

4.109 The Scientific Committee agreed that in the absence of reliable tagging information, the only other information currently available is CPUE. However, there is concern that CPUE estimates in some exploratory divisions are not compatible, as is the case when different vessels fish in different locations each year.

4.110 The Scientific Committee recalled that there is a requirement for vessels fishing in exploratory fisheries to carry out up to 20 research sets, which must have a minimum distance of 5 n miles. However, some of the lines being fished are up to 40 km long which makes the 5 n mile minimum distance ineffective as an effort-spreading mechanism. The Scientific Committee considered that an alternative might be to have a more structured research fishing plan, fishing in a more systematic pattern with shorter lines analogous to the experimental design used for the crab fishery in Subarea 48.3.

4.111 The Scientific Committee noted that WG-FSA had recommended that vessels entering a new SSRU in Subarea 48.6 and open SSRUs in Subarea 58.4 should be required to carry out 10 research sets. Sets would be carried out on, or close to, supplied positions within strata based on fishable area where that information is available. Alternate positions could be supplied to replace any positions that were found to be unfishable for any reason. It also considered that, if carried out annually by the same vessels, they could be used to develop a time series of relative abundance indices.

4.112 The Scientific Committee agreed that each open SSRU in Subareas 48.6 and 58.4 would be divided into two strata: (i) previously fished, and (ii) unfished or lightly fished. Five research sets, each comprising a minimum of 3 500 hooks and a maximum of 5 000 hooks, would be carried out in each stratum in accordance with Conservation Measure 41-01, Annex 41-01/B.

4.113 The Scientific Committee further noted that the location of the research sets would be randomly determined in the following manner. For Divisions 58.4.1 and 58.4.2, the location of the five research sets in the fished stratum would be produced by bootstrapping (without replacement) from the mid-points of the location of sets made previously in the fished stratum. Within the unfished stratum, the location of each of the five research sets would be provided by giving the vessel a random line of longitude. The vessel would then be required to ensure that each research set was in a general north–south orientation that intersected the 1 000 m contour and that line of longitude. For Subarea 48.6 and Divisions 58.4.3a and 58.4.3b, the location of the five research sets in each of the fished stratum and in the lightly fished stratum would be produced by bootstrapping (without replacement) from the mid-points of the location of sets made previously in each of the respective strata.

4.114 The Scientific Committee requested the Secretariat generate lists of random stations for each vessel participating in these exploratory longline fisheries, and for the list to be sent to notifying Members prior to the start of the 2008/09 season.

4.115 The Scientific Committee noted that preliminary assessments of *Dissostichus* spp. for the open SSRUs in Divisions 58.4.1 and 58.4.2 had been developed during the meeting of WG-FSA (Annex 5, paragraphs 5.21 to 5.29). These assessments had led to preliminary estimates of yield and recommendations on the reduction of catch limits for those open SSRUs.

4.116 Drs K. Shust and Pshenichnov, on behalf of Russia and Ukraine respectively, noted that the estimates of toothfish biomass in Divisions 58.4.1 and 58.4.2 related only to the open SSRUs. They noted that tagging of toothfish resulted in inadequately low tag-recaptures in Divisions 58.4.1 and 58.4.2 (WG-SAM-08/4), probably due to migrations of toothfish from the sites of tagging to the closed SSRUs. They also noted that the assumption that CPUE is proportional to toothfish density is not correct for a longline fishery, and that this leads to an increase in the uncertainty of the analysis. In open SSRUs the biomass of toothfish was estimated by means of an unknown constant (the catchability) (WG-FSA-08/43). Catchability of longline as a whole and longlining of toothfish in particular is unknown, and should not be used for biomass estimation. Drs Shust and Pshenichnov also pointed out that catches of immature (1–4 years old) fish in Division 58.4.2 (WG-FSA-08/23) using bottom trawls give ground to suggest that recruitment and biomass of fish in this division is higher than presented in WG-FSA-01/43.

4.117 Many Members noted that toothfish in Divisions 58.4.1 and 58.4.2 may come from the same stock, including fish on BANZARE Bank. This conclusion is drawn from the data and analyses for this region by WG-FSA over the last two years. The analyses do not suggest that the stock is depleted but that the region-wide population is likely to be much less than, say, in Subareas 88.1 and 88.2. As a result, there is no expectation that the stock in Divisions 58.4.1 and 58.4.2 is depleted in the open areas compared to the closed areas. Strategies to concentrate effort in such a way to collect data to assist with assessments remain the best approaches for developing these fisheries.

Dissostichus spp. (Subarea 48.6)

4.118 Four Members (Japan, Republic of Korea, New Zealand and South Africa) notified their intention to fish in the exploratory fishery in Subarea 48.6 in 2007/08; however, to date, none fished and the fishery remains open until 30 November 2008. The precautionary catch limit for *Dissostichus* spp. was 400 tonnes. There was no evidence of IUU fishing in 2007/08.

4.119 Two Members (Japan and Republic of Korea) and a total of three vessels notified their intention to fish for toothfish in Subarea 48.6 in 2008/09.

4.120 The Scientific Committee endorsed the recommendation of WG-FSA that the tagging rate in this subarea should be increased to three fish per tonne (Annex 5, paragraph 5.65).

4.121 The Scientific Committee also agreed that vessels entering an SSRU in Subarea 48.6 would be required to carry out research sets in accordance with the procedure outlined in paragraphs 4.112 to 4.114.

Dissostichus spp. (Division 58.4.1)

4.122 Four Members (Republic of Korea, Namibia, Spain and Uruguay) and six vessels fished in the exploratory fishery in Division 58.4.1 in 2007/08. The precautionary catch limit for toothfish was 600 tonnes and the reported catch so far was 413 tonnes. Information on IUU activities indicated that 94 tonnes of toothfish were taken in 2007/08 (Annex 5, paragraphs 5.30 and 5.31).

4.123 Six Members (Japan, Republic of Korea, New Zealand, South Africa, Spain and Uruguay) and a total of 13 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2008/09.

4.124 The Scientific Committee recommended that the tagging rate be maintained at a minimum of three fish per tonne (Annex 5, paragraph 5.100).

4.125 The Scientific Committee noted that a preliminary assessment of *Dissostichus* spp. in Division 58.4.1 had been carried out by UK and Spanish scientists and presented to WG-FSA (Annex 5, paragraphs 5.21 to 5.29). The Scientific Committee noted that this was the first assessment of *Dissostichus* spp. in this division and thanked the scientists involved for carrying out this work.

4.126 The Scientific Committee agreed that, although uncertain, the median estimates of yield provided for the open SSRUs in Annex 5, Table 13, provided the best available scientific advice on the yields for *Dissostichus* spp. in this division. However, the Scientific Committee was unable to provide consensus advice on catch limits for this division.

4.127 Some members of the Scientific Committee considered that the current network of open and closed SSRUs in this division made it difficult to assess the entire stock (paragraph 4.116). The Scientific Committee agreed that the issue of potential bias caused by open and closed SSRUs was best addressed by WG-SAM. The Scientific Committee requested Members to submit papers to the 2009 meeting of WG-SAM that addressed this issue.

4.128 The Scientific Committee also recommended that vessels entering an SSRU in Division 58.4.1 should be required to carry out research sets in accordance with the procedure outlined in paragraphs 4.112 to 4.114.

Dissostichus spp. (Division 58.4.2)

4.129 Two Members (Republic of Korea and Namibia) and three vessels fished in the exploratory fishery in Division 58.4.2 in 2007/08. The precautionary catch limit for toothfish was 780 tonnes and the reported catch so far was 217 tonnes. There was no evidence of IUU fishing in 2007/08.

4.130 Six Members (Australia, Japan, Republic of Korea, New Zealand, Spain and Uruguay) and a total of nine vessels notified their intention to fish for toothfish in Division 58.4.2 in 2008/09.

4.131 The Scientific Committee recommended that the tagging rate be maintained at a minimum of three fish per tonne (Annex 5, paragraph 5.100).

4.132 The Scientific Committee noted that a preliminary assessment of *Dissostichus* spp. in Division 58.4.2 had been carried out by UK and Spanish scientists and presented to WG-FSA (Annex 5, paragraphs 5.21 to 5.29). The Scientific Committee noted that this was the first assessment of *Dissostichus* spp. in this division and thanked the scientists involved for carrying out this work.

4.133 The Scientific Committee agreed that, although uncertain, the median estimates of yield provided for the open SSRUs in Annex 5, Table 13, provided the best available scientific advice on the yields for *Dissostichus* spp. in this division. However, the Scientific Committee was unable to provide consensus advice on catch limits for this division.

4.134 Some members of the Scientific Committee considered that the current network of open and closed SSRUs in this division made it difficult to assess the entire stock (paragraph 4.116). The Scientific Committee agreed that the issue of potential bias caused by open and closed SSRUs was best addressed by WG-SAM. The Scientific Committee requested Members to submit papers that addressed this issue to the 2009 meeting of WG-SAM.

4.135 The Scientific Committee also recommended that vessels entering an SSRU in Division 58.4.2 should be required to carry out research sets in accordance with the procedure outlined in paragraphs 4.112 to 4.114.

Dissostichus spp. (Division 58.4.3a)

4.136 One Member (Uruguay) and one vessel fished in the exploratory fishery in Division 58.4.3a in 2007/08. The precautionary catch limit for toothfish was 250 tonnes and the reported catch was 9 tonnes. There was no evidence of IUU fishing in 2007/08.

4.137 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2008/09.

4.138 The Scientific Committee recommended that the tagging rate be maintained at a minimum of three fish per tonne (Annex 5, paragraph 5.100).

4.139 The Scientific Committee noted that a preliminary assessment of *Dissostichus* spp. using a biomass dynamic surplus production model in Division 58.4.3a had been carried out by UK scientists and presented to WG-SAM (Annex 7, paragraphs 3.6 to 3.8). The Scientific Committee noted that this was the first assessment of *Dissostichus* spp. in this division and thanked the scientists involved for carrying out this work.

4.140 The catch limit for Division 58.4.3a in 2007/08 was 250 tonnes. The Working Group agreed that the assessment suggested that this level of catch was not sustainable and that the catch limit for this division be reduced to a level in the range of 86 to 113 tonnes.

4.141 The Scientific Committee also recommended that vessels entering an SSRU in Division 58.4.3a should be required to carry out research sets in accordance with the procedure outlined in paragraphs 4.112 to 4.114.

Dissostichus spp. (Division 58.4.3b)

4.142 Three Members (Japan, Namibia and Uruguay) and three vessels fished in the exploratory fishery in Division 58.4.3b in 2007/08. The precautionary catch limit for toothfish was 150 tonnes and the reported catch was 139 tonnes. Information on IUU activities indicated that 246 tonnes of toothfish were taken in 2007/08 (Annex 5, paragraph 5.50).

4.143 Three Members (Japan, Spain and Uruguay) and a total of three vessels notified their intention to fish for toothfish in Division 58.4.3b in 2008/09.

4.144 The Scientific Committee recommended that the tagging rate be maintained at a minimum of three fish per tonne (Annex 5, paragraph 5.100).

4.145 The Scientific Committee noted that a random longline survey of BANZARE Bank had been carried out by Australia in May 2008 (Annex 5, paragraph 3.32). The Scientific Committee agreed that the catch rates of *Dissostichus* spp. were very low during the survey, consistent with toothfish being depleted in the surveyed area. However, it was unable to reach consensus on the stock status of *Dissostichus* spp. across the entire division.

4.146 The Scientific Committee agreed that the research has shown the following:

(i) Based on fishing information until last year, the fisheries across BANZARE Bank show that the preferred fishing grounds were depleted in the Southern Area (SSRU B closed to fishing in 2007/08, Conservation Measure 41-07 (2007)).

(ii) Based on the survey and fisheries across BANZARE Bank, there are very few fish apart from in the preferred fishing grounds.

(iii) The fish found in the preferred fishing grounds are large and likely spawning, there are no small fish and fish are male dominated (79%).

(iv) In the survey, the fish are large and mostly male.

(v) Spawning fish in East Antarctica have only been found on BANZARE Bank (WG-FSA-07/44 and Annex 5, paragraph 3.32).

4.147 The Scientific Committee noted that only two of the three preferred fishing grounds in the area were covered by the random survey. However, the random nature of the survey implies the area was adequately covered. Japan noted it would have liked to see the third preferred fishing ground surveyed and a larger number of stations sampled to provide a more robust estimate of biomass. The Scientific Committee recommended that WG-SAM should look at how to design longline surveys and, in particular, how to deal with preferred fishing grounds and how to reconcile datasets from different types of fishing gear. It also referred back to Annex 5, paragraphs 5.84 to 5.87, which deal with the design of research surveys.

4.148 The Scientific Committee was unable to provide management advice on catch limits in this division.

4.149 The Scientific Committee recommended that vessels entering an SSRU in Division 58.4.3b should be required to carry out research sets in accordance with the procedure outlined in paragraphs 4.112 to 4.114.

Dissostichus spp. (Subareas 88.1 and 88.2)

4.150 In 2007/08, eight Members (Argentina, Republic of Korea, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and 15 vessels fished in the exploratory fishery in Subarea 88.1. The fishery was closed on 31 August 2008 and the total reported catch of *Dissostichus* spp. was 2 259 tonnes (84% of the catch limit) (CCAMLR-XXVII/BG/15, Table 2). During the course of fishing, SSRUs B, C and G were closed on 19 December 2007, triggered by the catch of *Dissostichus* spp. (total catch 259 tonnes; 83% of the catch limit).

4.151 The IUU catch for the 2007/08 season was estimated to be 187 tonnes (Annex 5, paragraph 5.66).

4.152 Four Members (New Zealand, Russia, UK and Uruguay) and four vessels fished in the exploratory fishery in Subarea 88.2. The fishery closed on 31 August 2008 and the total reported catch of *Dissostichus* spp. was 416 tonnes (73% of the catch limit) (CCAMLR-XXVII/BG/15, Table 2). SSRU E was closed on 1 February 2008, triggered by the catch of *Dissostichus* spp. (total catch 333 tonnes; 98% of the catch limit). There was no evidence of IUU fishing in 2007/08.

4.153 Nine Members (Argentina, Chile, Republic of Korea, 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 2008/09. Nine Members (Argentina, Chile, Republic of Korea, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and a total of 19 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2008/09.

4.154 In accordance with the advice of Scientific Committee in 2007, the assessment for Subareas 88.1 and 88.2 was not updated. The Scientific Committee agreed that the management advice on catch limits for Subareas 88.1 and 88.2 could be carried forward from last year.

4.155 The Scientific Committee noted that an extensive review of the three-year experiment in the toothfish fisheries in Subareas 88.1 and 88.2 had been carried out by New Zealand scientists (Annex 5, paragraphs 5.88 to 5.90). The review outlined the objectives and achievements of the three-year experiment, and identified minor changes to the operational framework to meet the science and management objectives of the fishery. The Scientific Committee thanked New Zealand for carrying out this work

4.156 Most Members agreed that considerable progress had been made on the stock assessment for *D. mawsoni* in Subareas 88.1 and 88.2 as a result of the experiment.

4.157 However, Drs Shust and Pshenichnov, on behalf of Russia and Ukraine respectively, expressed the opinion that the three-year experiment of toothfish tagging in the Ross Sea had been unsuccessful, as it did not result in significant improvement of toothfish stock assessment in those subareas. They pointed out several sources of substantial uncertainty of stock assessments of toothfish in the Ross Sea based on the tag-returns (WG-SAM-08/8). The first source is the absence of data from the closed SSRUs. Another source comes from taking into account tag-returns from the New Zealand fishery only, which operates from year to year within restricted areas of the Ross Sea and adjacent waters. Together, these sources may result in considerable underestimation of toothfish biomass and catch limit in the Ross Sea. Taking into account the reasons mentioned above, continuation of the toothfish tagging program should not be further confined to open SSRUs only. The uncertainties related to the current tagging schedule may be amplified even further under three- or five-year experiments of toothfish fishery management. Taking all this into account, Drs Shust and Pshenichnov suggested that the Commission consider the possibility of opening all closed SSRUs in order to distribute the exploratory effort across the entire Subareas 88.1 and 88.2 and provide better estimates of the toothfish stock in those subareas.

4.158 The Scientific Committee recognised the differing views of Members regarding the network of open and closed SSRUs in these two subareas (Annex 5, paragraphs 5.89 and 5.94 to 5.96). It recommended that the relative merits of the different views on harvest strategies and research programs for toothfish in the Ross Sea be evaluated using simulations (see Annex 7, paragraphs 5.1 to 5.6). It recommended that such work be submitted to WG-SAM for review of the simulation and assessment methodologies before submitting the outcomes to WG-FSA for consideration.

4.159 The Scientific Committee also noted that additional approaches to assessing and modelling the Ross Sea fishery were being carried out by New Zealand and Russian scientists and encouraged the further development of these new modelling approaches and their submission to WG-SAM for review and evaluation (Annex 5, paragraph 4.11; Annex 7, paragraphs 8.1 to 8.3).

4.160 The Scientific Committee endorsed the following recommendations:

(i) The creation of an additional SSRU in the region to the west of 170°E in the western Ross Sea including Terra Nova Bay and McMurdo Sound (i.e. SSRU 881J west). It further recommended that this new SSRU (881M) (Figure 2) should be closed to fishing because of its importance as a corridor for sub-adult toothfish moving between the shelf and the northern area to spawn.

(ii) Retain the current amalgamation of SSRU catch limits, and in addition amalgamate the catch limits for SSRUs 881J (east of 170°E) and 881L.

(iii) Re-adjust proportional catch limits in these revised SSRUs based on revised seabed areas and new CPUE.

(iv) Allow retention of catch limits for toothfish and by-catch species for ‘out of season’ experiments in open SSRUs.

(v) Continue with biennial assessments of *D. mawsoni* in the two subareas.

(vi) Develop specific data collection and research plans for the Subarea 88.1 and 88.2 fisheries.

4.161 The revised proportions of the catch limit to be allocated for the shelf, slope and northern regions of Subarea 88.1, based on proportional seabed area and CPUE using the methodology described in SC-CAMLR-XXIV, paragraphs 4.152 to 4.176, are given in Table 4.

Northern region:	SSRUs 881B, C, G = 0.13
Slope region:	SSRUs 881H, I, K = 0.74
Shelf region:	SSRUs 881J, L = 0.13
	SSRUs 881A, D, E, F, M = 0.

4.162 The Scientific Committee recommended new catch limits for *Macrourus* spp. in Subarea 88.1 based on the advice provided in Annex 5, paragraphs 6.16 to 6.22 and Table 17.

Research and data collection plans for exploratory krill fisheries

General aspects

4.163 The Scientific Committee reviewed the hierarchical characterisation of potential research and data collection plans for exploratory krill fisheries provided by WG-EMM (Annex 4, Tables 1 and 2) and agreed that:

(i) data collection from the ‘commercial fishing’ option (Annex 4, Table 1) would not be sufficient to satisfy future needs for scientific advice on exploratory krill fisheries;

(ii) flexibility should be provided by allowing Members (and vessels flagged under them) to select one research and data collection plan from a small set of plans that, while generic (Annex 4, paragraph 4.74), can nevertheless be adopted on a case-specific basis;

(iii) the set of research and data collection plans should include both fishery-dependent (Annex 4, Table 1) and fishery-independent (Annex 4, Table 2) plans;

(iv) sufficient time was not available to specify all the details required for each data collection plan in such a set and, therefore, the set of plans agreed for the

2008/09 krill fishing season should be considered provisional and subject to further review and refinement by WG-EMM and the Scientific Committee in 2009;

(v) vessels prosecuting exploratory krill fisheries and collecting data under a fishery-dependent plan should conduct both normal fishing operations and the research operations specified by the plan, with the distribution of fishing effort between normal and research operations determined on the basis of how much krill is caught during normal operations;

(vi) the set of data collection plans should be accompanied with a catch limit that is likely to be consistent with Article II of the Convention.

4.164 The Scientific Committee agreed that the set of data collection plans for case-specific selection by Members (and vessels flagged under them) should include:

(i) 'standardised systematic/random research trawls by fishing vessels' (Annex 4, Table 1);

(ii) 'standardised systematic acoustic transects by fishing vessels' (Annex 4, Table 1);

(iii) 'predator monitoring' (Annex 4, Table 2);

(iv) 'research survey from scientific vessel' (Annex 4, Table 2).

4.165 With respect to plans (i) and (ii) above, the Scientific Committee agreed that research trawls would provide the best information on krill demographics and that acoustic transects would be more likely to provide the information needed to estimate a precautionary catch level. Both strategies could provide information on the spatial distribution of krill.

4.166 In considering the possibility that acoustic transect data may be collected during prosecution of an exploratory krill fishery in 2008/09, the Scientific Committee agreed that SG-ASAM should, as a matter of priority, advise on protocols for the collection and analysis of acoustic data from commercial fishing vessels (paragraph 2.7).

Plan implementation

4.167 A schematic representation of the plans described below is provided in Figure 3.

4.168 The Scientific Committee agreed that, within a fishing season, vessels participating in exploratory krill fisheries should first conduct normal exploratory fishing operations and then conduct additional research requirements. Vessels would conduct normal fishing operations until they voluntarily decide to stop fishing for the season or until the catch limit for the exploratory fishery is reached. Vessels would then be expected to complete all required research operations – this must be completed within a fishing season.

4.169 The Scientific Committee agreed that:

(i) exploratory units are defined as areas of 1° latitude by 1° longitude size, and the vertices of these units shall occur at integer points of latitude and longitude;

(ii) ‘fishing’ is defined as any time that fishing gear, conventional trawls, pumped codends and continuous pumping gear are in the water;

(iii) a research haul is defined as a randomly located, oblique haul made with a research net to a depth of 200 m with a duration of 0.5 h. A set of research hauls is defined as three research hauls separated by a minimum of 10 n miles;

(iv) an acoustic transect is defined as a randomly located, continuous path, travelled at constant speed of 10 knots or less and in a constant direction. The minimum distance between start and end points is 30 n miles, and a set of acoustic transects is defined as two transects separated by at least 10 n miles.

4.170 The Scientific Committee agreed that, during normal exploratory fishing operations, vessels can choose to fish in any exploratory unit and use whatever methods best suit their unique fishing strategies. Nevertheless, to facilitate future comparisons between data collected during normal exploratory fishing operations and research operations, vessels would be required to conduct one set of acoustic transects or one set of research hauls in each exploratory unit visited during normal fishing operations.

4.171 The Scientific Committee recommended that the fishery-dependent data collection plans (plans (i) and (ii) in paragraph 4.164) be operationalised as follows:

(i) on completion (either voluntarily or if the catch limit has been reached) of normal exploratory fishing operations, the vessel will transit to the nearest, previously unvisited, exploratory unit and begin research operations;

(ii) the vessel will determine how many previously unvisited exploratory units must be surveyed during research operations by dividing the catch obtained during normal exploratory fishing operations by 2 000 tonnes and rounding that number to the nearest integer;

(iii) the vessel will then select a number of exploratory units equal to the number of units determined by the calculation in item (ii) above and conduct one set of acoustic transects or one set of research hauls in each of these units;

(iv) exploratory units visited during research operations must not have been visited during normal exploratory fishing operations;

(v) the survey will be conducted in a way that ensures the exploratory units visited during research operations will surround the units in which normal exploratory fishing operations previously occurred.

4.172 The Scientific Committee agreed that research hauls should be conducted with nekton trawls commonly used in scientific research (e.g. IKMT or RMT type nets) that have 4–5 mm mesh, including the codend. Members would be required to provide detailed information on the configuration of nets used to conduct research trawls.

4.173 The Scientific Committee agreed that acoustic transects should be conducted using a scientific echo sounder collecting information at 120 kHz. If possible, the echo sounder should be calibrated.

4.174 The Scientific Committee agreed that all vessels participating in exploratory krill fisheries should embark at least one scientific observer who would collect data throughout the duration of every fishing trip. More than one observer may be required to collect all the required information.

4.175 With respect to the fishery-independent data collection plans (plans (iii) and (iv) in paragraph 4.164), the Scientific Committee agreed that:

(i) that predator monitoring efforts should, as far as possible, follow CEMP Standard Methods and be conducted for a period of time sufficient both to cover the entire breeding period of land-based predators and to cover the duration of any exploratory fishing that occurs during their breeding season;

(ii) that the conduct of a survey from a research vessel should follow all data collection and analysis protocols specified for the CCAMLR-2000 Survey.

Data collection and reporting

4.176 With respect to data collection and reporting during research fishing operations, the Scientific Committee agreed that, as far as possible, data collection protocols should be consistent with those specified in the CCAMLR *Scientific Observers Manual*. Thus, while prosecuting an exploratory krill fishery, questions regarding data collection during research fishing should first be addressed by consulting this manual.

4.177 The Scientific Committee agreed that the data required from every research haul include:

(i) the start and end positions and times of the haul;

(ii) the date on which the haul was conducted;

(iii) characteristics of the haul such as tow speed, the maximum amount of wire payed out during a tow, the average wire angle during the tow, and calibrated flow-meter values that can be used to provide accurate measures of volume filtered;

(iv) an estimate of the total catch (in numbers or volume) of krill;

(v) a random sample of up to 200 krill or the entire catch, whichever is less, to be taken from the haul by the observer – the length, sex and maturity stage should be measured and recorded for all krill according to protocols in the CCAMLR *Scientific Observers Manual*.

4.178 The Scientific Committee agreed that, *inter alia*, the data required from acoustic transects should:

(i) as far as possible, be recorded following protocols specified for the CCAMLR-2000 Survey;

(ii) be linked to data recorded from a GPS;

(iii) be continuously recorded and then electronically archived every five days or whenever the vessel moves between exploratory units, which ever occurs most frequently.

4.179 The Scientific Committee acknowledged that biological data collected from net tows is critical for interpreting acoustics data. Therefore, it was further agreed that all acoustic transects should be accompanied by at least one net haul. These hauls can be conducted either with commercial trawls or with research trawls, but it is necessary for detailed information on either type of trawl to be provided to the Secretariat. Trawls that accompany acoustic transects can be conducted during the transect or immediately after the completion of the transect. In the latter case, the trawl should be conducted along a previous segment of the transect line. Trawls that accompany acoustic transects should be at least 0.5 h in duration, and the data collected from these hauls should be the same as those required for research hauls.

4.180 All data collected during research operations should be reported, by the Member prosecuting the exploratory fishery, to the Secretariat no later than one month after the conclusion of each fishing trip.

4.181 For normal fishing operations, the Scientific Committee agreed to a minimum set of reporting requirements for an exploratory krill fishery:

(i) 10-day catch and effort reporting system in accordance with Conservation Measure 23-02;

(ii) haul-by-haul catch and effort data in accordance with Conservation Measure 23-04, including the monthly reporting deadline;

(iii) scientific observer data in accordance with the CCAMLR Scheme of International Scientific Observation.

4.182 Data collected during the conduct of fishery-independent plans should be submitted to the Secretariat following guidelines developed for CEMP data and for CCAMLR-2000 data and in sufficient time to be considered by the next meeting of WG-EMM.

4.183 The Scientific Committee recognised that in providing Members (and the vessels flagged under them) the flexibility to select among research and data collection plans in the set of four plans outlined above, it would be necessary to collect detailed information on the configuration of every commercial trawl used during a fishing trip.

Catch limitations

4.184 To maximise the likelihood that CCAMLR will be able to achieve the objectives specified in Article II, the Scientific Committee advised an annual catch limit of 15 000 tonnes for exploratory krill fisheries. The Scientific Committee further advised that no more than 75% of this catch limit should be taken from areas within 60 n miles of known breeding colonies of land-based krill-dependent predators.

4.185 The Scientific Committee emphasised that the research and data collection plans agreed for the 2008/09 fishing season are provisional and, therefore, will require review and possible revision at the next meetings of WG-EMM and the Scientific Committee.

Proposal to combine conservation measures for new and exploratory fisheries

4.186 Dr Holt introduced CCAMLR-XXVII/33 which contained a proposal prepared by the USA to combine Conservation Measures 22-01 (new fisheries) and 22-02 (exploratory fisheries). The paper recalled that the new and exploratory conservation measures were developed over several years and that this resulted in a lack of consistency in information and requirements specified in the two measures. The new fishery measure serves predominately to notify the Commission of the intention to fish, with a generalised request for data. There is no organised protocol to ensure specific data are collected and reported. However, the exploratory fishery measure has detailed requirements for a data collection plan and a fishery operations plan. It also requires placement of a CCAMLR scientific observer to collect biological and fishery data on board the vessel. The use of separate new and exploratory conservation measures therefore potentially delays by one year the ability of the Commission to start gathering information needed to assess the status of proposed fisheries.

4.187 The proposed combined conservation measure attempts to ensure a minimum change in existing text which has already been agreed by the Commission in the two measures. The requirements under the proposed merger are the same as required by the existing exploratory fishery measure. The definition of an exploratory fishery has simply been expanded to include the first year of the fishery.

4.188 Dr Parkes welcomed the paper prepared by the USA and noted that the proposed unification of the conservation measures on new and exploratory fisheries is in accordance with the conclusions of previous discussions in the Scientific Committee on the development of a unified regulatory framework for CCAMLR (SC-CAMLR-XIX, paragraphs 7.2 to 7.23). Those discussions considered in detail the relationship between the new and exploratory measures and tabulated the existing regulatory requirements and how they might be generalised for application to the development of all fisheries (SC-CAMLR-XIX, Tables 7 and 8).

4.189 An important conclusion of the previous discussions was that a unified framework would negate the requirement for definitions of fishery types or stages that have become complex and ambiguous (SC-CAMLR-XIX, paragraph 7.10). Dr Parkes suggested that in the process of unifying the new and exploratory fisheries measures there was an opportunity to remove the need for a specific definition of an exploratory fishery, which has resulted in some difficulty in interpretation in the past. This could be achieved by having the provisions of the new measure apply to all fisheries, except those specifically listed in an annex. The fisheries to be listed in the annex would be those currently regarded as 'established' or 'assessed' fisheries. The Scientific Committee could provide advice each year on which fisheries should be listed, based on the information requirements for assessments and the preparation of management advice.

4.190 The Scientific Committee agreed that fisheries would need to be listed using the usual descriptions of species, gear and area.

4.191 Dr Constable thanked Dr Holt for presenting this proposal. Regarding the listing of fisheries, Dr Constable noted that, as fisheries develop and data enable full assessments to be undertaken, so fisheries may progress beyond the scope of the existing measure for exploratory fisheries. For example, the data collection plans and fishery operations plans for the toothfish fisheries in the Ross Sea have enabled the development of an assessment, however, it is not just a question of data availability, but also of the quality of those data that are important in determining the extent to which a fishery can be assessed and robust management advice developed.

4.192 The Scientific Committee agreed that there is significant merit in combining the new and exploratory fisheries conservation measures in order to rationalise the data collection and research requirements for fisheries in the early stages of development. It also recommended to the Commission that a list be made of fisheries to which the measure does not apply. If a fishery is not listed, then the measure would automatically apply.

Squid and crab resources

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

4.193 Crabs were not exploited in the 2007/08 season. Russia notified the Commission of its intention to fish for crabs in this subarea during the 2008/09 season. It indicated its intention to conduct fishing operations in accordance with conditions specified under Conservation Measures 52-01 and 52-02.

Management advice

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

Squid (*Martialia hyadesi*) (Subarea 48.3)

4.195 Squid were not exploited in the 2007/08 season. No proposal for the harvest of squid has been received by CCAMLR for the 2008/09 season.

Management advice

4.196 The exploratory fishery on squid was subject to Conservation Measure 61-01. No new information on the species was available. The Scientific Committee recommended that the conservation measure remain in force.

Fish and invertebrate by-catch

Macrourus move-on rules and by-catch limits in new and exploratory fisheries

4.197 The Scientific Committee noted that WG-FSA had reviewed the levels of fish and invertebrate by-catch, and noted that none of the limits on by-catch set in the conservation measures applying to the statistical areas managed by CCAMLR were exceeded during the 2007/08 season.

4.198 The Scientific Committee noted that WG-FSA had reviewed the performance of the modified by-catch move-on rule for *Macrourus* spp. in new and exploratory fisheries (Conservation Measure 33-03). As *Macrourus* spp. by-catch had not increased in 2007/08, the Scientific Committee recommended that the modified move-on rule be retained.

4.199 The Scientific Committee noted that WG-FSA was able to provide revised advice on precautionary by-catch limits for *Macrourus* spp. in the Ross Sea, as a result of a trawl survey conducted by New Zealand as part of IPY activities (Annex 5, paragraphs 6.16 to 6.22).

4.200 The Scientific Committee endorsed the recommendation that revised by-catch limits be apportioned across SSRUs as indicated in Table 17 of Annex 5, and welcomed the decoupling of the by-catch limit from the toothfish catch limit.

Year-of-the-Skate

4.201 The Scientific Committee noted the discussion by WG-FSA on protocols for data collection for the Year-of-the-Skate during the 2008/09 fishing season. It endorsed the recommendation that logbook forms L5 and L6 be altered, and L11 be removed to simplify the recording of data on skates (Annex 5, paragraph 6.34).

4.202 The Scientific Committee recommended that during the Year-of-the-Skate, all skates be brought on board or alongside the hauler to be correctly identified, scanned for tags and for their condition to be assessed. During 2008/09, all vessels should retain all skates that are dead or with life-threatening injuries (condition 1 or 2 in the logbook). For skates that are likely to survive if released (condition 3 or 4), the skate should be released by cutting the snood as close to the hook as possible or cutting the snood and removing the hook from the skate, providing this does not further injure the skate. The Scientific Committee requested that WG-FSA review this approach at its meeting in 2009.

4.203 The Scientific Committee endorsed the recommended tagging rate of one in every five skates caught in new and exploratory fisheries during 2008/09 up to a maximum of 500 skates per vessel, with all skates double-tagged. The tagging program will be coordinated by the Secretariat, which will be the repository for skate tagging kits. The Scientific Committee further endorsed that any tagged skates should be identified to species, measured before they are released and that, where possible, tagging experiments be undertaken to compare different tag types and estimate tag-shedding rates.

4.204 The Scientific Committee agreed that, when skates are caught on a line, they should be randomly sampled by observers at a rate of three skates/thousand hooks, with the *Dissostichus* spp. sampling reduced to four toothfish/species/thousand hooks for the purpose of collecting biological measurements. If sufficient numbers of skates are not caught to meet this protocol, it is proposed the total number of biological samples per line should remain constant with the additional sampling carried out on *Dissostichus* spp. The Scientific Committee recommended that increased recording of biological information for skates initially be limited to the Year-of-the-Skate, but be reviewed at next year's meeting of WG-FSA.

4.205 The Scientific Committee recommended that skates should not be sacrificed for biological sampling, and that female maturity stage only be recorded if the skate is dead or has sustained life-threatening injuries (conditions 1 and 2). All live skates which are part of the biological sampling and which have not sustained life-threatening injuries, should be handled with care and released after biological information has been recorded, if they are still suitable for release (i.e. still in condition 3 or 4).

Benthic invertebrate identification guides

4.206 The Scientific Committee welcomed the production of new tools for identifying benthic invertebrate by-catch, including a field guide to the invertebrates in Division 58.5.2 by Australia and an identification poster of benthic taxa for the Ross Sea by New Zealand, and noted that these tools could be used to improve the collection of data on potential VME encounters.

Bottom fishing activities and VMEs

4.207 The Scientific Committee recalled its deliberations last year on bottom fishing in CCAMLR high-seas areas (SC-CAMLR-XXVI, paragraphs 4.159 to 4.171), including endorsement of the report of WG-FSA, the questions to be addressed and special note of a number of issues (SC-CAMLR-XXVI, paragraphs 4.162 and 4.163). The Scientific Committee endorsed the procedure and definitions provided by WG-FSA, which are based on existing practices and procedures (SC-CAMLR-XXVI, paragraph 4.164 and Figure 1) and which clearly show what is needed to develop scientific advice on:

- (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.

4.208 The Scientific Committee also recalled the endorsement by the Commission of the framework provided by the Scientific Committee (CCAMLR-XXVI, paragraphs 5.11 and 5.12) and the proposed further work (CCAMLR-XXVI, paragraphs 5.13 to 5.15). It tasked the Scientific Committee with developing pragmatic and flexible guidelines for:

(i) identifying VMEs
(ii) defining actions taken by vessels which may encounter evidence of VMEs during the course of fishing.

These would be reviewed at its next meeting (CCAMLR-XXVI, paragraph 5.16).

4.209 The Scientific Committee noted the deliberations this year on this issue by WG-EMM (Annex 4, paragraphs 3.21 to 3.44) and WG-FSA (Annex 5, paragraphs 10.3 to 10.109). It agreed to structure its discussion according to the structure of advice from WG-FSA, which was organised in response to the expectations by the Commission for advice on guidelines and the implementation of Conservation Measure 22-06.

Guidelines

4.210 The Scientific Committee considered the following in providing advice to the Commission according to its request in CCAMLR-XXVI, paragraphs 5.13 to 5.15.

4.211 The Scientific Committee agreed that a suitable test of the guidelines would be whether significant adverse impacts on VMEs would be avoided while the scientific advice and management approaches were developed and refined.

Identifying VMEs

4.212 The Scientific Committee noted the deliberations of WG-FSA on identifying VMEs (Annex 5, paragraphs 10.44 to 10.55).

4.213 Knowledge exists on the distribution and abundance of benthic taxa in the Southern Ocean in sufficient form to develop maps of the distribution of some types of taxa (Annex 5, paragraph 10.45 and 10.64). It was noted that there may be a large degree of endemism, particularly on seamounts (Annex 5, paragraphs 10.46 and 10.47). It was also noted that there may be other sources of data on the distribution of VMEs and VME taxa, including data from recent IPY and CAML voyages (Annex 5, paragraph 10.48). Nevertheless, the Scientific Committee agreed that the general distribution of VMEs in the Southern Ocean will need to be inferred using habitat models (Annex 5, paragraph 10.49). These could be used to develop risk-assessment maps for predicting the level of risk of impacting VMEs in different fishing locations.

4.214 The Scientific Committee agreed (Annex 5, paragraphs 10.50 and 10.65) that direct evidence of VMEs, if available, should be included in the development of risk-assessment maps and in identifying VMEs that need to be avoided. It was agreed that camera evidence is the most compelling for identifying VMEs but that evidence gathered by research sampling devices, such as beam trawls, sleds and grabs, would be very strong indications of the presence of VME taxa.

4.215 The Scientific Committee noted that fishing gears are likely to be poor sampling devices of VME taxa (Annex 5, paragraphs 10.51 and 10.66). The Scientific Committee agreed that the presence of VME taxa or indicators of VMEs in samples from any of these methods would be evidence that VMEs could be present. However, it also agreed that the converse of no VME taxa or indicators of VMEs in the samples did not necessarily represent an absence of VMEs. The degree to which this could be concluded would be dependent on the selectivity and sampling efficiencies of the gears.

4.216 The Scientific Committee noted the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries (Annex 5, paragraphs 10.52 and 10.67). Consequently, it agreed that, in the first instance, the risk-assessment map will need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs.

4.217 On the basis of advice from WG-FSA (Annex 5, paragraphs 10.54 and 10.68) and WG-EMM (Annex 4, paragraphs 3.31 to 3.33), the Scientific Committee agreed that it would be useful to hold an expert workshop to consider the issues surrounding bottom fisheries and the need to avoid significant adverse impacts on VMEs. It agreed that the terms of reference should be:

> Workshop on Vulnerable Marine Ecosystems with respect of CCAMLR Conservation Measure 22-06
>
> To provide guidance on the following questions that are necessary to reduce uncertainty on the potential for CCAMLR bottom fisheries for causing significant adverse impacts on VMEs, taking account of the commentaries by WG-FSA, WG-EMM and SC-CAMLR, and the development of definitions and concepts in the WG-FSA report in 2007 (SC-CAMLR-XXVI, Annex 5, paragraphs 14.4 to 14.6):

(i) What habitats and habitat-forming taxonomic groups and rare taxa would be consistent with a VME, including methods for assisting in identifying the extent of habitats based on distributions and densities of habitat-forming taxonomic groups?

- (a) What are the likely life-history attributes of indicative VME taxa in those VMEs and, as a result, the likely resilience and resistance of those VMEs to bottom fishing impacts; what is the potential vulnerability of those VMEs to different gear types?
- (b) What is the lowest level of taxonomic resolution that could be used to describe taxonomic groups consistent with, or indicative of, a VME?
- (c) What is the likely importance of VME taxa to fish assemblages and the degree to which fish diversity could be used as indicators of VMEs?

(ii) What methods could be used for identifying potential locations of vulnerable taxa?

(a) What data are available, such as in the SCAR MarBIN database, for identifying the location of VMEs?

(b) In the absence of direct observations of VMEs, how might maps be developed indicating where these VMEs are likely to be?

(c) To what degree might benthic taxa be limited in their distribution?

(iii) What indicators could be used by fishing vessels to signal when they are fishing on VMEs?

4.218 On behalf of the USA, Dr Holt offered to host the one-week workshop in the USA during the coming intersessional period. The Scientific Committee thanked the USA for this generous offer, noting that the USA will correspond with Members once a venue and appropriate time are determined.

4.219 Dr Jones and Dr K. Martin-Smith (Australia) were appointed by the Scientific Committee as Co-conveners of the workshop, encouraging them to correspond with Members to involve as many experts on Southern Ocean benthic ecology as possible. The Scientific Committee agreed that three experts should be invited to the workshop to help its work.

4.220 The Scientific Committee agreed that the work on identifying VMEs and understanding the risks to VMEs of impacts by bottom fishing activities could be separated as a task from consideration of mitigation measures and data collection plans (Annex 5, paragraphs 10.55 and 10.69). Consideration of VMEs and risk could be undertaken in WG-EMM, and the consideration of mitigation measures could be part of the work of WG-FSA.

Actions to be taken by fishing vessels encountering VMEs

4.221 The Scientific Committee noted the advice by WG-FSA on defining actions taken by vessels which may encounter evidence of VMEs during the course of fishing which are described further in sections relevant to the implementation of Conservation Measure 22-06 (Annex 5, paragraphs 10.70 to 10.109). This is further considered in paragraphs 4.244 to 4.253.

Advice on tasks in Conservation Measure 22-06

4.222 The Scientific Committee considered the following advice on tasks identified in Conservation Measure 22-06.

Advice on submissions by Members of preliminary assessments and proposed mitigation measures

4.223 In accordance with the requests of Conservation Measure 22-06, paragraph 7, the Scientific Committee noted the review by WG-FSA of the preliminary assessments and proposed mitigation measures submitted by Members proposing to participate in bottom fishing (Annex 5, paragraphs 10.24 to 10.28 and 10.72). The Scientific Committee noted that only five Member proposals out of the total of 12 proposals submitted by 11 Members contained preliminary assessments. As a consequence, the Scientific Committee was unable to review and advise on the potential impacts of all new and exploratory fishery proposals.

4.224 The Scientific Committee noted the preliminary assessments and mitigation measures proposed by Members, which were collated in CCAMLR-XXVII/26. It also noted the summary of data on benthos in the CCAMLR database provided by the Secretariat in that paper. The Scientific Committee reviewed the benthos by-catch reporting (C2 and observer data) from vessels that have been included in notifications for the 2008/09 exploratory fisheries. This analysis confirmed that there was insufficient data in the database to assess and review the potential impact on VMEs or possible mitigation requirements for exploratory fishery notifications that were not accompanied by preliminary assessments.

4.225 The Scientific Committee noted the large variation in substance of the preliminary assessments and agreed that a common approach is needed for providing these assessments, similar to the requirements for notifying exploratory fisheries (Annex 5, paragraphs 10.25 and 10.73). The Scientific Committee recommended that the Commission adopt the pro forma developed by WG-FSA (Annex 5, paragraphs 10.25 and 10.26) and provided in Table 20 of Annex 5 as a suitable standard for Members submitting preliminary assessments of the potential for their proposed bottom fishing activities to have significant adverse impacts on VMEs. The pro forma is designed to be consistent with the requirements for proposals on exploratory fisheries and is based on the requirements set out in paragraphs 7(i) and (ii) in Conservation Measure 22-06.

Advice on procedures and standards for assessing potential effects of proposals and possible mitigation measures

4.226 The Scientific Committee noted that it is tasked to review, refine and, as needed, develop procedures and standards for assessing potential effects of proposals and possible mitigation measures (Conservation Measure 22-06, paragraph 7(iii)). The Scientific Committee noted that WG-FSA advised on three types of procedures and approaches:

(i) the magnitude of the existing footprint of bottom fisheries relevant to Conservation Measure 22-06 and the possible impacts that such a footprint may have had on VMEs (Annex 5, paragraphs 10.9 to 10.23);

(ii) the risk of past and future bottom fishing activities contributing to significant adverse impacts on VMEs (Annex 5, paragraphs 10.29 to 10.31, 10.49 and 10.50);

(iii) approaches to the development of mitigation measures for vessels (Annex 5, paragraphs 10.32 to 10.43).

Existing footprint of bottom fisheries

4.227 The Scientific Committee noted the updated maps provided by WG-FSA on the historical footprint of bottom fisheries with respect to Conservation Measure 22-06 (Annex 5, paragraph 10.17 and Figure 7).

4.228 The Scientific Committee agreed that most attention on evaluating potential impacts of bottom fishing on VMEs needs to be given to locations with the most fishing effort relative to seabed area (Annex 5, paragraph 10.76). It also recognised the need to distinguish between effort in shallow areas compared to deeper areas, which has only been undertaken for some areas of East Antarctica, including BANZARE Bank. It endorsed the method of WG-FSA in calculating potential proportions of seabed areas that may have been affected by longlines (Annex 5, paragraphs 10.9 to 10.12, 10.18 and 10.19) using a low and high value for the estimated width of the area affected by an individual longline – 1 m and 25 m. It also endorsed the recommendation of WG-FSA to update seabed area information for the three depth strata from reliable sources for all SSRUs (Annex 5, paragraph 10.20) for these calculations in the future, noting that 550 m depth should be used in place of 600 m depth in demarcating depth strata.

4.229 The Scientific Committee noted the results (Annex 5, Table 18) remain at a coarse resolution relative to the scale of VMEs considered by WG-FSA (Annex 5, paragraph 10.83). At the broad scale, these calculations indicate that up to 3–4% of the overall fishable area may have been affected on the seamounts in the north of the Ross Sea in SSRUs 881B and C over the last 10 years. It also noted that these data could be used to assess the possible contributions to impacts in different areas of proposed fishing activities (Annex 5, paragraph 10.80). However, the calculations do not consider VMEs in the actual areas fished as shown in Annex 5, Figure 7, and there is insufficient information on the areas proposed to be fished in the coming exploratory fisheries to advise on how they might contribute to impacts on VMEs. The Scientific Committee noted the general points surrounding these methods, including that such analyses will need to take account of the potential for lines to be overlapping, the degree of impact within the footprint is difficult to ascertain because of the absence of empirical data on the effects of the different types of longlines on benthic habitats and VME-taxa, and observed by-catch from longlines may not be a good indicator of interactions of longlines with VMEs. These points are elaborated in detail in Annex 5, paragraph 10.22.

4.230 The Scientific Committee noted that reducing the uncertainty in evaluations of accumulated impacts and the potential for proposed fishing activities to contribute to future impacts will be dependent on improving methods for assessing footprints coupled with the developing assessments of risk in different areas (Annex 5, paragraph 10.82).

4.231 The Scientific Committee noted the likely differences in habitat types and biodiversity between the following locations:

(i) near-shore waters surrounding Antarctica, in depths less than 200 m
(ii) shelf and bank areas down to 550 m
(iii) slope areas down to 1 500 m
(iv) areas deeper than 1 500 m.

In this respect, the Scientific Committee noted that research activities in shallow embayments might also impact VMEs either by sampling with commercial-size gear or accumulating the impacts of small trawling equipment. It was also noted that both of these circumstances are not currently covered by Conservation Measures 22-06 and 24-01. It agreed that it would be useful to consider further how to approach this issue at the Joint SC-CAMLR–CEP Workshop in 2009. For example, some consideration might be given as to whether there should be research limits on the total amount of research trawling that would be allowed in some areas.

Risk-assessment approaches

4.232 The Scientific Committee agreed that a risk-assessment approach similar to that used by WG-IMAF would be valuable and that the method considered by WG-FSA could be developed further in this regard (Annex 5, paragraphs 10.29 and 10.30). It noted that the risk of significant adverse impacts should be evaluated at spatial scales commensurate with the scale of VMEs, i.e. much smaller spatial resolution than that considered by WG-IMAF. The important elements of a risk assessment would include, *inter alia*, the following concepts:

(i) Not all areas are equal with regard to probability of encounters with, or impacts to, a VME but information needed to assess such probabilities is very limited.

(ii) Models of likely habitat can be developed based on geomorphological, oceanographic and other environmental data and relating these to observations of where different VME taxa might be found. Observations can include direct observations (using videos, benthic sampling equipment) or indirect observations such as by-catch from fisheries.

(iii) An appropriate scale for characterising risk would be 0.5° latitude and 1.0° longitude, consistent with CCAMLR fine-scale areas.

(iv) different areas will have different risks, e.g. higher-risk areas might be seamounts, heads of canyons and depths shallower than 550 m.

(v) There will be different requirements for data collection, research and mitigation for different levels of risk and different gear types.

(vi) The assignment of risk would need to be reviewed as new information becomes available.

4.233 The Scientific Committee noted the work on a risk-assessment framework in WG-EMM (Annex 4, paragraphs 3.22 to 3.29) and WG-FSA (Annex 5, paragraphs 10.29 and 10.30). It also noted that WG-FSA was unable to develop a risk-assessment map for use in providing advice this year on the possible effects of proposed fishing activities. It agreed that the approach should be developed further for the next meeting of WG-FSA (Annex 5, paragraph 10.84). It also agreed that direct evidence of VMEs should be included, when available, in the development of risk-assessment maps and in identifying VMEs that need to be avoided (Annex 5, paragraph 10.50). However, the Scientific Committee also noted the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries (Annex 5, paragraph 10.52). Consequently, it agreed that, in the first instance, the risk-assessment map will need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs, which will be facilitated by the workshop above (paragraph 4.217).

Mitigation measures

4.234 The Scientific Committee noted that mitigation measures include area closures prior to a fishing season as well as management of encounters of VMEs by vessels. It continued its discussions on the latter issue when considering advice on practices when evidence of VMEs is encountered (paragraphs 4.244 to 4.253).

4.235 The Scientific Committee noted that fishing is prohibited in all areas shallower than 550 m in Divisions 58.4.1 and 58.4.2 (Conservation Measures 41-04 and 41-05) because of the higher risk to benthic habitats (Annex 5, paragraph 10.83(iv)). In respect of the objectives in Conservation Measure 22-06, the Scientific Committee agreed that a prohibition on fishing shallower than 550 m should be more generally applied to bottom fisheries covered by Conservation Measure 22-06. The Scientific Committee noted that, notwithstanding this advice, specific provision may need to be given to a crab fishery using pots as proposed for an exploratory fishery for 2008/09 (CCAMLR-XXVII/20). This is because the experimental harvest regime agreed by WG-FSA (Annex 5, paragraphs 5.13 and 5.14) may be impacted by such a prohibition. The Scientific Committee agreed that if pot fishing occurs in Subarea 48.2, then it would need gear-specific mitigation requirements in order to enable exploratory activities on shelf areas (see paragraph 4.231).

Advice on the occurrence of VMEs

4.236 The Scientific Committee noted the advice of WG-FSA (Annex 5, paragraphs 10.63 to 10.69 and 10.96 to 10.100) and WG-EMM (Annex 4, paragraphs 3.21 to 3.38) on identifying VMEs for consideration in the requirement in Conservation Measure 22-06, paragraph 12.

4.237 The Scientific Committee noted that data were available in CCAMLR-XXVII/26 to review locations of catches of VME taxa but noted the issues of quality and quantity of those data (paragraph 4.224).

4.238 The Scientific Committee noted the submission of notifications of VMEs in Division 58.4.1 (SC-CAMLR-XXVII/13). It noted the review by WG-EMM of an earlier draft of the notification (Annex 4, paragraphs 3.34 to 3.38) and the review by WG-FSA (Annex 5, paragraphs 10.56, 10.57 and 10.98). It endorsed the view of WG-FSA that these were obvious cases of VMEs, with clear evidence of biodiversity-rich benthic communities.

4.239 The Scientific Committee endorsed the draft VME notification form developed by the Secretariat on the basis of the requirements in Conservation Measure 22-06 and tabular notification in SC-CAMLR-XXVII/13 (Annex 5, paragraphs 10.58, 10.59 and 10.99). It was designed in such a way that it could be submitted by Members as part of the 5-day reporting system during fishing operations but could also be used by Members undertaking research activities. The Scientific Committee recommended that it be used as the means of notifying the Secretariat when evidence of VMEs is encountered.

4.240 The Scientific Committee noted the request of WG-FSA to consider the method by which these notifications would be reviewed and the process for adding a VME to the Register of VMEs. The Scientific Committee noted that the latter process would need to be considered by the Commission. With respect to the method for reviewing notifications, the Scientific Committee noted that the notifications in SC-CAMLR-XXVII/13 had been reviewed by both WG-EMM and WG-FSA. It noted that such notifications only need to be reviewed by WG-EMM, following the division of responsibilities considered below (paragraph 4.268; Annex 5, paragraph 10.55).

4.241 The Scientific Committee noted that the requirements for protecting VMEs may change as more information becomes available, including data on the spatial extent of VMEs, and their vulnerability to fishing.

Advice on known and anticipated impacts

4.242 The Scientific Committee noted that WG-FSA was unable to provide advice this year on actual or potential encounters with VMEs by exploratory longline fishing (Annex 5, paragraphs 10.101 and 10.102), including no advice on known and anticipated impacts, but that some depth strata in some SSRUs may have experienced higher levels of interactions with bottom fishing gear than other areas in Subarea 88.1 (Annex 5, Table 18). The Scientific Committee recommended that this be further reviewed next year.

4.243 The Scientific Committee endorsed the recommendation of WG-FSA that a report akin to the Fishery Reports on ‘Bottom Fisheries and Vulnerable Marine Ecosystems’ be developed for collating the available knowledge on VMEs, the potential for significant adverse impacts, risk assessments and potential for impacts arising from bottom fisheries (Annex 5, paragraph 10.103). It requested that a template for that report be developed at the workshop (paragraph 4.217) and reviewed by WG-FSA and WG-EMM, including consideration of how such a report will be compiled and updated. It noted that, once established, the substance of the report could be separated into the relevant fishery reports.

Advice on practices when evidence of VMEs is encountered

4.244 In considering approaches to the development of mitigation measures and practices when evidence of VMEs is encountered, the Scientific Committee noted that these approaches could be naturally divided into three main classes of action – activities by observers, responses of vessels and reporting requirements (Annex 5, paragraph 10.32).

4.245 The Scientific Committee agreed that observations of benthic by-catch will be important in the coming year and endorsed the recommendation of WG-FSA that the measurements identified by WG-FSA (Annex 5, paragraphs 10.33 and 10.88) should be taken in the coming year. The Scientific Committee also endorsed the view of WG-FSA that it would be desirable for observers to obtain information on the operations of the gear and for developing monitoring protocols. However, given the high workloads of observers, these were considered to be lower priorities for the coming year (Annex 5, paragraph 10.34).

4.246 The Scientific Committee noted the consideration by WG-FSA of how vessels should respond to evidence of VMEs (Annex 5, paragraphs 10.36 to 10.40 and 10.89). The Scientific Committee also noted the consideration by WG-FSA on the reporting of encounters of fishing vessels with VMEs (Annex 5, paragraph 10.90).

4.247 The Scientific Committee noted the proposed mitigation measures and responses to encounters with VMEs from the preliminary assessments in Annex 5, Table 21. It noted the features for mitigation in these proposals were, collectively:

(i) evidence of a VME would be measured as a general quantity that could be easily determined by a vessel;

(ii) the Secretariat will need to be notified of encounters;

(iii) an area, including an appropriate buffer to account for uncertainty in location, surrounding the encounter needs to be determined for additional management of vessel and/or fleet operations;

(iv) effort in such locations should be limited.

4.248 The Scientific Committee noted that a difficulty in the discussion was resolving the tension between protecting VMEs from significant adverse impacts and obtaining the information on whether those impacts are arising or have arisen. Under such circumstances, a strategy for avoiding significant adverse impacts on VMEs, such as through identifying areas that need to be avoided, will need to be developed taking account of the issues in the report of WG-FSA, paragraph 10.38 (Annex 5, paragraph 10.91).

4.249 The Scientific Committee noted the observation by WG-FSA that continuing to fish in areas for which by-catch evidence indicates a possibility of interactions with a VME is contradictory to trying to protect VMEs from significant adverse impacts. Also, continuing such fishing in an area where evidence of a VME has been found may be contrary to Conservation Measure 22-06, paragraph 8 (Annex 5, paragraph 10.93).

4.250 The Scientific Committee recognised this conundrum (Annex 5, paragraph 10.40). It also noted that WG-FSA could not calculate the level of evidence of VMEs to trigger actions for the different vessels at its meeting this year and that WG-FSA agreed full compliance in providing data on benthos by-catch will be important in order to determine vessel-specific recommendations on trigger levels. An alternative strategy to vessel-specific trigger levels would be to identify areas that need to be avoided by all vessels (see Annex 5, paragraph 10.94).

4.251 The Scientific Committee agreed that it would be useful to undertake simulations of different management approaches to evaluate which avoidance/research approaches may be most useful in avoiding significant adverse impacts to VMEs when there is no information on which to judge a suitable approach, and requested Members to submit such simulations to WG-SAM for review and then to WG-FSA for consideration of the results.

4.252 In further considering the practices that could be recommended for the coming season, the Scientific Committee noted the following issues:

(i) the need to develop an approach that could be administered by vessels without relying on observers, including notifications of encounters to the Secretariat;

(ii) the need to limit effort in areas with VMEs but with some provision for research activities to provide data for review by the Scientific Committee and its working groups, noting that the approach should not lead to inadvertent significant adverse impacts on a VME;

(iii) some comparisons of benthos by-catch between vessels in similar areas could be helpful;

(iv) mechanisms for managing interaction should occur across the fleet, for example, areas identified as potentially having a VME should be given protection from the whole fleet rather than it being vessel-specific;

(v) a general approach should be developed that would be used by all vessels but with specific variations for different gear types where needed;

(vi) measures for this year would be reviewed next year based on the results of the 2008/09 season.

4.253 The Scientific Committee agreed practices for the coming season can be considered in five parts:

(i) identification by a vessel of a possible encounter during fishing operations
(ii) observation requirements
(iii) declaration of a Risk-Area
(iv) management actions
(v) review.

Identification by a vessel of a possible encounter during fishing operations

4.254 The Scientific Committee agreed that it should be the vessel's responsibility to record and notify evidence of a possible encounter with a VME. It also agreed the following on how such evidence could best be accumulated:

(i) longlines would be divided into segments containing 1 000 hooks or 1 200 m, whichever is the shorter length of line, and pot lines would be divided into 1 200 m segments. These segments become the monitoring and encounter units for both longlines and pots respectively;

(ii) at this stage, a potential interaction would best be measured by an accumulated volume of all sessile invertebrates as described on the New Zealand poster (WG-FSA-08/19);

(iii) for branching species, such as corals, which may not be easy to fit into a volume measurement, an equivalent weight to add to the volume of other material could be 1 kg corresponding to 1 litre;

(iv) all line segments should be monitored for benthos.

4.255 With respect of the use of volume and weights which are to indicate possible encounters, the Scientific Committee noted that a taxon-specific approach may be needed in the future. This is because of the possible need to take account of rare, small or susceptible species, particularly if those taxa are easily affected by longlines but have a low likelihood of being landed. It requested that the workshop advise on this issue.

4.256 The Scientific Committee agreed on the need for clear terminology and definitions for determining actions to be taken by vessels. The following terms were agreed:

(i) VME-indicator-unit
Either one litre of sessile taxa (paragraph 4.254(ii)) that can be placed in a bucket, or, for taxa covered under paragraph 4.254(iii) (branching species that may not easily fit into a volume measurement), one kilogram.

(ii) VME-evidence
In the interim of further advice on such evidence, a combined measure of at least 10 VME-indicator-units of sessile taxa (paragraph 4.254(ii)) recovered over a given section of line would be evidence of a possible encounter with a VME.

(iii) Risk-Area
An area around the location where the VME-evidence is recovered should be designated as an area where a VME may occur and would be potentially at risk from continued fishing until such time as the VME-evidence and other data on the area were reviewed and management actions determined.

4.257 The Scientific Committee noted that the quantity of 10 VME-indicator-units to be used as VME-evidence was derived from the data and experience from fishing in the Ross Sea and the Indian Ocean. This formed the basis of information in CCAMLR-XXVII/26. The Scientific Committee agreed that this is a useful foundation for determining the VME-indicator-units quantity this year. It noted that data from the coming season would be useful for advising on VME-evidence in the future.

4.258 The Scientific Committee agreed that if the VME-evidence is recovered within one line segment, then the location of that segment should be regarded as a Risk-Area in need of interim protection from fishing for the remainder of the season.

4.259 The Scientific Committee agreed that when VME-evidence is recovered, the vessel should immediately notify the Secretariat and Flag State of the location of the segment(s) in which that evidence was encountered.

4.260 The Scientific Committee noted that the designation of Risk-Areas according to accumulating VME-evidence in a single line segment may not alone provide protection to VMEs for which evidence may be split between line segments or be accumulated at close to the trigger level in each of a number of consecutive line segments. It was agreed that these scenarios of interactions with VMEs were possible but the Scientific Committee could not agree on strategies that might be used to determine when those VMEs could be designated as Risk-Areas. The Scientific Committee noted that VME-evidence accumulated over consecutive line segments could be used to designate a Risk-Area around those consecutive line segments.

Observation requirements

4.261 The Scientific Committee agreed that observers should be asked to do the following:

(i) during 'tally period', observer to note benthos coming to the surface;

(ii) on an encounter, observers review the benthos recovered for taxonomic detail (New Zealand poster, WG-FSA-08/19);

(iii) routine examination of any other material accumulated by the vessel outside the tally period;

(iv) all material reviewed by the observer should have an approximate location (at least to the resolution of that line segment).

Declaration of a Risk-Area

4.262 The Scientific Committee agreed that a buffer of 1 n mile around the segment(s) in which the evidence was obtained would be appropriate for determining the size of a Risk-Area, in order to allow for further data to be collected in the vicinity.

4.263 The Scientific Committee agreed that for a Risk-Area defined by a single line segment the location could be easily managed by a vessel if there was a mid-point of the segment used with a radius of protection of 1 n mile. This could be managed as an area of avoidance using a way point in a vessel's navigation system. The Scientific Committee noted that this approach will include adjacent segments in a Risk-Area.

4.264 The Scientific Committee noted that the approach described in paragraph 4.263 may not provide the protection needed if the VME extended over a number of miles as described in SC-CAMLR-XXVII/13 and, for example, the segment in which the VME-evidence was obtained were to intersect it at its periphery.

4.265 The Scientific Committee noted that the usual buffer in existing CCAMLR by-catch conservation measures was 5 n miles. However, it was noted this buffer had previously been applied to motile species, whereas VMEs were, at present, considered primarily on the basis of sessile and sedentary biota. The Scientific Committee noted that 5 n miles was used as the buffer in the recent measure on bottom fishing by the European Council in its Regulation No. 734/2008.

Management actions

4.266 The Scientific Committee agreed that the VME-indicator-units of benthos by-catch should be reported by the vessel for each segment of the line as defined above.

4.267 The Scientific Committee agreed that the vessel should immediately cease setting lines intersecting with a Risk-Area. The fleet should immediately cease setting lines intersecting with the Risk-Area after notification by Secretariat, which needs to occur within 24 hours of receiving a report of a VME-encounter.

Review

4.268 The Scientific Committee agreed that WG-FSA should be tasked to review the observer and vessel data at its next meeting and provide further advice on mitigation measures and practices when evidence of VMEs is encountered, taking account of the results of the workshop.

General

4.269 The Scientific Committee noted that:

(i) interim arrangements will need to be used in this coming year while further advice is developed and, thus, the system may not be perfect but will need to be sufficiently precautionary;

(ii) management and mitigation approaches agreed in other fora could be considered (European Community, NAFO).

Advice on other mitigation measures

4.270 With respect to Conservation Measure 22-06, paragraph 7(iii), the Scientific Committee has no further advice on other mitigation measures.

Advice on research and data collection plans

4.271 With respect to research and data collection plans for bottom fisheries under Conservation Measure 22-06, the Scientific Committee endorsed the view of WG-FSA (Annex 5, paragraph 10.106) that whatever strategy is adopted for the coming year, it will be important to collect as much benthos by-catch data as possible for analysis next year. It also agreed that experience of WG-IMAF showed the following to be important in combating the incidental mortality of seabirds in fisheries and will be relevant to avoiding significant adverse impacts on VMEs:

(i) education of the crews of vessels participating in exploratory bottom fisheries will help increase awareness of the value of VMEs, in terms of their marine biodiversity and as habitat to fish assemblages, and the importance of developing mitigation measures to avoid impacts on them;

(ii) continued development of methods to reduce the frequency of gear loss that could impact on VMEs.

4.272 The Scientific Committee endorsed the agreement of WG-FSA that it would be useful for observers to provide information on the following (Annex 5, paragraphs 10.33 and 10.107):

(i) the locations and types of taxa being landed, where identification should be at least to the level of morphotypes provided in the poster developed by New Zealand;

(ii) the numbers and, where possible, total mass of each taxon being landed;

(iii) information on the likely geographic origin of the taxa – noting that observations by hook or by magazine could be related to the geographic position of the line on the substratum, although this may require an observer to be provided with a hand-held GPS to note the position of the vessel when a taxon is landed;

(iv) in the future, an increase in the level of detail may be triggered by catches of specific types of taxa but it was recognised that for the near future records should be maintained of all landed taxa and that information by observers should be as complete as possible for the periods of observation.

4.273 The Scientific Committee noted the need to improve reporting of benthic by-catch in order for such data to be useful for analyses of the interaction of bottom fishing activities with VMEs.

Advice to the Commission

4.274 With respect to the development of guidelines on identifying VMEs and on actions to be taken by fishing vessels encountering VMEs (CCAMLR-XXVI, paragraphs 5.13 to 5.15), the Scientific Committee requested the Commission to:

(i) note:

(a) a suitable test of the guidelines would be whether significant adverse impacts on VMEs would be avoided while the scientific advice and management approaches were developed and refined (paragraph 4.211);

(b) the progress made by WG-FSA on methods and approaches for identifying VMEs (paragraphs 4.212 to 4.214);

(c) fishing gears are likely to be poor sampling devices of VME taxa. The presence of VME taxa or indicators of VMEs in samples from any of these methods would be evidence that VMEs could be present. However, the converse of no VME taxa or indicators of VMEs in the samples did not necessarily represent an absence of VMEs. The degree to which this could be concluded would be dependent on the selectivity and sampling efficiencies of the gears (paragraph 4.215);

(d) the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries (paragraph 4.216);

(e) advice on defining actions taken by vessels which may encounter evidence of VMEs during the course of fishing are described in sections relevant to the implementation of Conservation Measure 22-06;

(ii) endorse:

(a) an expert Workshop on Vulnerable Marine Ecosystems with respect of CCAMLR Conservation Measure 22-06 to provide guidance on the questions necessary to reduce uncertainty on the potential for CCAMLR bottom fisheries for causing significant adverse impacts on VMEs, taking account of the commentaries by WG-FSA, WG-EMM and SC-CAMLR, and the development of definitions and concepts in the WG-FSA report in 2007 (SC-CAMLR-XXVI, Annex 5, paragraphs 14.4 to 14.6) (paragraphs 4.217 to 4.219);

(iii) agree:

(a) that the general distribution of VMEs in the Southern Ocean will need to be inferred using habitat models (paragraph 4.213), which can then be used to develop risk-assessment maps for predicting the level of risk of impacting VMEs in different fishing locations. In the first instance, the risk-assessment map will therefore need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs.

4.275 The Scientific Committee considered the following advice on tasks identified in Conservation Measure 22-06.

4.276 With respect to advice on submissions by Members of preliminary assessments and proposed mitigation measures, the Scientific Committee recommended the Commission to:

(i) note:

(a) only five Members out of the 11 Members that submitted a total of 12 proposals contained preliminary assessments (paragraph 4.223). As a consequence, the Scientific Committee was unable to review and advise on the potential impacts of all new and exploratory fishery proposals;

(b) insufficient data were available in the CCAMLR database to assess and review the potential impact on VMEs or possible mitigation requirements for exploratory fishery notifications that were not accompanied by preliminary assessments (paragraph 4.224);

(c) the large variation in substance of the preliminary assessments and that a common approach is needed for providing these assessments, similar to the requirements for notifying exploratory fisheries (paragraph 4.225);

(ii) adopt:

(a) the pro forma in Table 20 of Annex 5 as a suitable standard for Members submitting preliminary assessments of the potential for their proposed bottom fishing activities to have significant adverse impacts on VMEs. The pro forma is designed to be consistent with the requirements for proposals on exploratory fisheries and is based on the requirements set out in paragraphs 7(i) and (ii) in Conservation Measure 22-06 (paragraph 4.225).

4.277 With respect to advice on procedures and standards for assessing potential effects of proposals and possible mitigation measures, the Scientific Committee recommended the Commission to:

(i) note:

(a) discussion and analyses of the magnitude of the existing footprint of bottom fisheries relevant to Conservation Measure 22-06 and the possible impacts that such a footprint may have had on VMEs (paragraphs 4.226 to 4.230);

(b) discussions on assessing risks of past and future bottom fishing activities contributing to significant adverse impacts on VMEs (paragraphs 4.232 and 4.233);

(c) discussions on the development of mitigation measures not related to advice on practices when evidence of VMEs is encountered (paragraphs 4.234 and 4.235);

(ii) endorse:

(a) the development of a risk-assessment framework and risk-assessment maps for indicating the risks of significant adverse impacts from bottom fisheries in the CAMLR Convention Area under Conservation Measure 22-06 (paragraphs 4.232 and 4.233), where the spatial resolution of such maps would be at a scale commensurate with the expected extent of VMEs rather than at the level of management areas;

(iii) agree:

(a) that a prohibition on bottom fishing shallower than 550 m should be more generally applied to bottom fisheries covered by Conservation

Measure 22-06, as is currently applied in Divisions 58.4.1 and 58.4.2 (paragraph 4.235) but noting that specific provision will need to be given to a crab fishery using pots as proposed for an exploratory fishery for 2008/09 (paragraph 4.235);

(iv) provide advice on:

(a) what it might consider to be most useful from analyses of the magnitude of the existing footprint of bottom fisheries relevant to Conservation Measure 22-06 (paragraphs 4.227 to 4.231).

4.278 With respect to advice on the occurrence of VMEs, the Scientific Committee recommended the Commission to:

(i) note:

(a) the discussion on the occurrence of VMEs (paragraphs 4.236 to 4.241);

(b) that the requirements for protecting VMEs may change as more information becomes available, including data on the spatial extent of VMEs, and their vulnerability to fishing (paragraph 4.241);

(ii) endorse:

(a) the review process for notifications of VMEs and that a notification be reviewed by WG-EMM before consideration by the Scientific Committee (paragraph 4.240);

(iii) agree:

(a) that the areas notified in SC-CAMLR-XXVII/13 in Division 58.4.1 are VMEs with clear evidence of biodiversity-rich benthic communities (paragraph 4.238);

(iv) adopt:

(a) the draft notification form for Members to notify the Secretariat when evidence of VMEs is encountered (paragraph 4.239).

4.279 With respect to advice on known and anticipated impacts, the Scientific Committee recommended the Commission to:

(i) note:

(a) consideration of known and anticipated impacts (paragraphs 4.242 and 4.243);

(ii) endorse:

(a) further work on assessing known and anticipated impacts of bottom fishing activities under Conservation Measure 22-06 (paragraph 4.242);

(b) the development of a report akin to the Fishery Reports on ‘Bottom Fisheries and Vulnerable Marine Ecosystems’ by collating the available knowledge on VMEs, the potential for significant adverse impacts, risk assessments and potential for impacts arising from bottom fisheries (paragraph 4.243).

4.280 The Scientific Committee wished to advise the Commission that, in the absence of (i) direct observations of impacts by fishing gear, (ii) censuses of the distribution and abundance of benthic habitats, and (iii) evaluation of the ecological consequences of the effects of fishing on those habitats and critical ecological processes, a precautionary strategy will need to be adopted that will successfully avoid significant adverse impacts on VMEs in the interim of impact assessments being completed and long-term mitigation strategies being developed. The Scientific Committee also noted the following issues need to be considered in formulating such a strategy:

(i) Many VME taxa are expected to be sessile, slow growing and long-lived, which means that if such taxa are depleted they are unlikely to recover in two to three decades as required in Article II. Therefore, escapement of VME taxa in space is an important consideration in maintaining viable VMEs.

(ii) Precautionary strategies need to be adopted to avoid significant adverse impacts on VMEs and VME taxa that are restricted in their distribution, such as, for example, locally endemic taxa.

(iii) Consistent with the precautionary approach, controlled acquisition of data will be needed.

(iv) A single fishing event is unlikely to cause significant adverse impacts on VMEs, but cumulative effects between assessments and management decisions could give rise to significant adverse impacts. Strategies are needed to limit cumulative effects between assessments as it will ultimately be a single fishing event that will cause the significant adverse impact in the course of a fishing period between assessments.

(v) Interim strategies could include:

  (a) large-scale closures of areas with a reasonable likelihood of including representative VMEs;

  (b) small-scale closures of areas on the basis of a limited by-catch of benthos during fishing operations, noting that benthos affected by longline systems may not be well represented in landed by-catch;

  (c) temporary closures of areas as in (b) while research is undertaken to establish the spatial extent of habitats and VMEs.

(vi) Without appropriate knowledge, it will be very difficult to predict when the effects of bottom fishing will have accumulated to cause significant adverse impacts on VMEs. Under such circumstances, significant adverse impacts may not be detected until after such impacts have obviously occurred.

(vii) If bottom fishing activities must overlap significantly with areas in which VMEs occur because of the distribution of fish, then the escapement of VMEs may need to be greater than expected. This is because of the need to allow for inadvertent impacts on VMEs, which could accumulate to cause significant adverse impacts.

4.281 With respect to advice on practices when evidence of VMEs is encountered, the Scientific Committee recommended the Commission to:

(i) note:

(a) its discussion on approaches to the development of mitigation measures and practices when evidence of VMEs is encountered (paragraphs 4.244 to 4.260);

(b) the conundrum between protecting VMEs from significant adverse impacts and obtaining the information on whether those impacts are arising or have arisen and that continuing to fish in areas for which by-catch evidence indicates a possibility of interactions with a VME is contradictory to trying to protect VMEs from significant adverse impacts and may be contrary to Conservation Measure 22-06, paragraph 8 (paragraphs 4.248 to 4.250);

(c) that it would be useful to undertake simulations of different management approaches to evaluate which avoidance/research approaches may be most useful in avoiding significant adverse impacts to VMEs when there is no information on which to judge a suitable approach and requested Members submit such simulations to WG-SAM for review and then to WG-FSA for consideration of the results (paragraph 4.251);

(d) consideration by the Scientific Committee of advice for the 2008/09 season on specific practices when evidence of VMEs is encountered during bottom fishing activities (paragraphs 4.252 to 4.268);

(e) interim arrangements will need to be used in the coming year while further advice is developed (paragraph 4.269);

(f) management and mitigation approaches agreed in other fora could be considered (European Community, NAFO) (paragraph 4.269);

(ii) endorse:

(a) the collection of benthos by-catch data by observers, including specific requirements for the coming year (paragraph 4.261), to facilitate analyses on VMEs and the effects of bottom fishing next year (paragraph 4.245);

(b) the definitions for VME-indicator-units, VME-evidence and Risk-Areas for use in determining what actions fishing vessels might take when evidence of a possible encounter with a VME occurs (paragraph 4.254 to 4.257);

(c) that WG-FSA be tasked to review the observer and vessel data at its next meeting and provide further advice on mitigation measures and practices when evidence of VMEs is encountered, taking account of the results of the workshop;

(iii) agree:

(a) that a vessel will be responsible for recording and reporting benthos by-catch, monitoring for VME-evidence and for notifying the Secretariat and Flag State of a possible encounter with a VME based on the VME-evidence (paragraphs 4.254, 4.255 and 4.266);

(b) on the method by which VME-evidence would be accumulated using segments of lines as monitoring units and that all segments should be monitored for benthos by-catch (paragraph 4.254);

(c) on what will constitute a Risk-Area and its management in 2008/09, taking account of the Scientific Committee's:

- agreement that if the VME-evidence is recovered within one line segment, then the location of that segment should be regarded as a Risk-Area in need of interim protection from fishing for the remainder of the season (paragraph 4.258);

- agreement that when VME-evidence is recovered, the vessel should immediately notify the Secretariat and Flag State of the location of the segment(s) in which that evidence was encountered (paragraph 4.259);

- note that the designation of Risk-Areas according to accumulating VME-evidence in a single line segment may not alone provide protection to VMEs for which evidence may be split between line segments or be accumulated at close to the trigger level in each of a number of consecutive line segments and that VME-evidence accumulated over consecutive line segments could be used to designate a Risk-Area around those consecutive line segments (paragraph 4.260);

- consideration and agreements on what would be required to declare a Risk-Area, including the designation of buffer zone (paragraphs 4.262 to 4.265);

- note that vessels should immediately cease setting lines intersecting with a Risk-Area and the fleet should immediately cease setting lines intersecting with the Risk-Area after notification by Secretariat, which needs to occur within 24 hours of receiving a report of a VME-encounter (paragraph 4.267).

4.282 The Scientific Committee has no advice for the Commission on other mitigation measures (paragraph 4.270).

4.283 With respect to advice on research and data collection plans, the Scientific Committee recommended the Commission to:

(i) note:

(a) that whatever strategy is adopted for the coming year, it will be important to collect as much benthos by-catch data as possible for analysis next year (paragraph 4.271);

(b) that experience of WG-IMAF showed the following to be important in combating the incidental mortality of seabirds in fisheries and that it will be relevant to avoiding significant adverse impacts on VMEs (paragraph 4.271):

- education of the crews of vessels participating in exploratory bottom fisheries will help increase awareness of the value of VMEs, in terms of their marine biodiversity and as habitat to fish assemblages, and the importance of developing mitigation measures to avoid impacts on them;

- continued development of methods to reduce the frequency of gear loss that could impact on VMEs;

(ii) endorse:

(a) the data to be collected by observers (paragraph 4.272);

(iii) agree:

(a) on the need to improve and take action to ensure reporting of benthic by-catch is useful for analyses of the interaction of bottom fishing activities with VMEs (paragraph 4.273).

4.284 The Scientific Committee noted that paragraphs 2 and 4 of Conservation Measure 22-05 could be deleted as they were no longer relevant.

INCIDENTAL MORTALITY

5.1 The Scientific Committee reviewed the report of WG-IMAF (Annex 6). It endorsed the report and its conclusions, and the plan of intersessional work (Annex 6, Table 1) subject to the comments set out below.

5.2 The Scientific Committee invited Members to review participation in WG-IMAF and to facilitate attendance of their representatives at meetings, especially technical coordinators and Members engaged in fishing activities in, or adjacent to, the Convention Area who have not recently participated in WG-IMAF (Annex 6, paragraph 1.10).

Incidental mortality of seabirds and marine mammals in fisheries in the Convention Area in 2007/08

5.3 The Scientific Committee noted that:

(i) the total extrapolated seabird mortalities due to interactions with fishing gear during longline fishing for *Dissostichus* spp. in the Convention Area in 2007/08 was estimated to be 1 355 petrels (91% white-chinned petrels, 7% grey petrels and 2% *Macronectes* species). All these estimated mortalities were from within the French EEZs, with 131 seabirds in Subarea 58.6 and 1 244 in Division 58.5.1 (Annex 6, paragraphs 2.3 and 2.4);

(ii) this is the third consecutive year that no albatrosses were observed captured in longline fisheries in the Convention Area and the second consecutive year that the only incidental mortality of seabirds observed captured in longline fisheries in the Convention Area was from the French EEZs;

(iii) a total of five seabird mortalities (three white-chinned petrels and two king penguins) were reported during trawling for finfish in the Convention Area, all occurring in the icefish fishery in Subarea 48.3. No seabird mortalities were reported during trawling for krill or during pot fishing (Annex 6, paragraphs 2.13, 2.18, 2.19 and 2.22);

(iv) nine seal mortalities were recorded in the Convention Area during the 2007/08 season (WG-FSA-08/5 Rev. 1, paragraph 5) comprising two Antarctic fur seals and one crabeater seal in the longline fishery and five Antarctic fur seals and one unidentified seal in the trawl fishery (Annex 6, paragraphs 2.23 to 2.26).

5.4 The Scientific Committee referred information to SCIC on those vessels that did not fully implement Conservation Measures 26-01, 25-02 and 25-03 (Annex 6, paragraph 2.49).

5.5 The Scientific Committee recommended that Members actively circulate the CCAMLR poster to educate fishers about the need to avoid discarding of hooks in offal, and (when developed) the CCAMLR marine debris poster (Annex 6, paragraph 2.54), to their fishers operating in areas where Convention Area seabirds and marine mammals occur, and ensure display of the posters on their vessels (Annex 6, paragraphs 2.31, 2.39 and 12.12).

Review of action plans to eliminate seabird mortality

France's action plan to reduce/eliminate seabird mortality in Subarea 58.6 and Division 58.5.1

5.6 The Scientific Committee is very encouraged by the reductions in incidental mortality of seabirds reported in Subarea 58.6 and Division 58.5.1 within the French EEZs (Annex 6, paragraphs 2.7 and 2.8).

5.7 These interim results can be directly linked to France's progress in implementing the action plan. The Scientific Committee recognised that, whilst some of the recommendations are still under consideration, many have already been implemented. It appears that significant reductions, and perhaps near-zero mortalities, can be realised with continued diligence and strict attention to adherence with the action plan.

5.8 The Scientific Committee requested France to:

(i) submit an English translation of SC-CAMLR-XXVII/BG/8 and, if possible, to send appropriate experts to WG-SAM (SC-CAMLR-XXVI, paragraph 5.6(ii)) (Annex 6, paragraph 3.10);

(ii) provide a detailed progress report on action plan implementation in 2009 to WG-IMAF and the Scientific Committee;

(iii) include figures to show the overlap between weekly fishing effort by sector and seabird incidental mortality rates in France's 2009 progress report (Annex 6, paragraph 3.12).

5.9 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 incidental mortality. The Scientific Committee welcomed France's stated aim to achieve near-zero seabird incidental mortality in the medium term, with reductions to less than 1 000 seabird incidental mortalities in the near term.

5.10 The Scientific Committee noted that its advice remained that were France to fully implement all elements of CCAMLR's best-practice advice for mitigation of incidental mortality of seabirds, the levels of mortality observed in the French EEZs would be substantially reduced to near-zero levels.

5.11 Prof. G. Duhamel (France) thanked Members and WG-IMAF for their support of efforts to reduce seabird incidental mortality and noted that France would continue to work jointly with WG-IMAF and other Members to effectively address this problem.

Incidental mortalities of seabirds during fishing outside the Convention Area

5.12 Given that considerably greater levels of mortality of Convention Area seabirds continue to occur in areas north of the Convention Area, compared to levels within the Convention Area, the Scientific Committee noted that WG-IMAF had requested Members to report on incidental mortality of Convention Area seabirds and marine mammals arising from fisheries conducted outside the Convention Area (Resolution 22/XXV, paragraph 3; Annex 6, paragraph 4.3). All Members of the Scientific Committee, with the exception of Argentina, endorsed this advice from WG-IMAF.

5.13 Dr E. Barrera-Oro (Argentina) noted that Argentina was not present at the WG-IMAF meeting.

5.14 The Scientific Committee noted it seemed counterintuitive that Members could successfully reduce the incidental mortality of seabirds when fishing in the Convention Area yet could still experience high levels of incidental mortality of seabirds in fisheries outside the Convention Area.

5.15 Several representatives of the Scientific Committee noted that they intend to provide new information on incidental mortality of Convention Area seabirds arising from fisheries conducted outside the Convention Area in 2009.

5.16 The Scientific Committee noted that in areas adjacent to the Convention Area, pelagic longline fisheries continued to pose a serious risk to Convention Area seabirds. The Scientific Committee recalled its advice in 2005 that the longline fisheries managed by CCSBT could be taking 10 000 albatrosses per year (SC-CAMLR-XXIV, Annex 5, Appendix O, paragraph 175) in stark contrast to the near-zero levels of albatross incidental mortality within the CAMLR Convention Area.

5.17 The Scientific Committee noted that the critical success factors in achieving the positive Convention Area results include: deployment of observers across the fleet; expert review and commentary on technical information; and the implementation of effective mandatory mitigation measures. The Scientific Committee agreed that the application of such an approach outside the Convention Area was a matter of urgency if the unsustainable impacts on some populations of Convention Area seabirds were to be reversed.

Incidental mortality of seabirds during unregulated fishing in the Convention Area

5.18 Estimates of seabird incidental mortality during IUU fishing within the Convention Area, previously estimated for longline effort, have not been prepared this year because most IUU effort was observed to be from vessels using gillnets and information from which to make extrapolations for this gear type were not available (Annex 6, paragraph 5.3).

5.19 The Scientific Committee requested additional information from Members with a regulated gillnet fishery that would provide some empirical data and guidance to assist in this process in the future (Annex 6, paragraph 5.4). Further, information from actions against IUU vessels should provide information of utility for WG-IMAF in describing the interaction between gillnet fishing and seabirds.

5.20 The Scientific Committee noted that information on gillnet interactions with seabirds and marine mammals might be available from similar gear types (e.g. trammel nets) used in research fishing within the Convention Area, fishing within a Member's EEZ, at-sea observations of IUU gillnet operations, and from the recovery of IUU fishing gear within the Convention Area. The Scientific Committee recommended that, where such information is provided, it also includes a technical description of the fishing gear to which the incidental mortality data relate.

5.21 Argentina and Uruguay indicated that they have extensive experience with the operational aspects of gillnet gear (i.e. trammel nets) in nearshore waters. It was recognised that this information could be of value in evaluating the potential incidental mortality of seabirds and marine mammals caused in IUU gillnet operations.

5.22 The Scientific Committee expressed serious concern that there was likely to be seabird incidental mortality arising from IUU gillnet fishing and recognised that the inability to estimate incidental mortality associated with this fishing activity does not imply that it is lower than would be anticipated had all of the reported IUU vessels deployed longlines (Annex 6, paragraph 5.6).

5.23 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 (SC-CAMLR-XXVI, 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

5.24 The Scientific Committee noted WG-IMAF's recommendation that the incidental mortality and depredation mitigation measure developed by Chile be reported as trotlines fitted with 'cachaloteras' (Annex 6, paragraph 6.8). The terminology for this gear configuration needs to be resolved such that all Scientific Committee working groups are using consistent terminology.

5.25 The Scientific Committee requested that ad hoc TASO develop intersessionally detailed descriptions of gear types, especially a technical description of the continuous trawling methods used in Convention Area krill fisheries that include gear used, fishing operations and details of on-board processing and overboard discharges (Annex 6, paragraph 6.9).

5.26 The Scientific Committee reiterated its recommendation (SC-CAMLR-XXVI, Annex 6, paragraph I.44) to test the utility of net binding, as appropriate, in other Convention Area pelagic trawl fisheries (Annex 6, paragraph 6.10).

5.27 The Scientific Committee recommended that Conservation Measure 25-02 be modified to include line-weighting specifications for vessels using the trotline method of longlining (Annex 6, paragraph 6.11).

Observer data collection

5.28 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, cruise reports and observer practices, including:

(i) with respect to general issues –

(a) in future the observers record detailed information on any observed banded birds in their cruise reports in order that the Secretariat can investigate the provenance of those birds (Annex 6, paragraph 7.3);

(b) updates to the matrix of observers tasks and priorities (SC-CAMLR-XXVI, Annex 5, Table 20) and the recommendations of observer coverage required by risk level (SC-CAMLR-XXVI, Annex 6, Table 20) in Tables 13 to 15 (Annex 6, paragraphs 7.21, 7.22 and 7.25);

(c) observers be requested to provide photographs of gear used within the Convention Area and any accidental or intentional loss of fishing gear, plastic strapping or any other non-biodegradable material (Annex 6, paragraph 7.28);

(d) ad hoc TASO develop a protocol for the collection of a photo library of fishing gear used (Annex 6, paragraphs 7.28 and 12.9);

(ii) with respect to krill fisheries –

(a) systematic observer coverage in the krill fishery is required to allow extrapolation of total marine mammal incidental mortality (Annex 6, paragraphs 7.4 to 7.8);

(b) the modified warp strike protocol be used in 2008/09 on continuous trawl vessels targeting krill (Annex 6, paragraphs 7.14 and 7.15);

(c) the data required to address the priorities of the Scientific Committee for observer data collection on krill trawl vessels pertaining to incidental mortality of seabirds and marine mammals (Annex 6, paragraph 7.23) are:

- observe 100% of vessels with the proportion of sets and hauls on each vessel to be observed identified in Annex 6, Table 14;
- record the use and design of mitigation devices;
- warp strike observations at least once per 24-hour period;

(iii) with respect to longline fisheries –

(a) technical coordinators encourage observers to undertake measurements of the streamer line once every seven days, and that the L2 form and appropriate instructions are modified to include the measurement technique used to estimate aerial extent (Annex 6, paragraphs 7.17 and 7.18);

(b) when reporting on longline fishing, distinguish which of the three fishing methods, Spanish system, autoline system or trotline system, or combination thereof, were used on a vessel. In addition, if a trotline system was in use, it was important to report whether ‘cachaloteras’ were used (Annex 6, paragraph 7.27);

(iv) with respect to trawl fisheries –

(a) the warp-strike protocol in all Convention Area trawl fisheries (SC-CAMLR-XXVI, Annex 6, paragraph II.124) should be implemented in 2008/09, particularly in trawl fisheries in Division 58.5.2 (Annex 6, paragraphs 7.9 to 7.11);

(b) observers provide a more detailed description of the mitigation measures used in the icefish fishery in Subarea 48.3 (Annex 6, paragraph 2.16).

5.29 The Scientific Committee noted that in those fisheries where a significant proportion of trawls are conducted at night, such as in Division 58.5.2, implementing the warp-strike protocol on a high percentage of trawls is not possible. The Scientific Committee requested that the Secretariat present information on the proportion of warp-strike observations for hauls observed during daylight and for hauls observed at night to WG-IMAF to review in 2009.

Research into the status and distribution of seabirds and marine mammals

5.30 The Scientific Committee noted the fundamental importance of up-to-date information on the status and distribution of seabirds in the development of risk assessments of interactions in fisheries. The Scientific Committee welcomed continued cooperation and coordination with ACAP and BirdLife International, including the standing invitation to experts from ACAP and BirdLife International (SC-CAMLR-XXVI, paragraph 5.56), to ensure the best available scientific information was available to CCAMLR (Annex 6, paragraph 8.2).

Assessment of risk in CCAMLR subareas and divisions

5.31 Revisions to the comprehensive assessments on the potential risk of interaction between seabirds and fisheries for all statistical areas in the Convention Area were not carried out this year as no new relevant information on the at-sea distribution of seabirds was provided. Accordingly, the assessments and advice provided in 2007 and combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31) were again endorsed by the Scientific Committee (Annex 6, paragraph 9.3).

5.32 The Scientific Committee recommended that, if undertaken, the research proposed in Division 58.4.4 by Japan be conducted in full compliance with Conservation Measure 25-02 (Annex 6, paragraph 9.6).

5.33 The Scientific Committee noted the proposal from Japan to be exempted from the requirement to conduct longline sink rate tests outside the Convention Area when fishing at the end of the 2007/08 season and into the 2008/09 season in Subarea 48.6. The Scientific Committee agreed that this proposed exemption did not present an additional risk to seabirds in the Convention Area (Annex 6, paragraph 9.9).

5.34 The Scientific Committee recommended that Conservation Measure 24-02 be modified to include:

(i) relaxation of the need to conduct initial sink rate testing outside the Convention Area, thus allowing such testing to be carried out within CCAMLR waters subject to the testing being undertaken with unbaited hooks. This would be applied to existing protocols A, B and C (Annex 6, paragraph 9.8);

(ii) Subarea 48.4 be added to paragraph 1 (Annex 6, paragraph 9.10);

(iii) a new protocol for the trotline and trotlines fitted with 'cachaloteras' systems (Annex 6, paragraph 9.11).

Incidental mortality of seabirds in relation to new and exploratory fisheries

5.35 The Scientific Committee recommended that:

(i) vessels fishing in new and exploratory longline and trawl fisheries have the required level of observation for incidental mortality and associated information as detailed in Annex 6, Tables 13 to 15 (Annex 6, paragraph 10.2);

(ii) marine mammal exclusion devices designed to prevent pinnipeds from entering the net be used in the exploratory krill fishery to be undertaken by Norway in Subarea 48.6 (CCAMLR-XXVII/13), and that observation of at least 25% of sets and 75% of hauls be undertaken (Annex 6, paragraph 10.6);

(iii) marine mammal exclusion devices designed to prevent pinnipeds from entering the net be used in all krill fisheries (Annex 6, paragraph 10.13);

(iv) observation take place to collect descriptive information about the potential for incidental mortality in the proposed pot fisheries (Annex 6, paragraph 10.8);

(v) a checklist, similar to that used for longline notifications for new and exploratory fisheries, be designed by the Secretariat specifically for notifications for other new and exploratory fisheries (Annex 6, paragraph 10.10).

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

5.36 The Scientific Committee recommended that:

(i) Members are encouraged to support the adoption of these FAO Best Practice Technical Guidelines for NPOA-Seabirds at the Twenty-eighth Session of COFI (2 to 6 March 2009) (Annex 6, paragraph 11.8);

(ii) the Commission be requested to consider what additional actions might be undertaken to expedite the adoption of measures to avoid or mitigate the incidental mortality of Convention Area seabirds during fishing managed by CCSBT (Annex 6, paragraph 11.11);

(iii) the Secretariat be asked to explore the possibility of obtaining incidental mortality and effort data, and other details, from the IOTC Secretariat about gillnetting regulated by the IOTC (Annex 6, paragraph 11.13);

(iv) the Commission note the increasing and beneficial role being played by ACAP in improving RFMOs' management of incidental mortality of Convention Area seabirds outside the Convention Area (Annex 6, paragraphs 8.1 and 11.1 to 11.3) and encourage CCAMLR Parties which have not yet acceded to ACAP to consider doing so;

(v) in addition to any other activities that might routinely occur:

(a) the CCAMLR Executive Secretary be requested to write to the Executive Secretaries of the RFMOs listed in Appendix 1 of Resolution 22/XXV, again reiterating the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area (Annex 6, paragraphs 11.5 and 11.6);

(b) the CCAMLR Executive Secretary be requested to seek the inclusion of an agenda item, reflecting the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area, on the agenda of the meeting of RFB secretariats to be held in March 2009 (Annex 6, paragraph 11.20(v)(b));

(c) relevant CCAMLR Parties be encouraged to undertake, or continue to undertake, the actions described in paragraphs 3, 4 and 5 of Resolution 22/XXV (Annex 6, paragraph 11.5).

5.37 The Scientific Committee requested the Secretariat to prepare and submit a paper to the RFB meeting referenced in paragraph 5.36(v)(b) that would illustrate the overlap of foraging ranges of seabirds that breed in the Convention Area with CCSBT fishing.

5.38 The Scientific Committee discussed these issues (paragraphs 5.12 to 5.16) and reiterated the importance of Members implementing Resolution 22/XXV, both in relation to the RFMOs they are party to and with respect to the fisheries under their jurisdiction.

Marine debris and its impacts on marine mammals and seabirds in the Convention Area

5.39 The Scientific Committee noted:

(i) that WG-IMAF's revised terms of reference include consideration of marine debris in the Convention Area, specifically the direct impacts of marine debris on seabirds and marine mammals (Annex 6, paragraph 12.2);

(ii) the general increase in the incidence of marine debris (Annex 6, paragraph 12.11).

5.40 The Scientific Committee recommended:

(i) the implementation of revised definitions of debris associated with seabird colonies (Annex 6, paragraph 12.3), and of the age and sex of Antarctic fur seals for reporting of marine debris (Annex 6, paragraph 12.4);

(ii) the development of a photo library of debris found, and inclusion of photos of fishing gear taken by observers, in this library (Annex 6, paragraph 12.9);

(iii) the inclusion of advice on marine debris when CCAMLR makes contact with other international organisations, including RFMOs (Annex 6, paragraph 12.10);

(iv) the production of an A3 perspex-backed poster to emphasise the importance of managing garbage in accordance with conservation measures, and the consequences to marine life of not managing garbage effectively (Annex 6, paragraph 12.12);

(v) that the Commission amend Conservation Measure 26-01 to ensure all plastic packaging bands are cut into small (~10 cm) sections prior to incineration (Annex 6, paragraph 12.13);

(vi) Members to provide data on marine debris to the Secretariat (Annex 6, paragraph 12.14).

5.41 The Scientific Committee congratulated WG-IMAF on its engagement on the topic of marine debris and its impacts on seabirds and marine mammals for the first time. The Scientific Committee endorsed the program of work to progress this topic further. In particular, the Scientific Committee sought advice on the provenance of hooks at breeding sites and an evaluation of whether these had come from Convention Area fisheries (Annex 6, paragraph 12.7). The Scientific Committee noted that this would require submission of detailed information from Members that conducted research in seabird breeding colonies and the collation of information about the different fishing gears used in the Convention Area (Annex 6, paragraph 7.29(i)(d)).

Interaction with other Scientific Committee working groups

5.42 The Scientific Committee noted ongoing and constructive interactions between WG-IMAF and WG-FSA, WG-EMM, WG-SAM and ad hoc TASO (Annex 6, paragraphs 13.1 to 13.6 and 14.3; Annex 5, paragraphs 7.7 to 7.11) and the Scientific Committee further noted that these increasing interactions contribute to the streamlining of the work of the Scientific Committee's working groups.

Streamlining the work of the Scientific Committee

5.43 The Scientific Committee endorsed:

(i) the revised terms of the reference for WG-IMAF (Annex 6, paragraph 15.7);

(ii) the core tasks to be addressed annually (Annex 6, paragraph 15.3);

(iii) the change to the name of the working group (Annex 6, paragraph 15.8);

(iv) the change to the naming of WG-IMAF papers (Annex 6, paragraph 15.9);

(v) joint sessions of WG-IMAF with other Scientific Committee working groups as needed (Annex 6, paragraph 15.10).

Other business

5.44 The Scientific Committee accepted the resignation of Mr Smith as Co-convener at the end of this year's meeting and noted that Ms Rivera will continue as Co-convener. Mr Smith was thanked for all his work and significant contributions to WG-IMAF over the last four years as Co-convener. The Scientific Committee agreed that Mr N. Walker (New Zealand) be appointed as a Co-convener of WG-IMAF to work with Ms Rivera.

Advice to the Commission

5.45 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

5.46 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 2008 and that, for the second 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 third consecutive year (paragraph 5.3);

(ii) the continued relatively low levels of seabird and marine mammal incidental mortality in trawl fisheries in the Convention Area in 2008 (paragraph 5.3);

(iii) the reductions in incidental mortality of seabirds reported in Subarea 58.6 and Division 58.5.1 within the French EEZs (paragraph 5.6);

(iv) France's submission and progress in implementing the action plan and that perhaps near-zero mortalities can be realised with continued diligence and strict attention to adherence with the action plan (paragraph 5.7);

(v) France's aim to achieve near-zero seabird incidental mortality in the medium term, with reductions to less than 1 000 seabird incidental mortalities in the near term (paragraph 5.9);

(vi) a recommendation that Members ensure their flag vessels display the CCAMLR posters on hook discards and marine debris (paragraph 5.5);

(vii) the assessment of implementation of relevant conservation measures and the listing of vessels not fully implementing the conservation measures (paragraph 5.4);

(viii) a request for information from Members with respect to gillnet fishing operations with respect to levels and by-catch rates of seabirds associated with gillnet operations (paragraphs 5.19 and 5.20);

(ix) a request to ad hoc TASO to develop a technical description of the continuous trawling methods used in Convention Area krill fisheries (paragraph 5.25);

(x) a recommendation to test the utility of net binding as appropriate (paragraph 5.26);

(xi) the research proposed in Division 58.4.4 by Japan (WG-FSA-08/39), if undertaken, be conducted in full compliance with Conservation Measure 25-02 (paragraph 5.32);

(xii) the proposal from Japan to be exempted from the requirement to conduct longline sink rate tests outside the Convention Area when fishing at the end of the 2007/08 season and into the 2008/09 season in Subarea 48.6. The Scientific Committee agreed that this proposed exemption did not present an additional risk to seabirds in the Convention Area (paragraph 5.33);

(xiii) that the Scientific Committee had appointed Mr Walker as a Co-convener of WG-IMAF following the retirement of one Co-convener, Mr Smith. Ms Rivera will continue as Co-convener (paragraph 5.44).

5.47 The Commission was requested to endorse:

(i) a series of requests to France to assist in the effort to further reduce the incidental mortality of seabirds in the French EEZs to near-zero levels (paragraph 5.8);

(ii) recommended changes to logbooks, cruise reports and observer practices (paragraph 5.28);

(iii) that vessels have the required levels of observation in new and exploratory fisheries, the use of marine mammal exclusion devices in all krill trawl fisheries, and the development of checklists for non-longline new and exploratory fisheries (paragraph 5.35);

(iv) the program being developed by WG-IMAF to review and analyse data on the level and significance of direct impacts of marine debris in the Convention Area (paragraphs 5.39 and 5.40).

5.48 All Members, except Argentina, requested the Commission to endorse WG-IMAF's request for Members to comply with the request to report on incidental mortality of Convention Area seabirds and marine mammals arising from fisheries conducted outside the Convention Area (paragraphs 5.12 and 5.15).

Specific advice

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

(i) production and distribution of a CCAMLR marine debris poster (paragraph 5.40(iv));

(ii) suggested revisions to Conservation Measures 25-02, 24-02 and 26-01 (paragraphs 5.27, 5.34 and 5.40(v));

(iii) continued action in respect of seabird mortality caused by IUU fishing (paragraph 5.23);

(iv) continued and diligent implementation of Resolution 22/XXV (paragraphs 5.16, 5.17 and 5.36 to 5.38).

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

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

6.2 Information collected by scientific observers on board longline, finfish trawl, pot and krill trawl cruises were summarised by the Secretariat in SC-CAMLR-XXVII/BG/2.

6.3 The Scientific Committee also noted the discussions on the observer program by WG-IMAF (Annex 6, paragraphs 7.1 to 7.29), WG-FSA (Annex 5, paragraphs 11.1 to 11.8) and WG-EMM (Annex 4, paragraphs 4.28 to 4.66).

Ad hoc TASO

6.4 The Scientific Committee recalled that it had endorsed the establishment of ad hoc TASO at its last meeting (SC-CAMLR-XXVI, paragraphs 7.9 to 7.12).

6.5 The Co-conveners of ad hoc TASO, Mr Heinecken and Dr Welsford, presented the report from the first meeting, held in conjunction with WG-EMM and WG-SAM in St Petersburg, Russia, on 19 and 20 July 2008 (SC-CAMLR-XXVII/BG/6).

6.6 The agenda of the first meeting of ad hoc TASO covered the design and operation of gear types used in fisheries in the Convention Area, observer priorities in the trawl, longline and pot fisheries, and the future work plan and terms of reference of the ad hoc group.

6.7 The Scientific Committee endorsed the terms of reference as developed by ad hoc TASO (SC-CAMLR-XXVII/BG/6, paragraph 4.2).

6.8 The Scientific Committee endorsed the long-term work plan of ad hoc TASO to include (i) ensuring an equivalent level of training and accreditation for observers across the Convention Area, and (ii) facilitating the exchange of expertise and experience between technical coordinators and experienced observers on methods of recruit training.

6.9 The Scientific Committee noted that many of the recommendations from ad hoc TASO had been useful to the work of the Scientific Committee and had been welcomed by WG-FSA (Annex 5, paragraph 11.4), WG-EMM (Annex 4, paragraphs 4.41 to 4.46) and WG-IMAF (Annex 6, paragraph 13.4).

6.10 The Scientific Committee considered plans for the next meeting of ad hoc TASO. While it noted that the meeting could be held separately to other working group meetings in the future to assist with the development of capacity building in Members' observer programs and fleets, it agreed that the meeting in 2009 be held in conjunction with WG-EMM and WG-SAM.

6.11 Dr Iversen was pleased to extend Norway's invitation to host WG-EMM, WG-SAM and ad hoc TASO in 2009.

6.12 The Scientific Committee requested that specific items referred to ad hoc TASO by the working groups be considered by the Co-conveners in developing their agenda.

6.13 Dr Barrera-Oro considered that the experts brought together in ad hoc TASO, including industry representatives, may be able to provide information on IUU operations using gillnets and requested that this be considered at the next meeting of ad hoc TASO.

6.14 Prof. O. Pin (Uruguay) agreed and considered that industry stakeholders and national observers that have experience outside of the Convention Area are likely to be able to provide valuable information to SC-CAMLR regarding the activities and impacts of IUU fishing.

6.15 Prof. Moreno noted that ad hoc TASO was evidently capable of dealing with a wide variety of technical issues. However, he noted that any Members with information on the activities and impacts of IUU fishing were obliged to report such information and that ad hoc TASO may not be an appropriate forum for such issues.

Advice from WG-FSA

6.16 The Scientific Committee considered and approved recommendations from WG-FSA concerning the aspects of the CCAMLR Scheme of International Scientific Observation discussed in Annex 5, paragraph 11.8.

Advice from WG-IMAF

6.17 The Scientific Committee considered and approved recommendations from WG-IMAF concerning the aspects of the CCAMLR Scheme of International Scientific Observation discussed in Annex 6, paragraphs 7.3, 7.13 to 7.20 and 7.29.

Advice from WG-EMM

6.18 The Scientific Committee noted that six scientific observer logbooks were submitted to the Secretariat for the 2006/07 season from observations conducted by CCAMLR scientific observers on the *Saga Sea* (Norway), *Niitaka Maru* (Japan) and *Dalmor II* (Poland) (Annex 4, paragraph 4.28).

6.19 The Scientific Committee also noted that the Secretariat had received five notifications of the placement of CCAMLR international scientific observers on krill fishing vessels in Area 48 in 2007/08 (Annex 4, paragraph 4.29). This information was updated at WG-IMAF (Annex 6, paragraph 2.20 and Table 7).

6.20 The Scientific Committee noted that the percentage of tows observed varied greatly between observers, seasons and vessels. For example, in 2006/07 between 20 and 86% of the tows were observed per observer trip, including both the traditional trawling method and the continuous fishing system, noting that this represented a much lower proportion of the total number of tows conducted in the fishery because of the overall level of observer coverage (Annex 4, paragraph 4.30).

6.21 The Scientific Committee endorsed the advice from WG-EMM regarding revision of the instructions in the *Scientific Observers Manual* to reflect the changed priorities for data collection (Annex 4, paragraphs 4.47 to 4.54).

6.22 The Scientific Committee noted the discussions on the level of scientific observer coverage for the krill fishery. It further noted that the Working Group had agreed that 100% vessel coverage (i.e. a minimum of one observer on each vessel for all the period that the vessel is in the Convention Area) using government-appointed or international observers should be undertaken as soon as possible (Annex 4, paragraph 4.58).

6.23 The Scientific Committee noted the request from the Working Group to consider the most practical way of initiating such coverage commencing in December 2009 (Annex 4, paragraph 4.59).

6.24 The Scientific Committee noted that after a two-year period of 100% observer coverage, WG-EMM would be in a position to provide advice on the level of ongoing observer coverage required (Annex 4, paragraph 4.61).

6.25 The Scientific Committee also noted the recommendation that any new entrants (Members or vessels) and vessels using new fishing methods must comply with a two-year 100% vessel-time coverage by government-appointed or international observers, noting that this could be reviewed after two years to determine the required coverage for subsequent years (Annex 4, paragraph 4.62).

6.26 The Scientific Committee also noted that vessels with increased catch and processing capacity may need more than one observer (Annex 4, paragraph 4.63).

6.27 All Members, except Japan, Republic of Korea and China, endorsed WG-EMM's plan for 100% scientific observer coverage across the entire krill fleet for two years, commencing in December 2009.

6.28 Mr Matsushima made the following statement:

> 'Japan has been putting great importance on collecting scientific data and biological samples from the krill fishery. In this regard, Japan has voluntarily dispatched scientific observers and also accepted observers from other Members on its krill fishing vessel, and provided scientific information and data to CCAMLR. We believe that such scientific contribution by Japan has been highly appreciated by SC-CAMLR.
>
> In this sense, Japan submitted a plan for systematic scientific observer coverage to WG-EMM in 2008 in response to the request by the Scientific Committee. However, unfortunately, Japan did not receive any feedback about how its plan was scientifically insufficient to achieve the objective which is mentioned in SC-CAMLR-XXVI, paragraph 3.7.
>
> Furthermore, in SC-CAMLR-XXVI, paragraph 3.14, the Scientific Committee agreed that WG-EMM should carry out an assessment of the consequences to the data collection effort of the different approaches which are suggested in paragraphs 3.10 and 3.11. However, there is no result of such an assessment in the report of WG-EMM.
>
> In this regard, Japan cannot find any scientific reason why 100% observer coverage is necessary, therefore, it cannot accept 100% observer coverage recommended by WG-EMM, even if it is initially for a period of two years.
>
> Having said so, Japan suggested that it will be able to deploy government-appointed observers to provide at least 50% observer coverage from the 2009/10 fishing season.'

6.29 Dr Shin queried the details of the assessment undertaken during WG-EMM regarding the consequences of employing different levels of observer coverage. He considered that an analysis to support the indispensableness of full coverage is still lacking, which his delegation continued to seek over the years. He regretted that the utility of the suggested high-level coverage was not sufficiently explored. He further noted that there is, however, a common ground for systematic coverage at a substantial level even for the present time, and hoped that this scope could still be utilised.

6.30 Dr Zhao expressed his understanding of the initiative leading to the recommendation with respect to 100% observer coverage. However, he also expressed his concern over the potential difficulties that may arise from such a sudden increase in observer coverage, as also mentioned in the deliberations made by Japanese and Korean delegates. Subsequently, Dr Zhao suggested that a more practical, stepwise-increase approach be adopted to accomplish the same objective.

6.31 Dr Zhao also noted, with regard to the recommendation in paragraph 6.24, that a distinction should be drawn between new entrants and new fishing methods, as they belong to two different categories. He further noted that no additional mandatory requirements should be placed on new entrants without a sound scientific justification.

6.32 Most Members expressed strong disappointment with the position taken by Japan, Republic of Korea and China on the issue of 100% observer coverage. Most Members considered that WG-EMM had indeed thoroughly evaluated Japan's proposal for 50% observer coverage (WG-EMM-08/34). The Working Group had agreed that after a two-year period of 100% coverage, it would be in a position to provide advice to the Scientific Committee on the level of ongoing observer coverage, given the expectation of systematic coverage of not less than 50% vessel-days in the krill fishery (Annex 4, paragraph 4.61).

6.33 These Members further expressed confusion at Japan's position, considering its full participation in the discussions leading up to WG-EMM's advice, and considered that such a position had the potential to seriously undermine the role of the Scientific Committee and its working groups.

6.34 The Scientific Committee agreed that an annex containing the text and paragraph numbers from prior discussions on observer coverage in the krill fishery be included for the Commission to use in its deliberations on this issue (Annex 9).

6.35 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 after the meeting.

FISHERIES MANAGEMENT AND CONSERVATION UNDER CONDITIONS OF UNCERTAINTY

Estimation of IUU catches

7.1 The Scientific Committee noted the advice of WG-FSA (Annex 5, paragraphs 8.3 to 8.8) on trends in IUU fishing in the 2007/08 fishing season. The Working Group reported that fewer IUU vessels had been observed in 2007/8, and that the estimated losses to IUU had also declined from 3 615 tonnes in 2006/07 to 1 169 tonnes in 2007/08 (Annex 5, Tables 2 and 3).

7.2 The Scientific Committee noted with concern that the IUU fleet is increasingly dominated by gillnet vessels (Annex 5, paragraph 8.4), and that for these vessels the configuration and dimensions of the gear used, the catch rates of toothfish, by-catch of fish and birds and impact on benthos are virtually unknown. In consequence, there were very high levels of uncertainty about the estimate of IUU catch for 2007/08 and WG-IMAF had been unable to make an estimate of seabird by-catch in the IUU fishery. Notwithstanding this uncertainty, the Scientific Committee noted that gillnets are a relatively destructive fishing method, are likely to be more efficient at catching fish than longlines, and that the vessels do not require bait and are operated with fewer crew than longline vessels.

7.3 The Scientific Committee agreed that, given the available evidence, it could not conclude that IUU fishing, and its effects, particularly its by-catch of fish, benthos and birds, had significantly declined in the Convention Area. Furthermore, Prof. Duhamel noted that IUU fishing was still occurring in Divisions 58.4.1, 58.4.3b and 58.5.1 and had reoccurred within Subareas 58.6 and 88.1 after a number of years in which there had been no IUU fishing in these subareas.

7.4 The Scientific Committee endorsed WG-FSA's call for Members to increase their efforts to document IUU gillnet activities in the Convention Area and, where feasible, to recover operational IUU gillnets or board IUU gillnet vessels to examine the vessel's catches and logbooks to gain an understanding of this IUU fishing method.

7.5 Prof. Moreno informed the Scientific Committee that information acquired from industry sources suggested that the gillnets used in IUU fishing in the Convention Area were up to 6 n miles in length and 80 m in height. Dr R. Leslie (South Africa) reminded the Scientific Committee that South Africa had presented information on the operation of IUU gillnet vessels to the Commission last year (CCAMLR-XXVI/BG/30 and BG/33). Dr Welsford suggested that information from comparisons of longline and gillnet catch rates in legitimate fisheries north of the Convention Area may assist in understanding the likely differences between these gears in the Convention Area, but that direct observations of gillnet activities in the Convention Area would still be required to fully understand their impact.

7.6 The Scientific Committee noted that while gillnets may be efficient at catching fish and by-catch, their interaction with birds would be quite different from that of longlines. For instance, for flighted birds this could involve the accidental catch of birds attracted to discarded offal rather than the direct catch of birds taking bait on hooks. It would also be expected that gillnets would have a greater impact with penguins in surface waters than do longlines.

7.7 The IUCN representative drew attention to a new report by TRAFFIC and WWF (CCAMLR-XXVII/BG/38) which presented a trade-based assessment of toothfish catches. These data could be used to provide improved estimates of IUU catch in the Convention Area.

7.8 Dr Barrera-Oro provided additional information on the catch of *D. eleginoides* in the Patagonian sector of the Argentine EEZ (Area 41). The catch limit for 2007/08 was the same as for the two previous seasons (2 500 tonnes), but only 1 800 tonnes were taken. The stock is increasing due to the management strategies implemented mainly in 2003. Since 2006/07, 2 020 fish have been tagged, 10 of which have been recovered. It is expected that the recovery rate will increase over the next few years, due to the good cooperation between the tagging program, the fishing fleet and scientific observers placed on vessels.

7.9 Dr Welsford noted that it would be useful if information on the Argentine tagging program, and details of tags released in waters adjacent to the Convention Area, could be provided to the Secretariat.

Climate change

7.10 Dr Trathan introduced two UK papers on climate change (SC-CAMLR-XXVII/7 Rev. 1 and BG/13). The papers highlighted four major areas where climate change could lead to impacts on marine ecosystems that would be of concern to CCAMLR.

7.11 The Scientific Committee thanked the UK for preparing these ideas on how the Committee could systematically consider the potential effects of climate change on the Antarctic marine ecosystem.

7.12 The Scientific Committee advised the Commission that the following consequences of climate change may carry significant risks to Antarctic marine ecosystems: increasing sea temperatures, increasing sea height, changes to global ocean thermo-haline circulation, increasing ocean acidification, the introduction of alien species and increasing accessibility in areas previously restricted by sea-ice to fishing, tourism and commercial transport.

7.13 The Scientific Committee agreed with the UK that there are four major areas of impact that will merit consideration by CCAMLR:

- the potential effects of climate change on invertebrates, including both pelagic and benthic communities;
- the potential effects of climate change on higher-trophic levels, particularly those that are likely to suffer from decreasing temporal and spatial coincidence with essential ecosystem functions;
- the potential effects of climate change on CCAMLR-managed fisheries, particularly the likely disruption of current population and recruitment dynamics;
- the special effects of increased accessibility associated with the increase in ice-free areas of high-Antarctic seas.

7.14 The Scientific Committee agreed that there were three key areas of work which would be required for it to provide specific advice to the Commission on what would be appropriate management responses to climate change, taking into account the issues in paragraph 7.13, that would ensure the objectives of the Convention are met; these are:

(i) To examine the robustness of the scientific advice provided by the Scientific Committee and the stock assessments prepared by its working groups in the face of increasing uncertainty accompanying climate change, particularly in relation to predictions of future population responses and recruitment levels.

(ii) To examine the need for, and implement as appropriate, improvements to current monitoring programs of harvested species and dependent and related species so as to provide robust and timely indicators of climate change impacts.

(iii) To determine whether CCAMLR's management objectives and performance indicators require modification to remain appropriate in the face of climate change uncertainty.

7.15 The Scientific Committee asked its working groups (WG-SAM, WG-EMM, WG-IMAF and WG-FSA) to consider the issues raised in paragraph 7.14 at their meetings in 2009.

7.16 Dr Constable informed the Scientific Committee that a workshop to address important issues in measuring, assessing and providing early-warning detection of climate change impacts on Southern Ocean ecosystems and biodiversity will be held in Hobart, Australia, from 20 to 24 April 2009 at CCAMLR Headquarters. The workshop (www.aad.gov.au/default.asp?casid=35088) Monitoring Climate Change Impacts: Establishing a Southern Ocean Sentinel Program, is sponsored by the Australian Antarctic Division, the Antarctic Climate and Ecosystems Cooperative Research Centre and WWF.

Fishery Management Plans

7.17 The Scientific Committee recalled that last year the Commission had agreed that the ad hoc group on the development of Fishery Management Plans (FMPs) should continue developing the concept and details of a generic CCAMLR fisheries management checklist, and outline the potential role of FMPs in the context of CCAMLR's established management approach (CCAMLR-XXVI, paragraph 5.7).

7.18 The coordinator of the ad hoc group advised the Scientific Committee that the group had not developed the fisheries management checklist any further during the intersessional period because of the realisation that the Performance Review Panel would be considering similar, and in many cases identical, issues. The group therefore decided to await consideration of the panel's report and prioritisation of its recommendations by the Commission before continuing its work.

SCIENTIFIC RESEARCH EXEMPTION

Notifications to conduct research surveys using commercial vessels

8.1 The Scientific Committee discussed two notifications of intent to conduct toothfish longline research in 2009 using commercial vessels under the provisions of Conservation Measure 24-01.

8.2 New Zealand proposed to conduct winter research in Subarea 88.1 to investigate the early life history and reproduction of *D. mawsoni* in the Ross Sea (Annex 5, paragraphs 5.108 to 5.110; see also CCAMLR-XXVII/BG/15).

8.3 The Scientific Committee noted that although most members of WG-FSA agreed that this survey would provide important information on the reproductive biology and early life history of *D. mawsoni* (Annex 5, paragraph 5.111), concern was expressed over the size of the proposed catch and with other elements of the proposal (Annex 5, paragraphs 5.111 to 5.115).

8.4 Japan proposed to continue research on the distribution and population structure of toothfish in Divisions 58.4.4a and 58.4.4b started in 2007/08 (Annex 5, paragraphs 5.116 and 5.117; see also CCAMLR-XXVII/BG/15).

8.5 The Scientific Committee noted the concern expressed by WG-FSA whether the research is going to impede the recovery of this stock. The catch limit for this area when the fishery was closed was only 103 tonnes and therefore the proposed catch of 120 tonnes seemed excessive.

8.6 The Scientific Committee noted that the conservation measure states that the area should remain closed until a survey has been carried out and the results considered by the Commission. It further noted that although the survey had been carried out, a detailed report of the survey had not yet been submitted and reviewed by the relevant working groups and by the Scientific Committee. It was also noted that the random longline survey design being proposed at the Scientific Committee meeting by Japan could best be reviewed by WG-SAM.

8.7 In response to the discussion at WG-FSA (Annex 5, paragraphs 5.118 to 5.121) Japan proposed to include additional elements in the survey:

(i) longline sets would be random in phase 1 of the survey;

(ii) comparative fishing in phase 1 of the survey between trotlines and the Spanish longline system;

(iii) increase in the tagging rate to five fish per tonne.

8.8 The Scientific Committee considered these additional elements and after much discussion recommended that before conducting additional research in this area, the following actions should be taken:

(i) the results of the recent longline survey be reported to WG-FSA at its next meeting;

(ii) the design of a future survey be discussed and agreed at WG-SAM;

(iii) in the next year, that comparable fishing trials be carried out in areas other than Division 58.4.4, to attempt the calibration of the trotline gear with the other longline gear.

CCAMLR-sponsored research

8.9 The Scientific Committee considered the general principles and requirements to be met for CCAMLR-sponsored research. It noted that such research:

(i) would be designed to support the Commission in its work to achieve the objectives in Article II;

(ii) needs to be consistent with the precautionary approach of CCAMLR;

(iii) should not undermine initiatives taken in other parts of CCAMLR or in other parts of the Antarctic Treaty System, such as species protection, closed areas and/or ASPAs and ASMAs;

(iv) under such direct sponsorship, could involve, *inter alia*,

(a) special catch allocations from a catch limit to undertake research;

(b) research exemptions to existing conservation measures provided for in Conservation Measure 24-01;

(c) coordination of data acquisition and field programs through the CCAMLR Secretariat;

(d) special requirements to be undertaken by all Members during fishing operations.

8.10 The Scientific Committee noted the previous experience for designing the CCAMLR-2000 Survey and other work done under the auspices of CCAMLR that the following steps would be involved in developing and utilising CCAMLR-sponsored research:

(i) Preparation:

(a) Demonstrate need of the research –

It was noted that 'need' can be determined from the consequences that the research will have for the Commission in achieving the objectives in Article II, e.g. is a catch limit too high (conservation objectives may not be met) or too low (conservation may not be an issue and more catch is possible) and not likely to be corrected using the existing process, and would the advice to the Commission be improved by the research? Analyses could be used to help demonstrate need, including management strategy evaluation, power analyses, and/or draft assessments using plausible datasets that may be obtained from research.

(b) Develop a research design to address the need –

It will be important to identify the data needed to be collected to resolve the issue, including the spatial and temporal sampling required to resolve the issue and the number of samples needed to achieve the accuracy and precision of the estimate required.

(c) Evaluate whether there may be short- or long-term effects of the research plan on current advice to the Commission –

It was noted that while the research is being undertaken, the quality of the current advice may be altered. The degree to which that would impact on the Commission achieving its objectives will need to be considered.

(d) Identify the necessary standards to be met during data collection –

Such standards will need to include specifying the data quality requirements (e.g. tagging), vessel and observer capability and standards, survey design and implementation.

(e) Determine any specific requirements to be met for implementing the research program –

Such requirements will include consideration of prospective participants (Members, fishing vessels, research vessels), how the participation will be managed, establishing a capability to meet standards, determining the contribution required from CCAMLR (catch allocation, requirements in conservation measures, research exemptions, Member contributions) and requirements of observers and vessels.

(ii) Implementation

(iii) Analysis of results

(iv) Provision of advice to the Commission.

8.11 The Scientific Committee agreed that these guidelines were very useful and recommended they be followed when establishing CCAMLR-sponsored research programs.

Notifications to conduct scientific surveys using research vessels

8.12 The Scientific Committee noted that the following Members would be conducting scientific research surveys in 2009 also in accordance with Conservation Measure 24-01:

Australia: demersal fish survey in Division 58.5.2 in May–June 2009
UK: demersal fish survey in Subarea 48.3 in January–February 2009
USA: demersal fish survey in Subarea 48.2.

COOPERATION WITH OTHER ORGANISATIONS

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

Cooperation with the Antarctic Treaty System

CEP

9.2 Dr N. Gilbert (CEP Observer) referred to the Executive Secretary's report of his attendance at CEP XI (Kiev, Ukraine, from 2 to 6 June 2008) (CCAMLR-XXVII/BG/5), and briefly highlighted those matters raised at CEP XI that would be of interest to the Scientific Committee.

9.3 Dr Gilbert noted that CEP XI had agreed a rolling five-year work plan as a means of prioritising its workload. Issues considered to be of high priority for the CEP include:

prevention of introduction of non-native species; aspects and impacts of tourism and non-governmental activities; global pressures on Antarctica including climate change and pollution, and the Antarctic protected areas system, including MPAs.

9.4 On the issue of non-native species, Dr Gilbert referred to CCAMLR-XXVII/BG/19 Rev. 1 which summarised the CEP's discussions on the matter to date. This had been prepared recognising the high priority afforded to the issue in the CEP's five-year work plan and in anticipation of dedicated time being spent on the matter at the CEP's next meeting. Dr Gilbert noted in particular the CEP's consideration of non-native species in the marine environment with hull fouling and ballast water exchange being vectors of concern.

9.5 CEP XI and ATCM XXXI had endorsed the Antarctic Environmental Domains Analysis (the terrestrial version of SC-CAMLR's bioregionalisation) developed by New Zealand, as a dynamic model to underpin the Antarctic protected area system and assist with the identification of new protected areas.

9.6 In this context the CEP had considered 21 new or revised protected or managed area management plans. Fourteen of these were endorsed by the CEP and subsequently adopted by the ATCM.

9.7 Dr Gilbert noted that SCAR had held a workshop in May 2008 in conjunction with ACAP and other experts to review the status of southern giant petrels (SC-CAMLR-XXVI, paragraph 10.3). On the basis of that assessment and advice from SCAR, the CEP had agreed that the species does not merit listing as a specially protected species under the provisions of Annex II to the Protocol.

9.8 The CEP discussed the environmental implications of a changing Antarctic climate noting SCAR's ongoing work to prepare a comprehensive report on Antarctic Climate Change and the Environment. The CEP noted that it would reconsider a proposal to hold a meeting of experts on Antarctic climate change on the basis of SCAR's report once it had been published.

9.9 The CEP had welcomed a presentation from the CCAMLR Observer on the work of CCAMLR in general. This had provided a useful insight for the CEP into the work of CCAMLR and assisted in the CEP's consideration of the proposed joint workshop with SC-CAMLR.

9.10 Dr Gilbert noted that SC-CAMLR-XXVI had suggested that a joint workshop be held with the CEP to consider issues of mutual interest to the two Committees (SC-CAMLR-XXVI, paragraphs 10.8 and 10.9). In response, CEP XI had welcomed the proposal as an opportunity to consider ways in which to improve and maintain practical cooperation between the two bodies. The CEP prepared the following list of issues that it felt were worthy of consideration at such a workshop:

- climate change research
- ecosystem and environmental monitoring
- protected areas and spatial management measures
- species requiring special protection
- marine pollution
- biodiversity management and non-native species.

9.11 The CEP had suggested that an overarching theme for the workshop might be 'Opportunities for collaboration and practical cooperation between the CEP and SC-CAMLR'. This was endorsed by the Scientific Committee.

9.12 The CEP had requested that the CCAMLR Observer to CEP convey these to SC-CAMLR (CEP XI Final Report, paragraphs 337 and 338; SC CIRCs 08/47 and 08/65).

9.13 The Scientific Committee noted that WG-EMM had considered the response from CEP for the proposed workshop at its meeting and had noted the importance of all the proposed issues for discussion and had highlighted 'Protected areas and spatial management measures' and 'Species requiring special protection' appeared particularly worthy of SC-CAMLR attention (Annex 4, paragraph 9.3). In the case of species protection, WG-EMM had noted that consideration should be given on how interactions and practical cooperation between SC-CAMLR and the CEP could be developed to facilitate the process of affording additional protection to species in which SC-CAMLR and/or the CEP had an interest(s) (Annex 4, paragraphs 9.1 to 9.5).

9.14 In further review of candidate issues for consideration at the Joint SC-CAMLR–CEP Workshop, the Scientific Committee agreed that VMEs should also be included in discussions relative to protected areas, spatial management and biodiversity. In particular, the Scientific Committee noted that the CEP might have knowledge of information on VMEs in embayments where national research programs are conducted (paragraph 4.231).

9.15 The Scientific Committee noted that the Joint SC-CAMLR–CEP Workshop Steering Group had been established by correspondence and that CCAMLR representation on the group comprised the working group conveners and current Scientific Committee Vice-Chairs, noting that the new Chair of the Scientific Committee would join this group upon election. The CEP had nominated its Chair and two Vice-Chairs to the Steering Group.

9.16 The Joint SC-CAMLR–CEP Workshop Steering Group had proposed the following terms of reference for the workshop:

I. To develop a shared understanding of the conservation objectives and priorities of the CEP and SC-CAMLR.

II. To identify areas of common interest between the CEP and SC-CAMLR.

III. To define mechanisms for ongoing practical cooperation between the CEP and SC-CAMLR, including the sharing and archiving of data and information and, where possible, the appropriate lead body on issues of mutual interest.

IV. To consider opportunities for future collaboration.

V. To develop a report and any recommendations for consideration by CEP XII and SC-CAMLR-XXVIII.

9.17 The Joint SC-CAMLR–CEP Workshop Steering Group had also proposed the following work plan for the steering committee:

- detailed agenda and schedule for the workshop to be prepared and circulated by the end of November;

- workshop participation to be agreed by mid-December with invitations to attend, including to keynote speakers, issued before the end of 2008;

- the report of the workshop to be prepared and translated (with support of the Antarctic Treaty Secretariat) for consideration at CEP XII (Baltimore, USA, from 6 to 9 April 2009) and by SC-CAMLR-XXVIII.

9.18 The Scientific Committee endorsed the terms of reference and the work plan and welcomed the offer from the USA to host the workshop in Baltimore, USA, on 3 and 4 April 2009, immediately prior to CEP XII. The Scientific Committee encouraged attendance at the workshop by its Members to facilitate exchanges between scientists.

SCAR

9.19 Dr G. Hosie (SCAR Observer) started his report on SCAR activities (CCAMLR-XXVII/BG/42) with a message from the new SCAR President, Prof. M. 'Chuck' Kennicutt II (USA). Prof. Kennicutt expressed his commitment to working closer with CCAMLR to address Antarctic issues together. He plans to visit CCAMLR at his earliest opportunity in 2009 to discuss future collaboration.

9.20 The SCAR XXX Business Meetings and 3rd Open Science Conference (OSC) were held in St Petersburg, Russia, from 5 to 11 July 2008. The Delegates Meeting was in Moscow, Russia, from 14 to 16 July 2008. The OSC was the most successful so far and the Polar Marine Ecosystem session was the largest of all sessions. SCAR XXXI Business and Delegates Meetings and 4th OSC will be in Buenos Aires, Argentina, in August 2010. Acidification of the Southern Ocean will be a key topic of the 4th OSC. SCAR will continue to invite the Chair of the Scientific Committee to attend SCAR's meetings.

9.21 The CAML has completed most of its major field work during the 2007/08 season. It was highly successful with 18 vessels involved in the circum-Antarctic survey. Field work will continue in 2008/09 with the South American LA CAML consortium studying the Drakes Passage area, and Australia and Japan studying plankton north of Syowa. A dedicated CAML symposium will be held in Genoa, Italy, from 17 to 21 May 2009, with papers to be published in a *Deep-Sea Research II* volume.

9.22 Dr Hosie's report highlighted significant progress in the development of SCAR-MarBIN and its value to CCAMLR and the wider Antarctic community. However, funding is only secure to the end of 2009.

9.23 His report also noted the expansion of the SO-CPR Survey around Antarctica. Russia and the USA participated in 2007/08, extending coverage to the Amundsen and Bellingshausen Seas and the Drake Passage. South America and will commence regular tows in the Drakes Passage from 2008/09 and France also south of Hobart. New Zealand will use a fishing vessel between New Zealand and the Ross Sea as part of the Ministry of Fisheries Biodiversity Project.

9.24 The former Expert Groups on birds and seals have merged into the Expert Group on Birds and Marine Mammals. Ms Patterson-Fraser will be the Chief Officer and Prof. M. Bester (South Africa) will be the Deputy Chief Officer. Provisional terms of reference are in CCAMLR-XXVII/BG/42, paragraph 37.

9.25 SCAR has created three new Action Groups:

(i) Prediction on Changes in the Physical and Biological Environment of the Antarctic – the terms of reference are listed in CCAMLR-XXVII/BG/42, paragraph 49;

(ii) Antarctic Fuel Spills – created in response to the sinking of the MS *Explorer*;

(iii) Cold Seeps and Hydrothermal Vents in Antarctica – to identify areas likely to contain VMEs.

9.26 The 10th SCAR Biology Symposium will be held in Sapporo, Japan, from 26 to 31 July 2009. The main theme is 'Antarctic Biology in the 21st Century – Advances in and beyond IPY'. There will be a session on Marine Biodiversity and Processes. Details are available at http://scarbiologysymposium2009.jp.

9.27 Dr Hosie also referred to the report of the meeting by the SCAR/SCOR Oceanography Expert Group to develop the Southern Ocean Observing System. SOOS will encompass physical, biogeochemical and ecological processes (CCAMLR-XXVII/BG/43).

SCAR-MarBIN

9.28 Mr D. Delbare (Belgium) presented the report on the SCAR Marine Biodiversity Information Network (SCAR-MarBIN) (CCAMLR-XXVII/BG/25). SCAR-MarBIN is a database on marine biodiversity in the Antarctic, which provides free and open access via internet.

9.29 This database has proven its value for CCAMLR during the Workshop on Bioregionalisation in Brussels, Belgium, in 2007 and also during the review of all known or potentially vulnerable ecosystems carried out by the Australian Antarctic Division this year. SCAR-MarBIN has proved to be a useful tool and can play a crucial role in the CCAMLR environmental mandate to act in the Southern Ocean and to conserve marine biodiversity through the promotion of the rational exploitation of marine living resources.

9.30 The SCAR-MARBIN project was initiated in May 2005 by SCAR, with the support of the Sloan Foundation, through CML. Thereafter the project is seen as the Belgian contribution to the IPY and is funded by the Belgian Science Policy Office until the end of 2009.

9.31 For the period after 2009 sponsors are sought. This item was also presented at the 2007 ATCM meeting in Kiev, Ukraine, with little response.

9.32 SCAR-MarBIN is presently seeking to broaden its support basis. It plans to do so by establishing a consortium of partners willing to provide funding to sustain and provide further its services to the Antarctic community.

9.33 The Scientific Committee noted that WG-FSA has identified SCAR-MarBIN as a valuable source of information on VMEs, including data on the taxonomy, distribution and abundance of benthic fauna (Annex 5, paragraph 10.45).

Reports of observers from international organisations

ASOC

9.34 Dr R. Werner drew attention to the papers tabled by ASOC (CCAMLR-XXVII/BG/24, BG/26, BG/27 and BG/30).

9.35 With regard to the Antarctic krill fishery, ASOC welcomed the intersessional work of the Scientific Committee relating to the risk assessment for the Stage 1 subdivision of the precautionary catch limit among SSMUs in Area 48. However, ASOC was also concerned by the high level of uncertainty that is affecting progress with that subdivision. This is of special concern taking into account that krill fishing notifications continue to increase, with notifications for the coming season exceeding nominally the interim catch limit of 620 000 tonnes for Subareas 48.1 to 48.4.

9.36 ASOC considered that a coordinated research plan for krill fisheries management in Area 48 should be developed as a matter of urgency in order to reduce key uncertainties. In the meantime, CCAMLR should consider taking precautionary measures to prevent excessive concentration of catch in coastal areas close to predator colonies. These measures must be accompanied by increased accountability and enforcement mechanisms to ensure adherence to these new provisions.

9.37 Until such measures are in place, or a subdivision of the precautionary catch limit among SSMUs is established, ASOC believed that CCAMLR Members should not commit to an increase in krill fishing capacity.

9.38 In addition, CCAMLR needs to begin to develop feedback management procedures as soon as possible. Accordingly, the Scientific Committee needs to develop recommendations to adapt and expand the current CEMP to the needs of a feedback management system at the SSMU level. Concurrently, funding mechanisms should be adopted to support existing and expanded monitoring, such as a dedicated CEMP fund.

9.39 ASOC was deeply concerned by the uncertainties related to the reporting of current krill catches as recently stated by WG-EMM. As a matter of urgency, a standardised method for reporting green weight of krill catches and a requirement that all vessels utilise this method should be established.

9.40 Finally, ASOC was encouraged by the WG-EMM discussion on systematic scientific observer coverage for all krill vessels, and hoped that the Scientific Committee will provide clear advice to the Commission so as to adopt a conservation measure requiring krill fishing nations to have systematic coverage of international scientific observers on board, in accordance with the CCAMLR Scheme of International Scientific Observation.

9.41 With regard to the impacts of climate change on Antarctic marine ecosystems, climate change has emerged as an important topic in Antarctic research over the past decade, but little in the way of policy or operational change has resulted at CCAMLR thus far. Climate-related changes are accelerating, including regional alteration of sea-ice persistence and extent. Future reductions in sea-ice overall are likely to lead to major alterations in the distribution and abundance of Antarctic marine species.

9.42 ASOC welcomed the request made by the Commission to the Scientific Committee with regard to incorporating the issue of climate change into its agenda. In the context of ecosystem-based management of Antarctic fisheries, CCAMLR, through this Scientific Committee agenda item, should take into account the cumulative impacts of fishing and climate change. Due to the serious implications of climate change, a proactive rather than a reactive approach is required. ASOC encouraged the Scientific Committee to increase its work expeditiously to develop mechanisms through which climate change impacts can be distinguished from fishing effects, in order to provide the Commission with the necessary advice for the development of sound management decisions.

9.43 With regard to the implementation of Networks of MPAs in Antarctica and the Southern Ocean, ASOC welcomed the intersessional work conducted by CCAMLR and the Scientific Committee, especially in relation to the intention to initiate the process to develop representative systems of MPAs across the priority areas identified so far. Also, ASOC supported the proposed Joint SC-CAMLR–CEP Workshop where the issues of protected areas and spatial management measures were recognised as being of particular relevance.

9.44 CCAMLR is now in a position to begin the process of designating networks of comprehensive, adequate and representative MPAs, including marine reserves, in the Southern Ocean. This process should be guided by designation criteria to be developed jointly by CCAMLR and the ATCM, of which representativeness should be a key criteria. The decision to designate networks of representative MPAs embodies both the ‘precautionary’ and ‘ecosystem’ approaches to conservation and management that are at the core of CCAMLR’s conservation principles. ASOC welcomed systematic conservation planning and fine-scale bioregionalisation as useful tools to designate representative MPA networks, and hopes that these tools can be translated as soon as possible into specific recommendations by the Scientific Committee in this regard.

9.45 With regard to bottom fishing, ASOC noted that the Scientific Committee is currently preparing its advice to the Commission to meet the requirements of UNGA Resolution 61/105 by the December 2008 deadline. This resolution requires that all regulated high-seas bottom fisheries without adequate conservation measures to protect VMEs be closed. ASOC was encouraged by discussions in informal subgroups and urged the Scientific Committee to provide agreed advice to the Commission on how best to meet the UNGA commitment within the CAMLR Convention Area.

9.46 With regard to seabird by-catch:

(i) ASOC commended CCAMLR on its achievements in reducing the incidental mortality of albatrosses and petrels in Southern Ocean fisheries. CCAMLR leads on best-practice and has contributed to the implementation of smart-fishing initiatives on a global scale. Innovative mitigation measures applied by CCAMLR Members have resulted in a substantial decrease in the number of seabirds killed in the CCAMLR region by licensed longline vessels.

(ii) ASOC noted with pleasure that reported levels of seabird by-catch in French EEZs continued to decrease, and ASOC looked forward to longliners licensed by French authorities achieving the same low levels as other longliners in the Convention Area.

9.47 ASOC also commended CCAMLR for successfully reducing the level of IUU fishing. This result, coupled with the shift to gillnetting by IUU fishers, has resulted in a very substantial reduction in overall seabird by-catch.

9.48 Finally, the conservation status of seabirds threatened by fishing cannot be improved only by further CCAMLR action. Seabird populations in the Southern Ocean are still threatened as a result of fishing in adjacent waters. ASOC suggested that the Scientific Committee recommends that the Commission urges its Members to engage more fully with ACAP to ensure that all relevant Coastal States, Flag States and RFMOs licensing longline fishing within the range of Southern Ocean seabirds, adopt and enforce mitigation measures to reduce seabird mortality.

IUCN

9.49 The IUCN representative brought to the attention of the Scientific Committee that SC-CAMLR-XXVII/BG/36 was presented by IUCN for information to the Scientific Committee as it provided a summary of information on research and commercialised products arising from biological samples from the Antarctic region provided by the Antarctic Biological Prospecting Database, noting that 56% of the records in the database originate from the marine environment of the Southern Ocean.

9.50 It was also brought to the attention of the Scientific Committee that the 9th Conference of the Parties of the Convention on Biological Diversity (CBD) has recently adopted scientific criteria for identifying ecologically or biologically significant marine areas in need of protection as well as scientific guidance for designing representative networks of MPAs, and that the CBD is inviting governments and relevant organisations to provide their views on, and experiences with, the use of these criteria and guidance.

9.51 The IUCN representative also advised that a CBD expert workshop will be convened next year in order to provide scientific and technical guidance on the use and further development of biogeographic classification systems, and on the identification of areas beyond the national jurisdiction, which meet the adopted scientific criteria.

9.52 IUCN encouraged the Scientific Committee to contribute to this global effort, particularly given the excellent work that this Committee has done with regard to bioregionalisation of the Southern Ocean.

9.53 IUCN and its World Commission on Protected Areas (WCPA) will be compiling information on progress with regards to MPA networks and bioregionalisation. WCPA has a subgroup on Antarctica and the Southern Ocean that looks forward to collaborating with the Scientific Committee on this topic.

Reports of CCAMLR representatives at meetings of other international organisations

ACAP

9.54 The Scientific Committee noted the attendance of the Science Officer at the ACAP Seabird Bycatch Working Group (SC-CAMLR-XXVII/BG/7) and that this invitation reflected the high regard for CCAMLR in respect of seabird by-catch mitigation. The Scientific Committee noted the positive contribution of ACAP invited experts to WG-IMAF and looked forward to future interactions with ACAP on all issues related to seabird by-catch.

CWP

9.55 CWP provides a mechanism to coordinate fishery statistical programs of RFBs and other intergovernmental organisations with a remit for fishery statistics.

9.56 The Data Manager participated in the Intersessional Meeting of the CWP which was held at the NAFO Secretariat, Dartmouth, Canada, from 7 to 9 July 2008. Meeting outcomes of interest to the Scientific Committee were reported in SC-CAMLR-XXVII/BG/5, and included:

- further consideration of the possible use of MCS-related data in the collection of fishery statistics and monitoring data. Some organisations, which do not have access to detailed haul-by-haul catch and effort data, are developing ways of using VMS data to determine the levels of fishing efforts on fishing grounds;

- consideration of the use of electronic logbooks, and a request that CCAMLR provide information on its electronic data forms (e.g. C1, C2, TAC, observer) at CWP-23;

- agreement to revise the CWP Handbook to reflect changes in data requirements which have emerged though ecosystem-based fishery management (see also paragraph 13.4);

- initiation of work on the integration of RFB databases on fisheries statistics, and especially those based on STATLANT data.

IWC

9.57 Dr K.-H. Kock (Observer to IWC) reported on the 60th Meeting of the Scientific Committee of the International Whaling Commission held in Santiago de Chile, from 1 to 13 June 2008.

9.58 A total of 2 214 whales were reported as being killed in 2007. Japan took 551 minke whales and 3 fin whales in the Southern Ocean while whaling under a special scientific permit. Some progress had been made to reconcile the very different abundance estimates obtained during the three circumpolar surveys (CPS I–III) conducted over the last 30 years.

9.59 One of the great unknowns is still the number of minke whales present in the pack-ice which is not accessible during scientific surveys. A number of recent estimates of humpback whale abundance on both sides of Africa demonstrated that these had recovered to various degrees (27–90%) from past exploitation. Past whaling reduced the number of blue whales from 256 000 (235 000–307 000) to 395 (235–804) in 1963 when further takes of blue whales were prohibited. Blue whale abundance was last estimated reliably in 1997 when it was 2 280 (0.9% of the initial size).

9.60 The IWC will hold a second workshop on climate change focusing on the Arctic, the western Antarctic and Bangladesh, probably in March 2009.

Future cooperation

9.61 The Scientific Committee noted a number of international meetings of relevance to its work and nominated the following observers and representatives:

- 11th session of the IOTC Scientific Committee, 5 to 9 November 2008, Seychelles – to be advised
- SCAR-MarBIN Workshop, 8 and 9 November 2008, Valencia, Spain – to be advised;
- Southern Seabird Solutions Trust review workshop, 10 and 11 November 2008, Nelson, New Zealand – to be advised;
- World Conference on Marine Biodiversity and Ecosystem Functioning (MarBEF), 11 to 15 November 2008, Valencia, Spain – to be advised;
- IWC workshop on climate change, 3 to 6 March 2009 (to be confirmed), near Siena, Italy – to be advised;
- CEP XII, 3 to 11 April 2009 (including SC-CAMLR-CEP Workshop), Baltimore, MD, USA – Scientific Committee Chair and CCAMLR Science Officer;
- Monitoring Climate Change Impacts – Establishing a Southern Ocean Sentinel Program (5-day CEP workshop), 20 to 24 April 2009, Hobart, Australia – to be advised;

- ICES Symposium 2009: Issues confronting the deep oceans: the economic, scientific and governance challenges and opportunities of working in the deep sea, 27 to 30 April 2009, Azores, Portugal – to be advised;

- ICES Working Group on Fisheries Acoustic Science and Technology (WGFAST), 18 to 22 May 2009, Ancona, Italy – to be advised;

- Biennial Fisheries Observers Conference, 19 to 24 July 2009, Portland, Maine, USA – Secretariat;

- 61st Annual Meeting of the SC-IWC, 31 May to 26 June 2009, Madeira, Portugal – Dr Kock;

- 3rd GLOBEC Open Science Conference, 22 to 26 June 2009, Victoria, British Columbia, Canada – Australia (Dr Kawaguchi);

- 10th SCAR Biology Symposium, 26 to 31 July 2009, Sapporo, Japan – SCAR Liaison Officer (Dr Hosie);

- Fifth Regular Session of the WCPFC Scientific Committee, 10 to 21 August 2009 (dates to be confirmed, venue to be determined) – to be advised;

- ICES Annual Science Conference, 21 to 25 September 2009, Berlin, Germany – to be advised;

- 14th Meeting of the CCSBT Scientific Committee (dates and venue to be advised) – to be advised;

- 5th Annual Meeting of the SEAFO Scientific Committee (dates and venue to be advised) – to be advised.

9.62 The Scientific Committee encouraged other representatives to participate, where possible, in these meetings, and report back to the 2009 meeting of the Scientific Committee.

REPORT OF THE CCAMLR PERFORMANCE REVIEW PANEL

10.1 The Scientific Committee reviewed the Report of the CCAMLR Performance Review Panel (PRP) (CCAMLR-XXVII/8) as mandated by the Commission at its meeting in 2007 (CCAMLR-XVI, Annex 7, paragraph 10). This item was considered as a separate item on the Scientific Committee's agenda.

10.2 The Scientific Committee considered general aspects of the PRP report and derived a plan for how recommendations made in the report could be considered, both during 2009 and beyond. PRP recommendations and subitems considered to be applicable to the Scientific Committee's work were identified in CCAMLR-XXVII/BG/39 and are provided in Table 5. However, the Scientific Committee agreed that all subitems under each recommendation should be examined to determine which ones were applicable to its work and how they were to be undertaken.

General comments

10.3 The Scientific Committee congratulated the PRP for their diligence in providing a very comprehensive report written over a very short period. The Scientific Committee agreed that the PRP's analysis of the scientific mission and activities was very thorough and illustrated a deep understanding of science in CCAMLR and how it relates to the Commission's objectives on the conservation of Antarctic marine living resources as contained in Article II.

10.4 The Scientific Committee appreciated comments made by the PRP concerning the status of advice provided to the Commission. The Scientific Committee was pleased to note that the PRP recognised the 'uniqueness' of CCAMLR because of its strong conservation credentials along with the precautionary principle and ecosystem approach (CCAMLR-XXVII/8, Item 1.3). The Scientific Committee noted that the PRP recognised that CCAMLR is particularly advanced in its development and use of methods to manage prey species so as to protect dependent predators, in assessing and limiting fishery impacts on by-catch species, and in providing a structured and precautionary process for the orderly development of new and exploratory fisheries (CCAMLR-XXVII/8, paragraph 3.1.1.16). The Scientific Committee acknowledged several similar views of the various scientific aspects of CCAMLR were provided by the PRP.

10.5 The Scientific Committee noted that readers, especially non-CCAMLR readers, stood the danger of concluding that CCAMLR performance was deficient if they only read the Executive Summary and Summary of Recommendations sections of the report. Failure to read the entire report would result in the reader not being aware of the many positive aspects identified by the PRP.

10.6 The Scientific Committee further noted that the PRP had indicated that for almost every aspect of the report, recommendations of additional work were identified. Many of these, if implemented, would require a large amount of resources, both of financial and personnel.

10.7 The Scientific Committee recognised the role that science in CCAMLR plays in the Antarctic Treaty System and in the international community as a whole. It was noted that science in CCAMLR has recently expanded its role from the traditional fishery-oriented role to a broader international role (e.g. climate change, MPAs etc.).

10.8 However, as discussed elsewhere in this report, the Scientific Committee recognised that it lacked the resources to adequately meet its objectives. This is because of several reasons, including costs associated with sending scientists to meetings, loss of expertise to other competing national programs, and failure of some Members to send representatives to working group meetings (paragraph 16.7).

10.9 The Scientific Committee endorsed the proposal that a way to ensure that critical information reaches the Scientific Committee and its working groups was to invite submission of relevant papers (e.g. VME/benthos, climate change etc.) from non-Member scientists. These papers could be submitted with long lead times, maybe two months prior to the start of a working group meeting. The Chair of the Scientific Committee and the conveners of the working groups could then decide which papers were relevant to its agenda and then distribute appropriate papers. This would not result in additional travel costs or time associated with attending the meeting.

PRP recommendations relative to the Scientific Committee

10.10 The Scientific Committee agreed that all aspects of the 10 general recommendations (Table 5) made by the PRP, as well as those found in the subitems, should be considered. The Scientific Committee further agreed that three recommendations should be reviewed during the coming intersessional year and that the additional recommendations should be taken up on a longer-term basis. The three recommendations to be considered during this coming year are Items 2.4 (Protected Areas), 3.1 (Status of Living Resources) and 3.2 (Ecosystem Approach).

10.11 The Scientific Committee requested that the Chair, during the intersessional period, form a Steering Committee to develop a 'roadmap' (plan of action) to provide direction to the various Scientific Committee working groups on how the three highest-priority recommendations can be addressed and how the remainder might be addressed in the future. The objective of this work is to ensure the Scientific Committee is able to provide advice to the Commission on these topics at its 2009 meeting.

BUDGET FOR 2009 AND FORECAST BUDGET FOR 2010

11.1 The agreed budget of the Scientific Committee for 2009 and the forecast budget for 2010 are summarised in Table 6. The notes in Table 6 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 one Secretariat staff (full meeting) and one Secretariat staff (2 days secretarial support) based on the assumption that the meeting will be held in association with the meeting of WG-EMM.

(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, computing facilities, report editing, translation and publication as annexes to the report of the Scientific Committee.

(4) Preparation and support for the annual meeting of WG-IMAF, computing facilities, report editing, translation and publication as annexes to the report of the Scientific Committee.

(5) 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 one Secretariat staff.

(6) Preparation and support for the Workshop on VMEs, report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs for three Secretariat staff.

(7) Costs associated with the Joint CCAMLR-IWC Workshop held in August 2008 (see SC-CAMLR-XXVI, paragraph 11.1).

(8) Preparation and support for the meeting of ad hoc TASO, report editing, translation and publication as an annex to the report of the Scientific Committee, and participation costs for Secretariat staff based on the assumption that the meeting will be held in association with the meeting of WG-EMM.

(9) Participation costs for five invited experts at working group meetings and workshops in 2009 (SG-ASAM: two invited experts; Workshop on VMEs: three invited experts).

(10) Estimated cost of producing a waterproof colour poster highlighting the danger to wildlife of debris disposal in the Convention Area (Annex 6, paragraph 12.12), translated into all CCAMLR languages, as well as Indonesian, Korean and Japanese. The Scientific Committee endorsed the production of 500 perspex-backed A3-size posters (A$6 000 including set-up cost and postage).

(11) Participation costs for one Secretariat staff at the Sixth International Fisheries Observer Conference in 2009.

11.2 The Scientific Committee noted that the deferred amount for the independent external review of the GYM held in the Special Science Fund will be repaid into the General Fund in 2009 as this amount was not utilised within the approved timeframe. The Fund currently holds an amount for part of the review of the *Scientific Observers Manual*, and the Scientific Committee agreed to carry this amount forward.

11.3 The Scientific Committee agreed to publish the report of the Joint CCAMLR-IWC Workshop as an annex to the report of the Scientific Committee. It noted that any remaining workshop funds would be transferred to the Special Science Fund, pending consideration of partial funding of a special publication arising from the work of the Joint CCAMLR-IWC Workshop.

11.4 The Scientific Committee endorsed the following expenditures under the Commission's budget for 2009:

(i) editorial support for the production of *CCAMLR Science*;

(ii) level funding of A$12 000 for language support for *CCAMLR Science*;

(iii) electronic dissemination of *CCAMLR Science* via the CCAMLR website;

(iv) completion of the 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 for use in the krill fishery;

(v) 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;

(vi) participation cost for the Chair of the Scientific Committee and the Science Officer at the 2009 meeting of the CEP.

11.5 The Scientific Committee sought further advice of the Commission on how the annual work required to address the UNGA resolution on bottom fishing can be accommodated in the already large workload of the Scientific Committee and its working groups (SC-CAMLR-XXVI, paragraph 11.7).

11.6 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 Scientific Committee recognised the need for a Science Plan in order to allocate priorities to its work and that of its working groups. The Scientific Committee sought further advice of the Commission on how CCAMLR may meet its expanding scientific requirements and manage its activities in the long term (SC-CAMLR-XXVI, paragraph 11.7).

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; the primary advice is provided elsewhere in this report.

Advice to SCIC

Mitigation measures to avoid incidental mortality of birds and mammals

12.2 The Scientific Committee noted that WG-IMAF (Annex 6, paragraph 2.49) had explicitly identified those vessels that did not achieve full implementation of the requirements of Conservation Measures 26-01, 25-02 and 25-03 and recommended that this information be passed to SCIC in order to facilitate an assessment of compliance. The vessels and aspects of the conservation measures involved were:

(i) *Antarctic Bay, Argos Froyanes*, *Shinsei Maru No. 3, Austral Leader II* and *Koryo Maru 11* which had plastic packing bands to secure bait boxes on board during cruises in the Convention Area (Annex 6, paragraph 2.30);

(ii) gear debris from the *Viking Bay* and the *Koryo Maru 11* and the discharge of garbage from the *Viking Bay* (Annex 6, paragraph 2.31);

(iii) *Koryo Maru 11* and the *Hong Jin No. 707* which exceeded the maximum spacing between weights on longlines (Annex 6, paragraph 2.32);

(iv) *Viking Bay* due to the discharge of hooks in offal (Annex 6, paragraph 2.38);

(v) *Insung No. 1* and *Antartic III* which used streamers that did not meet the minimum length specified (Annex 6, paragraph 2.41);

(vi) *Punta Ballena* which did not use haul-scaring devices on all hauls (Annex 6, paragraph 2.44);

(vii) *Maksim Starostin*, which used a net monitor cable during one krill trawl (Annex 6, paragraph 2.46);

(viii) *Dalmor II* which discharged offal during net hauling while trawling for krill (Annex 6, paragraph 2.47).

Scientific tagging program

12.3 The Scientific Committee noted the discussion of the implementation of the tagging program contained in the report of WG-FSA (Annex 5, paragraphs 3.46 to 3.63 and 5.81) and agreed that while the requirement to enter recapture details in logbooks, to provide photographs and return the tags to the Secretariat involved some redundancy, it allowed for improved validation. However, it recognised that digital images could be manipulated, therefore photographic evidence may not alone be evidence of a tag-return.

12.4 The Scientific Committee agreed that the Secretariat should check for correct transcription of returned tags, including all alphanumeric characters, further noting that a requirement to return all recovered tags was not currently part of Conservation Measure 41-01. The Scientific Committee was optimistic that the Secretariat-based centralisation of the tagging program in new and exploratory fisheries would go some way to addressing these issues into the future.

12.5 The Scientific Committee noted that there are two types of recording errors that could lead to a discrepancy in the rates of tagging and recapture reported by vessels and observers. These errors could be characterised as ‘accidents and non-compliance’ and it noted that it would be useful to separate detection and remediation methodologies for each type of error.

12.6 The Scientific Committee recognised that there is a clear incentive for a vessel to report the rate of tagging in order to comply with conservation measures. However, there is currently no such formal assessment of recapture rates, and it may be possible to manipulate recapture rates (and hence to influence the outcomes of assessment models) by reporting recaptures with incomplete data so as to make matching to a release record difficult or impossible.

12.7 The Scientific Committee noted the situation of a vessel that did not achieve the required tagging rate of three fish per tonne in Divisions 58.4.1 and then proceeded to fish in Divisions 58.4.3a and 58.4.3b and tag above the required rate. The Scientific Committee noted that the increased tagging outside Division 58.4.1 did not meet the objectives of the tagging program, and was concerned that such a situation may indicate that sufficient tags were not released throughout the fishing operation. The Scientific Committee noted that this issue was more appropriately considered by SCIC.

12.8 An investigation of tagging rate per vessel was plotted against time to check whether tagging was carried out at the same rate as fishing in accordance with Conservation Measure 42-01 (Annex 5, Figure 4). The results were very variable, with some vessels tagging at the correct rate throughout fishing, whilst other vessels initially released very few tags and the tagging rates sharply increased in the middle or at the end of the fishing period. The Scientific Committee was concerned that relatively high tagging rates over very short periods of time could be detrimental to the condition of the fish on release, and was not consistent with the required distribution of tagged fish throughout the area. The Scientific Committee recommended this issue be referred to SCIC and noted particular attention might need to be drawn to Conservation Measure 42-01 and changes made last year to address this issue.

Discrepancy between fine-scale catch reporting and CDS records

12.9 The Scientific Committee noted that last year WG-FSA (SC-CAMLR-XXVI, Annex 5, paragraph 4.29) questioned the occurrence of *D. eleginoides* in catches reported by the then Uruguayan-flagged vessel *Paloma V* which fished in Divisions 58.4.1 and 58.4.3b in 2006/07. The *Paloma V* had reported the majority of its catch from those divisions as being *D. eleginoides* (80% of the catch in Division 58.4.1; 92% in Division 58.4.3b), while the landings reported in the CDS indicated that the catch consisted mostly of *D. mawsoni*. In 2008 the Secretariat contacted the Uruguayan authorities to seek clarification and advice on the fine-scale data submitted by the *Paloma V* when the vessel fished in Divisions 58.4.1 and 58.4.3b in 2006/07, and to confirm the identity of toothfish species reported in the data. Uruguay confirmed that the catches of *D. eleginoides* reported in the fishery and observer data were correct, and that a discrepancy had occurred in the CDS data; this discrepancy was addressed (Annex 5, paragraph 3.5). The Scientific Committee considered that it may be appropriate that SCIC consider this issue further.

Bottom fishing notifications in accordance with Conservation Measure 22-06

12.10 The Scientific Committee considered the preliminary assessments and proposed mitigation measures provided by Members (CCAMLR-XXVII/26) to avoid and mitigate significant adverse impacts on VMEs and noted that only five out of 12 proposals contained such preliminary assessments. Furthermore, there was a large variation in substance of the preliminary assessments (paragraphs 4.223 to 4.225).

12.11 The Scientific Committee agreed that a common approach is needed for providing these assessments, similar to the requirements for notifying exploratory fisheries. It agreed that some consistency is needed in the provision of information, based on the requirements set out in paragraphs 7(i) and (ii) in Conservation Measure 22-06, and recommended a pro forma as described in Annex 5, Table 20, be used in future.

IUU gillnet fisheries

12.12 The Scientific Committee noted that the number of IUU fishing vessels observed in 2007/08 declined (Annex 5, paragraph 3.14). However, as the IUU fleet is increasingly dominated by gillnet vessels, there is currently no information to estimate the catch of these vessels, or the impact of gillnets on target and by-catch species, seabirds and marine mammals (Annex 6, paragraphs 5.8 to 5.10).

Data quality checking procedure

12.13 The Scientific Committee noted the methodology for assessing data quality that had been considered by WG-SAM and WG-FSA (WG-SAM-08/13) and noted that this could be used by SCIC with respect to the identification of vessels which did not comply with the CCAMLR data-reporting requirements. The Scientific Committee endorsed the recommendation of WG-FSA that the authors of WG-SAM-08/13 continue to develop a series of data-quality metrics in conjunction with the Secretariat during the intersessional period, and report progress to WG-SAM.

SECRETARIAT SUPPORTED ACTIVITIES

Data Management

13.1 The Scientific Committee noted the Data Manager's report on the work conducted in 2007/08 in support of the Secretariat's Data Management Function, and measures taken to maintain the integrity of CCAMLR data (SC-CAMLR-XXVII/BG/3). The Scientific Committee noted that the volume and complexity of this work continued to increase (SC-CAMLR-XXVII/BG/3, Figure 1), and that work had involved:

(i) database administration and maintenance, processing and validation of data submitted in 2007/08, revision of data forms in accordance with the decisions of the Commission and Scientific Committee, and the further development of database structures, routines and documentation;

(ii) data analysis and reporting for the Scientific Committee and its working groups and subgroups, and the Joint CCAMLR-IWC Workshop;

(iii) monitoring of 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) development of international collaborations, including contributions to the work of CWP, FIRMS and SCAR-MarBIN.

STATLANT Data

13.2 The Scientific Committee noted that the Secretariat had implemented the new approach agreed in 2007 to improve the quality of STATLANT data which are submitted annually by Contracting Parties (SC-CAMLR-XXVI, paragraphs 13.5 to 13.11; CCAMLR-XXVI, paragraph 4.89). The new approach had resulted in a marked improvement in the quality of STATLANT data on fishing effort and catches of by-catch species.

13.3 The Scientific Committee also noted that the improved STATLANT data now included a summary of catch data on incidental mortalities associated with fishing (IMAF). The Scientific Committee considered a proposal (SC-CAMLR-XXVII/BG/3) to include these STALTANT IMAF data in the reporting of CCAMLR fishery statistics in the *CCAMLR Statistical Bulletin*.

13.4 The Scientific Committee requested that the Secretariat develop an example of the type of table proposed to summarise the STATLANT IMAF data in the *Statistical Bulletin*, and distribute this example to Members intersessionally. Subject to Members' review, this summary of STATLANT IMAF data may be published in the forthcoming volume of the *Statistical Bulletin*. Such a summary may also serve to encourage the CWP to establish this reporting procedure across all of its Members.

Catch and effort data

13.5 The Scientific Committee endorsed WG-FSA's recommendation to modify the longline haul-by-haul catch and effort data form (C2 data) in order to capture variability in trotlines (Annex 5, paragraph 11.8):

- the number of hooks in a cluster
- the number of clusters on a dropline
- the spacing between the droplines
- the spacing between the hook clusters
- the distance of the lowest cluster of hooks above the bottom.

13.6 The Scientific Committee also endorsed WG-FSA's recommendation that when a vessel sets two sections of line that are joined under water, they be reported as two independent sets, the geographical start and finish positions of these sets being the positions of the anchors or grapnels.

Metadata

13.7 The Scientific Committee endorsed the steps proposed by the Secretariat (SC-CAMLR-XXVII/BG/4) to establish CCAMLR metadata in accordance with the Commission's decision (CCAMLR-XXVI, paragraph 4.89). These steps included:

(i) using the Global Change Master Directory (GCMD; see http://gcmd.nasa.gov) as the repository for metadata;

(ii) creating a GCMD portal for CCAMLR under the administration of the Secretariat;

(iii) identifying metadata classifications for CCAMLR fishery and research data;

(iv) creating and managing CCAMLR metadata records on the CCAMLR portal.

D4Science Project

13.8 The Scientific Committee noted the development of the D4Science Project, a European e-Infrastructure project, which aims to establish a grid-based network to meet the emergent needs of scientific communities affiliated with environmental monitoring and fisheries and aquaculture resources management (SC-CAMLR-XXVII/BG/3).

13.9 In the context of ecosystem modeling, the D4Science Project is developing a networked data environment to facilitate experiments with new assessment models, and may provide a platform to develop global concepts and standards for the exchange of ecosystem model summary data, such as the data used at the Joint CCAMLR-IWC Workshop.

13.10 The Scientific Committee requested that the Secretariat investigate the potential application of the D4Science Project to the work of CCAMLR, and report to WG-SAM and WG-EMM in 2009.

Rules for Access and Use of CCAMLR Data

13.11 The Scientific Committee did not provided any new advice on this matter.

Publications

13.12 The Scientific Committee noted that the following documents had been published in 2008 in support of its work:

(i) Report of the Twenty-sixth Meeting of the Scientific Committee
(ii) *CCAMLR Science*, Volume 15
(iii) *CCAMLR Scientific Abstracts 2007*, available on the CCAMLR website
(iv) *Statistical Bulletin*, Volume 20
(v) Revisions to the *Scientific Observers Manual*.

13.13 The Scientific Committee also noted the development of a web-based archive of meeting documents (CCAMLR-XXVI, paragraphs 14.3 and 14.4). During 2008 work has progressed and a modified reference library containing links to meeting documents is now available on the CCAMLR website under the relevant Commission and Scientific Committee password-protected sections.

13.14 Development has also been undertaken of a searchable, database-driven web archive. This consists of a single publicly accessible webpage containing a number of search fields. Users can search based on title, keywords, author and year. Users may also browse through the entire archive, with documents sorted by meeting and year.

13.15 Users are able to view the listing of search results for all documents held within the database, however, meeting documents are secured using a username and password combination in accordance with the security protocols of the existing document archive, thereby retaining the hierarchy of privilege currently in use. As a result, although the search results are visible, users are not able to view or save the documents unless logged in.

13.16 This archive has also been expanded to include a database of all publicly available documents, including publications and *CCAMLR Science*. These do not require a username or password to view or save documents.

13.17 The Scientific Committee congratulated the Secretariat for establishing a web-based library which will greatly improve Members' access to reference documents.

CCAMLR Science

13.18 In 2007 the Scientific Committee requested that the Editor, in consultation with the Chair of the Scientific Committee and the conveners of the working groups, prepare a revision of the publication policy of *CCAMLR Science*, including consideration of the procedure for selecting papers (SC-CAMLR-XXVI, paragraphs 13.24 and 13.25).

13.19 The Scientific Committee noted the advice on this matter provided by WG-SAM (Annex 7, paragraph 7.6), WG-EMM (Annex 4, paragraphs 9.10 to 9.14) and WG-FSA (Annex 5, paragraphs 14.5 to 14.8). Contributions by scientists from outside the CCAMLR membership were further considered in paragraphs 10.8 and 10.9.

13.20 The Scientific Committee congratulated the Science Officer for his revision, and endorsed the revised publication policy and procedure for selecting papers for publication, and enhanced role of the Editorial Board (SC-CAMLR-XXVII/6).

13.21 In encouraging a greater involvement of the Editorial Board in the process from submission to publication, the Scientific Committee encouraged the inclusion of relevant experts as members of the Editorial Board. The Scientific Committee requested that where such experts were identified, the Science Officer (Editor in Chief) should work with the Chair of the Scientific Committee to send letters of invitation to join the Editorial Board.

13.22 The Scientific Committee also requested that the Secretariat consider further ways to raise the impact factor of *CCAMLR Science*, and more generally to develop CCAMLR's outreach to the science community and beyond. Options may include the development of a newsletter, and greater use of web-based dissemination.

13.23 The Scientific Committee encouraged Members to continue contributing high-quality scientific papers of relevance to CCAMLR so as to ensure that *CCAMLR Science* continues to publish the best science available.

SCIENTIFIC COMMITTEE ACTIVITIES

Coordination of work of the Scientific Committee and its working groups

14.1 The Scientific Committee recognised that, as in previous years, there had not been time at the meeting for the working group conveners and the Chair of the Scientific Committee to consider the prioritisation of tasks for the future work of the Committee and its working groups. Therefore, the Scientific Committee recognised that there was a need to find a mechanism to progress the work of identifying those scientific priorities. The Chair of the Scientific Committee was tasked with identifying and implementing such a process.

14.2 The Scientific Committee noted that there was considerable overlap between the requirement to identify long-term scientific priorities and the tasks identified in paragraph 10.11 arising from the recommendations of the PRP and that a common approach should be adopted where possible.

Intersessional activities during 2008/09

14.3 The Scientific Committee accepted with great pleasure Norway's invitation to host the 2009 meetings of WG-SAM and WG-EMM, and the second meeting of ad hoc TASO, from 29 June to 17 July 2009 in Norway (exact venue to be confirmed).

14.4 The Scientific Committee agreed to the following meetings in the 2008/09 intersessional period:

- Joint SC-CAMLR-CEP Workshop, Baltimore, USA, 3 and 4 April 2009;
- SG-ASAM in Ancona, Italy, 25 to 29 May 2009 (Co-conveners Drs Watkins and O'Driscoll);
- WG-SAM in Norway, 29 June to 3 July 2009 (Convener Dr Constable);
- ad hoc TASO, Norway, 4 and 5 July 2009 (Co-conveners Dr Welsford and Mr Heinecken);
- WG-EMM, Norway, 6 July to 17 July 2009 (Convener Dr Watters). The FEMA2 Workshop will be held as a Focus Topic during the first week of WG-EMM and will be co-convened by the Conveners of WG-EMM and WG-FSA;
- Workshop on VMEs, Washington DC, USA (Co-conveners Drs Martin-Smith and Jones, venue and timing of meeting to be announced by December 2008);
- WG-FSA at CCAMLR Headquarters, Hobart, Australia, 12 to 23 October 2009 (Convener Dr Jones);
- WG-IMAF at CCAMLR Headquarters, Hobart, Australia, 12 to 16 October 2009 (Co-conveners Ms Rivera and Mr Walker).

14.5 The Scientific Committee endorsed the approach outlined in paragraph 10.9 for the Working Group meetings in the coming year, noting that it would be useful to involve scientists interested in the work of CCAMLR not only from non-Members but also from institutions not normally associated with SC-CAMLR.

CCAMLR-IPY projects

14.6 The Scientific Committee noted the participation of Members in a range of IPY surveys during the intersessional period. The Scientific Committee, *inter alia*:

- strongly endorsed initiatives undertaken as part of the IPY-CAML and noted that these initiatives were a great example of the successful cooperation and coordination that could take place between countries within the Antarctic Treaty System;

- noted IPY-CAML provided opportunity for scientists from Member countries to collaborate in the planning and undertaking of shared research and in the shaping of a new era in polar science;

- noted that the analyses from the Australian, French, German, Japanese, New Zealand, Norwegian and Russian IPY surveys and the 18 countries participating in the CAML surveys were well under way, the results of which would assist CCAMLR with its conservation of the unique Antarctic marine environment. The census would also strengthen understanding of the impact of significant global changes such as climate change.

14.7 Dr Constable, on behalf of Australia, thanked the many countries that have participated in CCAMLR projects on 18 major research vessels. These projects have contributed to nearly 1 million georeferenced records across 8 500 validated species in the SCAR-MarBIN data portal. Australia encouraged all Members to support ongoing data analysis and synthesis activities in support of CAML, and to contact the Census Coordinator at the Australian Antarctic Division for any further information.

Invitation of observers to the next meeting

14.8 The Scientific Committee agreed that all observers invited to the 2008 meeting would be invited to participate in SC-CAMLR-XXVIII.

Invitation of experts to the meetings of working groups

14.9 The Scientific Committee agreed that up to two experts may be invited to the meeting of SG-ASAM and that three invited expert would be invited to the Workshop on VMEs.

Next meeting

14.10 The next meeting of the Scientific Committee is scheduled at CCAMLR Headquarters in Hobart, Australia, from 26 to 30 October 2009.

ELECTION OF CHAIR AND VICE-CHAIR OF THE SCIENTIFIC COMMITTEE

15.1 The Scientific Committee sought nominations for a new Chair. Dr Iversen nominated Prof. Moreno. This nomination was seconded by Dr V. Siegel (European Community) and the Scientific Committee unanimously elected Prof. Moreno to the position for a term of two regular meetings (2009 and 2010). A very warm welcome was extended to the incoming Chair.

15.2 Dr Sullivan's term as Vice-Chair ended with this meeting and the Scientific Committee sought nominations for a new Vice-Chair. Dr Iversen nominated Dr Bizikov. This nomination was seconded by Dr Pshenichnov and the Scientific Committee unanimously elected Dr Bizikov to the position for a term of two regular meetings (2009 and 2010). A very warm welcome was extended to the incoming Vice-Chair.

15.3 The Scientific Committee thanked Dr Sullivan for his significant contribution to its work (see also paragraph 18.6).

OTHER BUSINESS

CCAMLR website password rationalisation

16.1 The Scientific Committee considered the Secretariat's proposal to rationalise the password system on the CCAMLR website (CCAMLR-XXVII/27). The main elements of this proposal were to use:

(i) a single username and password combination to allow access for Members to all restricted sections of the Commission;

(ii) a single username and password combination to allow access for Members to all restricted sections of the Scientific Committee;

(iii) a single username and password combination to allow attendees (NGOs and observers) access limited to Commission and Scientific Committee meeting information, but only for the current meeting;

(iv) a single username and password combination to allow access for invited experts to the relevant meeting information, but only for the current meeting.

16.2 Further, the Scientific Committee noted that this proposal would minimise Secretariat staff time and effort in administering usernames and passwords and would provide more user-friendly access to the restricted sections of the website for Members. The administrative effort required on the part of the official Member contacts to disseminate this information should also be reduced accordingly.

16.3 The Scientific Committee also noted that the current arrangement for CDS and Acceding States would remain unchanged.

16.4 The Scientific Committee noted that this change would facilitate greater integration across working groups and would not decrease the overall level of security compared to the current system. It congratulated the Secretariat on this proposal, and endorsed this rationalisation.

Capacity building

16.5 The Scientific Committee noted with concern that the workload of WG-FSA, and that of other working groups, has increased in recent years, while the number of participants and Members represented had decreased over the same period. As a result, the growing workload was shared by fewer participants, and WG-FSA was no longer able to address all of its tasks to the level of detail expected by the Scientific Committee. In this context, it noted the advice of WG-FSA that the move to a biennial assessment for three stocks had been extremely successful in releasing time during the intersessional period and at the meetings of WG-SAM and WG-FSA (Annex 5, paragraph 12.6).

16.6 The Scientific Committee agreed that development of a medium- to long-term Science Plan is urgently needed in order to address the competing demands of the Commission, facilitate coordination among working groups and assign research priorities. In the absence of a Science Plan, the Scientific Committee noted that WG-FSA would continue to address topics which it thought were of a high priority to the Scientific Committee. Such work would be limited by the time available at meetings, and by the number of participants and their areas of expertise.

16.7 The Scientific Committee reiterated its concern of the declining involvement of Members in the working groups. Those Members unable to attend can often have difficulty in understanding the outcomes and advice of the working groups. Under some circumstances, those Members may not be able to fully participate in discussions at the Scientific Committee and, in some instances, decisions have had to be delayed to subsequent years. Most Members agreed that this situation can delay timely advice on matters of importance to the Commission, particularly advice needed for achieving the objectives in Article II.

16.8 The Scientific Committee urged Members to consider ways of capacity building, including augmenting participation in the work of WG-FSA and other working groups.

Year-of-the-Grenadier

16.9 The Scientific Committee recalled a proposal to conduct the Year-of-the-Grenadier in 2010 (SC-CAMLR-XXVI, Annex 5, paragraph 6.39). However, the Scientific Committee agreed with WG-FSA to defer this activity provisionally until 2011 as the procedures established for the Year-of-the-Skate, and the ensuing results, can then be evaluated.

Year-of-the-VMEs

16.10 The Scientific Committee endorsed the proposal of WG-FSA to designate 2010 as the Year-of-the-VMEs in order to focus further research activities aimed at developing approaches to avoid and mitigate significant adverse impacts of bottom fishing on VMEs.

Reports of Members' Activities

16.11 The Scientific Committee reiterated its advice to the Commission that the Reports of Members' Activities are not required in its work, or that of its working groups (SC-CAMLR-XXIV, paragraphs 15.1 to 15.5).

ADOPTION OF THE REPORT

17.1 The report of the Twenty-seventh meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

18.1 In closing the meeting, Dr Sullivan thanked the conveners of the working groups, coordinators of other groups and all participants for their hard work during the meeting and intersessional period, and all Secretariat staff for their dedicated support. Earlier, Dr Sullivan also thanked the interpreters for facilitating the plenary discussions. These collective efforts had resulted in further advances in the work of the Scientific Committee. Dr Sullivan noted that he was unlikely to attend the Scientific Committee meeting next year but would be involved in CCAMLR again in future years.

18.2 Dr Miller presented posthumously Dr Fanta's gavel in recognition of her term as Chair of the Scientific Committee (2005–2007). Dr Miller invited the Scientific Committee to sign a book of condolences which will be forwarded to Dr Fanta's family.

18.3 Dr Miller noted Dr Holt's imminent retirement and, on behalf of the Secretariat, presented him with a small gift.

18.4 Dr Constable, on behalf on the Scientific Committee, expressed his deep appreciation to Dr Holt's outstanding contribution to the work of CCAMLR.

18.5 Dr Miller also presented a gavel to Dr Sullivan for chairing the meeting of the Scientific Committee.

18.6 Dr Constable also thanked Dr Sullivan for expertly leading the Scientific Committee through its deliberations.

18.7 The meeting was closed.

REFERENCES

Thomson, R.B., D.S. Butterworth, I.L. Boyd and J.P. Croxall. 2000. Modelling the consequences of Antarctic krill harvesting on Antarctic fur seals. *Ecol. Appl.*, 10 (6): 1806–1819.

Table 1: Catches (tonnes) of target species reported in 2007/08 (December 2007 to October 2008) (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	58.4.4*	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Icefish																		
Champsocephalus gunnari	Australia												199					199
	Chile			360														360
	Korea, Republic of			249														249
	UK			716														716
Total (icefish)**		0	0	1 326	0	0	0	0	0	0	0	0	199	0	0	0	0	1 524
Toothfish																		
Dissostichus eleginoides	Argentina															<1		<1
	Australia									<1			1 496					1 497
	Chile			388														388
	France***											2 853		684				3 537
	EC – Spain			814			<1									2		816
	Japan									36	77							113
	Korea, Republic of			53			<1									3		56
	Namibia						<1	<1		<1								1
	New Zealand			457	49											1		507
	Russia															<1	<1	<1
	South Africa			310										20	34	<1		364
	UK			1 584	49													1 632
	Uruguay			249					9	4						<1		263
Dissostichus mawsoni	Argentina															<1		<1
	Australia									2								2
	EC – Spain						66									44		110
	Japan									72	<1							72
	Korea, Republic of						277	82								423		782
	Namibia						59	134		21								214
	New Zealand				<1											717	345	1 063
	Russia															250	26	276
	South Africa															121		121
	UK															637	35	672
	Uruguay						10		0	5						61	10	85
Total (toothfish)		0	0	3 856	98	0	413	217	9	141	77	2 853	1 496	704	34	2 259	416	12 573

(continued)

Table 1 (continued)

Species	Country	Subarea or division																Total
		48.1	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Krill																		
Euphausia superba	Chile			2														2
	EC – Poland		4 686	2 419														7 104
	Japan	435	18 052	16 796														35 283
	Korea, Republic of		10 375	8 396														18 771
	Norway	2147	34 204	19 197														55 548
	Russia			222														222
	UK			<1														<1
	Ukraine		8 133															8 133
Total (krill)		2582	75 449	47032	0	0	0	0	0	0	0	0	0	0	0	0	0	125 063

* Catch reported during research fishing
** Fishing resumed in Subarea 48.3 in late October and an additional 1 040 tonnes were reported to 23 October
*** Catch reported to August 2008

Table 2: Catches (tonnes) of target species reported in 2006/07 (December 2006 to November 2007) (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 gunnar*i	Australia											1					1
	Chile			1 502													1 502
	EC – Germany	1															1
	Korea, Republic of			1 248													1 248
	UK			1 595													1 595
Total (icefish)		1	0	4 345	0	0	0	0	0	0	0	1	0	0	0	0	4 347
Toothfish																	
Dissostichus eleginoides	Australia											2 387					2 387
	Chile			345													345
	EC – Spain			369					1								370
	France										5 201		410				5 611
	Japan					75			2	35							112

(continued)

Table 2 (continued)

Species	Country	Subarea or division															Total
		48.1*	48.2	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Toothfish (continued)																	
	Korea, Republic of			202		2		<1							11		215
	Namibia							<1		5							5
	New Zealand			393	48										1		442
	South Africa			341									26	148			516
	UK			1 657	6												1 664
	Uruguay			232			94			35					<1		360
Dissostichus mawsoni	Argentina														152	42	194
	EC – Germany	<1															<1
	EC – Spain						233		1	81							315
	Japan					23			<1	73							96
	Korea, Republic of					4	260	58							453		775
	Namibia						23	65		20							108
	New Zealand				<1										1159		1 160
	Norway					7									151	109	267
	Russia														434	152	586
	South Africa														51		51
	UK														440	34	474
	Uruguay						24			3					239	9	275
Total (toothfish)		<1	0	3539	54	112	634	124	4	251	5 201	2 387	436	148	3091	347	16 329
Krill																	
Euphausia superba	EC – Poland	2307	3 171	1 936													7 414
	Japan	1608	15 220	7 473													24 301
	Korea, Republic of	11 636	14 341	7 112													33 088
	Norway	2868	32 860	4 055													39 783
Total (krill)		18 419	65 591	20 576	0	0	0	0	0	0	0	0	0	0	0	0	104 586

* Catch reported during research fishing

Table 3: Information provided in the notifications for krill fisheries in 2008/09.

Country and date of notification	Name of vessel(s)	Expected level of catch (tonnes)	Months during which fishing will proceed												Subareas and/or divisions where fishing will take place						Products to be derived from catch (%)										
			2008	2009											Subarea				Division												
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	48.1	48.2	48.3	48.4	58.4.1	58.4.2	Raw (crude)	Frozen	Boiled	Meat	Meal	Oil	Peeled	Fat	Chitin	Hydro-lysate	Other
Chile 26-Jun-08	*Betanzos*	16 000						x	x	x	x	x		x	x	x	x	x							90	10					
Cook Islands 23-Jun-08	*Hannover*	12 000	x	x	x	x	x					x	x	x	x	x	x					100									
Japan 17-Jun-08	*Niitaka Maru*	30 000		x	x	x	x	x	x	x	x				x	x	x				30		10		40		20				
Korea, Republic of 25-Jun-08	*Kwang Ja Ho*	18 000			x	x	x	x	x	x	x				x	x	x					55.56			44.44						
	Dongsan Ho	26 000		x	x	x	x	x	x	x	x	x	x			x	x					61.5			38.5						
	Insung Ho	12 000			x	x	x	x	x	x	x				x	x	x					100									
Norway 19-Jun-08	*Antarctic Navigator*	50 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					4			95	1					
	Juvel	50 000	x	x	x	x	x	x	x	x	x	x			x	x	x									2		7		18	
	Saga Sea	50 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					4			95	1					
	Thorshøvdi [1]	50 000				x	x	x	x	x					x	x		x							ns	ns					ns
Poland 20-Jun-08	*Dalmor II*	20 000			x	x	x	x	x	x	x	x			x	x	x					45	16	10	25	4					
Russia 25-Jun-08 27-Jun-08	*Maksim Starostin*	100 000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								100						
	Alexandre Kosarev	50 000									x	x	x	x	x	x	x		x	x					100						
	Kapitan Kuznetsov	30 000	x	x	x	x								x																	
	Ivan Ludnikov	30 000	x	x	x	x								x	x	x	x	x				50			50						
	Semiozernoe	30 000	x	x	x	x								x	x	x	x	x				50			50						
Ukraine 25-Jun-08	*Konstruktor Koshkin* *Topaz*[++]	15 000			x	x	x	x							x	x								20	39	1					40*

(continued)

Table 3 (continued)

Country and date of notification	Name of vessel(s)	Expected level of catch (tonnes)	Months during which fishing will proceed												Subareas and/or divisions where fishing will take place						Products to be derived from catch (%)										
			2008	2009											Subarea				Division												
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	48.1	48.2	48.3	48.4	58.4.1	58.4.2	Raw (crude)	Frozen	Boiled	Meat	Meal	Oil	Peeled	Fat	Chitin	Hydro-lysate	Other
USA 18-Jun-08	*Top Ocean* *Frey*[+] *Frigg*[+] *Odin*[+] *Thor*[+]	40 000		x	x	x	x	x	x	x	x	x	x		x	x	x	x						9	12	1					
Total	18 vessels	629 000	8	11	15	16	13	13	12	12	12	10	7	10	17	18	16	6	1	1											

ns Not specified
* Krill product for the *Konstruktor Koshkin* includes canned krill meat 40%.
[1] Norway has also notified its intention to participate in an exploratory fishery for krill in Subarea 48.6 using the vessel *Thorshøvdi*.
[+] Krill notifications withdrawn on 7 October 2008.
[++] Krill notifications withdrawn on 16 October 2008.

Table 4: Recommended proportional allocation of the yield estimate amongst SSRUs including the combining of SSRUs in the northern, slope, and shelf areas.

SSRU	Relative CPUE	Fishable area (km^2)	Proportion
881B	0.22	4 318	0.028
881C	0.58	4 444	0.075
881G	0.13	7 110	0.028
881H	0.39	19 245	0.221
881I	0.28	30 783	0.254
881K	0.36	24 695	0.263
881J	0.22	9 800	0.063
881L	0.14	16 807	0.068

Table 5: CCAMLR performance review recommendations relating to the Scientific Committee. Recommendations from the CCAMLR Performance Review are given in CCAMLR-XXVII/8.

2.3 Conservation
Recommendations 2.3.1.1, 2.3.1.2

2.4 Protected areas
Recommendations 2.4.3.2(b)

2.5 Marine Pollution
Recommendations 2.5.1.3

3.1 Status of living resources
Recommendations 3.1.1.1, 3.1.1.2, 3.1.1.3, 3.1.2.2, 3.1.2.3, 3.1.3.1, 3.1.3.2, 3.1.3.3, 3.1.3.6, 3.1.3.7

3.2 Ecosystem approach
Recommendations 3.2.1.1, 3.2.1.2, 3.2.1.3, 3.2.1.4, 3.2.1.5

3.3 Data collection and sharing
Recommendations 3.3.1.1, 3.3.2.1, 3.3.2.3, 3.3.4.2

3.4 Quality and provision of scientific advice
Recommendations 3.4.1.1, 3.4.1.2, 3.4.1.3

3.5 Adoption of conservation and management measures
Recommendations 3.5.2.2, 3.5.3.1, 3.5.3.2, 3.5.3.3, 3.5.3.4, 3.5.6.2, 3.5.6.3

6.1 Transparency
Recommendations 6.1.1.2, 6.1.2.1, 6.1.2.2, 6.1.2.3, 6.1.2.4

7.2 Efficiency and cost-effectiveness
Recommendations 7.2.1.2, 7.1.2.3, 7.2.2.4

Table 6: Scientific Committee budget for 2009 and forecast budget for 2010. The notes refer to the items described in the subparagraphs in paragraph 11.1.

2008 Budget A$		Item	2009 Budget A$		2010 Forecast A$		Notes
		WG-SAM					(1)
6 000		Secretariat support and participation costs	6 200		6 400		
20 000		Report completion and translation	21 000		21 800		
	26 000			27 200		28 200	
		WG-EMM					(2)
82 300		Secretariat support and participation costs	86 000		89 400		
40 000		Report completion and translation	42 000		43 700		
	122 300			128 000		133100	
		WG-FSA					(3)
5 700		Computing facilities	5 900		6 100		
31 000		Secretarial support	20 400		21 000		
83 600		Report completion and translation	60 400		62 000		
	120 300			86 700		89 100	
		WG-IMAF					(4)
		(previously costed under WG-FSA)					
		Secretarial support	12 000		13 000		
		Report completion and translation	27 000		28 600		
				39 000		41 600	
		SG-ASAM					(5)
0		Secretariat support and participation costs	6 000		0		
0		Report completion and translation	8 400		0		
	0			14 400		0	
		Workshop on VMEs					(6)
		Secretariat Support and participation costs	36 000				
		Report Completion and translation	8 400	44 400		0	
		Joint CCAMLR-IWC Workshop					(7)
88 500		Workshop organisation and invited experts	0		0		
12 000		Secretariat support and participation costs	0		0		
20 000		Report completion and translation	0		0		
	120 500			0		0	
		Ad hoc TASO					(8)
(7 000)		Secretariat support and participation costs	2 000		0		
0		Report completion and translation	4 000		0		
	(7 000)			6 000		0	
		Other Expenses for Scientific Committee Program					
	6 000	External experts invited to meetings		32 500		0	(9)
	5 000	Seabird poster		6 000		0	(10)
	1 500	Photographic template		0		0	
	0	International Fishery Observer Conference		8 000		0	(11)
	0	International Polar Year		0		0	
	1 200	**Contingency**		1 200		1 200	
	402 800			393 400		307 200	

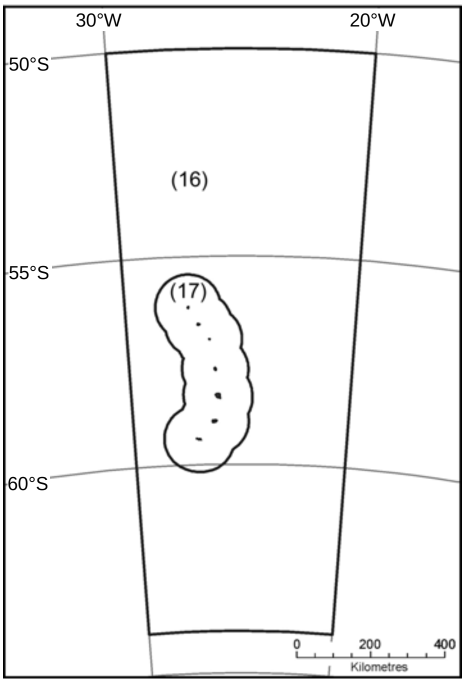

Figure 1: Proposed SSMUs for the krill fishery in Subarea 48.4. South Sandwich Islands Pelagic Area (16); South Sandwich Islands (17).

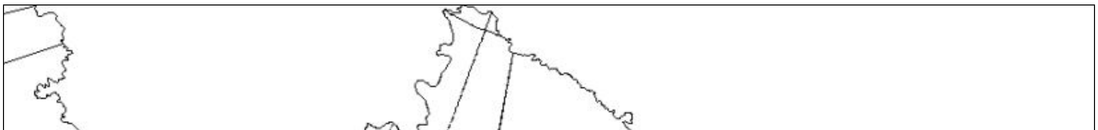

Figure 2: Location of SSRUs in the Ross Sea, including the new SSRU 881M.

Notification is reviewed by WG-EMM, Scientific Committee and Commission – Member may receive comments

Notifying Member selects plan on a case-specific basis

Fishery-dependent plans:
Acoustic transects* or research net hauls

Vessel conducts normal operations – one set of acoustic transects or one set of research hauls must be conducted in each exploratory unit where fishing occurs

Normal operations end voluntarily or catch limit is reached

Compute number of exploratory units in which to conduct research operations (R): R = total catch (tonnes)/2000

Vessel conducts research operations – one set of acoustic transects or one set of research hauls must be conducted in each of R exploratory units – these units must surround the area where normal fishing occurred

Vessel departs fishing grounds

Fishery-independent plans:
Predator monitoring or research survey

Vessel conducts normal operations while Member conducts research survey or monitors predators**

Normal operations end voluntarily or catch limit is reached

* Acoustic transects must be accompanied by one net tow

** Completion of research survey dependent on survey design and completion of predator monitoring occurs at end of breeding season – these times may or may not be coincident with completion of fishing operations.

Figure 3: Schematic description of main operations to be conducted during the planning a prosecution of exploratory krill fisheries.

ANNEX 1

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ANNEX 2

LIST OF DOCUMENTS

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SC-CAMLR-XXVII/3	Report of the Working Group on Ecosystem Monitoring and Management (St Petersburg, Russia, 23 July to 1 August 2008)
SC-CAMLR-XXVII/3 Corrigendum to Figure 2	Report of the Working Group on Ecosystem Monitoring and Management (St Petersburg, Russia, 23 July to 1 August 2008)
SC-CAMLR-XXVII/4	Report of the Working Group on Fish Stock Assessment (Hobart, Australia, 13 to 24 October 2008)
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SC-CAMLR-XXVII/14	Executive summary – Joint CCAMLR-IWC Workshop (Hobart, Australia, 11 to 15 August 2008)
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SC-CAMLR-XXVII/BG/8	Etude 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
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CCAMLR-XXVII/BG/6	Expert Workshop to consider Flag State Control Executive Secretary
CCAMLR-XXVII/BG/7	Report of attendance at the World Ocean in Globalization: Challenges in Marine Regions Conference (Nansen Institute, Oslo, Norway, 21 to 23 August 2008) Executive Secretary
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CCAMLR-XXVII/BG/19 Rev. 1	Topic summary of CEP discussions on non-native species (NNS) in Antarctica CEP Observer to CCAMLR

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CCAMLR-XXVII/BG/25	The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and the ecosystem approach As published in the *International Journal of Marine and Coastal Law*, Vol. 23, No. 3, 2008 Submitted by ASOC
CCAMLR-XXVII/BG/26	Furthering implementation of networks of MPAs in Antarctica and the Southern Ocean Submitted by ASOC
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CCAMLR-XXVII/BG/37	The use of trade-related measures in fisheries management Submitted by IUCN
CCAMLR-XXVII/BG/38	Continuing CCAMLR's fight against IUU fishing for toothfish Executive summary of the report by TRAFFIC International and WWF Australia Submitted by IUCN
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CCAMLR-XXVII/BG/43	The Southern Ocean Observing System (SOOS) Meeting Report (St Petersburg, 5 to 7 July 2008) Submitted by SCAR Observer to CCAMLR (G. Hosie, Australia)
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CCAMLR-XXVII/BG/44 Addendum to the IUCN report	Summary of the outcomes of the 4th IUCN World Conservation Congress, of relevance to CCAMLR Submitted by IUCN
CCAMLR-XXVII/BG/45	Heard Island and McDonald Islands Exclusive Economic Zone 2007/08 IUU catch estimate for Patagonian toothfish Delegation of Australia
CCAMLR-XXVII/BG/46	Report of the CCAMLR Observer to the 11th Session of the COFI Subcommittee on Fish Trade (Bremen, Germany, 2 to 6 June 2008) CCAMLR Observer (EC)
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ANNEX 3

AGENDA FOR THE TWENTY-SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE TWENTY-SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

1. Opening of meeting
   (i) Adoption of agenda
   (ii) Chair's report
   (iii) Preparation of advice to SCAF and SCIC

2. Advances in statistics, assessments, modelling and survey methods
   (i) WG-SAM advice
   (ii) SG-ASAM
   (iii) Joint CCAMLR-IWC Workshop
   (iv) Advice to Commission

3. Ecosystem monitoring and management
   (i) WG-EMM advice
   (ii) Management of protected areas
   (iii) Interactions between WG-EMM and WG-FSA
   (iv) Advice to Commission

4. Harvested species

   (i) Krill resources
      (a) Status and trends
      (b) WG-EMM advice
      (c) Advice to Commission

   (ii) Fish resources
      (a) Status and trends
      (b) WG-FSA advice
      (c) Advice to Commission

   (iii) New and exploratory fisheries
      (a) New and exploratory fisheries in 2007/08 season
      (b) Notifications for new and exploratory fisheries in 2008/09 season
      (c) Revision of boundaries
      (d) Advice to Commission

   (iv) Squid and crab resources
      (a) Status and trends
      (b) WG-FSA advice
      (c) Advice to Commission

   (v) Fish and invertebrate by-catch
      (a) Status and trends
      (b) WG-FSA advice
      (c) Advice to Commission

(vi) Bottom fishing in CCAMLR high-seas areas
  (a) Identification and protection of vulnerable marine ecosystems
  (b) Advice to Commission

5. Incidental mortality
   (i) Incidental mortality of seabirds and marine mammals arising from fisheries
   (ii) Advice to Commission

6. CCAMLR Scheme of International Scientific Observation
   (i) Scientific observations
   (ii) Advice to Commission

7. Fisheries management and conservation under conditions of uncertainty

8. Scientific research exemption

9. 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

10. Performance Review

11. Budget for 2009 and forecast budget for 2010

12. Advice to SCIC and SCAF

13. Secretariat supported activities
    (i) Data management
    (ii) Publications

14. Scientific Committee activities
    (i) Coordination of work of Scientific Committee and its working groups
    (ii) Intersessional activities
    (iii) CCAMLR-IPY projects
    (iv) Invitation of observers to next meeting
    (v) Invitation of experts to meetings of working groups
    (vi) Next meeting

15. Election of Chair and Vice-Chair

16. Other business

17. Adoption of Report of Twenty-seventh Meeting

18. Close of meeting.

ANNEX 4

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT
(St Petersburg, Russia, 23 July to 1 August 2008)

CONTENTS

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT
(St Petersburg, Russia, 23 July to 1 August 2008)

INTRODUCTION

Opening of the meeting

1.1 The fourteenth meeting of WG-EMM was held at Giprorybflot (State Research and Design Institute for the Development and Operation of Fishing Fleet), St Petersburg, Russia, from 23 July to 1 August 2008. The meeting was convened by Dr G. Watters (USA).

1.2 Dr Watters opened the meeting and welcomed the participants (Appendix A). He also thanked Giprorybflot for hosting the meeting with the support of the State Committee for Fisheries.

1.3 Dr V. Bizikov (Russia) welcomed the participants to St Petersburg and wished the Working Group success in its deliberations during the meeting. He noted that Russia had a long history of scientific research and commercial harvesting in Antarctica, and appreciated the role of CCAMLR and WG-EMM in developing approaches to the conservation of the Antarctic marine ecosystem.

1.4 The Working Group paused in memory of Dr Edith Fanta who passed away in May 2008. Dr Fanta will be remembered for her contributions to Antarctic science and the work of WG-EMM, her gentle and dedicated leadership of the Scientific Committee which she chaired from 2005 until her death, and the guidance which she provided to the working groups.

Adoption of the agenda and organisation of the meeting

1.5 The provisional agenda was discussed and the Working Group agreed to introduce a separate agenda item (new Item 6) to consider the ecosystem effects of fisheries that target finfish. With these changes, the agenda was adopted (Appendix B).

1.6 WG-EMM noted the changes in the format of its meeting in 2008, with the inclusion of two focus topics:

(i) risk assessment for Stage 1 subdivisions of the precautionary krill catch limit among SSMUs in Area 48 (Item 2);

(ii) discussion to progress the implementation of spatial management measures that aim to facilitate the conservation of marine biodiversity (Item 3).

1.7 Item 2, dealing with subdivision of precautionary krill catch limits amongst SSMUs in Area 48, was chaired by Dr P. Trathan (UK).

1.8 Item 3, dealing with spatial management measures to facilitate conservation of marine biodiversity, was chaired by Dr P. Penhale (USA).

1.9 The Working Group considered discussions from three intersessional meetings:

(i) WG-EMM's Predator Survey Workshop convened by Dr C. Southwell (Australia);

(ii) WG-SAM convened by Dr A. Constable (Australia);

(iii) ad hoc TASO co-convened by Dr D. Welsford (Australia) and Mr C. Heinecken (South Africa).

1.10 Documents submitted to the meeting, including documents submitted to the Predator Survey Workshop, are listed in Appendix C.

1.11 The report was prepared by Drs D. Agnew (UK), A. Constable (Australia), S. Fielding (UK), M. Goebel (USA), S. Grant (UK), S. Hanchet (New Zealand), S. Hill (UK), Mr J. Hinke (USA), Drs R. Holt (USA), C. Jones (USA), S. Kawaguchi (Australia), É. Plagányi (South Africa), D. Ramm (Data Manager), K. Reid (Science Officer), C. Reiss (USA), P. Trathan (UK), W. Trivelpiece (USA), J. Watkins (UK) and D. Welsford (Australia).

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

1.12 Dr Watters noted that feedback from previous meetings of the Commission, Scientific Committee and other working groups had been used to structure WG-EMM's agenda, and he summarised this feedback by reviewing the agenda and highlighting key points of relevance from those previous meetings:

(i) The Commission endorsed a staged approach to the development of the krill fishery in Area 48, with advice on a Stage 1 subdivision of the precautionary krill catch limit among SSMUs[1] to be based on a risk assessment (CCAMLR-XXVI, paragraphs 4.18 and 4.19; see also SC-CAMLR-XXVI, paragraph 2.14). Work to advise on the Stage 1 SSMU allocation was endorsed as priority work for WG-EMM in 2008 (SC-CAMLR-XXVI, paragraph 3.40), and a focus topic (Item 2) was developed to provide opportunity for this work and for consideration of relevant advice from WG-SAM.

(ii) The Commission continues to implement an array of spatial management measures in the Convention Area, and the Scientific Committee has requested advice on scientific aspects such as bioregionalisation (SC-CAMLR-XXVI, paragraphs 3.85 to 3.87 and 3.93) and methods to select and designate MPAs (SC-CAMLR-XXV, paragraph 3.33). Furthermore, in light of urgent requirements specified in UNGA Resolution 61/105, the Scientific Committee had encouraged its working groups to collaborate in considering VMEs (SC-CAMLR-XXVI, paragraph 14.9). A focus topic (Item 3) was developed to provide opportunity for addressing these issues.

[1] Referred to hereafter as 'Stage 1 SSMU allocation'.

(iii) The Scientific Committee requested information on the status and trends in the krill fishery including, *inter alia*, information on how to quantify effort in the krill fishery (SC-CAMLR-XXVI, paragraph 4.17), the requirements for biological data collected from the krill fishery (SC-CAMLR-XXVI, paragraph 3.51), the collection of data by scientific observers (including a review of the report of ad hoc TASO (SC-CAMLR-XXVII/BG/6)), and data requirements relevant to exploratory krill fisheries (SC-CAMLR-XXVI, paragraph 3.53). These topics were addressed in Item 4.

(iv) The Scientific Committee requested advice on aspects relating to the krill-centric ecosystem. The Working Group agreed to, *inter alia*, review the report of the Predator Survey Workshop (WG-EMM-08/8), work needed to revise estimates of krill yield (SC-CAMLR-XXVI, paragraph 3.40) and advice from WG-SAM on implementing ordination methods to present trends in CEMP indices (SC-CAMLR-XXVI, Annex 4, paragraphs 5.75 and 5.76). These topics were addressed in Item 5.

(v) The Scientific Committee recognised the need for WG-EMM to evaluate interactions involving targeted finfish and other top predators (SC-CAMLR-XXVI, paragraph 3.99). This topic was addressed in Item 7.

(vi) The Scientific Committee requested that WG-EMM and WG-FSA collaborate to adopt preliminary terms of reference for a second FEMA Workshop (SC-CAMLR-XXVI, paragraph 3.100). Work to progress the forthcoming Joint CCAMLR-IWC Workshop is also required (WG-EMM-08/15). These points were discussed in Item 8.

1.13 The Working Group also agreed to consider CCAMLR's input to the agenda and work plan of the Joint SC-CAMLR–CEP Workshop proposed for 2009 (see Item 9).

FOCUS TOPIC: RISK ASSESSMENT FOR STAGE 1 SUBDIVISIONS OF THE PRECAUTIONARY CATCH LIMIT AMONG SMALL-SCALE MANAGEMENT UNITS IN AREA 48

Subdivision of the Area 48 krill catch limit amongst SSMUs

2.1 Dr Trathan, as chair of this focus topic, presented the Working Group with a review of the development of progress on this topic. The Working Group recalled that, in the past, the Scientific Committee had requested that WG-EMM consider and develop modelling approaches that allow subdivision of the precautionary catch limit for Antarctic krill (*Euphausia superba*) in Area 48 among several SSMUs.

2.2 WG-EMM has been developing models to assist with this task since 2004, notably through three workshops:

(i) Siena, Italy (at the 2004 meeting of WG-EMM and the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management) – A broad range of model structures and functional relationships were discussed (SC-CAMLR-XXIII, Annex 4, Appendix D, paragraph 3.16) and it was generally agreed that it would be important to explore a variety of model structures that captured the potential ecosystem effects of fishing. It was agreed that spatially structured krill population models were required (SC-CAMLR-XXIII, Annex 4, Appendix D, paragraph 7.6) that allowed interactions to be explored, principally between:

(a) the krill population
(b) spatial catch limits and the fishery
(c) krill predators
(d) transport of krill.

(ii) Yokohama, Japan (at the 2005 meeting of WG-EMM and the Workshop on Management Procedures), where it was agreed that at least three key additional aspects should be incorporated into models (SC-CAMLR-XXIV, Annex 4, paragraph 2.11). These were:

(a) shorter time steps and/or seasonality
(b) alternative movement hypotheses, so-called krill flux
(c) a threshold krill density below which a fishery will not operate.

(iii) Walvis Bay, Namibia (at the 2006 meeting of WG-EMM and the Second Workshop on Management Procedures), where model definitions were further refined.

Options for subdividing the catch limit

2.3 The Working Group recalled that three models relevant to the subdivision of the precautionary krill catch limit have been considered previously; these are EPOC, FOOSA and SMOM[2]. These models have been used to examine six candidate options to inform WG-EMM about how best to subdivide the precautionary catch limit for krill:

1. the spatial distribution of historical 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. structured fishing strategies in which catches are rotated within and between SSMUs.

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[2] EPOC (Ecosystem, Productivity, Ocean, Climate modelling framework) Constable (2005, 2006, 2007, WG-SAM-08/15); FOOSA – formerly KPFM (Krill–Predator–Fishery Model) – Watters et al. (2005, 2006, WG-EMM-08/13); SMOM (Spatial Multi-species Operating Model) Plagányi and Butterworth (2006, 2007, WG-SAM-08/17).

2.4 In 2007, WG-SAM reviewed the body of work available to help identify a program of work that could lead to advice on a subdivision of the krill catch limit among SSMUs (SC-CAMLR-XXVI, Annex 7, paragraphs 5.7 to 5.51).

2.5 At that time, WG-SAM agreed that management advice and its implementation to subdivide the krill catch limit among SSMUs needed to occur in a staged approach. Such an approach would involve an evaluation of the risks to krill, predators and the fishery arising from the different candidate options for subdividing catch limits, 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. This staged approach was endorsed by SC-CAMLR last year (SC-CAMLR-XXVI, paragraph 3.36).

2.6 WG-SAM had suggested that Stage 1 of a subdivision could be an initial subdivision based primarily on Options 2, 3 or 4, noting that Option 1 had been previously found to achieve the poorest balance of ecosystem and fishery objectives, and that the development of approaches under Options 5 and 6 would help in the assessment processes in subsequent stages, but required additional work and so should be accorded a high priority starting in 2009. This approach was also endorsed by SC-CAMLR last year (SC-CAMLR-XXVI, paragraph 3.36).

2.7 WG-SAM had also suggested that the use of empirical data in models would help with model development, including agreement of an *a priori* set of benchmarks (SC-CAMLR-XXVI, Annex 7, paragraphs 5.24 to 5.26). WG-SAM developed an initial list of potential benchmarks for consideration by WG-EMM – the WG-SAM 'calendar' of known or suspected changes in the ecosystem. This calendar covers the period from 1970 to 2007. The rates and timing of events in the calendar are only approximate, levels of abundance and variability are not provided, and no reference observations are provided for fish.

Stage 1 scenarios

2.8 WG-SAM recommended that models should simulate eight essential scenarios when evaluating the different SSMU candidate options (SC-CAMLR-XXVI, Annex 7, paragraphs 5.37 and 5.38):

(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;

(iv) model outputs during this stage should focus on comparing SSMU Options 2, 3 and 4;

(v) simulations should be run for different levels of harvest rate 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 were 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).

Performance measures

2.9 Ecosystem models have been developed to simulate and compare the performance of the candidate options for allocating the precautionary krill catch limit, where relative performance is judged according to how well these options meet the objectives of Article II of the CAMLR Convention. WG-SAM recommended that performance measures should be derived for the status of krill, predator populations and the fishery over relevant time scales (SC-CAMLR-XXVI, Annex 7, paragraphs 5.39 to 5.47).

Risk assessment of Stage 1 scenarios

2.10 WG-SAM suggested that the provision of advice should be based on a risk assessment using elements of the performance measures (SC-CAMLR-XXVI, Annex 7, paragraph 5.48).

2.11 It was agreed that the following elements should be considered:

(i) suitable fishery performance measures could be model specific, provided they represented long-term performance and variability;

(ii) suitable predator performance measures should indicate the probability of change in the populations;

(iii) performance measures for krill should be based on the existing decision rules used to set krill yields;

(iv) a risk matrix of the performance of different candidate options relative to these measures should be presented.

Process for providing advice on Stage 1

2.12 WG-SAM 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 intersessional plan proposed by WG-SAM was endorsed by SC-CAMLR in 2007 (SC-CAMLR-XXVI, paragraph 3.36).

Advice from WG-SAM

2.13 Three modelling approaches have been developed (FOOSA, SMOM and EPOC) for use in evaluating the subdivision of the Area 48 krill catch limit amongst SSMUs, hereafter termed 'SSMU allocation'. Dr Constable (Convener of WG-SAM) summarised the advice from WG-SAM regarding these different modelling approaches, with discussion focused on:

(i) tools for population, food-web and ecosystem modelling (Annex 7, paragraph 5.9);

(ii) evaluation of management strategies (Annex 7, paragraph 6.21).

Tools for population, food-web and ecosystem modelling

2.14 Dr Constable summarised discussions on:

(i) use of the WG-SAM calendar and the numerical calendar of events for tuning krill-based food-web models and on their potential development (Annex 7, paragraphs 5.12 to 5.16);

(ii) how FOOSA and SMOM are capable of capturing the trends in predator populations as specified in the calendar, given krill as a driver of the ecosystem (Annex 7, paragraphs 5.21 and 5.30);

(iii) how the FOOSA-like implementation in EPOC could provide a useful comparison with the modelling approaches used in FOOSA and SMOM (Annex 7, paragraphs 5.28 and 5.30);

(iv) the advice that WG-EMM should review the evidence and attendant uncertainty in support of the krill trend represented in the WG-SAM calendar (Annex 7, paragraph 5.16).

2.15 Dr Constable reported that WG-SAM advised that both FOOSA and SMOM could replicate the numerical calendar (WG-EMM-08/10) and consequently no further technical queries on model structure were raised by WG-EMM. However, the Working Group did consider a number of ecological issues and interpretations in relation to the models.

2.16 Firstly, Dr Kawaguchi queried whether the scenarios implemented in FOOSA that included krill movement (WG-EMM-08/13) were plausible and how the krill turnover rates for each scenario compared with known ecological values. Dr Watters responded that the initial conditions in FOOSA were set up to ensure that the initial rates of predator population increase were consistent with the numeric calendar. Dr Watters added that a metric could be provided to illustrate the simulated ratio between krill turnover rate and the extent to which the system was sustained by movement of krill from surrounding areas. He noted that when considering results from simulations, there were downward trends in krill that might be an artefact of the model implementation; however, no such trends were evident in model performance statistics when comparing between trials with fishing and trials with no-fishing.

2.17 Dr Constable noted that it was important to assess the extent to which the ecosystem model predictions were consistent with expectations from the single-species krill yield model, and how one might deal with any observed incompatibilities such as might result from an incorrect parameterisation of krill movement. Dr Constable suggested that this was important because, at present, there has been only limited exploration of scenarios that investigate what would happen if the fishery reduced krill to 75% of its pre-exploitation abundance.

2.18 Secondly, Dr T. Ichii (Japan) commented that top-down control may be unrealistically strong in FOOSA, as in many SSMUs predator demand exceeded krill biomass such that the model predicted that there would be zero krill surplus in many coastal SSMUs. He further queried whether the large consumption of krill by fish included in the model was realistic, noting that this results in advice that fishing should operate in pelagic rather than coastal areas.

2.19 Dr Watters confirmed that FOOSA results indicated that there was a greater risk of predator declines under scenarios with more fishing in coastal areas and a greater risk to the fishery that it will not be able to take all of its quota when fishing was concentrated in pelagic SSMUs. He explained that estimates of the krill surplus in SSMUs needed to be evaluated in the context of krill flux rather than just of standing stock. Furthermore, he referred to examples provided in WG-EMM-08/13 (e.g. Figure 10 in that paper) which demonstrated that bottom-up control was very strong in FOOSA as krill abundance was strongly limiting predator dynamics. Dr Watters indicated that if necessary, metrics were available to analyse simulation outputs to assess the relative strength of bottom-up control. Finally, Dr Watters agreed that there was considerable uncertainty in modelling fish, particularly given that mesopelagic fish were not well represented in many field sampling programs. Moreover, the WG-SAM calendar did not specify how fish abundance had changed over the period from 1970 to 2007; consequently, FOOSA was not tuned for the fish component, rather it used a parameterisation based on a compilation of information from the literature. Available information suggests that fish are major consumers of krill in the Antarctic ecosystem.

2.20 Dr V. Siegel (Germany) added that krill surplus is a function of not only flux but also the local production of krill.

Evaluation of management strategies

2.21 Dr Constable summarised the advice provided by WG-SAM on the evaluation of management strategies (Annex 7, paragraphs 9.6 and 9.7); this was considered under three headings:

(i) framework for Stage 1 evaluations
(ii) performance measures
(iii) risk assessments.

Framework for Stage 1 evaluations

2.22 General advice from WG-SAM on the SSMU allocation is provided in Annex 7, paragraphs 6.5 to 6.25. WG-SAM recommended that both FOOSA and SMOM can be used to provide advice on SSMU allocation; however, WG-EMM should discuss the relative plausibility of each scenario.

Performance measures

2.23 Dr Constable summarised discussions from WG-SAM related to:

(i) departures from baseline norms indicated by no-fishing trials (Annex 7, paragraph 6.26);

(ii) whether fish should be included in performance measures given the paucity of data on this component (Annex 7, paragraph 6.27);

(iii) the need for WG-EMM to consider the paucity of data on fish when considering outputs from the models (Annex 7, paragraph 6.28);

(iv) the use of CSIs (Annex 7, paragraphs 6.29 and 6.30).

2.24 Dr Hill explained that estimates of krill consumption by myctophids were based on extrapolations from small-scale surveys which suggested that myctophids are major consumers of krill. Corroboration of these conclusions has recently been provided by British Antarctic Survey (BAS) through additional analyses of myctophid diet data from large-scale surveys across the Scotia Sea. Dr Hill noted that fish have been parameterised as well as possible within the models given available information and literature as presented in Hill et al. (2007).

2.25 Dr Constable noted that models capture the general dynamic of how the system might respond under fishing, but stressed that the outputs cannot be expected to reflect the dynamics of an individual predator in an individual SSMU. Rather, they describe the behaviour of generic predators and hence it is necessary to include fish because they capture the dynamics of that kind of predator.

Risk summaries

2.26 Dr Constable reported that WG-SAM had reviewed a number of tools that could be used in formulating advice on SSMU allocation, including new tools (CSI – WG-SAM-08/16) and an implementation of the risk summaries (WG-EMM-08/44) outlined by WG-SAM in

2007. Dr Constable reported that WG-SAM had recommended that WG-EMM should consider use of these tools when formulating its advice. General advice on risk summaries is given in the WG-SAM report (Annex 7, paragraphs 6.31 to 6.44).

2.27 Discussions by the Working Group on potential ecological aspects pertaining to risk summaries focused on the role of climate change and how this could be included in modelling approaches. It was noted that such considerations were considered by WG-SAM in 2007, and were considered to be optional for the evaluation of the Stage 1 SSMU allocation. Dr Siegel recommended that, based on existing work relating to identifying different climate oceanographic regimes, these different scenarios could be represented in modelling work undertaken as part of subsequent stages.

2.28 Dr Kawaguchi noted that the impacts of climate change on an ecosystem are generally thought to involve cascading effects and that some of these enhance one another in a non-linear manner. It is therefore important to consider such synergistic effects when modelling the future impacts of climate change on an ecosystem.

2.29 Dr M. Naganobu (Japan) and Dr Kawaguchi both noted that it is difficult to predict the effects of climate change but that some fishers have reported that they have detected some changes in the ecosystem that they believe may potentially be related to climate change. Dr Constable suggested that using a management feedback approach was one way of helping to assess such issues, as illustrated by WG-SAM-08/16 which suggested a methodology for including fisheries data to capture the changing dynamics of the ecosystem and hence creating feedback management information. Dr Holt stressed the potential usefulness of relating such fisheries-derived data to the krill fishery to further inform on various aspects of climate change.

2.30 The Working Group recognised that Stage 1 advice on SSMU allocation could be provided this year, but that a range of alternative climate-change scenarios would need to be considered as part of a broader- and longer-term risk assessment for subsequent stages.

Analyses and risk assessment

2.31 The Working Group noted that in order to estimate SSMU allocation for Stage 1, a number of tasks are needed:

(i) To use the best available data to estimate SSMU allocation proportions for the different options following the methods detailed in Hewitt et al. (2004a) and in WG-EMM-08/12:

 (a) Option 2: estimates of predator demand in each SSMU from available predator abundance data and consumption rates;

 (b) Option 3: estimates of the proportion of krill in each SSMU derived from the CCAMLR-2000 Survey;

 (c) Option 4: uses the difference between estimates of krill standing stock and predator demand.

(ii) Assess the relative risks under the different options using the modelling tools available (FOOSA, SMOM, EPOC). The risk assessments are based on yield multipliers that scale the yield from zero, through the current trigger level, to 1.25 × the precautionary catch limit.

(iii) Calculate the SSMU allocations using the proportions determined in (i) above, multiplied by the yield multiplier determined in (ii) above, multiplied by the yield (from the GYM).

Krill fishery performance measures

2.32 The Working Group discussed aspects of performance of the fleet in coastal and pelagic SSMUs (see below). Discussions of the performance of the krill population, predators and the fleet in FOOSA and SMOM models are given in paragraphs 2.45 and 2.49.

2.33 WG-EMM-08/55 reported on analyses of data from 22 oceanographic surveys carried out in Subarea 48.2 between 1962 and 1997. Based on an analysis of geostrophic circulation, four different patterns of water movement were identified by the authors, the most common being one (Type I) in which there is an anti-cyclonic circulation around the South Orkney Islands of water arising in the Weddell Sea. In Type II there is no such anti-cyclonic circulation, but Weddell Sea water is still diverted westwards across the northern limit of the island group. Both these types lead to a concentration of krill in the main fishing grounds in SSMUs SOW and SONE. In Type III and IV, water moves to the east and is not entrained around the South Orkney Islands. A Type III pattern was present during the CCAMLR-2000 Survey, and resulted in a large krill biomass being present in the northeast of SOPA, with relatively little biomass concentrated in the traditional fishing areas in coastal SSMUs. The high biomass in the pelagic area was therefore not typical of the pattern that has been exploited successfully by the fishery.

2.34 WG-EMM-08/24 presented data sampled on the 29th cruise of the FV *Konstruktor Koshkin* in Subarea 48.2 from March to April 2008. The paper examined the distribution of commercial aggregations of krill, their fishable biomass in the different periods of observation, krill biological state, hydro meteorological and ice conditions. The paper noted that for Ukrainian vessels to be profitable, they required krill concentrations of a density of 250 g m^{-2}. These concentrations form only rarely in the pelagic SSMU and they are extremely unstable. The paper reported that fishing in pelagic areas is unlikely to be commercially feasible in the near future, and proposed an alternate SSMU allocation in Subarea 48.2.

2.35 WG-EMM-08/16 used the CCAMLR-2000 Survey acoustic dataset to compare pelagic and shelf SSMUs in terms of the frequency of 1 n mile integration units with krill densities above and below a range of threshold values. In general, pelagic SSMUs had markedly lower frequencies of fishable integration units where the threshold density for fishing was set at 100 g m^{-2} following Kasatkina and Ivanova (2003). The contrasting probability of encountering fishable concentrations in pelagic and shelf SSMUs suggests that the fishery will be less efficient and, perhaps, less economically viable in pelagic SSMUs. This is despite the fact that the absolute abundance of both krill and fishable concentrations of krill is higher in pelagic than in shelf SSMUs. The paper also derived empirical relationships between

SSMU-scale krill density and the frequency of fishable integration units for the full range of threshold levels. These relationships may be useful for linking the scales represented in operating models with those that affect the behaviour and performance of the fishery.

2.36 Dr V. Spiridonov (Russia) recalled that in the 1980s the former Soviet Union had concerns about potential impacts of krill fishing in coastal areas on predators. However, attempts at that time to reallocate fleets to pelagic areas failed because suitable concentrations of krill could not be found. He further noted that there were some seasonal aspects to the formation of krill concentrations, with concentrations forming particularly in coastal areas in the late autumn, but that this behaviour was still poorly understood.

2.37 Dr Watters noted that CCAMLR krill catch records (WG-EMM-08/5) suggest that in the early 1980s significant catches were taken from pelagic SSMUs. However, Dr Spiridonov suggested that the precise location of these catches may not have been accurately recorded in the very early years of the fishery. Dr Kawaguchi further suggested that the fishing strategy followed by the early Soviet fishery may not have needed as high a density of krill as is needed by current commercial operations.

2.38 The Working Group noted that these studies were important in helping to understand how the fishery might be impacted by the various options being considered for the SSMU allocation, which it had specifically requested in 2007 (SC-CAMLR-XXVI, Annex 4, paragraph 6.41). They could be used in a number of ways, including:

(i) to assist with parameterisation of fishery behaviour in the current models using the relationship shown in WG-EMM-08/16 between SSMU-scale krill density and threshold densities for krill operations;

(ii) to inform interpretation of the performance of different allocation options under modelling scenarios, for instance where two options may perform equally in respect of predators but differ in the proportion of krill taken in pelagic and coastal SSMUs.

2.39 Further work on determining the relationship between SSMU-scale krill density and the threshold density for krill operations would be beneficial. Dr S. Kasatkina (Russia) suggested that this might be achieved by acquiring acoustic data from commercial vessels, and noted that a recent ICES workshop (ICES, 2007) had established protocols for acquiring and using such data. Dr Kawaguchi suggested that further analysis of krill fishery behaviour (such as described in WG-EMM-08/40) would also be valuable in this regard.

Risk assessment of Stage 1 scenarios

2.40 The Working Group discussed the risk assessments undertaken for providing advice on SSMU allocations as requested by the Commission (CCAMLR-XXVI, paragraphs 4.18 and 4.19; see also SC-CAMLR-XXVI, paragraph 2.14) under this agenda item. Specific requirements and important issues relevant to the risk assessment are provided in SC-CAMLR-XXVI, Annex 7, paragraphs 5.37 to 5.48 and SC-CAMLR-XXVI, Annex 4, paragraphs 6.39 to 6.46. Based on these guidelines, it was agreed that Stage 1 advice could be provided to the Scientific Committee in 2008.

2.41 Throughout this section, the precautionary catch limit is estimated as γB_0. The risk assessments considered here are based on yield multipliers that scale the yield from zero, through the current trigger level (equivalent to 0.15 × the precautionary catch limit), to at least 1.25 × the precautionary catch limit.

Review of fishing options

2.42 WG-EMM-08/12 reviewed the six fishing options identified in Hewitt et al. (2004a). Since the original presentation of the fishing options in 2004, additional data and analyses have become available with which to ascertain whether the fishing options still have the potential to meet the needs of the fishery, yet retain the principles of Article II of the CAMLR Convention. The authors noted that Options 5 and 6 remain under development and Option 1 has already been excluded as an option by this Working Group. For Options 2 (spatial distribution of predator demand for krill) and 4 (krill biomass less predator demand), limited data on krill consumption, particularly by flying seabirds, squid and fish, creates considerable uncertainty in our understanding of the spatial distribution of consumption. For Options 3 (spatial distribution of krill biomass) and 4, uncertainty arises from the estimates of krill biomass. The authors noted that the CCAMLR-2000 Survey provides the best available data, but that changing analytical methods have not converged on more precise estimates of biomass. Additionally, little data exist on how krill in the Scotia Sea are linked to the Weddell Gyre or the ACC. The data on krill biomass, however, is considered to be more comprehensive than the data on predator demand for krill. The authors suggested that a strong case can be made against Option 4, which is likely to increase ecosystem risk when the underlying estimates of consumption are incomplete, especially if they are biased. The paper suggested that the data on the distribution of krill standing stock are likely to be more reliable than those documenting the distribution of predator demand, favouring Option 3 for Stage 1 advice. Finally, the authors suggested that delay in subdividing the catch could incur some risk to the ecosystem, as the status quo is equivalent to Option 1.

2.43 The Working Group noted that the uncertainty associated with predator demand can be addressed through better assessments of predator abundance. The Working Group recalled that the Predator Survey Workshop (WG-EMM-08/8) has initiated work to compile data from the Scotia Sea region to update estimates of abundance and devise methods that account for uncertainty in abundance estimates. Recent surveys of pack-ice seals (WG-EMM-PSW-08/6) and preliminary estimates of penguin abundance in the Scotia Sea region (WG-EMM-08/53) were identified as important contributions to our knowledge of krill predator abundances. However, gaps in predator data remain, especially for flying seabirds, squids and fish.

2.44 In terms of a risk assessment, the Working Group questioned whether subsets of data without bias or substantial uncertainty could be identified to better constrain estimates of predator consumption. Dr Trathan noted that the Predator Survey Workshop attempted such subsetting, whereby only the major consumers of krill identified in Croxall et al. (1985) were considered. Of the subset considered (see WG-EMM-08/8), crabeater seals (*Lobodon carcinophagus*) were identified as the major consumers of krill in the Scotia/Weddell Sea region. The Working Group also noted that uncertainty in krill demand can be accounted for within the simulation frameworks being used in the risk assessment. Such consideration was suggested as a course of work for providing advice in subsequent stages.

Risk assessment

2.45 The Working Group considered WG-EMM-08/30, which presented a risk assessment of Options 2, 3 and 4 using FOOSA. Example metrics of risk for krill, predators and the fishery that could be used for providing advice were presented. For krill and predators, risk was assessed relative to a baseline abundance that was determined by an initial model condition or by a comparable no-fishing trial. Risks for each predator group were presented on SSMU scales, and based on individual parameterisations or weighted-average risks across all parameterisations. Weighted-average risks were based on plausibility weights for each parameterisation in the reference set and the authors assigned unequal weights to illustrate the model-averaged risks. For all groups, risk was presented as a probability of exceeding a threshold of performance as a function of increasing harvest rates from 0.15γ (the current trigger level) to 1.25γ (25% more than the precautionary catch limit).

2.46 The Working Group noted that the risk metrics presented in WG-EMM-08/30 are based on the existing decision rules for krill. In the paper, changes in krill biomass were referenced to: (i) initial model conditions (rather than median krill biomass over a period prior to the start of fishing); and (ii) medians of comparable no-fishing trials[3]. For the purpose of presentation, the risks to krill were assessed on a regional scale, rather than for any particular SSMU.

2.47 The risk to predators was measured in terms of (i) the probability of depletion to a fraction of a baseline abundance, and (ii) the probability of not recovering to a fraction of a baseline abundance after a period of no fishing. WG-EMM-08/30 presented results referenced to 75% of the baseline abundance on SSMU-specific and regional scales. Presenting results referenced to other fractions of baseline abundance is possible.

2.48 The risk to the fishery was assessed with the log of the mean catch, the CV in the mean catch and the probability that, during the fishing period, krill density would fall below a threshold that would require an involuntary change in the fishery. For the purposes of the latter risk metric, WG-EMM-08/30 presented krill density thresholds of 10, 15 and 20 g m^{-2}. Presenting results referenced to other threshold densities is possible. The Working Group requested that fishery performance also be measured by comparing the catch relative to the full allocation for each yield multiplier.

2.49 The Working Group also considered risk assessment results from SMOM that were produced by Dr Plagányi during the meeting of WG-SAM. WG-SAM recommended that those results be considered by WG-EMM. Results available to the Working Group were for predators only, and the presentation of risk used the same format as FOOSA, as described in paragraph 2.47.

2.50 The Working Group considered the method of using CSIs for the risk assessment, as described in WG-SAM-08/16 (see Appendix D). WG-SAM recommended that the methods presented in this paper be considered by WG-EMM. Risk can be assessed with an aggregate performance measure across all predators at SSMU-specific and regional scales, from an ensemble of results from one or more simulation models. The CSI is used to measure the

[3] The second risk metric for krill described in WG-EMM-08/30 was computed as the probability that, at the end of the fishing period, the abundance of krill falls below 75% of the median abundance computed for the same time from Monte Carlo trials that simulate the absence of fishing.

range of variation in ecosystem response, and risk is assessed by considering whether fishing causes the CSI to depart significantly from the range of variation recorded during a baseline period. Thresholds defining a significant departure could be specified by nominating a quantile from the distribution of the index from the baseline period, for example, the lower 10th percentile. Risk is then assessed as a probability that fishing causes the CSI to exhibit values below the nominated percentile.

2.51 The use of the CSI to assess risk is predicated on the assumption that changes in abundance of krill will cause changes in the performance of predators, depending on the degree to which predators are dependent on krill for satisfying their life-history requirements. A precautionary approach would require that the probability of departure from baseline variability in the CSI not increase too much as the yield multiplier increases. Dr Constable suggested that until more data were available to describe how individual predator groups respond to krill fishing, the CSI provides a useful metric for measuring the general ecosystem response to fishing.

2.52 The CSI approach is not model specific; results from an ensemble of models, like SMOM and FOOSA, can be combined to aggregate across the uncertainties represented in each model. The Working Group noted that combining model results may be helped by weighting the scenarios in terms of plausibility. Dr Watters cautioned, however, that aggregating across model results may be inappropriate in some cases. For example, the basic model used to create the results available from SMOM was very similar to the 'nst' parameterisation used in FOOSA (i.e no krill movement and hyperstability). Creating an ensemble of results with duplicate scenarios would implicitly weight those scenarios higher, which could also introduce bias into the aggregated results.

2.53 The Working Group questioned how different model results should be weighted when an ensemble of results is compiled. Dr Watters noted that weighting schemes could be based on quantitative and qualitative considerations of both statistical and ecological plausibility. For example, WG-EMM-08/30 presented results with unequal weightings based on the authors' experience during parameter estimation and resulting dynamics of the predator groups. Some parameterisations were assigned lower weights because they were less able to capture the relevant dynamics specified in the WG-SAM calendar and proved difficult to fit to the data. Other parameterisations could not be so distinguished and were therefore assigned equal weighting. Dr Plagányi explained that model results from SMOM were assigned equal weighting because all 12 parameterisations in the reference set described in WG-SAM-08/17 fitted to the WG-SAM calendar equally well and are equally plausible. Dr Constable suggested that model plausibility might also be assessed relative to the future dynamics in simulation trials. The Working Group agreed that equal weighting of all model scenarios would be most appropriate if defensible methods for alternative weighting schemes could not be agreed.

2.54 The Working Group further agreed that unequal weighting of results from different models would be difficult, particularly if unknown or unquantified biases were present in models. The Working Group noted that bias in the models could arise from different parameterisations or model structures, and assessing the direction and magnitude of bias within an ensemble of model results may not be possible. The Working Group identified three potential sources of bias in the model results of FOOSA and SMOM:

(i) First, the relative competitive abilities of predators and the fishery could result in bias. For the FOOSA results presented in WG-EMM-08/30, predators and the fishery are modelled as equal competitors for krill. In the SMOM results presented to the Working Group, the fishery is modelled as an inferior competitor to predators. In such cases, the fishery does not always take its full allocation although in reality this could possibly occur in the future (paragraphs 2.86 to 2.88).

(ii) A second bias could have been introduced by the trend in krill biomass, as specified by the WG-SAM calendar. Negative trends in krill abundance could result in higher probabilities of violating the krill decision rules in fishing scenarios.

(iii) A third potential source of bias derives from the use of bathtubs and how the movement of krill is modelled. The Working Group suggested that movement could sustain local krill stocks despite fishery removals.

2.55 The Working Group agreed that negative bias would be introduced under all three scenarios. Negative bias would decrease the perceived risk to the ecosystem for a given yield multiplier. The Working Group agreed that such bias could lead to advice on SSMU allocations that was not as precautionary as intended. In this case, the risks reported in a risk assessment should be considered as the minimum risks to the ecosystem for a given harvest rate.

2.56 The foregoing discussions about the model bias and weighting in FOOSA and SMOM, and the use of FOOSA results to compile a set of CSIs, led to a number of proposed analyses that would be undertaken during the course of the meeting. First, given the possible biases in model results, the Working Group requested that the risk assessment results presented in WG-EMM-08/30 be recalculated using equal weighting for all parameterisations. Second, the Working Group requested that fishery performance also be assessed as the ratio of catch to allocation.

2.57 The main results from the risk assessment are provided in paragraphs 2.58 to 2.74.

Interpretation of model results

Assessment of Fishing Options 2, 3 and 4

2.58 The Working Group noted the advice of WG-SAM-08 (Annex 7, paragraph 9.6) that although there are differences between the models, FOOSA and SMOM could each be considered to be an adequate implementation of the methodological approaches specified by WG-SAM-07 and WG-EMM-07. During the course of WG-EMM-08, the models were re-run in a manner that would most closely allow comparisons between their results. It was agreed that the scenario results from FOOSA should be combined with equal weighting, and that the SMOM parameterisation most closely approximates the 'nst' scenario in FOOSA.

2.59 The Working Group noted how CSIs could be interpreted to indicate the indirect food-web effects of krill fishing on krill predators. It agreed that the CSIs were useful for understanding the aggregate effects of fishing across the region but expressed concern that this might mask the spatial variability of effects, i.e. potential for greater effects to be evident in individual SSMUs. During the course of WG-EMM-08, Dr Constable used the software tool developed and reviewed in WG-SAM (Annex 7, paragraphs 6.37 to 6.42) to present the CSI results from FOOSA outputs for candidate Options 2 to 4, including plots for Option 3 showing how the region-wide CSI compares to an SSMU-specific CSI.

2.60 The results were presented by Dr Watters (FOOSA), Dr Plagányi (SMOM) and Dr Constable (CSI plots of FOOSA results). The results were presented in Figures 1 to 11 following the graphical probability risk assessment suggested in WG-EMM-08/30 and the CSI approach detailed in Appendix D. The model outputs show that there are trade-offs inherent in selecting among Options 2, 3 and 4, and these trade-offs are expressed as the risks to predator populations and fishery distribution and performance.

Impacts on the krill population

2.61 The effects on the krill population predicted by FOOSA and SMOM are shown in Figures 1 and 7.

2.62 In all options in FOOSA, the probability that minimum krill abundance during the fishing period is <20% of the abundances from comparable no-fishing trials remains at 0 as the yield multiplier increases up to 1.0 (Figure 1).

2.63 The responses in respect to krill abundance at the end of the fishing period are similar in Options 2 and 3 for both FOOSA and SMOM. There is an increase in risk that krill abundance measured at the end of the fishing period is less than 75% of the median abundances from comparable no-fishing trials in Subarea 48.3 as the yield multiplier increases beyond 0.15 (equivalent to the current trigger level) and in Subareas 48.1 and 48.2 and Area 48 as a whole as the yield multiplier increases beyond 0.5. However, for Option 4 the risk appears to be limited to Subarea 48.3.

2.64 For Options 2 and 3, there is substantial variation in risk to individual SSMUs that the local krill population abundance falls below 75% of its abundance in comparable no-fishing trials (Figure 7).

Impacts on predator populations

2.65 The results of FOOSA and SMOM indicate that, for yield multipliers up to 0.15, Options 2 and 3 do not pose a significant risk that predator populations would be reduced to 75% or less of the abundances that might occur in the absence of fishing (Figures 2, 3 and 8).

2.66 The risks to predators associated with Option 4 are much higher than Options 2 and 3 in both SMOM and FOOSA. Implementation of Option 4 would increase the risk that predator populations would be reduced to 75% or less of the abundances that might occur in the absence of fishing compared to Options 2 and 3. These results are consistent for both FOOSA and SMOM (Figures 2, 3 and 7) and arise from the increasing limitation of the spatial distribution of the fishery to coastal SSMUs in Option 4. The proportion of the total catch allocated to coastal SSMUs in Options 2, 3 and 4 of FOOSA were 30, 38 and 66% respectively (WG-EMM-08/30, Table 1). Results from FOOSA indicate that the risks to predators at the trigger level (0.15 × yield) are greater under Option 4 than Options 2 and 3.

2.67 At higher levels of the yield multiplier, the results of FOOSA and SMOM differ in respect to predators. The risk that predators would be depleted below 75% of the abundances that might occur in the absence of fishing rises markedly at yield multipliers approaching 0.5 for both Options 2 and 3 in SMOM (Figure 8), but only for Option 3 in FOOSA (Figure 3). The probability of significantly depleting predator abundances remains low for Option 2 of FOOSA until the yield multiplier approaches 1.0. Thus Option 2 would appear to offer lower risks of negatively impacting predator populations than Option 3 given the model structure in FOOSA, but in SMOM the two options appear to result in similar risks to predators. This is partly attributable to the movement scenarios depicted in FOOSA but not SMOM indicating greater risk under Option 3.

2.68 In both models penguin and fish predators are impacted at lower levels of harvest rate, with low probability of significant impacts on seals and negligible impacts throughout all tested harvest rates for whales. A significant difference between the models is the increased risk to fish in SMOM compared to FOOSA (Figure 8 compared to Figure 2 'nst'). Dr Plagányi suggested that this might arise from the inclusion of historical catches of fish in SMOM whereas those catches are not included in FOOSA. At moderate harvesting rates the approach in SMOM results in high relative impacts on fish when compared to the no-fishing option since fish are assumed to be on a recovery trajectory in the latter case.

2.69 A presentation of the CSI analysis described in WG-EMM-08/16 is shown in Figure 10 (see Appendix D). The results are similar to those presented in Figure 2, and particularly demonstrate the difference in risks resulting from the use of the scenarios with and without krill movement. The Working Group agreed that this analysis captured the general properties of change within SSMUs and summarised well the sorts of magnitudes of change that may be expected even at the individual SSMU level (an example of which is given in Figure 11).

Impacts on the fishery

2.70 Implementation of Options 2 and 3 would require that the fishery mostly operate away from coastal areas, with 70 and 62% respectively of catch being allocated, within the models, to pelagic SSMUs. Although available biomass may be higher in pelagic SSMUs (because the total area of these SSMUs is substantially greater than the area of coastal SSMUs), the risks that krill densities will fall below thresholds which necessitate involuntary changes in the behaviour of the fishing fleet are substantially increased in pelagic SSMUs (Figure 4). Nevertheless, both SMOM and FOOSA predict that catches could be greatest in pelagic SSMUs (Figures 5 and 9). There is also a higher probability that the fishery will not be able to catch the allocated catch limit of krill in some SSMUs (Figure 6). Using results from FOOSA, the performance of the fishery is significantly worse under Option 4 than Options 2 and 3, and marginally worse in Option 3 than Option 2.

2.71 The Working Group noted that in Figure 5 many SSMU-specific model-averaged catches predicted from the implementation of Option 4 were low compared to other options because all of the parameterisations in the reference set implicitly describe initial conditions that would prohibit fishing in many SSMUs. It recalled that the SSMU allocation within the model trials would result in allocations different to that arising in reality. This is because the model simulates the estimation of krill biomass or predator demand to represent the process that would be undertaken in reality, which is described in detail in paragraph 2.31.

2.72 Dr Watters noted that the poorer relative performance of the fishery at higher harvest levels was because, as the yield multiplier increases, the fishery comes into stronger competition with predators and at some point it cannot catch its allocation. Even at the trigger level the fishery cannot catch all its allocation in some SSMUs.

2.73 Dr Plagányi noted the lower steepness of the trend in log mean catches seen in Figure 9 compared to Figure 5. She suggested that the cause was the fact that in SMOM the fishery was an inferior competitor to predators (fishing occurs only after predators have taken their catch) whereas in FOOSA they are equal competitors, so that as harvest rate increases, the fishery can realise a greater proportion of the allocation.

2.74 Dr Agnew noted that the flat trajectories seen in Figure 6 suggest that there are some SSMUs where the fleet may not be able to achieve its catch levels even when these are very low. Dr Constable suggested that it might be possible to examine this feature by analysing the data from the current fishery and combining this with a fleet dynamic model.

Consideration of uncertainty

2.75 The Working Group discussed the implications of a number of areas of uncertainty in FOOSA and SMOM.

Model conditioning

2.76 The Working Group reviewed evidence for the magnitude and timing of the specified step-change in krill abundance suggested by WG-EMM-08/10, noting that the specified trend in krill could result in negative bias in the models. The step-change was based on an analysis of FIBEX and CCAMLR-2000 Survey results, which suggested a halving of krill density in the Scotia Sea between the early 1980s and the 1999/2000 season. A decline of this magnitude was supported by published net-haul data (Atkinson et al., 2004; WG-EMM-08/P4). The regional coherence of krill density in AMLR surveys suggests that the 50% reduction in krill biomass could be applied to all SSMUs.

2.77 The Working Group noted that the comparison of FIBEX and CCAMLR-2000 Survey data may not be appropriate and that net-haul data might be a better indicator of changes in density over time. In general, the Working Group agreed that the true magnitude of any step-change in krill biomass is generally unknown, but no alternative estimates were provided by the Working Group for future consideration.

2.78 The Working Group examined evidence for whether a step-change in krill abundance had occurred. The WG-SAM calendar specifies that the step-change occurred in the late 1980s. The Working Group noted that penguins are particularly sensitive to changes in krill availability and that available evidence from penguins supports a step-change decline in krill. Dr Trivelpiece noted that the abundance of Adélie penguins (*Pygoscelis adeliae*) at Admiralty Bay exhibited a sharp decline in the late 1980s, concurrent with the first in a series of ice-free years. The decline was likely driven by reductions in juvenile survival during winter, rather than a reduction in adult survival.

2.79 Dr Kawaguchi questioned whether local availability of krill to penguins might have changed, rather than the overall density of krill throughout the region. Dr Trivelpiece clarified that, at the scale of foraging areas during the breeding season, there is no clear evidence that krill availability has changed. The aggregations of krill thought to be necessary for breeding success of penguins in Subarea 48.1 appear to continue to support chick production on a consistent basis. The Working Group noted that there appeared to be a general coherence of penguin responses at the South Orkney Islands and at South Georgia and that this supported the view of a more regional-scale change in krill density.

2.80 Some members of the Working Group noted that there is a large body of evidence for climatically driven changes in the Antarctic Peninsula region and asked whether other predators may have also declined. Specifically, the idea of a step-change in krill biomass raised the question of whether a regime shift might have occurred. The large amount of environmental variability evident in the Scotia Sea suggests that some predator groups will co-vary strongly with krill. Other predators that are less dependent on krill may show less correlation with environmental indices. However, if a step-change had occurred, it would be difficult to accept a scenario where other krill-dependent predators had not also responded. Dr Goebel noted that fur seal recruitment at Cape Shirreff had declined to near zero in recent years, but noted that these data do not span the step-change in krill.

2.81 The Working Group agreed that the available evidence for changes in krill-dependent predators supported the conclusion that a step-change in krill was likely to have occurred, but that the magnitude should be considered less certain.

2.82 Drs P. Gasyukov (Russia), Bizikov and Kasatkina noted that the Working Group did not discuss the WG-SAM calendar in sufficient detail. They also noted that the WG-SAM calendar does not give any indication of the dynamics of fish populations. The role of fish in the ecosystem remains an important source of uncertainty in this work.

2.83 The Working Group agreed that existing data may be useful for updating the calendar in the future to include the general expectations for fish dynamics (Annex 7, paragraphs 5.14 and 5.15).

2.84 Drs Gasyukov, Bizikov and Kasatkina also noted two issues arising from the use of the CCAMLR-2000 Survey to provide SSMU-scale estimates of krill density (Hewitt et al., 2004a; WG-EMM-08/30) included in the WG-SAM calendar. These were:

(i) the total krill biomass in Subareas 48.1, 48.2 and 48.3 calculated from multiplying SSMU krill density by SSMU area (values from Table 1 of Hewitt et al., 2004a) is 150% of the survey estimate B_0;

(ii) existing analysis of the CCAMLR-2000 Survey has provided density estimates by survey stratum (Hewitt et al., 2004b). In the WG-SAM calendar, these densities were assigned to SSMUs following Hewitt et al. (2004a). This potentially masks SSMU-scale heterogeneity in krill density. It is the opinion of Drs Gasyukov, Bizikov and Kasatkina that the densities used in the calendar do not reflect the real SSMU-scale krill biomass. Furthermore, it is necessary to estimate SSMU-scale density directly from CCAMLR-2000 Survey data for further application in models. This should be based on the reanalysis of survey data using the most up-to-date methods agreed by SG-ASAM and compatible with the assessment of the precautionary catch limit.

2.85 Dr Hill noted that:

(i) the difference between the survey estimate of biomass and the total biomass implied by Hewitt et al. (2004a, Table 1) is attributable to the different areas considered. It is necessary to extrapolate to the whole of Subareas 48.1, 48.2 and 48.3 in order to progress the work on SSMU allocation. However, to be precautionary, the B_0 estimate must be constrained by the area surveyed;

(ii) although SSMU-scale krill density might be more heterogeneous than implied by Hewitt et al. (2004a), this is the only available analysis that gives information on krill density at this scale. The model results should be considered in the context of this source of uncertainty along with the other sources listed in paragraphs 2.52 to 2.56 and 2.75 to 2.81.

(iii) FOOSA and SMOM are designed to evaluate SSMU allocations of catches determined within the models. There is no requirement for strict correspondence between the biomass estimates used to set the precautionary catch limit and those used to initialise the models. However, the work presented here makes use of the current estimate of γ (i.e. $\gamma = 0.093$) (SC-CAMLR-XXVI, Annex 4).

Model results

2.86 Dr Constable commented on the relatively flat response of krill population dynamics to increasing levels of yield multipliers displayed by both FOOSA and SMOM (Figures 1 and 7). He suggested that the fact that the models predicted a probability of less than 50% of the krill population being depleted at the end of the fishing period to 75% of its median spawning abundance in the no-fishing scenario indicated that the krill population was not responding as expected to increasing catch levels. In his opinion, this suggested that should the models be wrong, and that if, in reality, a higher probability of depletion of the krill population should arise, then the choice of harvest rate would not have been precautionary and the impact on predators would be likely to be higher than anticipated. A suitable precautionary approach to this uncertainty would therefore be needed to decrease the harvest rate suggested by the model runs to indicate a rate with an acceptable level of risk (paragraph 2.55).

2.87 Drs Plagányi and Watters stated that in their models the krill population did respond appropriately to increasing levels of yield multipliers. The apparently flat response in Figures 1 and 7 was caused by: (i) the fact that, in some areas, the fishery, acting as either an equal (FOOSA) or inferior (SMOM) competitor to predators, is not realising the full catch levels associated with the yield multiplier, and there is a high probability of the density of krill falling to levels that limit fishery performance particularly in pelagic SSMUs; and (ii) in the models containing movement of krill, these movements would be allowing a redistribution of krill amongst SSMUs that would reduce the amount of depletion of the krill population.

2.88 Dr Agnew recalled the discussions reported in paragraphs 2.32 to 2.39 which indicated that the fishery is unlikely to be able to efficiently take the catch limits allocated to pelagic SSMUs in the foreseeable future. Dr Constable noted that because it may be possible in the future for the krill fishery to develop technologies that make it economically and technologically feasible to achieve the catch allocations even in pelagic SSMUs, it is necessary that scenarios be developed to investigate what would happen if the fishery could take the full catch limit. At present the scenarios have not addressed this possibility even for coastal SSMUs.

2.89 Conservation Measure 51-01 limits the krill catch in Subareas 48.1, 48.2, 48.3 and 48.4 to 620 000 tonnes until the Commission has defined an SSMU allocation and, conversely, does not require an SSMU allocation to be determined while the catch remains below this trigger level. The Working Group noted that in all scenarios of each model there was only a very small risk to predators when the yield multiplier was set at a rate that corresponds to the trigger level of 620 000 tonnes (0.15 × the yield) and the SSMU allocation was determined by Options 2 or 3. Predictions from FOOSA indicated that implementation of Option 4 could lead to risks for predators.

2.90 The Working Group recalled its previous advice (SC-CAMLR-XXV, Annex 4, paragraph 5.24) that Option 1 would have relatively greater negative impacts on the ecosystem compared to the other fishing options. Preliminary analysis by the Working Group suggested that this would probably involve a higher risk to predators at yield multipliers of 0.15 than the negligible risks identified above for Options 2 and 3. There may therefore be some negative ecosystem impacts arising from the retention of the current fishing pattern as the total catch approaches 620 000 tonnes.

2.91 Dr Holt emphasised that a worst-case scenario (from the point of view of the predators) might be a concentration of catches close to 620 000 tonnes, for instance such that the total catch was taken from a single or a few SSMUs. Dr Bizikov noted that the trigger level should not be a barrier to fishery development nor should it carry an appreciable risk of negatively impacting the ecosystem.

2.92 The Working Group recognised that, should the allocations appropriate to Options 2 to 4 be applied to the current fishery, this would constrain the present catch in a number of SSMUs even though the total annual catch is only 17% of the trigger level.

2.93 The Working Group noted that decisions regarding the current trigger level are matters for the Commission.

2.94 Dr Bizikov recalled that very large catches of krill had been taken in the mid-1980s (400 835 tonnes in 1986/87, primarily from the Antarctic Peninsula, Elephant Island, SOW and SGE SSMUs) and significant ecosystem impacts had not been observed. Dr Trathan suggested that there might have been impacts that were unobserved (in SSMUs with no CEMP monitoring site or where the CEMP monitoring system was not fully developed at that time).

Advice to the Scientific Committee

2.95 The Working Group agreed that the overall conclusions to be drawn from the model analyses were:

(i) Option 4 performs significantly worse than Options 2 and 3 across all performance indicators;

(ii) Options 2 and 3 appeared to perform equally well under a number of scenarios; the differences in performance of Options 2 and 3 between models were due to the different model structures, for instance the inclusion of movement, parameterisation of predator dynamics and treatment of fish;

(iii) under Options 2 and 3 the risk of negative impacts on predators was negligible at yield multipliers of 0.15 (the harvest rate consistent with the trigger level);

(iv) under Options 2 and 3 the risk of negative impacts on predators increased at yield multipliers greater than 0.25 to 0.5 with penguins and fish being most significantly affected, seals affected to a minor degree and whales unaffected;

(v) Options 2 and 3 include allocations of 70 and 62% respectively of total catch to pelagic SSMUs, where indications from the models and from paragraphs 2.32 to 2.39 suggest that fishery performance will be significantly negatively impacted.

2.96 The Working Group recalled its discussion surrounding the model results on the catches of the fishery and the variation in the performance of the fishery under the different options (paragraphs 2.70 to 2.74).

2.97 The Working Group noted discussions relevant to bias (paragraphs 2.52 to 2.56) and uncertainty (paragraphs 2.75 to 2.94).

2.98 The Working Group noted discussion relative to the trigger level reported in paragraphs 2.92 and 2.93.

2.99 The Working Group noted that the current spatial distribution of catches does not follow the pattern assumed under Options 2 or 3, but more closely reflects that under Option 1, the historical fishing distribution. The Working Group could not provide explicit advice to the Scientific Committee on the risks associated with distributions of catches under Option 1, which may apply as the total catch approaches the trigger level. However, it noted that its previous advice (SC-CAMLR-XXV, paragraph 3.11) had suggested that allocations based on historical fishing distribution would have greater negative impacts on the ecosystem than other options.

2.100 The Working Group noted that the development of the models leading to the provision of advice for Stage 1 SSMU allocation had been technically challenging and that to develop the necessary models for advice in subsequent stages would be equally challenging, if not more so. Therefore, the Working Group wished to highlight this fact to the Scientific Committee and to emphasise that WG-EMM would need the necessary time (and information) to develop the models so that they were formulated appropriately.

2.101 The Working Group agreed that considerable progress has been made in assessing the relative risks of the different allocation options (see paragraph 2.31(ii)) and that this was sufficient for Task 2 of the Stage 1 SSMU allocation as detailed in paragraph 2.31.

2.102 The Working Group noted that estimates of predator consumption are uncertain primarily as a result of incomplete estimates of abundance of predators (WG-EMM-08/8 and 08/12). It also noted that the SSMU-scale krill density is not adequately estimated in available analyses of the CCAMLR-2000 Survey and it will remain uncertain until the issues surrounding methods for estimating krill abundance from the acoustic data are resolved (paragraph 5.111).

FOCUS TOPIC: DISCUSSION TO PROGRESS THE IMPLEMENTATION OF SPATIAL MANAGEMENT MEASURES THAT AIM TO FACILITATE THE CONSERVATION OF MARINE BIODIVERSITY

Background

3.1 Dr Penhale, as chair of this focus topic, presented the Working Group with a review of the development of progress on the topic of area protection and the development of candidate MPAs by CCAMLR.

3.2 The Working Group recalled that during the early 2000s, the work of the Subgroup on Designation and Protection of CEMP Sites had expanded in scope to include the review of management plans containing marine areas that are submitted to CCAMLR for approval. In 2002 this subgroup was renamed as the 'Advisory Subgroup on Protected Areas' (CCAMLR-XXI, paragraph 4.17). In 2003 the revised terms of reference of this subgroup were endorsed by the Commission (CCAMLR-XXII, paragraph 4.26) and included providing advice on the implementation of MPAs that may be proposed in accordance with provisions of Article IX.2(g) of the Convention.

3.3 In 2004 the Commission addressed the topic of MPAs and urged the Scientific Committee to proceed with this work as a matter of priority. It also reaffirmed the need to develop advice on MPAs commensurate with Articles II and IX of the Convention (CCAMLR-XXIII, paragraph 4.13). This was followed by the 2005 CCAMLR Workshop on Marine Protected Areas (SC-CAMLR-XXIV, Annex 7) held in the USA. The objectives of this workshop included a discussion of how the establishment of MPAs could be used to contribute to furthering the objectives of CCAMLR, including conservation and rational use.

3.4 In 2005 the Commission endorsed the Scientific Committee's advice arising from the 2005 CCAMLR Workshop, agreeing that the primary aim was to establish a harmonised regime for the protection of the Antarctic marine environment across the Antarctic Treaty System (CCAMLR-XXIV, paragraph 4.12). It was recognised that both CCAMLR and the CEP (through Article V of the Protocol on Environmental Protection to the Antarctic Treaty) have an interest in protected areas. The Commission also endorsed the Scientific Committee's work plan to hold a workshop to advise on a bioregionalisation of the Southern Ocean, including a fine-scale subdivision of biogeographic provinces (CCAMLR-XXIV, paragraph 4.17).

3.5 Plans for the Bioregionalisation Workshop progressed in 2006, including the establishment of a steering group comprising members from CCAMLR and the CEP (CCAMLR-XXV, paragraph 6.1). Additionally, the Commission commented that the Bioregionalisation Workshop would be an important step in the Commission's activities to develop a representative network of MPAs (CCAMLR-XXV, paragraphs 6.1 to 6.6). The 2007 Workshop on Bioregionalisation of the Southern Ocean was held in Brussels (SC-CAMLR-XXVI, Annex 9).

3.6 The Working Group noted that this workshop considered available bathymetric, physical oceanographic and biological data, and that benthic and pelagic systems were considered separately. The Working Group noted that the Scientific Committee had endorsed the outcome of the workshop, noting that it can be used to inform spatial management and is a primary foundation for understanding the biological and physical heterogeneity in the Southern Ocean (SC-CAMLR-XXVI, paragraph 3.71 to 3.89). The Commission endorsed the recommendations for future work on bioregionalisation and noted the Scientific Committee's view that further work 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 (CAMLR-XXVI, paragraphs 7.18 and 7.19).

3.7 The Working Group noted the advice of the Scientific Committee with respect to the application of the BRT method toward further refinement of Southern Ocean bioregionalisation (SC-CAMLR-XXVI, paragraph 14.4(iv)), which was further explored during WG-SAM-08.

3.8 Dr Hanchet summarised the WG-SAM discussions with respect to BRTs (Annex 7, paragraphs 4.13 to 4.19). The Working Group encouraged work to further develop the application of this method, which may be applicable in further work on bioregionalisation.

3.9 Dr Constable was concerned that the use of common species with the BRT approach might not be useful, and that extrapolating outside the geographic range may not be appropriate due to issues surrounding endemism.

3.10 Dr Grant questioned whether data layers from the BRT analysis should be incorporated into the current bioregionalisation maps, or used as separate layers providing information on individual species where available.

3.11 The Working Group agreed that the existing benthic and pelagic bioregionalisations were adequate, although further refinement may be undertaken as more data layers and products become available.

3.12 Dr Holt noted that data around the Southern Ocean remain relatively sparse, and that it is important to recognise the quality and quantity of data with respect to the various regions, particularly when predictive methods are used to infer data-sparse regions. Dr Siegel noted the importance of data coverage at large spatial scales.

3.13 With respect to benthic bioregionalisation, Dr Constable noted that there is a great degree of endemism and heterogeneity, and that the existing bioregionalisation is likely to be adequate for the purposes of CCAMLR. With respect to the pelagic realm, he felt that the work that has been conducted is also sufficient.

3.14 The Working Group noted that it was important that bioregionalisation incorporate not only species information, but structure and function of species assemblages as well.

3.15 Dr Grant noted that there are some aspects of ecosystem function that may not be amenable to being captured in a bioregionalisation.

3.16 The Working Group agreed that it is very difficult to include all aspects into a single bioregionalisation map, and that such information on species distributions and ecosystem processes may be more appropriately utilised as separate data layers, for example as may be used in a systematic conservation planning process.

3.17 Dr Naganobu agreed that the topic is highly complex, and that it is currently in a relatively early stage in relation to terrestrial bioregionalisation studies. He noted that there are still great uncertainties with respect to basic environmental indices in the Southern Ocean, and that more research should be directed toward basic tasks to better elucidate these indices.

3.18 Dr Constable noted that the existing bioregionalisation maps could be used to help identify areas of interest. Although these areas of interest may change in character over time, they are unlikely to change significantly in their location. Bioregionalisation maps could therefore be used to highlight key areas in which small-scale patterns could then be investigated further. Dr Holt noted the importance of establishing criteria for the identification of areas of interest.

3.19 Dr Spiridonov noted that other schemes of bioregionalisation can be interpreted in terms of oceanographic boundaries. He drew attention to a publication written by a physical oceanographer (Maslennikov, 2003) that has been produced in Russian. He indicated that it may be valuable in better constructing a bioregionalisation of the Southern Ocean. He inquired as to the possibility of having the book translated, so that it would be more useful for the Working Group as a whole.

3.20 The Working Group agreed that this publication could provide valuable additional insights into factors that influence bioregionalisation and encouraged Russia to pursue mechanisms to have the book translated into English.

Identifying vulnerable marine ecosystems

3.21 The Working Group noted Conservation Measure 22-06 and recalled that the working groups were tasked by the Scientific Committee to collaborate in work that includes methods to identify VMEs, develop operational definitions of what constitutes significant harm to VMEs and mitigate impacts (SC-CAMLR-XXVI, paragraph 14.9). There were three papers tabled for consideration towards addressing these topics.

3.22 WG-EMM-08/37 presented a risk management framework for avoiding significant adverse impacts of bottom fishing gear on VMEs. This approach is proposed for implementing the requirements of Conservation Measure 22-06 and based on the discussion by the Scientific Committee last year. The framework is similar to that used by ad hoc WG-IMAF to minimise the risk of longline mortality on seabirds. The framework has three parts:

(i) Risk analysis –

Evaluation of

(a) current and proposed fishing activities in specified areas including method and footprint (spatial and temporal extent, frequency);

(b) evidence of potential VMEs in an area of proposed fishing activity, with associated uncertainty;

(c) expected scale of interactions between fishing activities and VMEs, with associated uncertainty;

(d) possible impact of interactions on VMEs, with associated uncertainty;

(e) potential for recovery of VMEs following fishing disturbance, with associated uncertainty.

(ii) Options to eliminate risk –

Management options will be evaluated for the degree to which the risks will be reduced. Such options could include specific at-sea activities based on operational indicators and by-catch or spatial management. Research activities will be specified, when needed, to help identify suitable alternatives for eliminating risk and/or to evaluate the effectiveness of specific management options.

(iii) Review –

This aims to determine whether the measures for eliminating risk need to be updated, revised and/or supplemented. The plans for reviews would include timelines and the data requirements for undertaking such reviews.

3.23 In support of the risk analysis, WG-EMM-08/37 proposed the use of a risk analysis matrix, which relates the qualitative likelihood of an interaction with VMEs and the qualitative and semi-quantitative consequence of the impact of bottom fishing on VMEs. The paper noted that this matrix allows for gear- and operation-specific consideration of what might be vulnerable, knowing that taxa and habitats will have different vulnerabilities depending on the types of gear and the scale of the fishing operations. Importantly, consideration needs to be given to whether species and habitats have low resistance and/or low resilience to disturbance caused by fishing activities.

3.24 WG-EMM-08/37 also used publicly available databases, including SCAR MarBIN, to begin the development of a CCAMLR-specific guide to categories of VMEs and associated qualitative life-history characteristics of benthic taxa in the CAMLR Convention Area.

3.25 The Working Group agreed that a risk analysis framework represents a sensible approach to implementing Conservation Measure 22-06, and thanked the author for tabling this paper for consideration by WG-EMM. It recommended the author continue developing this approach, along with other interested members, for use by WG-FSA.

3.26 The Working Group recalled that the endorsed aim for managing interactions with non-target species was, in order of priority (SC-CAMLR-XXII, paragraphs 4.135 and 4.136 and Annex 5, paragraph 5.230):

(i) avoidance
(ii) mitigation
(iii) catch limits.

3.27 The Working Group noted that the vast majority of Antarctic benthic invertebrate species exhibit slower growth rates and longer life spans than their global counterparts. Further, different parts of the Southern Ocean are likely to exhibit different benthic properties, processes and disturbance regimes, and these should be considered and integrated into the risk framework. As a consequence, further precaution may be required in managing bottom fisheries between different areas of the Southern Ocean.

3.28 The Working Group noted that specific longline gear configuration (e.g. Spanish system, dropline, trotline) will most likely result in differences in the degree of interaction with the seabed, as was indicated by ad hoc TASO (SC-CAMLR-XXVII/BG/6, paragraph 2.10). These factors should be further explored at the 2008 meeting of WG-FSA. The Working Group recommended that strategies used to limit the impact of gear types on benthos and benthic communities, such as the current requirement that longline gear deployments in some exploratory fisheries be limited to depths greater than 550 m, could be further explored. The Working Group indicated that by-catch information from longlines using different configurations could be useful toward identifying VMEs.

3.29 Mr B. Weeber (New Zealand) informed the Working Group that New Zealand held a workshop on VMEs as part of its notification process for fishing in the Ross Sea in the 2008/09 season. A report of this workshop, along with a proposed definition of VMEs and preliminary assessment of potential impact by the longline fishery for *Dissostichus* spp. by the New Zealand fishery in the Ross Sea, will be included in their notification and presented at the upcoming meeting of WG-FSA.

3.30 The Working Group agreed that Antarctic benthic invertebrate ecosystems have not historically been on the agendas of WG-EMM and WG-FSA.

3.31 Dr Jones noted that it is important to begin a process for reducing the uncertainty in our knowledge of the types of taxonomic groups and habitats that may be vulnerable to CCAMLR bottom fisheries. He also noted that there are a number of publications and individual databases that might help in this regard, such as numerous records of gorgonian or antipatharian communities in the Southern Ocean (Barry et al., 2003). He proposed that a workshop be held to help bring these data together, and to provide guidance on the following points that are necessary to reduce uncertainty on the potential for CCAMLR bottom fisheries for causing significant adverse impacts on VMEs:

(i) vulnerability of Southern Ocean benthic taxa to CCAMLR bottom fisheries;

(ii) characterisation of habitats and habitat-forming taxonomic groups and rare taxa that would be consistent with a VME, including methods for assisting in identifying the extent of habitats based on distributions and densities of habitat-forming taxonomic groups;

(iii) methods for identifying potential locations of vulnerable taxa;

(iv) indicators that could be used by fishing vessels to signal when they are fishing on VMEs;

(v) quality of available data, such as in the SCAR MarBIN database, for this purpose.

3.32 Dr Jones also proposed that the workshop be held under the auspices of CCAMLR and include Antarctic benthic invertebrate specialists.

3.33 The Working Group agreed that a workshop of this nature is urgently needed, and should include benthic invertebrate specialists, gear specialists, scientific observers and other key CCAMLR scientists. Such a workshop could be held in conjunction with TASO, WG-FSA, or under alternative arrangements. In addition to information collected through research expeditions on potential locations of VMEs, the Working Group agreed that information collected by observers on invertebrate by-catch would be critical for the workshop to evaluate the levels of interaction between demersal fishing gears and benthic habitats in the Convention Area.

3.34 WG-EMM-08/38 presented a notification of two VMEs that were detected in SSRU 5841H. Evidence is based on direct video observation during the CEAMARC-CASO cruise conducted from December 2007 to January 2008. Camera transects were <2 n miles apart; thus, there is some degree of uncertainty associated with the extent of the VME. The paper suggested a buffer zone of 5 n miles around the observed area to mitigate the effect of spatial inaccuracy. Included in WG-EMM-08/38 is a proposed pro forma that could be used to notify the Scientific Committee and working groups when a VME is detected. The pro forma includes elements that detail the type of VME, the evidence used to detect the VME, the location of observations and the data repository.

3.35 Dr Naganobu questioned whether the content of the notification in WG-EMM-08/38 was meant to proceed directly into a conservation measure. He was concerned that the process of notifying the presence of a VME in the Convention Area is overly simplified, and felt that only video/photo observations are not strong enough evidence. He felt that the information contained in WG-EMM-08/38 was preliminary and the observations should be recorded as initial information.

3.36 Some Members indicated that these notifications are part of the obligations of Members under Conservation Measure 22-06. Dr Constable noted that the notifications provide the detail of the locations of two VMEs and a suggested strategy for ensuring fishing does not cause significant adverse impacts on them. The Working Group also noted that it was the responsibility of the Commission to decide on the management of VMEs.

3.37 Dr Jones noted that there are potentially three methods of detecting VMEs in the Southern Ocean: direct, indirect and predicted (WG-EMM-08/37), with ‘direct’ providing the strongest evidence. He felt that the information provided in WG-EMM-08/38 represented direct, clear indications of the presence of two VMEs in SSRU 5841H.

3.38 The Working Group endorsed the approach of providing information on a potential VME outlined in WG-EMM-08/38. This information could potentially be used to update the

VME registry that was adopted by the Scientific Committee. The Working Group noted that the method for approval of adding a VME to the VME inventory identified in Conservation Measure 22-06 would need to be further considered by the Scientific Committee.

3.39 WG-EMM-08/18 provided an overview of the New Zealand IPY-CAML survey of the Ross Sea region of Subarea 88.1 that was conducted in February–March 2008. The paper described the benthic survey of distribution and abundance of benthic assemblages for shelf, slope, seamount and abyssal sites in the Ross Sea region by means of sled, beam trawl, video transects and multicorer. The paper noted that the results of this benthic sampling will be useful for better understanding the distribution and abundance of benthic invertebrates found in VMEs. The authors noted that, combined with physical data, this may be useful for prediction of other areas where VMEs may occur. A summary report of the distribution of benthic invertebrates found in VMEs collected during this and previous surveys will be prepared for the 2008 meeting of WG-FSA.

3.40 Dr Jones noted that modelling approaches, such as the BRT method, may be useful for predicting where VMEs may exist within the Ross Sea outside of where the survey sampled.

3.41 Dr Constable emphasised the urgency to adopt and refine methods that can be used to ensure that risks to VMEs are reduced so that future fishing activities do not adversely impact VMEs, given that damaged VMEs will likely take a long time to recover, and that the cumulative effects of fishing will increase the risk of damaging VMEs. The Working Group agreed that cumulative impacts are very important, and that the rate of regeneration of the taxa that comprise VMEs is likely to be on a very long time scale.

3.42 Dr Spiridonov noted that the impact of bottom longlining is very poorly understood, and although documenting by-catch is important, the Working Group should also be concerned about the quality of the information. He suggested that photographs of benthic by-catch should be taken by observers.

3.43 The Working Group noted that the information on invertebrate by-catch contained in the CCAMLR database is generally at a variable level of taxonomic resolution and may be of limited value with respect to identifying potential VMEs.

3.44 The Working Group agreed on the need to establish levels of appropriate taxonomic groupings, including those that are considered vulnerable, to inform scientific observers as to the appropriate level of sampling. The Working Group noted that there are taxonomic guides being developed for Southern Ocean observers, and some of these should be available for review at WG-FSA.

Defining candidate marine protected areas

3.45 The Working Group recalled that recent discussions by CCAMLR and the CEP have concluded that the issues of where and how to establish a system of marine areas for the conservation of biodiversity in the Southern Ocean should be addressed as a matter of priority (CCAMLR-XXIII, paragraph 4.13; CEP, 2006, paragraphs 94 to 101).

3.46 Recent work on this topic has addressed a number of theoretical aspects, including bioregionalisation analysis (SC-CAMLR-XXVI, Annex 9), the potential for using conservation measures to achieve protection of marine biodiversity (SC-CAMLR-XXV/BG/19), and the definition of criteria for selecting areas for protection (SC-CAMLR-XXVI/BG/24).

3.47 The Working Group noted that a number of methods could be used for designing a representative system of MPAs, including, *inter alia*, bioregionalisation and 'systematic conservation planning'.

3.48 The Working Group considered the attributes of a process based on systematic conservation planning. In 2007 the Bioregionalisation Workshop had highlighted systematic conservation planning as an appropriate process by which important areas for conservation could be selected and designed (SC-CAMLR-XXVI, Annex 9). This process requires the definition of conservation objectives and uses spatial information on biodiversity patterns, ecosystem processes and human activities to identify the areas that should be included within a protected-area system in order to achieve the defined objectives.

3.49 Dr Trathan introduced WG-EMM-08/49 which provided a worked example of how the systematic conservation planning methodology might be applied in identifying important areas for conservation in the pelagic environment, using Subarea 48.2 (South Orkney Islands) as a pilot study area. The aim of WG-EMM-08/49 was not to identify areas for protection or management at this stage, but rather to test the utility of this methodology, and to demonstrate the types of data and the range of decisions that would be required to undertake such an analysis.

3.50 WG-EMM-08/49 demonstrated that systematic conservation planning is an objective and transparent methodology that assists in the identification of options for spatial protection of biodiversity and other valuable features. The systematic conservation planning process can be summarised into six stages:

(i) define the planning region (broad area of interest in which the study will be undertaken), and divide this into a grid of 'planning units';

(ii) compile relevant ecological data relating to the biodiversity of the planning region;

(iii) set conservation targets;

(iv) review existing conservation areas within the planning region;

(v) select additional conservation areas;

(vi) implement conservation actions.

3.51 WG-EMM-08/49 used MARXAN software to focus on steps (i) to (v) of the above process, and provided an illustration of how important marine areas for conservation might be identified using currently available data. Step (vi) was not considered as part of this study.

3.52 The Working Group noted that MARXAN software has been widely used for systematic conservation planning in a range of habitats worldwide.

3.53 The Working Group noted that, for using MARXAN, it is important to consider a combination of objectives, and not simply individual species or habitats. It noted that the use of MARXAN aims to optimise all conservation objectives at a minimum cost and that costs can be evaluated in a variety of units; potentially these could include such metrics as habitat area, financial cost or CPUE. The analysis described in WG-EMM-08/49 aimed to achieve all of the conservation objectives set in the pilot study in the smallest possible area, thus looking for areas in which more than one conservation objective can be met in the same location.

3.54 The Working Group noted that the results described in WG-EMM-08/49 are largely consistent with expected outcomes based on existing knowledge of the ecological processes in the study region. It therefore concluded that important pelagic areas for conservation could be identified using the methodology described in this pilot study, and on the basis of currently available information.

3.55 The Working Group noted that the systematic conservation planning approach requires data on a range of species and ecological processes, and that input is needed from scientific experts to define which datasets, and which parameters, are most appropriate for inclusion in the analysis. If required, data on human activities such as scientific research activities, fishing and tourism, could be incorporated. However, the Working Group recognised that the spatial distribution of existing human activities may change in the future and therefore a strategic network of representative MPAs should not simply consider those areas where existing human activities are ongoing.

3.56 The Working Group noted that a critical step in systematic conservation planning was the development of appropriate conservation objectives, and that this must be done on a scientific basis with input from appropriate experts as far as possible. The Working Group agreed that if systematic conservation planning were to be used, then conservation objectives would need to be developed in light of the objectives set out by the 2005 CCAMLR Workshop (SC-CAMLR-XXIV, Annex 7). Such objectives would also need to take into account criteria defined by Annex V to the Protocol on Environmental Protection.

3.57 WG-EMM-08/49 focused on the pelagic environment as an example, however, the Working Group agreed that it would be valuable to undertake similar analyses for the benthic environment. Once this has been completed, pelagic and benthic results could feasibly be considered together, to identify areas that may be important for conservation in both environments.

3.58 The Working Group noted that the outcomes from a systematic conservation planning process could be used to complement existing management tools such as SSMUs. MARXAN is one of a suite of tools that might be employed to assist with identifying important areas for conservation, but it cannot be used in isolation. Results from MARXAN do not provide a definitive ‘solution’ to the question of where important areas for conservation are located, but the outcomes can be helpful in informing decision-making.

3.59 The Working Group therefore endorsed the use of MARXAN as one feasible method for undertaking systematic conservation planning.

3.60 The Working Group noted that key outcomes of the 2007 Bioregionalisation Workshop had been the primary and secondary maps of pelagic bioregions (SC-CAMLR-

XXVI, Annex 9, Figures 3 and 4), and that some of these data had been used in the analysis described in WG-EMM-08/49. The secondary regionalisation map shows that there is a high level of heterogeneity in Subarea 48.2, and the Working Group noted that other such heterogeneous areas also exist elsewhere in the Southern Ocean (Figure 12). The Working Group recognised that many of these heterogeneous areas occur in regions of complex bathymetry and in areas where ecosystem processes are thought to be complex. It agreed that these areas should be given priority in more closely examining how a representative system of protected areas could be identified.

3.61 The Working Group therefore agreed that it should, as a priority, initiate a process to develop representative systems of MPAs across these areas. Therefore, Members were encouraged to use appropriate methodologies to further this work, using, *inter alia*, bioregionalisation and/or systematic conservation planning.

3.62 The Working Group noted that further work would contribute to the development of 'best-practice' guidance, which could then be employed in the selection of important areas for conservation of marine biodiversity, and the implementation of appropriate conservation actions.

Developing a harmonised approach

3.63 The Working Group noted that both CCAMLR and the CEP have obligations for protecting marine biodiversity. A system for establishing protected areas exists under Annex V of the Protocol on Environmental Protection, with a mechanism for approval by CCAMLR of such areas with a marine component. CCAMLR has also initiated a process to identify and establish areas to protect marine biodiversity.

3.64 The Working Group agreed on the importance of cooperation between CCAMLR and the CEP, to improve approaches for area protection by both bodies and to develop further means for practical cooperation.

3.65 WG-EMM-08/52 summarised the CEP discussions on the proposal for a Joint SC-CAMLR–CEP Workshop to be held in 2009, immediately prior to the CEP XII meeting in Baltimore, USA. The CEP has nominated its chair and two vice-chairs as representatives of a joint workshop steering group, and recommended that this group should be convened as soon as practical.

3.66 The Working Group agreed that the topics identified by the CEP for possible consideration by the joint workshop were important topics of mutual interest. The issues of protected areas and spatial management measures were recognised as being of particular relevance. The Working Group also noted that there are synergies between the CCAMLR bioregionalisation work and the CEP Environmental Domains Analysis for Terrestrial Antarctica.

3.67 The Working Group further agreed that the proposed joint workshop should not address these topics in substantive detail, but that it should focus on the development of mechanisms for practical cooperation.

3.68 The Working Group agreed to support the proposal for a joint workshop, and to support the attendance of the SC-CAMLR working group conveners. Members were also encouraged to consider the attendance of other individuals who would be able to contribute to these discussions.

3.69 The Working Group recommended that the Scientific Committee discuss the types of information that would be most useful for presentation to the workshop on behalf of SC-CAMLR, and to provide advice on this to the working group conveners in preparation for the workshop. Further discussion on the development of an agenda and practical arrangements for the workshop are reported in paragraphs 8.19 and 9.1 to 9.5.

Work plan

3.70 The Working Group agreed that further work to progress the implementation of spatial management measures for the conservation of marine biodiversity should include:

(i) further development of the BRT method;

(ii) a workshop to be held under the auspices of CCAMLR to bring together data on the types of taxonomic groups and habitats that may be vulnerable to CCAMLR bottom fisheries, and to provide guidance on points that are necessary to reduce uncertainty on the potential for CCAMLR bottom fisheries for causing significant adverse impacts on VMEs (paragraph 3.31);

(iii) initiation of processes to develop representative systems of MPAs across the priority areas identified in Figure 3.1, using, *inter alia*, bioregionalisation and/or systematic conservation planning;

(iv) identification of the types of information that would be most useful for presentation to the Joint SC-CAMLR–CEP Workshop on behalf of SC-CAMLR, and consideration of the attendance of individuals who would be able to contribute to the workshop discussions.

Key points for consideration by the Scientific Committee and its working groups

3.71 The Working Group recalled that recent discussions by CCAMLR and the CEP have concluded that the issues of where and how to establish a system of marine areas for the conservation of biodiversity in the Southern Ocean should be addressed as a matter of priority (CCAMLR-XXIII, paragraph 4.13; CEP IX Final Report, paragraphs 94 to 101) (paragraph 3.45).

3.72 The Working Group agreed that the existing benthic and pelagic bioregionalisations developed by the 2007 Bioregionalisation Workshop were adequate, although further refinement may be undertaken. The Working Group encouraged work to further develop the BRT method (paragraphs 3.7 and 3.8).

3.73 The Working Group agreed that a risk-analysis framework represents a sensible approach to implementing Conservation Measure 22-06. It recommended that this approach should continue to be developed for use by WG-FSA.

3.74 The Working Group agreed that a workshop should be held under the auspices of CCAMLR to bring together data on the types of taxonomic groups and habitats that may be vulnerable to CCAMLR bottom fisheries, and to provide guidance on points that are necessary to reduce uncertainty on the potential for CCAMLR bottom fisheries for causing significant adverse impacts on VMEs (paragraph 3.31).

3.75 The Working Group endorsed the approach of providing information on a potential VME outlined in WG-EMM-08/38. It noted that the approval of the addition of a notification of a VME to the VME inventory would require endorsement of the Scientific Committee.

3.76 The Working Group noted that a number of methods could be used for designing a representative system of MPAs, including, *inter alia*, bioregionalisation and/or systematic conservation planning (paragraphs 3.48 to 3.58). It endorsed the use of MARXAN software as one feasible method for undertaking systematic conservation planning (paragraph 3.59).

3.77 The Working Group agreed that it should, as a priority, initiate a process to develop representative systems of MPAs across the priority areas identified in Figure 12 (paragraphs 3.60 and 3.61). Therefore, Members were encouraged to use appropriate methodologies to further this work, using, *inter alia*, bioregionalisation and/or systematic conservation planning.

3.78 The Working Group agreed on the importance of cooperation between CCAMLR and the CEP and agreed to support the proposal for a Joint SC-CAMLR–CEP Workshop, which will address topics related to protected areas and spatial management measures.

STATUS AND TRENDS IN THE KRILL FISHERY

Fishing activity

4.1 WG-EMM-08/5 reported on the krill fishery in the 2007/08 season. So far this season, six vessels from five Member countries have fished for krill, exclusively in Area 48. A total of 84 110 tonnes of krill was caught to the end of May. Projections based on catches reported to the end of May suggest that the total catch for the season will be approximately 108 000 tonnes. This estimate is below the recent (2004/05) and long-term (1986/87) maximum annual catches for Area 48 (129 026 and 400 835 tonnes respectively), and within 4% of catch totals in the previous two seasons. Nonetheless, the catches taken by individual Members over recent years have varied considerably, with catches taken by Norway increasing dramatically. The catch statistics show a pattern of monthly accumulation (Figure 9 in WG-EMM-08/5) that is reasonably consistent between seasons but also may indicate an anomalous slow-down in May 2008, suggesting that the final total catch for 2007/08 might be lower than the estimate. The paper also provided details of the deployment of scientific observers in the krill fishery from 1999/2000 to 2006/07 where the observers followed the CCAMLR Scheme of International Scientific Observation.

4.2 The Working Group thanked the Secretariat for WG-EMM-08/5 and noted the importance of this information in its work.

4.3 The Working Group noted that Poland had not yet submitted haul-by-haul data for 2006/07 and that Korean haul-by-haul data for 2004/05 remained incomplete. Dr Ramm advised that the Polish authorities had experienced difficulties with their fishery computing systems, and would submit the outstanding data as soon as possible. The Republic of Korea had advised that some haul-by-haul data from 2004/05 were not collected and, therefore, cannot be submitted to CCAMLR.

4.4 The Working Group noted the variety of net configurations reported by scientific observers (WG-EMM-08/5). The wide range of net configurations, including the size of the mouth opening of nets, is likely to have a strong influence on gear selectivity and catchability. The Working Group agreed that information on net configuration is likely to be important for understanding fishery performance.

4.5 The Working Group also urged scientific observers to include information on seal exclusion devices in observer reports (SC-CAMLR-XXVII/BG/6, paragraph 2.7).

4.6 WG-EMM-08/6 summarised krill fishery notifications for 2008/09. Nine countries submitted notifications for 23 vessels. All notifications included an intent to fish in Area 48, and the notification from Russia included an intent to fish in Subarea 58.4. In addition, Norway and Russia had notified for exploratory fisheries for krill in Subareas 48.6 and 88.3 respectively. The Working Group noted that the Secretariat had been advised prior to the meeting that Russia had withdrawn its notification for the exploratory fishery for krill in Subarea 88.3.

4.7 The total notified catch was 879 000 tonnes of krill (excluding the Norwegian exploratory fishery notification). This exceeds the trigger level for Area 48 (Subareas 48.1, 48.2, 48.3 and 48.4) for the second consecutive year. However, actual catches have remained relatively constant over recent years (and fallen as a proportion of notifications, see WG-EMM-08/6). The notifications were for fisheries using four different gear types including beam trawls.

4.8 With regard to the Russian and US notifications, the Working Group noted that the intention to fish in Subarea 48.3 during the austral summer is a departure from previous practice.

4.9 There is uncertainty about the potential impacts of beam trawls, as indicated in the Russian notification, used in the krill fishery. Dr Bizikov advised that the beam trawls will be used for midwater fishing, in combination with a pumping method, and would be unlikely to have a greater benthic impact than other krill fishing methods.

4.10 The Working Group requested that details of gear characteristics and patterns of use be included in future notifications. The Working Group encouraged Members who notified for krill fisheries in 2008/09 to provide this information in advance of this year's meeting of the Scientific Committee.

4.11 The Working Group also requested that details of gear used be reported, by haul or haul range, in the future by scientific observers (e.g. net configuration, how many nets are used, and how often nets are switched) (see SC-CAMLR-XXVII/BG/6, paragraph 2.7).

4.12 The Working Group noted that 12 new vessels are intending to enter the fishery. The Working Group agreed that a fishery consisting largely of new vessel entrants could make it particularly difficult for the development of its work. The Working Group therefore agreed that it was important to have a structured program of data collection to rapidly establish a profile of new vessels.

4.13 The Working Group drew the Scientific Committee's attention to the discrepancy between notified and actual catches, noting that the Working Group is currently unable to assess the seriousness of the intent to fish in the majority of notifications. The Working Group had previously requested that Parties provide notifications that more accurately predict catches, but the discrepancy has increased dramatically over recent years. The request to improve the accuracy of notifications should be repeated.

4.14 The Working Group noted that details of the vessels notified to fish for krill in the 2008/09 season indicate that sufficient vessel capacity exists to exceed the trigger level. This emphasised the need to make rapid progress on SSMU allocation.

4.15 The Working Group noted that Norway had notified its intention to conduct an exploratory fishery for krill in Subarea 48.6 (CCAMLR-XXVII/13). Fishing will be conducted by the vessel *Thorshøvdi* using both conventional trawling and a continuous pumping method with a target catch of 15 000 tonnes of krill. The notification of intent includes a commitment to comply with all relevant conservation measures, and is associated with relevant krill density estimates, stock structure information and by-catch issues which are reported in WG-EMM-08/28 and 08/29.

4.16 The Working Group noted that there is an increasing trend in the capacity of vessels in the krill fishery and there is currently some uncertainty among Working Group members about how this capacity may be utilised (e.g. for storing processed catch transhipped from other vessels, for storing catch originating from this vessel, or use as a processing factory). For example, the capacity of *Thorshøvdi* (7 720 m^3) greatly exceeds that of other vessels included in this year's notifications.

4.17 The Working Group indicated that uncertainty about the practical details of certain notifications submitted to the Working Group would need to be supplemented to facilitate full advice on the likely course of the krill fishery in the forthcoming season and suggested the Scientific Committee may wish to consider additional information provided to it in respect of:

(i) update on the status of vessels intending to enter the fishery for the first time in 2008/09, and the anticipated dates when these vessels will be operational (Chile, Cook Islands, Norway, Russia, Ukraine, USA) (paragraphs 4.12 and 4.13);

(ii) configuration and use of beam trawls (Russia) (paragraph 4.9).

Description of the fishery

4.18 WG-EMM-08/32 examined the krill fishing records from 1973 to 2008 available from the CCAMLR database (C1 data). In total, 94% of the historical catches were taken in depths between 0 and 200 m, with a peak at 50 m. Efficient and stable fishing grounds were distributed in a narrow range, with steep meridional gradients between –1.0° and 1.0°C for the mean water temperature from the surface to 200 m (MTEM-200). In the main fishing regions off East Antarctica, the Scotia Sea and the north of South Georgia, large fishing catches were concentrated in waters colder than –0.5°, 0.0° and 1.0°C respectively. Especially large fishing catches indicated two remarkable peaks, –0.5°~0.1°C and 0.5°~0.8°C, which were located in the Scotia Sea and north of South Georgia respectively. MTEM-200 seems to provide habitat information on circumpolar-distributed species for krill and also other organisms.

4.19 Dr Naganobu added some further points to the review in paragraph 4.18. The historical krill distribution, based on the *Discovery Reports'* net sampling, similarly coincided with this study's results and each of the isopleths of MTEM-200 substantially corresponded with each oceanic front in the Southern Ocean. MTEM-200 can be applied for the further analysis of seasonal and/or annual variability.

4.20 WG-EMM-08/39 characterised the behaviour of the krill fishery using CCAMLR krill C1 data from the more recent 10 years by analysing distances travelled by vessels in relation to catch level. This revealed a pattern that mean travel distances are longer after the least catch levels, and the travel distances decrease as catch level increases to certain catch levels, and then distances travelled increase again above that catch level for Japanese vessels. The paper suggested the need for updates of some of the parameters used in the krill fishery fleet dynamics models published in late 1980s, to reflect changes in the efficiency and scale of the krill fleet's operations. A considerable year-to-year variability was revealed for the probabilities of repeated operation at same locations. Fishing vessels showed a pattern of frequent change of fishing grounds. The analysis suggested that krill availability for the fishery in 2000 seemed to be at its lowest in the last 10 years (WG-EMM-08/40). Fishery behaviour differentiates between market-type considerations/strategies, which are often the argument for changing fishing patterns, and catching efficiency/operational requirements in an area. It underscores the importance of high-quality year-round data from observers from all vessels participating in the krill fishery to assist in interpreting the annual fishing results (WG-EMM-08/39).

4.21 The Working Group welcomed the analysis for its contribution to understanding the fishery dynamics, and encouraged the author to further develop the analysis by: (i) aggregating fishing operations in space and time to attempt to identify any broader-scale patterns in time and space; (ii) comparing behaviours between coastal and pelagic areas to inform possible difference in operation between these areas; and (iii) taking into account the captain's experience in the analysis to help understand learning curves in operations of new entrants. Analysis of fishing behaviour in relation to predator colony positions and use of length-frequency distribution to inform the status of the krill population were also suggested. It was noted that C1 data do not include krill length-frequency data.

4.22 Dr Kasatkina noted the importance of including the number of vessels operating at the same fishing ground at the same time in the vessel behaviour analysis, since it may affect krill availability per vessel and consequently affect vessels' operational behaviour.

4.23 WG-EMM-08/24 summarised scientific observations conducted for 42 days by a national observer on board a Ukrainian krill trawler in Subarea 48.2 during March–April 2008. A total of 565 tows were made. Mean CPUE was 18.3 tonnes of krill per hour, and the average catch was 208.5 tonnes of krill per day. Size distributions of krill in March and April were similar (ranging between 23 and 61 mm) but the percentage of large krill (>48 mm) and small krill (<40 mm) fell by 20% in April. Juvenile fish by-catch (*Champsocephalus gunnari*) was only recorded from one tow, with fish having a mean body length of 14.3 cm and average weight of 13.0 g. No seal by-catch was recorded. Large-sized whales were repeatedly observed off the South Orkney Islands during the observation.

4.24 The Working Group noted that the two modal sizes observed in the krill length-frequency distribution were consistent with the sizes observed in the US AMLR Program conducted in the same region during the same season, although their proportions were different (WG-EMM-08/26).

4.25 WG-EMM-08/57 reported on fish by-catch caught by the *Niitaka Maru* from 6 to 30 August 2007 to the north of South Georgia. Fish by-catch was observed in 26 of 87 net tows examined (29.9%). Among the seven fish species observed (three Myctophidae, one Zoarcidae, one Nototheniidae and two Channichthyidae), *Krefftichthys anderssoni* (Myctophidae) was most frequently observed (38.5% of hauls examined). Owing to the small amount of by-catch, no clear relationships between krill CPUE and fish by-catch could be confirmed in the present study.

4.26 Dr Naganobu noted that the Japanese fish by-catch observation program has been continuing for over 10 years, and had developed a fish identification sheet for at-sea use by observers (WG-EMM-07/32).

4.27 The Working Group noted that the major by-catch species was myctophiids, whereas the major by-catch species usually reported from this area is icefish larvae. The Working Group commented that this may reflect the difference in at-sea sorting protocols, since this observation was undertaken before the fish and fish larvae by-catch protocol was updated in the electronic observers logbook (paragraph 4.43). The difference in the depth of the net hauls, as well as interannual variation of the species compositions, could also be the reason. The importance of using a consistent protocol across vessels was reiterated.

Scientific observation

Observer deployment

4.28 Six scientific observer logbooks were submitted to the Secretariat for the 2006/07 season from observations conducted by CCAMLR scientific observers on the *Saga Sea* (Norway), *Niitaka Maru* (Japan) and *Dalmor II* (Poland).

4.29 In addition, the Secretariat has received five notifications of the placement of CCAMLR international scientific observers on krill fishing vessels in Area 48 in 2007/08.

4.30 At the request of WG-EMM (SC-CAMLR-XXVI, Annex 4, paragraph 4.58), the Secretariat provided a summary of all observer data submitted to the Secretariat for the krill fishery from 1999/2000 to 2006/07 (WG-EMM-08/5). The Working Group noted that the percentage of tows observed varies greatly between observers, seasons and vessels. For example, in 2006/07 between 20 and 86% of the tows were observed per trip, including both the traditional trawling method and the continuous fishing system (WG-EMM-08/5, Table A1).

4.31 The Working Group noted that observer coverage reported in WG-EMM-08/5 was reported as the proportion of tows observed while the observer was on board. The Working Group requested the Secretariat to also indicate the proportion of total tows observed in future reports.

4.32 The Working Group noted the submission of some national scientific observer data in accordance with the CCAMLR Scheme of International Scientific Observation, and encouraged all Parties with national observers to collect and submit data to the Secretariat in accordance with this scheme.

4.33 The Working Group agreed that the information provided in WG-EMM-08/5 was very useful in understanding the extent of scientific observer data held by the Secretariat.

Conversion factors

4.34 Vessel-derived conversion factors have been reported consistently since 2001/02, however, the observer-calculated conversion factors are less common due to the difficulties experienced by observers in obtaining accurate data or gaining access to the processing factory (SC-CAMLR-XXVII/BG/6, paragraph 3.14). The Working Group noted the need to develop a set of protocols and guidelines for observers to assist in the collection of accurate conversion factor data (WG-EMM-08/6).

4.35 WG-EMM-08/46 examined uncertainties in krill catch arising from the use of product conversion factors from scientific observer data, and a limited amount from fine-scale (C1) data reported over the past five years. Conversion factors ranged between 1 and 26 across product types. Given this variability in conversion factors, a nominal reported catch of 600 000 tonnes may represent a catch of 2.5 million tonnes in an extreme case, assuming all the catch was boiled product. Information on product-specific conversion factors, as well as the product composition of the catch, is critical to better quantify the level of uncertainty in reported krill catches.

4.36 In the current reporting system, the product-specific catches and conversion factors are not reported and therefore it is not possible to identify whether the catch reported was based on conversion factors or direct measure of green weight.

4.37 The Working Group further noted the range of new products produced by the krill fishery and recognised that estimation of conversion factors for some of these novel krill products may be impractical.

4.38 Dr T. Knutsen (Norway) noted that Norway has implemented a flow-scale system and is now reporting fine-scale data based on a measurement of 'green weight' of krill prior to processing.

4.39 The Working Group expressed its serious concern over the inconsistency in the way the amount of krill removed from the ecosystem may be recorded, which is causing uncertainties in the catch reported to the Secretariat. The Working Group advised the Scientific Committee to encourage Members to evaluate the possibility of accurately reporting catch on the basis of green weight caught, recognising that this is a matter of some urgency.

By-catch

4.40 No seabird and seal by-catch was observed by scientific observers in 2006/07 (WG-EMM-08/5, Table A5).

Ad hoc Technical Group on At-Sea Operations

4.41 Dr Welsford presented the report of ad hoc TASO (SC-CAMLR-XXVII/BG/6). The Working Group noted TASO's discussions on the design and operation of krill fishing gears in the Convention Area (SC-CAMLR-XXVII/BG/6, paragraphs 2.1 to 2.8). The Working Group agreed with TASO's recommendation for the establishment of a standard format for reporting gear configuration in the observer report.

4.42 The Working Group also noted the discussions by ad hoc TASO on data collection priorities in the krill fishery (SC-CAMLR-XXVII/BG/6, paragraphs 3.1 to 3.16). The Working Group noted that the observer priorities in the current CCAMLR *Scientific Observers Manual* were not consistent with those agreed by SC-CAMLR (SC-CAMLR-XXVI, paragraph 3.6). The Working Group requested that appropriate changes are made to ensure that the data priorities are consistently represented.

4.43 The Working Group also noted that observers considered the newly adopted CCAMLR larval fish by-catch protocols (observer logbook form K11), which provides increased coverage and data collection, and a more efficient use of the observer's time to collect these data. The Working Group agreed to the proposal by ad hoc TASO (SC-CAMLR-XXVII/BG/6, paragraph 3.5) that a small workshop of experts be held to assess the digital images of larval fish archived through the new larval fish by-catch protocol, as a way to assess at-sea identifications by observers.

4.44 The Working Group agreed with the recommendation of ad hoc TASO that all data requested to be collected by observers in the krill fishery should be evaluated in terms of their value for providing advice to the Scientific Committee without causing excessive workloads for observers.

4.45 The Working Group reviewed the terms of reference developed by ad hoc TASO and agreed that it was the role of the Working Group to specify data requirements for observers and that TASO's role is to provide advice on how these requirements could be achieved.

4.46 The Working Group thanked ad hoc TASO for its report. It agreed that the information collated by the experts brought together in TASO had greatly enhanced the ability of the Working Group and its observer subgroup to understand the operations of fishing vessels and practicalities of at-sea data collection. The Working Group looked forward to future meetings of TASO and particularly encouraged Members participating in the krill fishery to send observers, technical coordinators and industry representatives to attend future meetings.

Scientific Observers Manual

4.47 WG-EMM-08/45 examined the quantity and quality of data submitted by CCAMLR scientific observers. This analysis considered the spatial coverage as well as a consideration of length and sex/maturity stages of krill.

4.48 The Working Group agreed with the suggestion in WG-EMM-08/45 that 200 krill should be measured for five net hauls every 30-day period, and if the vessel moves 50 n miles (based on analysis in WG-EMM-08/39) or into another SSMU, then a new sampling period should begin.

4.49 The Working Group also agreed, on the basis of the analysis in WG-EMM-08/45, that the current instructions for observers on sexing and maturity stages should be simplified.

4.50 The Working Group also discussed the difficulties of using the colour chart included in the manual to identify greenness of krill. However, the Working Group agreed that observer protocols should not be altered without appropriate assessment of the utility of the current protocol and the resulting data. The Working Group recommended a review of the collection of krill colour data, which should address the following questions:

- Are there any past, current or intended analyses of these data?
- What level of detail do such analyses require?
- Is the same information available from other data sources that are currently collected or might be collected more efficiently than krill colour data (e.g. product information, captains' decisions)?

4.51 The Working Group further recalled that it had referred to WG-FSA for further development the existing guides to the identification of larval fish taken as by-catch in the krill fishery (SC-CAMLR-XXVI, Annex 4, paragraph 4.37). Subsequently, WG-FSA had requested that the Secretariat translate into English the guide published by VNIRO in 1986 (SC-CAMLR-XXVI, Annex 5, paragraph 10.10). WG-EMM noted that a preliminary English version of this guide was now available.

4.52 The Working Group advised the Scientific Committee that a revision of the instructions in the *Scientific Observers Manual* is required to reflect the changed priorities for data collection (paragraph 4.66), as well as to reflect the changes in data requirements:

(i) measure 200 krill from five randomly selected hauls during each 30-day period (or from one sample of 200 krill each five-day period for the continuous fishing methods). All krill should be measured to the nearest millimetre from the eye to the tip of the telson;

(ii) the maturity and sex stage to be reported in five classes (juvenile, males, females, mature males and gravid females) of the krill measured for their length;

(iii) a new krill length measurement reporting period will commence if the vessel moves operation >50 n miles or moves between SSMUs;

(iv) fish by-catch should be observed twice a day following the existing fish by-catch protocol, including the fish-larvae sampling protocol.

4.53 The Working Group agreed that protocols for observation of incidental mortality of seabirds and marine mammals should be revised according to clarification to be made by ad hoc WG-IMAF on the application of the CCAMLR warp-strike protocol, including operation on continuous fishing methods.

4.54 The Working Group noted that a fish by-catch protocol that includes a procedure for sampling fish of all sizes (and is consistent with the existing fish-larvae sampling protocol) should be developed.

Observer coverage for krill fishery

4.55 A plan for systematic scientific observer coverage (WG-EMM-08/34) was submitted by Japan in response to the request by the Scientific Committee (SC-CAMLR-XXVI, paragraph 3.13). Japan proposed deployment of well-trained government-appointed observers with 50% vessel-day coverage, with the achievement of 100% (spatial and temporal coverage) every two years, and prompt submission of data to the Secretariat.

4.56 The Working Group welcomed Japan's proposal and supported its intention to formalise systematic observer coverage on krill vessels.

4.57 The Working Group recalled the two-staged approach put forward by the Scientific Committee in 2007, stressing the high level of coverage needed to understand the overall behaviour and impact of the fishery during the earlier stage, and to collect sufficient data to evaluate the regime for routine monitoring of the fishery to inform population and ecosystem models (SC-CAMLR-XXVI, paragraphs 3.7 to 3.12).

4.58 The Working Group agreed that the 100% vessel coverage (i.e. a minimum of one observer on each vessel for all the period that the vessel is in the Convention Area) using government-appointed or international observers should be undertaken as soon as possible. During the initial phase of 100% observation, monthly submission of some of the data (krill measurement, by-catch and warp strikes) might be required to allow real-time feedback. This would require an increased workload for the Secretariat and WG-EMM to ensure assessment and provision of feedback on the performance of the observer program in the krill fishery.

4.59 The Working Group requested the Scientific Committee to consider the most practical way of initiating such coverage (for example, to take effect from December 2009), as this will allow sufficient time to recruit and train the observers to be deployed while being prepared to have coverage over a full fishing season.

4.60 The Working Group agreed that all observers need to be government trained and accredited, and that Members should be encouraged to arrange bilateral agreements to deploy international observers wherever possible.

4.61 The Working Group agreed that after a two-year period of 100% coverage, it would be in a position to provide advice to the Scientific Committee on the level of ongoing observer coverage, given the expectation of systematic coverage of not less than 50% vessel-days in the krill fishery.

4.62 The Working Group agreed that any new entrants (Members or vessels) and vessels using new fishing methods must comply with a two-year 100% vessel-time coverage by government-appointed or international observers, noting that this could be reviewed after two years to determine the required coverage for subsequent years.

4.63 The Working Group noted that vessels with increased catch and processing capacity may also need more than one observer to ensure data collection to be equivalent to the proportion of catch observed in other vessels.

4.64 The Working Group reiterated that for any level of coverage, the data must be of high quality, consistent across vessels and fishing methods, and collected in accordance with the CCAMLR Scheme of International Scientific Observation, following the instructions outlined in the *Scientific Observers Manual*.

4.65 The Working Group noted that there were inconsistencies with the priorities outlined by the Scientific Committee and those in the *Scientific Observers Manual*, and suggested that the latter be revised to reflect the new priorities.

4.66 The Working Group agreed that the priorities for data collection from the krill fishery should be:

- fish by-catch including larvae
- krill length-frequency distribution and maturity and sex stage
- trawl warp strikes
- incidental mortality of seabirds and marine mammals
- fishery dynamics and operation details.

Regulatory issues

4.67 The Working Group reviewed conservation measures that apply to krill fisheries (reported in WG-EMM-08/5), and agreed to advise the Scientific Committee on Conservation Measures 21-03 and 21-02.

4.68 With regard to Conservation Measure 21-03, the Working Group recalled the need to record information that describes the fishing technique to be used by krill fishing vessels (Annex 21-03/A). The Working Group agreed with the recommendation of TASO (SC-CAMLR-XXVII/BG/6, paragraph 2.16) to advise the Scientific Committee that it would be useful for Members to include information on specific details of the gear configuration when notifying their intent to participate in any krill fishery. This would include mesh size of the net, the mouth opening of the net, as well as the presence and design of a seal exclusion device, and any changes in trawl configuration during the trip. The addition of a relevant diagram in the scientific observer's report to CCAMLR should be considered to record this. It was recommended that a new notification pro forma should be developed for recording this information.

4.69 The Working Group noted that Conservation Measure 21-02 requires Members to notify the Commission of intent to participate in an exploratory fishery not less than three months in advance of the next regular meeting of the Commission. The Working Group agreed that the notification deadline in Conservation Measure 21-02 could lead to situations in which notifications of Members' intent to participate in an exploratory krill fishery were provided after the annual meeting of WG-EMM; such situations would not allow WG-EMM to provide advice to the Scientific Committee on any issues pertaining to such notifications. The Working Group therefore recommended that Conservation Measure 21-02 be revised so that notifications for exploratory krill fisheries must be received prior to the annual meeting of WG-EMM.

4.70 The Working Group recognised that Norway's notification of its intent to participate in an exploratory krill fishery in Subarea 48.6 (CCAMLR-XXVII/13) was provided to the Commission with sufficient time for WG-EMM to consider the notification and advise the Scientific Committee on aspects related to the data collection plan required by Conservation Measure 21-02 (paragraph 3). WG-EMM thanked Norway for its timely notification.

Exploratory krill fishery research data collection requirements

4.71 The Working Group recalled the request in 2007 from the Scientific Committee (SC-CAMLR-XXVI, paragraph 3.29) that 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.

4.72 The Working Group noted the notification by Norway for an exploratory krill fishery for the forthcoming season in Subarea 48.6, an area where little data on krill or krill predators exists. However, the Working Group noted that Germany and Norway have conducted recent scientific surveys in this subarea. The Working Group requested that Germany and Norway make analyses of acoustic and net data from the surveys on krill collected within Subarea 48.6 available for consideration by WG-EMM during the 2009 meeting (paragraph 5.51).

4.73 The Working Group noted that, at present, there is no formal estimate of biomass in Subarea 48.6, and thus no precautionary catch limit. It was also noted that there is currently no existing exploratory fishery research data collection plan for krill, as there are in exploratory toothfish fisheries (Conservation Measure 41-01) and crab fisheries (Conservation Measure 52-01).

4.74 The Working Group noted the requirement of Conservation Measure 21-02 for an orderly development of any exploratory krill fishery, with its attendant requirements for data to be collected that could be used to refine subsequent management decisions. With respect to a vessel entering an exploratory krill fishery, a set of research requirements and a data collection plan, similar to those set out for exploratory toothfish fisheries, is needed. The Working Group agreed that it would be best if these research requirements were generic, and suitable for any exploratory krill fishery notification in any subarea or division.

4.75 The Working Group recalled Conservation Measure 21-02, paragraph 3, which specifies that a data collection plan shall include, where appropriate:

(i) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 1(ii) of the measure, and the date by which such data are to be reported annually to CCAMLR;

(ii) a plan for directing fishing effort during the exploratory phase to permit the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, dependent and related populations and the likelihood of adverse impacts;

(iii) a plan for the acquisition of any other research data by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required for the Scientific Committee to evaluate the fishery potential and the ecological relationships among harvested, dependent and related populations and the likelihood of adverse impacts;

(iv) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities.

4.76 The Working Group recognised that there were four major considerations in the development of such a research plan:

(i) Any research requirement should include a strategy for collecting additional data outside the specific region where the vessel is actively targeting krill or transiting. The Working Group agreed that some measure to distribute effort would likely be necessary to collect this information, as this would provide information on spatial demographics and biomass that would be needed for assessment purposes.

(ii) Acoustic data provide valuable information that can be used to determine distribution and abundance of *E. superba*, and therefore, would be an important component of any research data collection plan.

(iii) Information should be collected from commercial trawls.

(iv) A system of SSRUs could be employed in an effort to learn more about the spatial distribution of the krill stock being fished. The Working Group noted that there is precedent in using this approach in both toothfish exploratory research requirements (Conservation Measure 41-01) and the crab fishery experimental harvest regime (Conservation Measure 52-02).

4.77 The Working Group agreed to provide a hierarchical approach to a data research collection plan. This will consist of different levels of data collection effort that would correspond to different levels of management advice. This could provide an indication as to the benefit and likelihood of meeting the management objectives with respect to each combination of data level and requirement.

4.78 Tables 1 and 2 detail such hierarchical approaches. Each table first details the key assessment questions required that will lead to advice on ecosystem-based management of a krill fishery (left column). Four levels of research based on fishery-dependent data collection are presented in the top row of Table 1. For each research plan based on fishery-dependent data, the table details how well that particular data collection strategy can address each of the key assessment questions.

4.79 The Working Group noted that the first two research strategies, commercial fishing and logged under-way acoustics, do not impose additional time and travel burden on fishing vessels. Thus, all research data for these strategies are collected while vessels are conducting fishing operations consistent with purely commercial activities while appropriate acoustic instruments are installed. In contrast, the two acoustic/trawl transect strategies do require additional time and travel effort by fishing vessels.

4.80 With respect to the fishery-dependent data collection, the Working Group agreed that the systematic acoustic trawl transect strategy would provide the best information with which to estimate a precautionary level of yield most rapidly. A proposed outline plan to operationalise the elements of this strategy is detailed as follows:

> Krill SSRUs (equivalent to fine-scale rectangles) are defined as areas of 0.5° latitude by 1° longitude across the larger CCAMLR areas. This previous definition is minimally acceptable given the large area of pelagic environments:
>
> 1. ‘Fishing’ is defined as any time that fishing gear, conventional trawls, pumped codends and newer continuous pumping gear are in the water.
>
> 2. A research haul is defined as a dedicated oblique haul made with a net (CCAMLR-approved design) to a depth of 200 m with a surface to depth to surface duration of 0.5 h.
>
> 3. A set of research hauls is defined as three research hauls where each research haul shall be a minimum of 10 n miles apart.
>
> 4. An acoustic transect is defined as a continuous path at constant speed and direction with a minimum distance of 30 n miles between the start and end points. Such transects can include continuous fishing operations.
>
> 5. Required research strategy –
>
>   (i) upon entry into a krill SSRU to fish, and before fishing, the vessel will be required to (a) conduct an acoustic transect across the krill SSRU, and (b) undertake a set of research hauls;
>
>   (ii) if after five days (continuous or discontinuous) of fishing the fishing vessel decides to stay in the same krill SSRU, then the fishing vessel must conduct a further acoustic transect and a further set of research hauls;

(iii) prior to leaving the krill SSRU, the fishing vessel will be required to complete an acoustic transect across the krill SSRU, along with a set of research hauls.

It is recognised that, in general, the search behaviour of the fishing vessels may encompass many of these attributes when entering an SSRU and searching for fishable aggregations of krill. Likewise, it is recognised that the continuous fishing techniques may also provide similar data.

4.81 Some members of the Working Group agreed that a research strategy such as this would impose a relatively small amount of additional steaming time, but would yield a large amount of data that could potentially be used towards an assessment of the resource.

4.82 Other members felt that the system was too complex, and may be difficult for the vessel to successfully execute.

4.83 The Working Group noted that any exploratory krill fishery should include some form of safeguard to ensure that the Commission could achieve its objectives with respect to Article II. One such safeguard could be a 'move-on rule', as well as a limitation on catch within certain areas. The Working Group agreed that fishing in a region which is close to an island or shelf area is more likely to impact land-based predators, and such regions should be afforded additional protection.

4.84 With respect to scientific observation, the Working Group recognised that some exploratory fisheries are required to carry two scientific observers. Dr Welsford indicated that ad hoc TASO concluded that the workload for one observer on a krill vessel is tractable, but if more data is needed, there would likely be the need for more observers. The data requirements, and therefore observer requirements, for the different levels of fishery-dependent data collection are given in Table 1.

4.85 The Working Group agreed that the appropriate level of observer coverage is essential to ensure the success of whichever data collection plan is approved.

4.86 With respect to the acoustic system, the Working Group agreed it would be beneficial to specify a set of guidelines as to the optimal frequency for detecting krill. It was recommended that previous SG-ASAM reports and the ICES report on 'Collection of acoustic data from fishing vessels' (ICES, 2007) may provide guidance or recommendations as to the optimal frequency or frequencies for subsequent data analyses.

4.87 The Working Group recognised that the analysis of the collected acoustic data requires expertise, and represents a significant expenditure of time and effort. It was recognised that not all Members may have such resources available. The Working Group noted that these potential limitations may be overcome by Members collecting the data and then sub-contracting the data analysis to other Members or Parties. The Working Group requested that the Scientific Committee consider this issue further.

4.88 With respect to data reporting, the Working Group agreed to a minimum set of reporting requirements for an exploratory krill fishery when fishing commercially:

(i) 10-day catch and effort reporting system in accordance with Conservation Measure 23-02;

(ii) haul-by-haul catch and effort data in accordance with Conservation Measure 23-04, including monthly deadline;

(iii) scientific observer data in accordance with the CCAMLR Scheme of International Scientific Observation;

(iv) if acoustic data is being provided, the vessel will need to follow specific requirements and recording format as agreed by the Commission bearing in mind paragraph 4.86.

4.89 The Working Group agreed that any research collection plan must also include research hauls, since there is little information that can be used towards addressing basic assessment questions with commercial hauls only.

4.90 The Working Group agreed on the need to identify the specific data requirements for research hauls, including what kind of data is needed, the timing of the collection, and who would collect the research data.

4.91 Data required from every research haul should include:

(i) start and end position;

(ii) estimate of total catch (green weight) of krill;

(iii) random sample of 200 krill to be taken from the haul by the observer – length, sex and maturity staged according to the CCAMLR *Scientific Observers Manual*;

(iv) species composition of the by-catch.

4.92 The Working Group recognised that the proposed fishery-dependent research data collection strategy set out in paragraph 4.80 is only one example of how a research data collection plan could be achieved, and that other plans could be equally effective. For example, with respect to the timing of research hauls, some members agreed that research hauls should be taken every five days as set out in the proposed strategy. This would result in two research sampling events per 10-day reporting period. Other members felt it was more adequate to have research hauls taken every 10 days. There were also questions raised with respect to the optimal size of each sampled SSRU.

4.93 The Working Group agreed that it would be highly advantageous that gear used during research hauls be standardised across all vessels participating in an exploratory fishery, as this would considerably reduce uncertainty when comparing results across different gear types. However, the Working Group did not have adequate time to consider details on specifications for a standardised research trawl. The Working Group requested advice from ad hoc TASO as to what type of standardised gear could be deployed, given that this gear may need to be swapped with the principal commercial krill trawl, and thus must be able to be changed quickly and with minimal effort.

4.94 The Working Group emphasised that any research data collection plan using fishery-dependent data collection strategies should be standardised across all exploratory krill fisheries.

4.95 The Working Group recognised that an alternative form of data collection could be to collect data through fishery-independent collection strategies. This could consist of a predator monitoring program for krill predators foraging in the exploratory fishing area, or a fishery-independent scientific krill survey. The former could potentially provide data that could be used to monitor whether predator performance is being degraded by the exploratory fishery. The latter could directly be used to provide an estimate of B_0, and an assessment of the resource. Details on such fishery-independent monitoring strategies are set out in Table 2.

Key points for consideration by the Scientific Committee and its working groups

4.96 Krill fishery:

(i) haul-by-haul data remain to be submitted by Poland for 2006/07 (paragraph 4.3);

(ii) trends in the krill fishery (paragraphs 4.1 and 4.6 to 4.8);

(iii) notifications of intention to fish for krill in the 2008/09 season (paragraphs 4.6 to 4.17).

4.97 Scientific observation in the krill fishery:

(i) lack of data on product-specific catches and conversion factors are creating difficulties in verifying the accuracy of 'green weight' of krill caught (paragraph 4.36).

(ii) the request for Members to be encouraged to evaluate the possibility of accurately reporting catch on the basis of direct estimates of 'green weight' to resolve the problem of inaccurate catch reporting (paragraphs 4.39);

(iii) WG-EMM agreement on the role of ad hoc TASO (paragraph 4.45);

(iv) revisions required in the *Scientific Observers Manual* (paragraphs 4.52, 4.65 and 4.66);

(v) the need for a fish by-catch sampling protocol consistent with the existing larval fish sampling protocol (paragraph 4.54);

(vi) an agreed strategy for implementing a scientific observer program to achieve systematic coverage in the krill fishery (paragraphs 4.58 to 4.63).

4.98 Regulatory issues:

(i) the need to record information that describes the fishing technique to be used by krill vessels (paragraph 4.68);

(ii) the consideration of notifications for exploratory krill fisheries and requirements for data collection plans needed to implement Conservation Measure 21-02 (paragraphs 4.69 to 4.95).

STATUS AND TRENDS IN THE KRILL-CENTRIC ECOSYSTEM

Report of WG-EMM-STAPP

5.1 Dr Southwell presented the report on the Predator Survey Workshop (WG-EMM-08/8), which was held at the CCAMLR Headquarters, Hobart, Australia, from 16 to 20 June 2008. The terms of reference for the workshop are outlined in WG-EMM-08/8, paragraph 1.5. Participants at the workshop included two experts from SCAR (Ms D. Patterson-Fraser and Dr B. Raymond) and an independent, invited expert (Dr R. Fewster). A report from Dr Fewster on her findings on the workshop is presented in WG-EMM-08/9.

5.2 The workshop agreed to restrict its deliberations to 11 priority species (1 ice-breeding seal, 1 land-breeding seal, 4 penguins and 5 flying seabirds) that breed in Area 48 and whose consumption of krill had previously been estimated to be close to, or greater than, 100 000 tonnes per annum. These species are listed in WG-EMM-08/8, Table 1, and are considered to be the most important land-based krill consumers in the Scotia Sea (Croxall et al., 1985).

5.3 Workshop participants had been invited to submit new survey results, reviews and summaries of existing data, raw data and new estimation procedures for priority species. A database structure had been developed prior to the workshop to facilitate the submission of penguin abundance data. Submissions included:

(i) new survey results for the crabeater seal (WG-EMM-PSW-08/6), Antarctic fur seal (*Arctocephalus gazella*) (WG-EMM-PSW-08/14), macaroni penguin (*Eudyptes chrysolophus*) (WG-EMM-PSW-08/4) and white-chinned petrel (*Procellaria aequinoctialis*) (WG-EMM-PSW-08/5);

(ii) a review of flying seabird surveys and abundance estimates in the published literature (WG-EMM-PSW-08/10);

(iii) penguin count data from unpublished sources (ASI), published literature (BAS) and CEMP;

(iv) two new procedures for estimating penguin abundance (WG-EMM-PSW-08/11 and 08/15).

5.4 A general framework for estimating abundance was established and a distinction made between count data and data required to adjust counts for issues such as detectability, availability and sampling (collectively termed adjustment data). The count and adjustment data for each of the identified priority species in each SSMU were then reviewed (WG-EMM-08/8, Attachment 4, Tables 4.1 to 4.11):

(i) Both count and adjustment data for the crabeater seal were considered to be good, although availability data were based on haul-out of seals in regions outside of Area 48, resulting in possible bias.

(ii) Spatial coverage of fur seal count data in Subarea 48.1 was good and recent. Spatial coverage of count data in Subarea 48.3 was good but data are relatively old; however, ongoing surveys are scheduled for completion in 2009.

(iii) For the four penguin species, the spatial cover of count data was generally good, but the recency of data varied from current to relatively old. Adjustment data for detectability and sampling are generally assumed to be unnecessary for estimation of penguin abundance because most counts are assumed or known to be a census where all target objects are counted. However, adjustment data for availability were generally limited for all four penguin species.

(iv) Count data were generally poor or old for all species of flying seabirds except the white-chinned petrel at South Georgia, where a recent survey has been conducted. There is no adjustment data of any sort for the Antarctic prion (*Pachyptila desolata*), southern fulmar (*Fulmarus glacialoides*) and Cape petrel (*Daption capense*), while adjustment data for the white-chinned petrel and South Georgia diving petrel (*Pelecanoides georgicus*) are good but could be improved.

5.5 The workshop then reviewed the estimation procedures that have been previously and currently applied to these data:

(i) the estimation procedures applied to crabeater seal data were considered state-of-the-art;

(ii) the estimation procedures used to derive a total abundance estimate for fur seals at South Georgia have not been described in detail. Estimation of abundance from new surveys planned for 2009 will involve modelling of haul-out and demographic data;

(iii) a number of different methods have been used for adjusting penguin count data for availability. The workshop recognised that there was a need to standardise availability adjustment methods where possible;

(iv) estimation methods for flying seabirds are often poorly described. The workshop noted that one of the key issues limiting estimation of flying seabird abundance from land-based surveys was the lack of habitat maps.

5.6 Two new procedures for estimating penguin abundance were submitted to the workshop. WG-EMM-PSW-08/15 described a three-stage hierarchical Bayesian model to correct off-peak counts and make them comparable with CEMP standard method counts. WG-EMM-PSW-08/11 reported a parametric bootstrap method developed in the R language. The workshop welcomed both of these new estimation methods and encouraged their further development and application.

5.7 The workshop agreed that it could provide the following recommendations and advice to WG-EMM at varying time-scales:

(i) Immediate recommendations –

(a) recent survey work in Area 48 provided major improvements in the state of knowledge about the abundance of crabeater seals, fur seal pup production in the South Shetland Islands, macaroni penguins at South Georgia and white-chinned petrels at South Georgia;

(b) aerial surveys of Antarctic fur seals are scheduled for completion in the 2008/09 field season;

(c) the continued development of a new database containing existing penguin count data that can serve as a basis for the production of large-scale abundance estimates;

(d) the development of two new methods to account for bias and uncertainty in raw count data when estimating total abundance that provide complimentary utility for estimating SSMU-specific abundance;

(e) a major gap in abundance data for priority species is for flying seabirds throughout Area 48, except for white-chinned petrels at South Georgia. Given the lack of land-based data for this group, the workshop recommended that WG-EMM invite submissions on at-sea data for flying seabirds in Area 48 for consideration at WG-EMM-09. The workshop identified US AMLR summer cruise data, US-LTER summer and winter cruise data, and BAS data at South Georgia and across the Scotia Sea as potential datasets.

(ii) Short-term (immediate intersessional for WG-EMM-08) –

The development of SSMU-scale estimates of penguin abundance as an illustration of the compiled database, provided in WG-EMM-08/53. These estimates are preliminary in that they only account for uncertainty in the accuracy of the count data and only approximate adjustments for availability are made.

(iii) Medium-term (intersessional for WG-EMM-09) –

(a) if feasible, production of SSMU-specific crabeater seal abundance estimates based on the habitat modelling approach presented in WG-EMM-PSW-08/6;

(b) the anticipated completion of the Antarctic fur seal survey at South Georgia in early 2009 will provide an important update to the existing abundance estimates from 1991;

(c) further development and testing of the new estimation procedures for penguins, and implementation of those procedures to quantify bias and uncertainty in adjusting raw counts.

(iv) Future work. The workshop identified several gaps in data that can only be filled through a long-term work plan –

(a) recent count data for penguins in the western South Shetland Islands and eastern Antarctic peninsula;

(b) count data for flying seabirds throughout Area 48;

(c) adjustment data for most species in most areas. Strategic collection of adjustment data to improve estimation of penguin abundance is of particular importance;

(d) development of alternate survey methods for large penguin colonies.

5.8 The Working Group thanked Dr Southwell for his report and for convening the Predator Survey Workshop. The work of WG-EMM-STAPP represents a substantial contribution to the work of CCAMLR and for quantifying predator abundance within SSMUs.

5.9 In particular, the Working Group noted that a combined database of penguin count data, comprising data collected under CEMP, data from the ASI and historical data from the literature, was an essential contribution to the work of CCAMLR.

5.10 Dr Trathan noted that such a database would eventually be made available to CCAMLR. Data access would fall under the Rules for Access and Use of CCAMLR Data.

5.11 The Working Group noted that the submission by BAS on crabeater seal distribution and abundance alone was important and a significant progress to quantifying abundance of important krill-consuming predators.

5.12 One of the aims of the Predator Survey Workshop was to identify gaps in our knowledge of predator abundance and with this in mind (as also noted in WG-EMM-08/53), geographic areas with poor coverage were identified (e.g. SSMU APE). Future survey work would best focus on these geographic gaps.

5.13 The Working Group also appreciated the attempts by the Predator Survey Workshop towards estimating uncertainty in predator abundance estimates and noted that this will be particularly useful for modelling estimations.

5.14 It was noted by the Predator Survey Workshop and the Working Group that one of the problems in using existing data to derive regional-scale abundance estimates for penguins, was that the year of the most recent count at individual colonies varies substantially, so some standardisation or adjustment for year of count is necessary. Data collected at long-term monitoring sites are important for making this kind of adjustment. It will also be important, if possible, to report the year to which each abundance estimate applies. There is a need to incorporate work addressing these issues into the long-term work plan of the group.

5.15 Dr Southwell noted that the work of the group with regard to quantifying predator abundance was a staged process and the work of the Predator Survey Workshop was merely the first stage of a multi-stage process with the ultimate goal of regional-scale estimates.

5.16 The Working Group noted that future work should include fish predators. With this in mind, a first step might be, similar to what was undertaken by the Predator Survey Workshop, to identify which of the list of krill consumers were also important fish predators.

Status of predators, krill resource and environmental influence

Predators

5.17 Dr Ramm presented WG-EMM-08/4, a summary of CEMP indices. Processing and validation of data submissions from Member countries continued with particular emphasis on adherence of data submissions to standard methods. This year, data were submitted by seven countries reporting from 11 sites.

5.18 Figure 3 of WG-EMM-08/4 presented a summary of CEMP parameters and Table 1 provided a summary of CEMP indices in the database. This indicated that there has been a decrease in the number of sites from which data are submitted and a decrease in the number of parameters submitted from some other sites. The Secretariat had been advised that the Edmondson Point site was not monitored in 2007/08; aerial photographs of the penguin colonies at the Ross Island site were collected in 2007/08, photographs taken since 2003/04 are being processed and the derived A3 data will be submitted in due course.

5.19 The Working Group noted that some CEMP data from the Australian CEMP program were awaiting analysis and would be submitted to the Secretariat in the future.

5.20 The Working Group also noted that CEMP data from the Bouvet Island site were collected in 2007/08 (WG-EMM-08/28).

5.21 Dr Trivelpiece presented WG-EMM-08/P12, 08/50, 08/51 and 08/P11 to the Working Group.

5.22 WG-EMM-08/P12 presented an analysis of at-sea data on Cape petrel, chinstrap penguin (*P. antarctica*) and krill distributions near Elephant Island during January for the 2004–2006 summers. Patch dynamics of krill strongly influenced the local abundance and distribution of seabirds, suggesting that future modelling work incorporate the impact of krill patchiness in relation to predator foraging demand. The authors suggested that information on the distribution of seabirds may provide a mechanism to better understand choices made by the fishery, given the changes in patchiness, search time and predator distribution at sea. Such information could be used to interpret potential interactions between seabirds and the krill fishery. Negative effects, such as competition through the depletion of patches by fishing vessels, may impact predator populations at the local scale. Other studies have proposed that krill fishing be restricted within 50–100 km of penguin breeding colonies; this study reinforces that proposition.

5.23 The Working Group endorsed the suggestion of the Predator Survey Workshop (WG-EMM-08/8, paragraph 6.9) that it would be helpful to investigate whether at-sea observations of seabirds might be an alternative method for estimating abundance and consumption values for these species within SSMUs. The Working Group encouraged Members with pertinent data to prepare papers for review at the 2009 meeting of WG–EMM.

5.24 WG-EMM-08/50 examined interannual changes in the foraging strategies and diet of gentoo penguins in the South Shetland Islands, Antarctica, over five years (2002–2005 and 2008). *Euphausia superba* was the primary diet item, and fish the secondary. The number of chicks that survived from hatching to crèche was nearly constant among years, while diet composition and diving patterns were highly variable. These results indicate that gentoo penguins (*P. papua*) could forage on several types of prey, and at different depths without compromising their ability to provision their chicks. The authors suggested that this flexibility may contribute to why gentoo penguin populations have remained stable, or are increasing, in the region, while populations of their congeners with less flexible foraging strategies have declined. Predator monitoring of several species simultaneously provides additional insight into how changes in krill abundance may affect population dynamics of predators and should be important considerations for modellers of krill–fishery–predator interactions in the Southern Ocean.

5.25 The Working Group noted that although the foraging strategy of gentoo penguins was flexible, krill dominated the diet in all years. It seems unlikely that gentoo penguins would be able to entirely compensate their diet with fish if there were a more serious depletion of krill as evidenced by gentoo penguins at South Georgia, which experience a near-total collapse in breeding success during years when krill biomass in the region is substantially reduced.

5.26 The Working Group noted that gentoo penguins, though more flexible in their foraging strategies than their congeners, still respond to changes in krill biomass through prey-switching. In addition, they provide valuable opportunities for comparative studies with chinstrap and Adélie penguins in response to environmental change and variability.

5.27 WG-EMM-08/51 reported preliminary progress to apply FOOSA at the scale of interactions among the three breeding penguin populations, krill and environmental variability at Admiralty Bay, King George Island.

5.28 This work-in-progress serves two purposes:

(i) Down-scaling FOOSA will allow for the estimation of parameters, including stock-recruitment parameters and the shape parameters that describe the sensitivity of predator survival to changes in krill density. Little information on these parameters at the regional (i.e. Scotia Sea) scale exists, but detailed information is available at the local scale. The ability of FOOSA to predict the observed changes in penguin abundance at the small scale of this study site may be useful for advancing the implementation of ecosystem-based management objectives in the entire Scotia Sea region.

(ii) Syntheses of diverse data from Admiralty Bay have identified alternative hypotheses about juvenile penguin survival that can be incorporated into FOOSA. The alternative hypotheses can be formally tested as competing models using standard model selection criteria. By testing competing hypotheses, the authors expect to gain valuable insight on the dominant drivers of change within the study populations and improve the biological realism of FOOSA.

5.29 The authors noted that the relative importance of bottom-up (krill availability and food-web changes) versus top-down (predator) control of the penguin populations may be changing under conditions of low breeder abundances. Predation pressure may accelerate downward trends in populations when these populations reach small sizes, further reducing the time period when conservation measures might be put in place to help mitigate the declines in predators.

5.30 WG-EMM-08/P11 presented data from a long-term ecosystem monitoring program of the predators at South Georgia together with a krill population model to simulate natural and fisheries-induced variability in krill abundance and examine the power to detect the effects of different levels of fishing. The results indicate that although the monitoring program has a proven ability to detect the effects of natural variability in krill abundance, its ability to detect the effects of fishing may be limited if there is a requirement for statistical significance at the 95% level.

5.31 Changing the probability of a Type I error (α) from 0.05 to 0.2 produced a marked increase in statistical power. The authors suggested that when considering methods for using predator response data to detect the effect of fishing, it might be appropriate to set the α level higher than used in normal statistical hypothesis testing, which would reduce the risk of Type II error (i.e. not detecting a real effect) but increase the risk of Type I error (falsely identifying an effect). The authors argued that this is consistent with the precautionary approach.

5.32 The authors suggested that developing a better understanding of the role of environmental processes on variability in krill abundance would, in effect, allow the environment to be included as a covariate in the analysis of monitoring data. This could effectively control for the environmentally driven component of the overall variability and increase the power to detect change arising specifically from the effects of the krill fishery.

5.33 The Working Group noted that it is important to correctly identify the environmental variables that are driving the variability when exploring this approach.

5.34 The Working Group further noted that the analyses presented in WG-EMM-08/P11 illustrate the trade-offs in making management decisions. An understanding of the relative impacts of making Type I and Type II errors in management actions can lead to a more dynamic approach to management.

5.35 Dr Goebel presented WG-EMM 08/25, 08/31 and 08/35 to the Working Group.

5.36 WG-EMM-08/25 presented data on minke whale (*Balaenoptera acutorostrata*) diet from whaling expeditions over four years from 1982/83 to 1985/86 in whaling Areas 1–4 and 6. Sixty-five percent of the whales taken were from CCAMLR Area 48. Over 12 000 minke whales were harvested and over 11 000 (N = 11 652) stomachs were analysed. Of these, 46% (N = 5 354) contained prey. All stomachs with prey had *E. superba* and 94% of the stomachs were composed entirely of *E. superba*. Secondary items included crystal krill (*E. crystallorophias*) and Antarctic silverfish (*Pleuragramma antarcticum*). Most of the *Pleuragramma* came from minke whales taken from Area 2. Krill in stomachs were staged for sex and maturity according to standard protocol. No length-frequency data are given, but the author did report on median krill length, maturity and sex ratio. Although no statistical analyses are presented, the author did report differences in krill composition by area and season.

5.37 Both WG-EMM-08/31 and 08/35 report on a multi-vessel oceanographic study of the Ross Sea in the 2004/05 season. In many regards they are similar studies of oceanography in relation to krill and whale distribution for parts of Subareas 88.1 and 88.2. However, there are some important differences. The study area in WG-EMM-08/31 covered from 160°E to 160°W and from 78°S to 60°S. Sampling extended further north than in WG-EMM-08/35 and included waters of the ACC. The study area used for WG-EMM-08/35 covered from 165°E to 155°W, and from 69°S to the Antarctic continent. Temporal coverage was greater in WG-EMM-08/31 and covered from late December through most of February. The study reported in WG-EMM-08/35 was a one-month study from mid-January to mid-February.

5.38 Both studies found similar results in the distribution of *E. superba* and *E. crystallorophias*. The latter species occurred in greater abundance in colder waters over the continental shelf, while *E. superba* was found in warmer deeper water. *Euphausia superba* and *E. crystallorophias* distributions are presented for both papers.

5.39 WG-EMM-08/31 reported on whale distributions for three species, humpback (*Megaptera novaeangliae*), blue (*B. musculus*) and minke whales. WG-EMM-08/35 reported on the distribution of minke whales only. Minke whales in both studies had a similar distribution in colder water (relative to humpback whales) and were found in greater abundance in the shelf slope region and at the ice edge and fed primarily on *E. superba*. Humpbacks, on the other hand, occurred only in the warmer water of the ACC. Only minke whales were sampled for diet studies.

5.40 Dr Naganobu suggested that these papers provide evidence of the strong relationships between oceanographic variability in water mass and circulation patterns of the surface layer (MTEM-200) with the distribution and abundance of krill and baleen whales. He suggested that this close relationship would allow results from the local scale of the survey to be widely applied to the whole region.

Krill

Observations at depths below 200 m

5.41 Most observations to date indicate that the bulk of the population of post-larval krill is typically confined to the top 150 m of the water column. For example, WG-EMM-08/32 described how 94% of all krill catches in the fishery occur at depths shallower than 200 m, while analysis of the CCAMLR-2000 Survey (Demer, 2004) indicated that acoustic biomass of krill was essentially confined to the top 150 m.

5.42 In contrast, WG-EMM-08/P1 reported observations using a deep-water remotely operated vehicle in the austral summer of 2006/07 which revealed the presence of adult *E. superba*, including gravid females, at depths down to 3 500 m in the Marguerite Bay region on the western Antarctic Peninsula. Adult krill were found close to the seabed at all depths but were absent from fjords close inshore. At all locations where krill were detected, they were seen to be actively feeding, and at many locations there were exuviae (cast moults).

5.43 Two other papers presented at the meeting dealt with krill occurring deeper than 200 m. WG-EMM-08/P10 reported on the vertical distribution of euphausiids in the Ross Sea and its adjacent waters in 2004/05. In depth-stratified RMT8 net samples, juvenile *E. superba* were distributed in the top 200 m in the offshore region near the SACCB, but gravid females were dominant in the slope region and were most abundant in the 400–600 m layer.

5.44 Similarly, WG-EMM-08/28 provided a preliminary report on acoustic and trawl catch data collected during the Antarctic Krill and Ecosystem Studies (AKES) survey conducted in

Subarea 48.6 on board RV *G.O. Sars*. While the acoustic data showed that *E. superba* were mainly found above 150 m, the trawl catches indicated that a small part of the stock resides in water deeper than 500 m.

5.45 The Working Group recalled that there are extensive data from the winter fishery around South Georgia that show that, in winter, krill are likely to occur deeper in the water than in summer. However, the Working Group agreed that the observations presented in WG-EMM-08/P1 were novel and challenging to the view of krill as essentially a pelagic organism.

Krill surveys

Surveys in Subarea 48.6

5.46 WG-EMM-08/28 provided an overview of the Norwegian 2008 AKES survey around South Georgia in Subarea 48.3 and along transects in the region of the 0° meridian in Subarea 48.6. Preliminary results suggested some differences between the population structures in the two subareas. The large adult *E. superba* found in the South Georgia region were less mature than those sampled in Subarea 48.6. The authors also noted that pygmy krill (*E. frigida*) and spiny krill (*E. triacantha*) were more abundant in the South Georgia region compared to Subarea 48.6.

5.47 WG-EMM-08/28 also presented a preliminary biomass estimate of ~14 million tonnes of *E. superba* for the part of Subarea 48.6 covered by the two transects undertaken during the second leg of the AKES cruise. Given that the survey area covered 302 000 n miles^2 this equates to a krill biomass density of ~13.6 g m^{-2}.

5.48 The Working Group thanked Norway for the effort expended to undertake this survey in an area for which there was little previous information and looked forward to the full analysis and future publication of the results.

5.49 WG-EMM-08/7 reported on a German contribution to CCAMLR-IPY in the austral summer of 2007/08 where a standardised krill net sampling survey was conducted in the Lazarev Sea (south of 60°S) (part of Subarea 48.6). *Euphausia superba* were found in 49 out of 52 RMT samples but krill density was only 0.87 g m^{-2}, the second-lowest values in a series of four surveys. Bigeye krill (*Thysanoessa macrura*) occurred in high numbers during the current summer survey and outnumbered the density of *E. superba* five times. South of 62°S, size composition of *E. superba* was dominated by 1- and 2-year-old krill, however, the proportion of 1+ was lower than 2+ krill, indicating only a moderate 2007 year class. Between 60° and 62°S, older length classes larger than 35 mm dominated the krill stock. The krill population was in a developing maturity stage and krill larvae were scarce. A comparison with 2006 data revealed that spawning occurred at least three weeks later in the 2008 season than during the 2006 study. *Euphausia crystallorophias* occurred only at few neritic Antarctic coastal stations and numbers were relatively low.

5.50 The Working Group noted that in addition to *E. superba*, other euphausiid species in Subarea 48.6 are also important, which will provide alternative pathways through the food web and will have implications for the relationships between harvested and dependent species.

5.51 The Working Group also noted that acoustic survey data taken on the German cruise would provide important information on the biomass of krill in Subarea 48.6 and encouraged submission of an appropriate biomass assessment to the next meeting of WG-EMM.

Surveys of the Ross Sea area

5.52 WG-EMM-08/P10 reported on distribution and population structure of euphausiids in the Ross Sea and its adjacent waters during the summer of 2004/05. Among the euphausiid species, *E. triacantha* was dominant in biomass north of the SACCB, *Thysanoessa* spp. was widely distributed north of the continental slope, while *E. superba* was distributed from the SACCB to the slope. *Euphausia crystallorophias* were found at 200–300 m in the colder water of the continental shelf. *Euphausia superba* individuals with body lengths of 40 to 51 mm were dominant. While 26 to 40 mm individuals were conspicuously scarce in the survey, the authors suggest that this probable 2+ year class was distributed separately from other year classes north of the slope area and was not captured because of the coarse sampling grid.

5.53 WG-EMM-08/31 and 08/35 both provided biomass estimates of krill in Ross Sea. WG-EMM-08/35 described a two-ship survey with each ship carrying out a different but overlapping survey design. Krill were identified using a two-frequency dB difference of 2–16 dB and TS was calculated using Greene et al. (1991). The mean biomass densities of *E. superba* were 5.13 (±7.11 g m^{-2}) and 2.53 (±2.25 g m^{-2}) for the two ships. This resulted in a combined biomass of 1.4 million tonnes (CV 0.32) from an area of ~110 000 n $miles^2$. A biomass estimate for *E. crystallorophias* of 0.6 million tonnes was calculated.

Multi-year data series

South Georgia

5.54 WG-EMM-08/48 presented data on the multiple time scales of variability in the krill populations at South Georgia. Krill acoustic density data from surveys conducted in the early, middle and late period of the summers of 2001 to 2005, together with krill population size structure over the same period from predator diet data, were used with a krill population dynamics model to evaluate potential mechanisms behind the observed changes in krill biomass. Krill abundance was highest during the middle of the summer in three years (in 2001, 2002 and 2005) and in the late period in two years (2003 and 2004); in the latter there was evidence that krill recruitment was delayed by several months. A model scenario with empirically derived estimates of both the magnitude and timing of recruitment in each year showed the greatest correlation with the acoustic series. The results are consistent with a krill population with external (allochthonous) recruitment entering a retained adult population. The results highlight the importance of the timing of recruitment, especially where this could introduce a mismatch between the peak of krill abundance and the peak demand from predators which may exacerbate the effects of changes in krill populations arising from climate change.

5.55 The Working Group discussed the magnitude of krill flux and migration in the South Georgia region. It recognised that there is considerable retention, spatial stability and predictability of the krill population found over the South Georgia shelf. However, it was stressed that the South Georgia krill population is not self-sustaining and is totally dependent on the recruitment of krill that will have originated from the ice-dominated regions to the southwest of the island.

5.56 The Working Group recognised that the results of WG-EMM-08/48 had important implications for the management of krill, especially if there is an assumption that a temporal separation between fishing and the period of peak predator demand could reduce competition for krill between fisheries and predators at South Georgia.

South Shetland Islands region

5.57 WG-EMM-08/19 reported on a recalculated US AMLR time series of net-derived abundance of *E. superba* and three species of other Antarctic zooplankton for the Elephant Island region. Over the period from 1992 to 2007 three equal-sized peaks in the abundance of *E. superba* were detected in 1996, 1998 and 2002/03.

5.58 WG-EMM-08/41 presented updated krill recruitment data for the Elephant Island region of the South Shetland Islands for 2002–2008. All recruitment indices showed that high recruitment (R1) occurred in 2003 and in 2007/08, with low recruitment occurring during the intervening years. Significant differences in the proportional recruitment indices occurred between legs within years indicative of the changing pattern of krill recruitment within the Elephant Island region.

5.59 WG-EMM-08/P12 reported on influences of spatial variability of *E. superba* on seabird foraging behaviour near Elephant Island (paragraph 5.22). In the context of describing the status of krill, the paper presented measures of krill patchiness in relation to the abundance of krill and showed that when krill is significantly less abundant, the scale of patchiness increases.

5.60 The Working Group noted the clear interannual trend in population recruitment in these data and re-emphasised the strong links established between krill recruitment, sea-ice dynamics and global climate processes, such as ENSO, that impact the Scotia Sea.

South Orkney Islands

5.61 WG-EMM-08/26 compared the biomass of *E. superba* around the South Shetland and South Orkney Islands in 1999, 2000 and 2008. Length-frequency distributions of krill in 2000 and 2008 at Elephant Island and the South Orkney Islands were similar. On the basis of this observed similarity in population structure, a biomass estimate using acoustic data collected as part of US AMLR finfish surveys in 1999 and the krill length distribution derived from Elephant Island in the same year was derived. In 2008 a dedicated krill biomass survey resolved a total of ~2.7 million tonnes of krill in the South Orkney region. Overall, the comparison of biomass from these three years suggests that krill biomass in the South Orkney Islands is similar to the biomass in the South Shetland Islands, especially the Elephant Island region.

5.62 The Working Group welcomed this approach to derive krill biomass using acoustic data collected as part of a finfish survey and noted such data, derived from ancillary studies, can be used to better resolve the temporal trends in krill biomass in this region.

5.63 The Working Group noted that although at times the population structure at the South Orkney Islands is highly variable, it appears that much of this variability may be due to sampling in relation to water masses originating from the Weddell Sea. In addition, the detection of similar krill recruitment classes in predator diet data collected at the South Orkney and South Shetland Islands also supports the congruence between the krill population in the two regions.

5.64 In summary, the Working Group emphasised the importance of the long-term datasets on krill abundance that were now resulting from national programs in the Scotia Sea and urged their continuation into the future.

Large-scale distribution and abundance of *E. superba*

5.65 The krill fishery tends to focus on the shelf and shelf-break regions (for example, WG-EMM-08/55 and 08/32), although, historically, considerable fishing effort has been expended in oceanic regions in both the southwest Atlantic and the area between 30° and 150°E.

5.66 WG-EMM-08/P4 presented a quantitative circumpolar distribution map of *E. superba* based on a net sample database (8 137 samples) collected between 1926 and 2004. The numerical densities were standardised to a common sampling method. From this analysis 70% of the total stock is concentrated between 0° and 90°W and, overall, 87% of the total stock live over deep oceanic water (>2 000 m) and occupy regions of moderate food (0.5–1.0 mg chl-*a* m^{-3}). Advection models suggest some loss northwards from these regions and into the low chlorophyll belts of the ACC. The authors found possible evidence for a compensating southwards migration, with an increasing proportion of krill found south of the ACC as the season progressed. The authors indicated that the retention of krill in moderately productive oceanic habitats is a key factor in their high total production. While growth rates are lower than those over shelves, the ocean provides a refuge from shelf-based predators. The unusual asymmetrical circumpolar distribution of krill thus reflects a balance between advection, migration and top-down and bottom-up processes.

5.67 WG-EMM-08/17 undertook a re-appraisal of the total biomass and annual production of *E. superba*. Net-based databases of density and length frequency (KRILLBASE) yield a summer distributional range of $\sim 19 \times 10^6$ km^2 and a mean total abundance of 8×10^{14} post-larvae with a circumpolar biomass of 379 million tonnes. For the CCAMLR-2000 Survey area, this equates to a krill biomass estimate of 106 million tonnes. These values are based on a standardised net sampling methodology but they integrate over the period 1926–2004, during which krill abundance has fluctuated.

5.68 In WG-EMM-08/17, gross post-larval production is estimated conservatively at 342–536 million tonnes y^{-1}, based on three independent methods. These are high values, within the upper range of recent estimates, but consistent with the concept of high energy throughout for a species of this size. The similarity between the three production estimates reflects a broad agreement between the three growth models used, plus the fact that, for a given population size, production is relatively insensitive to the size distribution of krill at the start of the growth season. These production values lie within the envelope of what can be supported from the Southern Ocean primary production system and what is required to support an estimated predator consumption of 128 to 470 million tonnes y^{-1}.

5.69 The Working Group recognised that these large global syntheses obtained from the combination of many different datasets had an extremely valuable contribution to make to our understanding of the operation of the oceanic ecosystem. In addition, the Working Group noted that net-based estimates of krill biomass may be useful for comparison with those obtained from acoustic surveys.

5.70 The Working Group also recognised that the patterns of small-scale variability and change in krill biomass (over annual to decadal time scales) were often masked through the requirement to average over long time scales so that circumpolar coverage could be derived. The Working Group concluded that further submissions providing assessment of time trends in such datasets would be welcomed and noted that further discussion may be possible in the context of the forthcoming Joint CCAMLR-IWC Workshop.

Krill parasites

5.71 WG-EMM-08/P9 presented data on the histopathology of *E. superba* bearing black spots. Such spots have been noticed on the cephalothorax of krill since January 2001. Histological observations from krill sampled in the winters of 2003, 2006 and 2007 in the South Georgia region revealed that the black spots were melanised nodules composed of hemocytes surrounding either bacteria or amorphous material. In the 2007 samples, 42% of krill had such melanised nodules. Unidentified parasites were observed in some krill that had melanised nodules. The authors suggested that krill had been initially affected by parasite infections, and the parasitised spots were secondary infections by environmental bacteria after the parasites had escaped from the host body.

5.72 The Working Group recalled its request for data on the frequency of krill infected with black spots to be recorded by scientific observers on krill fishing vessels (SC-CAMLR-XXVI, Annex 4, paragraph 4.67) in order to consider the potential consequences of this condition on krill reproductive performance and mortality (SC-CAMLR-XXVI, Annex 4, paragraphs 5.52 to 5.56). Given the negative effect of a black spot disease on the reproductive success of North Atlantic shrimp (*Pandalus borealis*), the Working Group encouraged further work to understand whether such effects may also occur in *E. superba*.

Environment and climate impacts

5.73 Six papers were submitted for consideration by the Working Group under this topic. These consisted of four published papers (WG-EMM-08/P2, 08/P3, 08/P5 and 08/P6) and two working group papers (WG-EMM-08/32 and 08/33).

5.74 In WG-EMM-08/32 the authors explained increased understanding on the importance of the MTEM-200 index as it relates to the global scale, and to the distribution of krill. The authors used the commercial krill fishery data from 1973 to 2008 to document the vertical distribution of effort and found that most krill were caught within 50 m of the surface. To derive a global MTEM-200 index, the authors used the global summary of water column temperature using the *World Ocean Atlas* (Locarinni et al., 2005) to calculate the integrated temperature index. The authors show that krill catches are associated with a narrow temperature range (–0.5° to 0.5°C), with more defined peaks associated with certain areas. The authors further concluded that this association is considerable even using historical data from the Discovery surveys, suggesting a consistent feature of the krill environment.

5.75 In WG-EMM-08/P3 the authors used temperature data collated from a number of historical datasets around South Georgia to examine the seasonal and long-term temperature trends in this region. They examine the time period from the mid-1920s to the early 2000s.

5.76 The authors used a Restricted Maximum Likelihood (REML) mixed-model approach to examine the temporal trends in water temperature. The model included a simple sinusoidal model for seasonal heating and cooling, and a spatial model to account for geographical variability in the temperature distribution in this area. The authors found that there is a significant warming in the upper 100 m of the water column over this period. Importantly, the authors found that the rate of warming was greater for winter than for summer. These changes (0.9° and 2.3°C in summer and winter respectively) are greater than observed in other studies (e.g. Gille, 2002). The authors further determined that this warming has resulted in a southward movement of the mean ice edge by 150 km. Finally, the authors showed that minimum temperatures have changed (rising to a winter minimum from –0.5° to about 0.25°C over this time period) and they have inferred that this could impact zooplankton, phytoplankton and krill growth, reproduction and community structure.

5.77 In WG-EMM-08/33 the authors provided an update to their ongoing efforts to document the importance of the DPOI which is defined as the sea-level pressure difference between Rio Gallegos, Argentina, and the Esperanza Base in the Antarctic Peninsula. This index reflects the strength of the westerly winds, and has been used to correlate krill abundance in previous studies (Naganobu et al., 1999). The authors used CTD data from two transects off the Antarctic Peninsula to determine the MTEM-200 index and correlate these two indices. The authors found a significant correlation between the two indices firmly linking them together. This analysis continues to build local indices that have a global importance in determining krill distribution (WG-EMM-08/32), and may be correlated with broad-scale atmospheric climate modes.

5.78 Dr Naganobu noted that the CTD data were provided by the US AMLR Program and thanked it for providing data for this research. He further noted the importance of the US AMLR's data collection program to the work of CCAMLR and encouraged the continued collection of these data.

5.79 The Working Group noted that the work presented in WG-EMM-08/33 clearly linked broad-scale atmospheric forcing to measurable variability in the ecosystem, and that the greatest effects are shown during ENSO conditions (e.g. 1997/98), and encouraged the continued development of this approach.

5.80 WG-EMM-08/P2 and 08/P6 examined the importance of global climate modes of variability, principally the ENSO-scale variability, on the Southern Ocean environment, krill and predator populations.

5.81 In WG-EMM-08/P2 the authors examined how ENSO variability affects the net-abundance and acoustically derived biomass of krill in the South Georgia region of the Scotia Sea. They developed an index of the SST anomaly for the period 1990 to 2004 to elucidate periods of higher than average and lower than average temperature. They also examined the importance of sea-ice to these relationships.

5.82 The authors of WG-EMM-08/P2 correlated these temperature anomalies with the ENSO signal at a variety of lags, in order to account for direct (0-lag) and delayed (2–3 year lags) effects of the atmospheric modes to the local impacts across the Scotia Sea. The authors used data derived from Atkinson et al. (2004) describing the long-term decline in krill abundance. Using a detrended data series, they showed how SST anomalies and sea-ice are associated with changes in krill abundance and biomass. They further examined these impacts on upper trophic level predators.

5.83 The Working Group discussed the projection in WG-EMM-08/P2 of a 95% decline in krill over the next 100 years and suggested the model may not reflect areas outside the South Georgia/Scotia Sea region, given the regional focus of the model and the life history of krill. The Working Group also noted that the dependence of krill fluctuations at South Georgia may reflect processes upstream. Discussion also focused on what the implications of this would be for collecting data to separate the effects of climate from fishing given this variability.

5.84 WG-EMM-08/P6 examined the influence of environmental forcing, specifically the role of climate drivers like ENSO on the population dynamics of predators and prey in the Southern Ocean. The authors provided a list of 10 ways that the environment can influence the predator and prey groups. Among these are simple things, such as changing the distribution of animals to more complex interactions involving entire communities of animals and species groups. The authors identified a variety of confounding factors, including previous removals and local extirpations of higher-level predators that would impact the ability to detect the response of the ecosystem to climate change. The authors noted that detecting longer-term climate signals in predator dynamics will be difficult as the time series are relatively short, even in the longer biological time series that exist.

5.85 The final paper considered in this section (WG-EMM-08/P5) attempted to model the impact of changing environments and climate on a variety of species around the Antarctic. The authors used a stochastic matrix model for the population dynamics of a variety of predators, including fur seals, to examine the sensitivity of life history traits and vital rates across the life span of animals. The authors tested the hypothesis that life-history traits are buffered and show low variability in the face of environmental changes.

5.86 The authors of WG-EMM-08/P5 chose the SST anomaly previously described for the South Georgia region as the representative climate driver in their model. The authors also used the relationships developed by WG-EMM-08/P5, including the effect of changing food availability on krill abundance, to examine the capacity to buffer environmental conditions. The authors found that fitness of fur seals in the South Georgia region declined with increased SST anomalies, beginning in the 1990s. Other species (other seals, penguins and some flying seabirds) did not exhibit the same loss of fitness in these modelling efforts, suggesting that the loss of fitness by fur seals was a regional, rather than global, problem. The authors concluded that, as environmental variability increases with climate change, those species with more constrained life histories should exhibit considerable negative responses to that change and variability.

5.87 The Working Group noted that this was an interesting approach to examine the sensitivity of vital rates and species responses to environmental variability.

Other prey species

5.88 WG-EMM-08/36 examined the community structure of copepods in the Ross Sea. Three communities were found: an ACC community, a Ross Sea community and a community spatially located between these two. The authors concluded that the copepod community in the Ross Sea is characterised by low densities of animals. The authors further suggested that the associations of copepods among communities were related to different physical regimes. In addition to the water mass associations, they suggested that the mixing environments may influence the community structure. The authors hypothesised that over long time scales environmental conditions could spatially shift community structure.

5.89 The Working Group noted that this was an interesting study as there are few studies on zooplankton community structure in the Ross Sea. The Working Group encouraged further work on such topics.

5.90 WG-EMM-08/P8 compared the zooplankton community structure around South Georgia in the South Atlantic with historical information. The authors used physical data collected during each time period to characterise the physical environment, and to examine temporal changes in the environment that could affect the community structure of the planktonic (phytoplankton and zooplankton) community over this time period. The environmental signal they examined in most detail was the potential effect of temperature associated with ENSO forcing. It should be noted that the impact of ENSO and other climate modes can impact the productivity of the system. The authors resolved a number of issues associated with taxonomic nomenclature required when comparing the data collected over a long time period. Despite a comprehensive review, the authors did not find strong evidence for a change in the zooplankton community structure.

5.91 The Working Group discussed why the zooplankton community around South Georgia seemed relatively insensitive to changes in the environment, given the observed changes in water column temperature over this same time period. It was concluded that this may reflect the lack of a continual time series, but may also reflect the relatively common and widespread distribution of zooplankton across the Scotia Sea.

5.92 The Working Group noted that although long-term trends in community change were not detectable, the community structure was affected by ENSO, and so would be sensitive to changes when the changes are large.

5.93 It was noted that the zooplankton community analysis was also conducted to reinforce the recently developed CPR program that has been started by the BAS in the southwest Atlantic.

5.94 Dr Fielding noted that myctophid data were collected during the RV *Tangaroa* survey (WG-EMM-08/18) and that these data would be useful in the future, given the uncertainty surrounding the magnitude of the midwater fish in relation to a number of issues relevant to WG-EMM. The authors were encouraged to more fully develop these data.

Methods

CEMP standard methods

5.95 The Subgroup on Methods (convened by Dr Goebel) met and considered two issues concerning CEMP standard methods. The first was Standard Method A7 (fledging weights for gentoo penguins). The subgroup had noted in earlier discussions that gentoo penguins, unlike Adélie and chinstrap penguins, do not 'fledge' in the sense of having a single departure from the colony to sea. Rather, they have a 1–2 week 'fledging period' that entails frequent trips to sea followed by returns to the colony, where they continue to be provisioned by their parents. Thus, the current methodology for collecting fledging weights for Adélie and chinstrap penguins is not applicable for gentoo penguins, and a new methodology needs to be proposed and considered by the subgroup. Since no revision was proposed to the Working Group this year, it was decided to defer this issue to the future after a proposed change can be completed for review by the subgroup.

5.96 The second issue concerned Standard Method A3 (penguin breeding population size (number of pairs)), and the timing of nest counts for estimation of penguin adult breeding population. The concern arose during the Predator Survey Workshop, when a paper addressing such counts reported incorrectly that some historical counts were conducted in relation to a fixed calendar date. However, after some discussion the Subgroup on Methods determined that Standard Method A3 already requires that nest counts be conducted on the basis of annual phenology for each species (i.e. nest counts in relation to the median date of egg laying).

Methods of zooplankton sampling

5.97 WG-EMM-08/19 reported an error in the calculation of water volume filtered by the IKMT that is used in the long-term zooplankton time series (late 1980s to present day) collected by the US AMLR Program. This error has affected the estimated densities of all zooplankton, including krill, since 2000. The US AMLR Program cautions Members to enquire about data previously provided by AMLR that may be in error.

Acoustic methods for TS estimation and identification of *E. superba*

5.98 WG-EMM-08/29 described the use of stereo cameras mounted on a lowered TS probe to observe krill *in situ* around South Georgia and Bouvet Island. A variety of krill behaviours were photographed including swarming, loose aggregations and synchronised schooling.

5.99 The Working Group recognised the importance of *in situ* orientation as a key variable in the TS estimation of krill using the SDWBA model. The Working Group noted the paucity of information on the orientation of krill and looked forward to receiving the analysis of the measurements made during this survey.

5.100 WG-EMM-08/54 presented a reanalysis of a dataset used to assess the two-frequency (120 and 38 kHz) fixed window (2–12 dB) identification of *E. superba*. The authors extended the identification method to include the three-frequency variable window identification adopted by CCAMLR and a two-frequency variable window suggested by SG-ASAM, all using the SDWBA model with a fixed orientation of 11° (SD 4°). Net-validated krill aggregations were identified very well by the two-frequency variable window of identification. The authors noted that in comparison with the fixed window, the variable window would reduce the amount of acoustic by-catch that may occur when targets other than krill are present. However, the three-frequency variable window, as presently configured, was not always able to identify krill swarms and this may result in an underestimation of krill biomass.

5.101 The Working Group welcomed such independent validations of the krill identification technique adopted by CCAMLR in 2007. However, it was recognised that due to the technical nature of the paper, further consideration of the issues should be referred to the next meeting of SG-ASAM. The Working Group supported a proposal that work to collate international acoustic data from known krill targets would enable a rigorous assessment of the current krill identification techniques.

5.102 The Working Group noted the conclusion of WG-EMM-08/54 that developing the ability to use long-term datasets for generating management advice through tracking variation in relative krill abundance should also become an important goal for CCAMLR.

5.103 Other key variables in estimating the TS of *E. superba* are the density and speed of sound contrasts. WG-EMM-08/56 Rev. 1 detailed such measurements made on krill from the South Shetland Islands and the Ross Sea. The density and sound speed contrasts measured were in the region of previously published values, although Ross Sea values were greater than the South Shetland Islands and previously published values. The TS of a 'standard length' krill was calculated with these values using the SDWBA model and shown to vary by ~6 dB.

5.104 The Working Group discussed the importance of the work in WG-EMM-08/56 Rev. 1 and 08/28 to attain well constrained values for density and speed of sound contrast for TS models. It was noted that these values would likely vary seasonally, geographically and ontogenetically.

5.105 The Working Group identified that the three papers, WG-EMM-08/29, 08/54 and 08/56 Rev. 1, were trying to assess key uncertainties in the acoustic estimate of krill biomass. A discussion ensued regarding the measurement of uncertainties in acoustic estimates and to what level this should be revised. It was agreed that, given time, these variables could be categorised and related to more simply measured variables, such as length and maturity stage.

5.106 WG-EMM-08/26 presented krill biomass estimations around the South Orkney Islands (discussed in paragraphs 5.61 and 5.62) using acoustic data collected during finfish surveys. A simple bootstrapping approach was used to generate confidence intervals.

5.107 The Working Group welcomed an approach that could be used to derive krill biomass estimates from surveys not designed specifically for that purpose. It was recommended that the applicability of such techniques for using alternative survey designs in acoustic studies could be investigated by SG-ASAM.

5.108 The Working Group noted that acoustic data collected by commercial fishing vessels could provide valuable data for use in deriving estimates of krill biomass (details are provided in paragraph 4.76). In this context, the Working Group noted the recently published ICES report on 'Collection of acoustic data from fishing vessels' (ICES, 2007).

5.109 WG-EMM-08/28 introduced the January–March 2008 IPY AKES survey carried out on the RV *G.O. Sars*. An aspect of this survey was to establish *in situ* TS values for krill using both hull-mounted and lowered echo sounders, to investigate the distribution of krill using a Simrad MS70 quantitative sonar, and to investigate the identification of krill targets using a hull-mounted multi-frequency (six frequencies: 18, 38, 70, 120, 200 and 333 kHz) echo sounder.

5.110 The Working Group noted that this was an exciting project that could offer many insights into acoustic techniques in the Southern Ocean, particularly the multi-frequency (six frequencies) identification techniques reported.

5.111 The Working Group further noted that several different acoustic methods for krill biomass estimation were utilised within WG-EMM-08/26, 08/28, 08/31, 08/35, 08/54 and 08/P2. The Working Group asked that an appendix of the accepted identification technique and current TS estimation model coefficients be included in the next SG-ASAM report.

5.112 The Working Group reiterated the importance of estimating uncertainties and providing measures, such as probability density functions, of confidence in the B_0 estimate. The Working Group discussed the implication this may have on the estimate of B_0 and recalled paragraph 2.20(i) of WG-EMM-07 (SC-CAMLR-XXVI, Annex 4) which states:

> '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 in the peer-reviewed literature where appropriate.'

5.113 The Working Group noted that this refers specifically to the use of protocols in setting the precautionary catch limit and indicated that it would welcome submissions on revisions and updates to acoustic protocols so that these could be assessed by SG-ASAM at the earliest opportunity.

Recommendations to SG-ASAM

5.114 SG-ASAM should provide advice that will assist in quantifying uncertainties in krill B_0 estimates. In particular, SG-ASAM should:

(i) validate acoustic identification techniques – by collating a set of net-validated acoustic data and evaluating whether acoustic target identification methods are biased;

(ii) evaluate and consider available information and current methods for the measurement of krill orientation and material properties, and use analyses of tilt angle from recent research cruises;

(iii) provide a probability density function of the estimate of B_0 based on the current understanding of uncertainties in various parameter values.

5.115 SG-ASAM should document the current agreed protocols for B_0 assessment in an appendix to its next meeting.

5.116 SG-ASAM should investigate the use of ancillary acoustic data (e.g. from finfish surveys, exploratory fisheries data and commercial fisheries' echo sounders) and the required analytical methods with a view to:

(i) providing krill biomass estimates from areas that are not regularly surveyed
(ii) documenting protocols for exploratory fisheries acoustic data processing and interpretation.

Future surveys

5.117 One Member notified the Working Group of future surveys in the coming year. As part of the US AMLR's monitoring program in the South Shetland Islands area, the US program will conduct a bottom trawl survey in the South Orkney Islands during the second of two legs in February and March of 2009. The survey will be the second bottom trawl survey of the area, and will occur a decade after the last survey conducted in 1999. Acoustic data and some krill hauls will be conducted in order to extend the utility of this survey.

5.118 Following this notification, the Working Group discussed the importance of extending surveys by individual countries or in developing interest in a second Scotia Sea-wide survey to estimate the biomass of krill in Area 48 for assessment purposes. It was noted by a number of members of the Working Group that there had been an attempt to develop such a survey during the 2007/08 IPY. Others noted that the development of a second large-scale survey would require a number of years, as was the case for the CCAMLR-2000 Survey.

5.119 Ecosystem considerations:

(i) the outcomes of WG-EMM-STAPP on abundance of krill predators, noting the substantial progress on assessing abundance of krill predators and how it may guide further work assessing abundance of other predators (paragraphs 5.1 to 5.16);

(ii) the increasing work on climate change impacts on the Southern Ocean which may assist the Commission in understanding the consequences of climate change for the CAMLR Convention Area (paragraphs 5.74 to 5.86);

(iii) the request by WG-EMM to SG-ASAM for advice on quantifying uncertainty in the acoustic estimation of krill biomass (paragraphs 5.114 to 5.116).

(iv) the importance of continued improvement in acoustic methodologies for providing advice on estimates of B_0 (paragraphs 5.112 and 5.113).

ECOSYSTEM EFFECTS OF FISHERIES THAT TARGET FINFISH

A historical perspective

6.1 WG-EMM-08/P7 hypothesised that a major mid-1980s shift in the ecological structure of significant portions of the Southern Ocean was partially due to the serial depletion of fish by intensive industrial fishing, rather than solely to climate factors as previously hypothesised. Over a brief period (1969–1973), several finfish stocks were on average reduced to <50%, and finally (mid-1980s) to <20%, of their original size. A climate index, the Southern Annular Mode, once oscillated between two states, but has remained in its 'positive mode' since the time of the fish extraction. As breeding stocks decreased, the authors hypothesised that availability of annually produced juvenile fish, fed upon by upper-level predators, remained low. Correlations between predator populations and fish biomass in predator foraging areas indicate that southern elephant seal (*Mirounga leonina*), Antarctic fur seal, gentoo penguin, macaroni penguin and 'imperial' shag (*Phalacrocorax atriceps*) – all feeding extensively on these fish, and monitored at Marion Island, Crozet Islands, Kerguelen Islands, Heard Island, South Georgia, South Orkney Islands and South Shetland Islands, where fishing was concentrated – declined simultaneously during the two periods of heavy fishing. The authors concluded that these patterns indicate the past importance of demersal fish as prey in Antarctic marine systems.

6.2 The Working Group thanked the authors for their contribution, but noted that there were some inconsistencies in the citations of the results of other papers as well as the treatment and interpretation of potential lag effects between the decline in prey and the decline in predators. It also considered that trends in fish populations were an important aspect of the krill ecosystem models and that future models could investigate the inclusion of some of the results presented in this paper.

Ross Sea

6.3 WG-EMM-08/18 provided details of a major New Zealand research voyage to the Ross Sea region during February and March 2008, in support of IPY-CAML. The 50-day voyage on the RV *Tangaroa* involved an extensive survey of marine organisms from viruses to pelagic and demersal fish and cephalopods from the surface down to depths of 3 500 m, and from the continental shelf and slope of the Ross Sea to unexplored seamounts and abyssal plains immediately to the north. A wide range of pelagic and benthic sampling gear, including plankton nets, midwater and demersal trawls, seabed cameras, sleds and corers were deployed.

6.4 The authors anticipated that the results of the survey will be directly relevant to many aspects of the work of CCAMLR and its working groups. An important aspect of the survey was to collect quantitative (both density and abundance) data on key species or species groups, such as *E. crystallorophias* and *P. antarcticum*, that will provide quantitative inputs to the Ross Sea ecosystem model. Other data collected during the survey will contribute to work being carried out on the biodiversity and bioregionalisation in the Southern Ocean (paragraphs 3.4 to 3.20), and VMEs in the Ross Sea region (paragraphs 3.21 to 3.44).

6.5 Dr Holt expressed his appreciation to New Zealand for including US and Italian scientists in the survey, noting the international nature of the voyage. The Working Group thanked New Zealand for carrying out such a comprehensive survey and for making the data available to CCAMLR for consideration. It was noted that this was the first such comprehensive survey of the Ross Sea.

6.6 WG-EMM-08/42 reported on the further development of a mass-balanced carbon-budget trophic model of the Ross Sea as a step towards investigating ecosystem effects of the fishery for Antarctic toothfish (*D. mawsoni*). The model now has 30 trophic groups representing all major biota of the Ross Sea. Many of the lower trophic-level species in the model are grouped by functional role because information is not available at greater taxonomic resolution. The model separates seven key apex predators by species. A survey of the available literature, and both published and unpublished data, provided an initial set of parameters describing the abundance, energetics (growth, reproduction, consumption) and trophic linkages (diets, key predators) for each model group.

6.7 The authors described the method used to adjust the parameters to give a balanced model taking into account estimates of parameter uncertainty and the large range of magnitude in trophic flows between different groups of organisms. Biomass, production, consumption, export and diet fractions were adjusted simultaneously. Changes to the initial set of parameters needed to obtain balance were significant, especially for bacteria. Excluding bacteria, the adjustments required for balance from the parameters estimated *a priori* were <46% (biomass), <15% (production, consumption) and <28% (diet fractions). The authors noted that the balanced model presented had not yet been validated and should be considered a work in progress. Future work is aimed at developing a plausible minimum-realistic model with which to investigate and manage the effects of the *D. mawsoni* fishery on the Ross Sea ecosystem.

6.8 Dr Naganobu noted the recent reports of freshening of the upper layer (Shelf Water) (Jacobs et al., 2002) and Antarctic Bottom Water (Rintoul, 2007) in the Ross Sea region. He noted that this needs to be understood when considering simulation modelling of the Ross Sea ecosystem.

6.9 Dr Southwell noted that new estimates of the abundance and distribution of pack-ice seals in the Ross Sea region were available. Dr Watters queried the high consumption:biomass ratios used for sperm (*Physeter catodon*) and killer whales (*Orcinus orca*) and noted that new estimates for these parameters, as well as estimates of abundance of other top predators, should become available from the Joint CCAMLR-IWC Workshop. The Working Group thanked the authors for their contribution and encouraged New Zealand to continue its work on ecosystem modelling in the Ross Sea.

6.10 WG-EMM-08/27 amalgamated over 500 stable isotope values for fish, squid and octopod samples obtained from longline fishing vessels from four CCAMLR SSRUs (881C, H, I and J). The samples included six species of fish including *D. mawsoni* and *D. eleginoides*, together with four of their main fish prey species (De Witt’s icefish (*Chionobathyscus dewitti*), blue antimora (*Antimora rostrata*), Whitson’s rattail (*Macrourus whitsoni*) and a moray cod (*Muraenolepis* spp.)), four squid, including the colossal squid (*Mesonychoteuthis hamiltoni*), and three benthic octopod species.

6.11 Most fish showed a δ15N range greater than 3.4‰, spanning more than one trophic level, whilst *D. mawsoni* exhibited a range of 7‰ (9–16‰), which is equivalent to two trophic levels. This implies that the diet of all species sampled is quite variable, and this variation was analysed using regression methods. Length and SSRU were the most significant variables in explaining the variation of δ15N and δ13C. Overall, *D. mawsoni* and *D. eleginoides* occupied a trophic level equivalent to killer whales and Weddell seals (*Leptonychotes weddellii*). The four fish prey species were all at least one trophic level below them.

6.12 There was no significant difference in *D. mawsoni* δ15N and δ13C values between the northern area, Ross Sea slope and Terra Nova Bay trench. In contrast, each of the main prey fish species caught in the northern area had enriched δ13C values compared to the Ross Sea slope. Since this enriched δ13C signature is not found in *D. mawsoni*, this suggests that *D. mawsoni* are mainly feeding on the Ross Sea slope area and the authors inferred that they are likely to have a moderately short residence time in the other two areas.

6.13 Dr Watters questioned whether stable isotope analysis had been carried out for *P. antarcticum*. Dr Hanchet replied that new estimates for this species suggested δ15N and δ13C values consistent with other toothfish prey taken from the Ross Sea shelf.

6.14 Dr Constable noted that it was also important to look at the temporal variation in stable isotope signatures. Dr Hanchet noted that New Zealand scientists were intending to collect a range of tissue types (blood, muscle, hard parts) from *D. mawsoni* in the future so that the recent history of stable isotopes within an individual fish could be better understood.

6.15 WG-EMM-08/43, 08/22, 08/23, 08/21, 08/20 and 08/24 were presented to the Working Group. A general discussion of these papers took place surrounding the potential decline in *D. mawsoni* at McMurdo Sound and the plausibility of using aerial census counts of Weddell seals to monitor the ecosystem effects of the toothfish fishery in the Ross Sea.

6.16 WG-EMM-08/43 addressed the importance of *D. mawsoni* as a prey item of Weddell seals in the southern Ross Sea. It reviewed: the life history of Weddell seals with particular reference to the McMurdo Sound region; direct information on the diet of Weddell seals including habitat overlap, stomach contents analysis, scat and vomit remains; direct observations by divers and scientists and animal-mounted camera information. The paper presented a preliminary analysis of recent stable isotope data using the IsoSource mixing model. Finally, the paper compared the assumed natural mortality rate of *D. mawsoni* in the McMurdo Sound region to the estimated consumption by Weddell seals. The authors provided various estimates of the proportion of toothfish in the Weddell seal diet, but noted that they are very dependent on the assumptions used in the calculations.

6.17 The authors concluded that while there is strong evidence that toothfish are eaten by Weddell seals in the McMurdo Sound region between October and January, it is plausible but unproven that they are an important prey item. They go on to note that the fishery for *D. mawsoni* in the Ross Sea could have a detrimental effect on Weddell seal populations in the McMurdo Sound region if: (i) the commercial fishery (directly or indirectly) reduces the abundance of toothfish in the McMurdo Sound region, (ii) the magnitude of the change in toothfish abundance is enough to change the behaviour and/or foraging success of seals there, and (iii) the change of behaviour and/or foraging has an adverse effect on the seal population.

The authors recommended further data collection and stable isotope analysis of samples of blood, muscle tissue and hair from breeding and non-breeding seals in the McMurdo Sound region to help determine trophic overlap.

6.18 WG-EMM-08/22 addressed the importance of *D. mawsoni* as a prey item of Weddell seals and killer whales in the southern Ross Sea. It reviewed aspects of their life history and behaviour with reference to the McMurdo Sound region, direct observations by divers, scientists and animal-mounted cameras, and results of biochemical (stable isotope and fatty acid) analyses. The authors asserted that biochemical analyses are inconclusive because of the timing and location of the animals sampled, and that more weight should be accorded to direct observations.

6.19 The authors of WG-EMM-08/22 used direct observations from scientists and video footage to derive an estimate of the daily food intake and likely proportion of toothfish in the diet of Weddell seals. They then went on to estimate that the non-breeding part of the Weddell seal population in McMurdo Sound consumes 52 tonnes of toothfish during the spring and summer months. They further noted that the annual consumption based on the breeders and other months of the year is likely to be substantially higher. They concluded that there is strong evidence that *D. mawsoni* are important in the diet of top predators and that monitoring (e.g. initiation of CEMP in regard to toothfish fisheries) is required for effective management of the ecosystem effects of the toothfish fishery.

6.20 WG-EMM-08/23 concerned aerial census counts of Weddell seals along the Victoria Land coast in the eastern Ross Sea. The paper noted that there is currently no ecosystem monitoring program (CEMP) in place under CCAMLR with respect to the Ross Sea fishery. In a previous paper to WG-EMM (WG-EMM-07/13), the authors described protocols for an aerial census of Weddell seals in this area. In the present paper, they compared counts made from the air with those from the ground in Erebus Bay, McMurdo Sound, in November 2007, and also summarised historical results of aerial surveys made along the coast of Victoria Land. The authors noted that the high correlation (r = 0.99) between air and ground counts shows that aerial photography can successfully be used to document changes in distribution and abundance of Weddell seals. Ground counts of Erebus Bay colonies, made annually from 1974 to 2007, demonstrate the sensitivity of count data to environmental variability. The authors concluded that on the basis of this and the 2007 paper, a Weddell seal monitoring program can now be put into effect under CEMP, and noted that this would need to begin with a one-off survey to identify all important haul-out locations and the ones that best lend themselves to aerial surveillance.

6.21 WG-EMM-08/21 provided a preliminary summary of data recorded by US scientists fishing through the ice for *D. mawsoni* at McMurdo Sound. They noted that since 1971, about 4 500 *D. mawsoni* have been captured, with total captures of 200–500 per year. They noted that more recently, with similar effort, numbers are nearly zero. The authors presented daily data on catch and effort for the year 1987 (a year they report as being typical of catch results before the exploratory fishery started) and for 2001 (just after the onset of the exploratory fishery and after about 1 500 tonnes had been caught). Catch data, but no corresponding effort data, have been provided since 2001. The authors noted that the entire dataset awaits computerisation, but that the subset of data clearly shows a marked decline in CPUE in McMurdo Sound once the Ross Sea fishery had reached maturity in 2001/02.

6.22 WG-EMM-08/21 also presented daily sightings of killer whales from a lookout at Cape Crozier on Ross Island during December and January of each year from 2003 to 2007, and noted that killer whales have become infrequent since January 2006. Lastly, the paper presented data on the proportion of *P. antarcticum* in the diet of Adélie penguins since 2003/04, noting that the proportion of *P. antarcticum* in their diet in 2007/08 was the highest in the 5-year time series presented and was similar to 1996/97. On the basis of these observations, the authors concluded that the fishery has caused a trophic cascade at McMurdo Sound. The paper recommended that the catch limit in the fishery be reduced, including a moratorium on the shelf, until the McMurdo Sound toothfish population is restored and a program is in place to monitor ecosystem effects of the fishery.

6.23 WG-EMM-08/20 was a letter authored by 25 Antarctic scientists in regard to WG-EMM-08/21 on the decline of *D. mawsoni* from McMurdo Sound. They express concern that this is the first sign that the Ross Sea ecosystem is being irreparably altered, and that several extensive time series of unequalled climate records and responses of the biota to climate change are in jeopardy of being compromised. They state that five time series, each extending for more than 40 years, have been 'blindsided' by the impacts of overfishing. The time series include annual counts of Adélie and emperor penguins (*Aptenodytes forsteri*), benthic community composition and growth, Weddell seal demography and toothfish prevalence as indicated by scientific catch rates. The paper recommended a steep reduction in the catch limit in the fishery, including a moratorium on the shelf, until the McMurdo Sound toothfish population is restored and a program is in place to monitor ecosystem effects of the fishery.

General discussion

6.24 The Working Group identified several inconsistencies in WG-EMM-08/21 which required further elaboration by the authors:

(i) The authors noted that they have caught 4 500 fish over a 30-year period (1971–2001), implying an average catch of 150 fish per year. This is inconsistent with the claim that total captures once numbered 200–500 fish per year before exploitation started.

(ii) The authors also claimed that they chose 1987 as a 'typical year in catch results' for the pre-exploitation period. However, as shown in Figure 6 of the paper, the catch in that year was 412 fish – this is not a typical year if the average was only 150 fish.

(iii) There were several other inconsistencies in the text. For example, the caption to Figure 7 states that 10 sets were made in 2001 – however, a total of 29 sets were reported for 2001 in Appendix 2 of the paper. Also, the paper stated that in 1996/97, vessels fished off Cape Crozier for long periods (page 12); however, in that year, the first year of the exploratory fishery, the total catch of toothfish was <1 tonne and this was taken well outside the Ross Sea itself.

6.25 The apparent decline in toothfish catches coincided with a change in the scientific fishing location. Although the authors state that catch rates were similar before and after the change in fishing location, not enough detail is presented to determine whether this is the case. Furthermore, although the text says the new site was only 0.5 km from the original site, this is not consistent with the scale on the map shown in Figure 4 of the paper or with it being a distance of 4 km from McMurdo Station. The physical and environmental features of the two sites with respect to bottom depth, current, substrate, temperature, distance from the edge of the fast-ice etc. should also be provided. Commercial catch rates are very dependent on fishing location, therefore it would be surprising if this was not the same for a research fishing site.

6.26 In considering the above issues, the Working Group was unable to adequately assess the conclusions of the paper at the current time. It requested the authors to provide the following historic data on:

(i) the location, number of sets, number of hooks, number of fish caught, soak-time and CPUE (number of fish per set) by day, month and year for all years since sampling started in 1971. Other details, such as weight of fish caught, fate of fish (e.g. kept, released, tagged) and bait used each year, would also be useful;

(ii) the length-frequency distribution – perhaps grouped over 2- or 3-year intervals;

(iii) specific details of the two sites with respect to bottom depth, current, substrate, water temperature, distance from the edge of the fast-ice etc.

6.27 The Working Group also noted that the evidence for a switch in Adélie penguin diet was rather weak. Although the highest percentage of *P. antarcticum* in the diet occurred in 2007/08 (55%), the lowest percentage of *P. antarcticum* in the diet had occurred the previous year (32%). The Working Group further recalled that research carried out by Emison in the 1960s suggested that the annual proportion of *P. antarcticum* in the diet of Adélie penguins ranged from 40–60% (Emison, 1968).

6.28 The Working Group then considered the proposal for an aerial census of the Weddell seal population as a CEMP index outlined in WG-EMM-08/23. It recalled its advice on this matter at last year's meeting where it noted: (i) that the monitoring program would need to be well designed (be theoretically sound and pragmatic), (ii) the minimum data requirements for a viable program, and (iii) the need for a long-term funding commitment (SC-CAMLR-XXVI, Annex 4, paragraph 5.25).

6.29 Several members recalled the detailed process followed when developing the CEMP indices, including identifying objectives, agreeing on standard methodologies, the likelihood of detecting change (power analysis), the collection of ancillary data (e.g. dietary studies and monitoring other prey species), the risk that the program may be unable to detect impacts, and the need for long-term commitment to the program.

6.30 The Working Group agreed that an aerial census was likely to be the most appropriate method for monitoring the abundance of Weddell seals. However, it also noted that, by itself, an aerial census may not be sufficient to determine possible ecosystem effects of the toothfish fishery. It considered that: (i) the program may be unable to detect impacts within a reasonable timeframe, and (ii) it would be difficult to prove that any changes in the Weddell seal population were a result of the fishery and not due to other factors, such as climate change or changes in other more important prey.

6.31 The Working Group noted the high level of variability in the seal counts shown in Figure 1 of WG-EMM-08/23 and that, given this high level of variability, the power of detecting changes in the abundance of the Weddell seal population was likely to be quite low unless the variability can be explained with covariates. The Working Group also noted the need for other ancillary data to be collected as part of the monitoring program. This would include data on the distribution and abundance of key species such as *D. mawsoni*, *P. antarcticum* and *E. crystallorophias*, and the need to obtain unbiased estimates of Weddell seal diet.

6.32 Dr Watkins noted that it may be possible to use upward-looking moored acoustic transducers to measure krill and silverfish abundance in the McMurdo Sound region. This approach had been successfully carried out at South Georgia and would enable the recording of year-round acoustic backscatter and ancillary data.

6.33 Although no *D. mawsoni* hard parts are found in Weddell seal scats and vomits, Dr Welsford noted that it may be possible to use DNA techniques to determine whether scats and vomits contained traces of toothfish muscle. This could be used to obtain better estimates of the occurrence of toothfish in the Weddell seal diet.

6.34 The Working Group was also concerned that Weddell seals may not be a very good candidate for monitoring ecosystem effects caused by the toothfish fishery. This is because Weddell seals could potentially prey-switch from toothfish to silverfish or squid if there was a reduction in the local toothfish abundance. Such a prey-switch would be hard to detect because toothfish also feed on these species.

6.35 The Working Group also considered the question of relative foraging efficiency when Weddell seals forage for silverfish and toothfish. It noted that further work needs to be done to evaluate potential trade-offs in foraging between the two species that could affect the physiology and condition of the breeding and non-breeding parts of the population.

6.36 Dr Plagányi noted that the relationships between the Weddell seal and its prey could be explored through simulation and modelling – which could take into account such direct competitive and indirect foraging effects. Dr Constable agreed, noting that the lack in spatial and temporal overlap between the fishery and the Weddell seal population would make it difficult to interpret population trends, especially when any effects on the seal population are likely to be lagged.

6.37 The Working Group noted that a spatial population model was being developed by New Zealand to address movement of toothfish within the Ross Sea, and that the model could potentially be used to examine ecosystem effects of fishing (paragraph 6.7; Annex 7, paragraphs 5.1 to 5.6). It noted that there was a considerable amount of data on satellite tracking of Weddell seals in the western Ross Sea and also on movements of tagged toothfish which could help inform the model.

6.38 The Working Group noted that in the absence of ecosystem monitoring techniques, it may be more prudent to treat toothfish as a prey species rather than as a predator species. This would imply the use of the 75% escapement rule rather than the 50% escapement rule currently used for toothfish.

6.39 However, Dr Hanchet noted that the current stock assessment suggests that the stock is at about 82% of its unexploited biomass (SC-CAMLR-XXVI, Annex 5, Appendix I). If there has really been a decline in toothfish predators at that biomass level, then even a 75% escapement level would be too low. The Working Group noted that an alternative option would be to have a fishing-free buffer zone along the coastline of the western Ross Sea – which would remove direct fishing pressure from areas immediately adjacent to the land-based predators.

6.40 The Working Group agreed that it would be useful to discuss these issues with WG-FSA members at the future FEMA meeting (paragraph 8.6).

Advice to the Scientific Committee

6.41 The Working Group agreed that an aerial census was probably the best method for monitoring Weddell seal abundance in the western Ross Sea and indicated that the work proposed to identify all important haul-out locations (paragraph 6.20) would be useful. However, at this time, it was unable to endorse the aerial census as a CEMP index because it was not clear whether a change in the index could be directly attributed to the toothfish fishery (paragraph 6.30).

6.42 The Working Group recommended further work on designing a program to fully monitor effects of fishing. It noted that additional data would be needed in developing a monitoring program, including data on the distribution and abundance of *D. mawsoni*, species of demersal fish and silverfish, and estimates of the importance of diet components to Weddell seal production (paragraph 6.31).

6.43 The Working Group also recommended the development of a spatial population model to explore interactions between *D. mawsoni* and Weddell seals in the western Ross Sea (paragraph 6.37).

Future work

6.44 The Working Group recommended further collection of material for stable isotope analysis, including a range of tissue types from fish and Weddell seals in the McMurdo Sound region to help determine trophic interactions (paragraphs 6.14 and 6.17).

STATUS OF MANAGEMENT ADVICE

Protected areas

7.1 The Scientific Committee is referred to the outcomes of the focus topic on spatial management measures that aim to facilitate the conservation of marine biodiversity (paragraphs 3.71 to 3.78).

Harvesting units

7.2 No new information on harvesting units was available for consideration.

Small-scale management units

7.3 WG-EMM-08/11 summarised the data available on land-based predators that could be used for subdividing Subarea 48.4 into SSMUs. It indicated that chinstrap penguins are the dominant predators and present on all islands, while the smaller abundances of gentoo and macaroni penguins and fur seals are concentrated in the six northern-most islands. It is proposed that Subarea 48.4 be subdivided into two SSMUs consistent with the approach for separating pelagic and coastal SSMUs in Subareas 48.1, 48.2 and 48.3.

7.4 The Working Group noted that, based on the use of foraging density and species composition, it may be possible to further subdivide the coastal SSMU in Subarea 48.4 into one encompassing the six northern-most islands and one encompassing the remaining islands in the south. It was also noted that Adélie penguins were present despite the absence of sea-ice in summer. In winter, sea-ice regularly extends northwards into the chain of islands.

7.5 The Working Group recommended that the proposal in WG-EMM-08/11 to partition Subarea 48.4 into a coastal and a pelagic SSMU be adopted, noting that further analyses may indicate the need for further subdivision of the coastal SSMU into northern and southern areas when additional data are available.

Analytical models

7.6 The Scientific Committee's attention is drawn to the discussion on advances in modelling in support of the SSMU allocation discussed in paragraphs 2.13 to 2.30.

Existing conservation measures

7.7 The Scientific Committee's attention is drawn to the discussion on regulatory issues in paragraphs 4.67 to 4.95. Specific points for consideration are indicated in paragraphs 7.9, 7.10 and 7.12.

Key points for consideration by the Scientific Committee and its working groups

7.8 SSMU allocation:

(i) the risk assessment for the Stage 1 SSMU allocation is completed and advice on this is contained in paragraphs 2.95 to 2.101;

(ii) a range of climate-change scenarios will need to be considered as part of a broader-and longer-term risk assessment in subsequent stages of the SSMU allocation (paragraph 2.30).

7.9 Spatial management measures that aim to facilitate the conservation of marine biodiversity:

(i) development of a representative system of marine protected areas through, *inter alia*, bioregionalisation and/or systematic conservation planning (paragraphs 3.71 to 3.73 and 3.76 to 3.78);

(ii) implementation of Conservation Measure 22-06 concerning VMEs, including a risk-analysis framework (paragraph 3.73), a workshop to provide guidance on identifying taxonomic groups and habitats and reducing uncertainty associated with identifying VMEs (paragraph 3.74), and for the process of notification of VMEs (paragraph 3.75).

7.10 Krill fishery:

(i) haul-by-haul data remain to be submitted by Poland for 2006/07 (paragraph 4.3);

(ii) trends in the krill fishery (paragraphs 4.1 and 4.6 to 4.8);

(iii) notifications of intention to fish for krill in the 2008/09 season (paragraphs 4.6 to 4.17).

7.11 Scientific observation in the krill fishery:

(i) lack of data on product-specific catches and conversion factors are creating difficulties in verifying the accuracy of 'green weight' of krill caught (paragraph 4.36);

(ii) the request for Members to be encouraged to evaluate the possibility of accurately reporting catch on the basis of direct estimates of 'green weight caught' to resolve the problem of inaccurate catch reporting (paragraph 4.39);

(iii) WG-EMM agreement on the role of ad hoc TASO (paragraph 4.45);

(iv) revisions required in the *Scientific Observers Manual* (paragraphs 4.52, 4.65 and 4.66);

(v) the need for a fish by-catch sampling protocol consistent with the existing larval fish sampling protocol (paragraph 4.54);

(vi) an agreed strategy for implementing a scientific observer program to achieve systematic coverage in the krill fishery (paragraphs 4.58 to 4.63)

7.12 Regulatory issues:

(i) the need to record information that describes the fishing technique to be used by krill vessels (paragraph 4.68);

(ii) the consideration of notifications for exploratory krill fisheries and requirements for data collection plans needed to implement Conservation Measure 21-02 (paragraphs 4.69 to 4.95).

7.13 Ecosystem considerations:

(i) the outcomes of WG-EMM-STAPP on abundance of krill predators, noting the substantial progress on assessing abundance of krill predators and how it may guide further work assessing abundance of other predators (paragraphs 5.1 to 5.16);

(ii) the increasing work on climate change impacts in the Southern Ocean which may assist the Commission in understanding the consequences of climate change for the Convention Area (paragraphs 5.74 to 5.86);

(iii) advice on research to detect the ecosystem effects of toothfish fishing in the Ross Sea (paragraphs 6.41 to 6.43);

(iv) the request from WG-EMM to SG-ASAM for advice on quantifying uncertainty on the acoustic estimation of krill biomass (paragraphs 5.114 to 5.116);

(v) the importance of continued improvement in acoustic methodologies for providing advice on estimates of B_0 (paragraphs 5.112 and 5.113).

7.14 General:

(i) consideration of the future work program of WG-EMM, including:

- the proposed terms of reference for the FEMA2 workshop to consider the ecosystem effects of the toothfish fishery in the Ross Sea (paragraphs 8.1 to 8.6);
- a proposed revision to the Working Group agenda (paragraphs 8.8 to 8.10);
- consideration of the subjects for discussion and the CCAMLR representatives of the Joint SC-CAMLR–CEP Workshop Steering Group (paragraphs 3.65 to 3.69 and 9.1 to 9.5).

FUTURE WORK

Second Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA2)

8.1 The Conveners of WG-EMM and WG-FSA introduced a set of topics for the Second Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA2). In proposing the topics, the Conveners noted that:

(i) there is considerable interest in considering the ecosystem effects of fishing for toothfish in the Ross Sea;

(ii) fisheries for toothfish in the Ross Sea are exploratory;

(iii) there are parallels between the SSRUs in the Ross Sea and the SSMUs in the Scotia Sea;

(iv) experience gained from advising on spatial management strategies for krill in Area 48 could be applied to advise on the management of fisheries in the Ross Sea;

(v) ecosystem models are not always required to provide useful advice from an ecosystem perspective.

8.2 Given the points outlined above, the Conveners thus proposed that the FEMA2 Workshop be structured in a manner that treats fisheries for toothfish in the Ross Sea as a case study of how ecosystem considerations can be used to advise on the management of fisheries that target finfish.

8.3 The Conveners proposed four topics for consideration at the FEMA2 Workshop:

(i) Evaluate whether the level of escapement currently espoused in existing decision rules for toothfish in the Ross Sea is sufficiently precautionary when these fish are viewed as important prey as well as predators. Such an evaluation should include a comparative analysis of the importance of toothfish as prey in different regions throughout the Southern Ocean.

(ii) Evaluate whether the existing boundaries of SSRUs in the Ross Sea could be revised on the basis of overlap between the spatial distribution of the fishery, the foraging areas of predators on toothfish, and other information, such as the presence or density of VMEs. Such an evaluation should include work similar to that used for defining SSMUs in Area 48 (SC-CAMLR-XXI, Annex 4, Appendix D).

(iii) Evaluate whether the existing basis for distributing the precautionary catch limits for toothfish among SSRUs in the Ross Sea could be revised on the basis of the information considered in (ii) above.

(iv) Evaluate whether steps to implement possible revisions evaluated in (ii) and (iii) above would impact results from the ongoing tagging studies that are important components of the research plan and stock assessment process for exploratory fisheries for toothfish in the Ross Sea.

8.4 The Working Group agreed that it would be useful to consider the FEMA2 Workshop as a focus topic (paragraph 8.11) during its 2009 meeting. It was further agreed that the conveners of WG-EMM and WG-FSA should jointly chair the workshop.

8.5 However, it was suggested that, given the short time available to conduct FEMA2 (paragraph 8.11), the workshop would not likely be able to address all four topics. It was also suggested that FEMA2 should address the first two topics and that the remaining topics may be taken up in the future.

8.6 It was noted, however, that WG-FSA may want to comment on the desirability of discussing topics (iii) and (iv). The fourth topic has wider application to WG-FSA than WG-EMM. Therefore, the Working Group agreed to provide WG-FSA its advice relative to all four topics. After discussion by WG-FSA on what topics might be considered at the FEMA2 Workshop, it was suggested that the conveners of WG-EMM and WG-FSA provide a proposal on the terms of reference for FEMA2 to the Scientific Committee.

Revised agenda and long-term work plan for WG-EMM

8.7 The Working Group discussed how it might structure its agenda for future meetings. It was recognised that an agenda should aim to facilitate the achievement of long-term objectives while simultaneously maintaining the flexibility needed to address the annual requirements for scientific review and advice that will be expected by the Scientific Committee and the Commission in the future.

8.8 The Working Group agreed that at least four topics require work over the long term, all of which have previously been endorsed by the Scientific Committee or have been identified as a topic of interest to the Commission.

(i) The development and evaluation of feedback management strategies for the krill fishery, including work to estimate predator abundance and demand (e.g. SC-CAMLR-XXV, paragraph 3.25) and to support the staged development of the krill fishery in Area 48 (e.g. SC-CAMLR-XXVI, paragraph 3.36(vii)).

(ii) The development and application of methods to facilitate the conservation of marine biodiversity in the Convention Area, including work to identify VMEs (e.g. SC-CAMLR-XXVI, paragraph 14.5) and define candidate MPAs (e.g. SC-CAMLR-XXVI, paragraph 3.87) and to achieve a harmonised approach (e.g. SC-CAMLR-XXV, paragraph 3.32) within the Antarctic Treaty System and within CCAMLR.

(iii) Consideration of the ecosystem effects of fishing for finfish (e.g. SC-CAMLR-XXVI, paragraph 3.99), including further collaboration with WG-FSA.

(iv) Consideration of the impacts of climate change on the Antarctic marine ecosystem (e.g. CCAMLR-XXVI, paragraph 15.36).

8.9 The Working Group agreed that focus topics (as per Items 2 and 3 of the agenda for this meeting) provided a mechanism to facilitate requirements for short-term advice, and that long-term work objectives should form the primary items of its future agenda. It was noted that the topic of climate change was a cross-cutting issue that could be considered under multiple agenda items.

8.10 The Working Group agreed that the Scientific Committee should review the following proposal for structuring the future agenda of the Working Group:

1. Introduction (opening of the meeting, adoption of the agenda and appointment of rapporteurs, review requirements for advice and interaction with other working groups)

2. Focus topic (to be determined on an annual basis with priority given to topics that relate to needs for short-term advice)

3. Ecosystem effects of fishing for krill (krill, dependent predators, the fishery and scientific observation, surveys and monitoring, climate impacts and feedback management strategies)

4. Ecosystem effects of fishing for finfish (fish, dependent predators, fisheries and scientific observation, surveys and monitoring, climate impacts and collaboration with WG-FSA)

5. Spatial management to facilitate the conservation of marine biodiversity (VMEs, protected areas, and harmonisation of approaches, both within CCAMLR and across the ATS)

6. Advice to the Scientific Committee and its working groups

7. Future work

8. Other business

9. Adoption of the report and close of the meeting.

8.11 With respect to the proposal for Agenda Item 2, the Working Group agreed that a focus topic might not be required in every year. Nevertheless, it was recognised that the FEMA2 Workshop is a priority matter for the Scientific Committee and would likely provide a useful focus topic in 2009 (further discussion on FEMA2 is summarised in paragraphs 8.1 to 8.6). Beyond 2009, it was envisaged that focus topics would be agreed at the preceding meeting of SC-CAMLR where the conveners of the working groups and the Chair of the Scientific Committee can consult with Members. This would also provide an opportunity for considering the time required for, and timing of, the focus topics. It was noted that, generally, focus topics should not occupy more than two to three days of the annual WG-EMM agenda.

8.12 The Working Group also highlighted the importance of increased collaboration with WG-FSA to successfully conduct work on the proposed Item 4, including receiving information from annual Fishery Reports and from surveys designed to study finfish. The Working Group would itself aim to provide WG-FSA with advice that broadens the ecosystem context of finfish stock assessments, possibly ultimately including the development of ecosystem operating models that could be used to evaluate management strategies for finfish.

Joint CCAMLR-IWC Workshop

8.13 Dr Constable introduced the papers presented to WG-EMM on the Joint CCAMLR-IWC Workshop due to be held in Hobart, Australia, from 11 to 15 August 2008. WG-EMM-08/16 provided a summary by the workshop co-conveners of progress in preparing for it, noting that:

(i) the workshop is currently well within budget, potentially leaving funds available for commissioning post-workshop work if required;

(ii) all expert groups were progressing well, except for the expert group on flying seabirds, which is being progressed by the co-conveners in consultation with experts involved with ACAP in order to obtain a review paper by the end of the year;

(iii) consultations with the SC-IWC were held by Dr Constable attending the SC-IWC meeting in Santiago, Chile, in May 2008.

8.14 WG-EMM-08/15 is a background paper for the workshop providing an introduction on the requirements for modelling in CCAMLR and IWC. Its genesis was in response to many requests from expert group coordinators to provide the context in which they were developing their review papers. It is intended that, should the paper be developed with the other papers in publication, then the modellers of CCAMLR and IWC are requested to participate in the production of an updated manuscript.

8.15 WG-EMM-08/47 provided a summary of progress on papers by the expert groups at the time of the deadline for submissions to WG-EMM. Dr Constable updated the Working Group as to progress on the manuscripts, as the final deadline for completion was one week before the workshop. He indicated that, other than flying seabirds, manuscripts have been received from all groups but baleen whales, protists and oceanography, although a draft of the baleen whales manuscript had been prepared in time for the SC-IWC meeting and a draft protist manuscript was available. Members of the Working Group were encouraged to read the manuscripts and provide input to the workshop by corresponding with Dr Constable if they were unable to attend.

Additional key points for consideration by the Scientific Committee and its working groups

8.16 Validation and access to models advising on SSMU allocations:

(i) The Working Group noted that at present it is in the process of developing three models to allocate catch between SSMUs in Area 48. However, except for the authors, few people in the Working Group are familiar with the operation of the models. In fact, the preparation of input data, parameterisation of the models, calculations provided by the models, and analysis of the results are not transparent and are not easily accessible to other members of the groups. As a result, it is difficult to validate the output or conclusions provided by the models.

(ii) The Working Group noted that all models applied for developing krill management procedures are complex and their effective implementation requires that an independent and critical approach be taken. This can be ensured by establishing within WG-EMM, a subgroup of experts from interested Members who will be able to verify calculations and applications of the models used, including the raw data preparation, calculation procedures and analysis of the results. The subgroup could ensure that the application of the models is transparent and that they are verified.

(iii) It was agreed that for the subgroup to undertake its work, it would require preparation of detailed descriptions of the models, preparation of user manuals for the models, and provision to the Secretariat that the model software is in accordance with all the requirements of CCAMLR, including test cases.

(iv) Interested Members should appoint to this subgroup scientists with sufficient expertise to verify the model application.

(v) The Working Group noted that, as necessary and in accordance with procedures in SC-CAMLR-XXVI, Annex 7, paragraph 6.3, WG-SAM could continue to review the methodological implementation of models used for SSMU allocation.

(vi) The Working Group also agreed that, for models to be used by the Working Group in providing advice, they should be sufficiently developed for use by members of the Working Group other than the model developers. This will enable wider participation of Working Group members, as needed, in the development, validation and review of results of assessments with respect to SSMU allocation. The Working Group agreed that participation by Members in the assessment work, as is done in WG-FSA, is highly desirable. In order to facilitate the participation of others in this assessment work, the Working Group recommended that:

(a) sufficient documentation is provided with a model to guide its use by others, for example, as has been provided for CASAL and GYM;

(b) software, example input files and test cases are submitted to the Secretariat for access by Members.

8.17 Workshop on Antarctic benthic invertebrate ecosystems to be held in conjunction with TASO, WG-FSA or under alternative arrangements (paragraphs 3.31 to 3.33 and 3.74).

8.18 Initiation of a process to develop a representative system of MPAs across heterogeneous areas (paragraphs 3.60 to 3.62).

8.19 Joint SC-CAMLR–CEP Workshop on ‘opportunities for collaboration and practical cooperation between the CEP and CCAMLR’ (paragraphs 3.63 to 3.70 and 9.1 to 9.5).

OTHER BUSINESS

Joint SC-CAMLR–CEP Workshop

9.1 The Working Group discussed the proposal for a joint workshop between SC-CAMLR and the CEP (‘Opportunities for collaboration and practical cooperation between the CEP and SC-CAMLR’) (WG-EMM-08/52). This workshop is currently scheduled to be held in early April 2009, immediately prior to the CEP XII meeting in Baltimore, USA (see also paragraphs 3.63 to 3.69).

9.2 Noting suggestions outlined in WG-EMM 08/52 and SC CIRC 08/31, the Working Group indicated that, in its view, it would be appropriate for CCAMLR representation on a Joint SC-CAMLR–CEP Workshop Steering Group to comprise the working group conveners and current Scientific Committee Vice-Chairs. The Steering Group would plan the workshop terms of reference and agenda, with the SC-CAMLR participants providing an outline of likely CCAMLR interests in time for consideration by the Scientific Committee at its 2008 meeting. The Working Group also noted an expectation that the two Scientific Committee Vice-Chairs would be replaced on the Steering Group by the new Scientific Committee Chair when elected.

9.3 In considering the themes proposed by the CEP for the workshop, the Working Group highlighted the importance of all proposed items. However, it noted that two themes ('Protected areas and spatial management measures' and 'Species requiring special protection') appeared particularly worthy of SC-CAMLR attention. In the case of species protection, the Working Group noted that consideration should be given on how interactions and practical cooperation between SC-CAMLR and the CEP could be developed to facilitate the process of affording additional protection to species in which SC-CAMLR and/or the CEP had an interest(s).

9.4 The Working Group anticipated that the Steering Group will undertake its work electronically, and that there may be an opportunity for some of the group to meet at SC-CAMLR-XXVII in October 2008.

9.5 Given the shortage of time available to develop SC-CAMLR's input into the workshop, the Working Group agreed that the Secretariat would urgently circulate the Working Group's views to all SC-CAMLR Members to expedite development of SC-CAMLR's involvement in the Steering Group. It was envisaged that such development would take into account any suggestions made by the joint Steering Group and would comprise a draft agenda and work plan for consideration by SC-CAMLR-XXVII.

SCAR climate change review

9.6 The Executive Secretary noted that SC CIRC 08/41 conveyed an invitation from SCAR for CCAMLR to comment on a recent SCAR review ('Antarctic climate change and the environment') comprehensively (495 pages) addressing climate change in the Antarctic. This invitation had arisen from discussions at CEP XI in June 2008.

9.7 The Working Group noted that the time available for comment (before 1 September 2008) was very short. It was not, therefore, in a position to provide any consolidated advice to the Scientific Committee on the SCAR review. Consequently, it was also noted that the heavy CCAMLR meeting schedule in July–August 2008, and the timing of the SCAR request for comments, provided no real opportunity for an institutional response from the Scientific Committee.

Southern Ocean Sentinel Workshop

9.8 Dr Constable drew the meeting's attention to SC CIRC 08/37 describing plans for a workshop ('Monitoring climate change impacts – establishing a Southern Ocean sentinel program') to be hosted by Australia at the CCAMLR Headquarters, from 20 to 24 April 2009. Further details of the workshop are available by email at sos@aad.gov.au.

CCAMLR Science

9.9 As the new *CCAMLR Science* Editor-in-Chief, Dr Reid reiterated that the aim of the journal is to communicate the science being done in CCAMLR to the broader scientific community. The journal is also a vehicle to advertise CCAMLR's work and to encourage scientists to become involved in it.

9.10 The Working Group recognised that there should be a clear distinction between working group papers and peer-reviewed papers in *CCAMLR Science*. The latter need to be accessible to a broader readership. As such, *CCAMLR Science* emphasises and clearly describes the context of CCAMLR's scientific work and aims to communicate any consequences/conclusions beyond CCAMLR.

9.11 Dr Reid reminded potential authors to ensure that they conform with the Rules for Access and Use of CCAMLR Data in respect of CCAMLR and working group data released into the public domain via publication in *CCAMLR Science*. To ensure that this is done, a new tick box will be included on the *CCAMLR Science* manuscript submission form to indicate that permission to publish (and to cite working group papers) has been granted by the data originators/owners.

9.12 The Working Group noted that Dr Reid was inviting comments from all SC-CAMLR working groups on manuscript submission and *CCAMLR Science* editorial process. A Secretariat paper will be submitted to SC-CAMLR-XXVII.

9.13 The Working Group inquired whether it would be possible for press-ready *CCAMLR Science* manuscripts to be placed on the website in a manner similar to the 'First View' system used by other journals.

9.14 In discussing availability of *CCAMLR Science* papers on the website, the Working Group noted that the Secretariat was in the final stages of implementing a password-protected web-based archive for all CCAMLR publications, including working group papers. Currently the archive was in library form, but its second phase will provide a fully searchable document database. The Working Group congratulated the Secretariat for developing and providing this very valuable resource.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

10.1 At the time of adoption, Dr G. Skaret (Norway) extended an invitation by Norway to host the meetings of WG-EMM and WG-SAM in 2009. The Working Group thanked Dr Skaret and Norway for the invitation.

10.2 The report of the fourteenth meeting of WG-EMM was adopted.

10.3 In closing the meeting, Dr Watters thanked all participants for their valuable contributions to the work of the Working Group. The meeting had completed several important tasks, including the risk assessment for the Stage 1 SSMU allocation, an agreed strategy for deploying scientific observers in krill fisheries, and the elaboration of a fishery-based research plan and data collection plan for exploratory fisheries for krill. The Working Group had also revised its agenda for future meetings so as to better integrate its work with that of WG-FSA, and further consider ecosystem effects of fishing for finfish and spatial management to facilitate the conservation of marine biodiversity.

10.4 Dr Watters thanked the Russian Federation for hosting the meeting and providing excellent meeting facilities and support.

10.5 Dr Watters thanked Drs Penhale and Trathan for chairing the two focus topics, and the rapporteurs for bringing together the results and advice from the meeting. Dr Watters also thanked the Secretariat staff for their support.

10.6 Dr Watters acknowledged Dr Holt's long-standing contributions to, and support of, the work of WG-EMM. Dr Holt was due to retire prior to the next meeting of the Working Group.

10.7 Dr Trathan, on behalf of the Working Group, thanked Dr Watters for his patience, good humour and expertise in convening his first meeting of WG-EMM and for leading the Working Group into a new phase of its work.

10.8 Dr D. Miller (Executive Secretary) presented Mrs L. Zaslavskaya with a small gift in appreciation of the great support provided by her team at the Institute.

10.9 The meeting was closed.

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Table 1: Fishery-dependent data collection modes, and the ability of the data types collected to address specific assessment questions derived from Conservation Measure 22-01 as it relates to exploratory krill fisheries.

	Fishery-dependent data collection			
	Commercial fishing	Logged under-way acoustics	Standardised systematic/random research trawls by fishing vessels	Standardised systematic acoustic transects by fishing vessels
Data types:	Location of fishing not constrained. Data collected by observers and vessel, equivalent to established fisheries.	Calibration and SST required. Data collected during fishing operations and transits between aggregations. Data collected by observers and vessel, equivalent to established fisheries.	Trawl stations need to be nominated and sampling standardised. Data collected by observers and vessel, equivalent to established fisheries.	Location and extent of transects need to be nominated. Calibration and SST required for acoustics.
Key assessment questions*	Can the fishing/data collection strategy address the key assessment question?			
1. What is the distribution and density of krill across the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas of high krill density.	Partial – some temporal and spatial coverage partially independent of areas of high density as vessels locate krill aggregations.	Likely – temporal and spatial coverage independent of areas of high density.	Likely – temporal and spatial coverage independent of areas of high density.
2. What is the population structure of krill within the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas of high density.	Partial – some temporal and spatial coverage partially independent of areas of high density as vessels locate krill aggregations.	Likely – temporal and spatial coverage independent of areas of high density.	Likely – temporal and spatial coverage independent of areas of high density.
3. What is the distribution and density of by-catch across the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas of high density.	Unlikely – current acoustic-based analyses provide no information on likely by-catch rates.	Likely – temporal and spatial coverage independent of areas of high density.	Unlikely – current acoustic-based analyses provide no information on likely by-catch rates.
4. What is the proximity of krill aggregations/fishery operations to predator foraging areas?	Possible – fishing may occur in some areas of a krill aggregation that are also used by predators.	Possible – fishing may occur in some areas of a krill aggregation that are also used by predators.	Likely – temporal and spatial coverage independent of areas of high density.	Unlikely – current acoustic-based analyses provide no information on predators.
5. What are the catch rates/selectivity of krill relative to areas where assessments exist?	Possible – data may be available if the same vessel/gear fishes in the exploratory area and assessed areas allowing standardisation.	Possible – data may be available if the same vessel/gear fishes in the exploratory area and assessed areas allowing standardisation.	Possible – data may be available if the same vessel/gear fishes in the exploratory area and assessed areas allowing standardisation.	Possible – data may be available if the same vessel/gear fishes in the exploratory area and assessed areas allowing standardisation.
6. What are the fleet dynamics of the fishery in the management area?	Possible – searching strategies and move-on decisions by vessels in commercial fishing context may be collected by observer/vessel data.	Possible – searching strategies and move-on decisions by vessels in commercial fishing context may be collected by observer/vessel data.	Unlikely – systematic fishing unlikely to reflect fishing strategies of commercial fishing.	Unlikely – systematic fishing unlikely to reflect fishing strategies of commercial fishing.
7. What is the impact of fishing on the standing stock of krill?	Unlikely – temporal and spatial coverage likely to be limited to areas of high density.	Possible – data may be available if the same vessel/gear systematically transits area immediately before and after fishing in a region.	Possible – data may be available if the same vessel/gear performs systematic fishing immediately before and after fishing in a region.	Possible – data may be available if the same vessel/gear performs systematic transects immediately before and after fishing in a region.

(continued)

Table 1 (continued)

	Fishery-dependent data collection			
	Commercial fishing	Logged under-way acoustics	Standardised systematic/random research trawls by fishing vessels	Standardised systematic acoustic transects by fishing vessels
Pre/post-collection data processing and management	Secretariat required to collate and summarise data for use by working groups for review and assessments.	Requires Members to calibrate acoustic gear and collect and archive large volumes of data by vessel using acoustic logging system. Members required to provide post-processing and analysis to produce biomass/density estimates. Secretariat required to collate and summarise data for use by working groups for review and assessment.	Members required to provide post-processing and analysis to produce biomass/density estimates. Secretariat required to collate and summarise data for use by working groups for review and assessments.	Data collected by observers and vessel. Requires Member to calibrate acoustic gear and collect and archive large volumes of data by vessel using acoustic logging system. Members required to provide post-processing and analysis to produce biomass/density estimates. Secretariat required to collate and summarise data for use by working groups for review and assessments.

* Questions 1 and 2 relate to Conservation Measure 22-01, paragraph 1(ii)(a), questions 3 and 4 to paragraph 1(ii)(b) and questions 5 to 7 to paragraph 1 (ii)(c) of the measure.

Table 2: Fishery-independent data collection modes, and the ability of the data types collected to address specific assessment questions derived from Conservation Measure 22-01 as it relates to exploratory krill fisheries.

	Fishery-independent data collection	
	Predator monitoring	Research survey from scientific vessel
Data types:	Data on predator abundance, population dynamics and foraging, equivalent to CEMP monitoring.	Scientific acoustic and trawl sampling data, equivalent to large-scale surveys, e.g. BROKE-West, CCAMLR-2000.
Key assessment questions*	Can the fishing/data collection strategy address the key assessment question?	
1. What is the distribution and density of krill across the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas where predators forage.	Likely – temporal and spatial coverage independent of areas of high density or projected fishing effort.
2. What is the population structure of krill within the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas where predators forage.	Likely – temporal and spatial coverage independent of areas of high density or projected fishing effort.
3. What is the distribution and density of by-catch across the management unit?	Unlikely – temporal and spatial coverage likely to be limited to areas where predators forage.	Likely – temporal and spatial coverage independent of areas of high density or projected fishing effort.
4. What is the proximity of krill aggregations/fishery operations to predator foraging areas?	Likely – key objective of predator monitoring.	Likely – temporal and spatial coverage independent of areas of high density or projected fishing effort.
5. What are the catch rates/selectivity of krill relative to areas where assessments exist?	Unlikely – predator selectivity unlikely to provide data on fishing gear selectivity across areas.	Possible – data may be available if the same vessel/gear fishes in the exploratory area and assessed areas allowing standardisation.
6. What are the fleet dynamics of the fishery in the management area?	Unlikely – predator selectivity unlikely to provide data on fishing gear selectivity across areas.	Unlikely – survey fishing unlikely to reflect fishing strategies of commercial fishing.
7. What is the impact of fishing on the standing stock of krill?	Possible – predator responses may indicate impact of krill fishery on the stock in the medium to long term.	Possible – data may be available if the same vessel/gear performs survey fishing immediately before and after fishing in a region.
Pre/post-collection data processing and management	Requires Members to commit to long-term monitoring of predator populations foraging in the area of the exploratory fishery.	Requires Member to develop research plan for review by working groups. Requires Member to provide vessel with calibrated acoustic gear and collect and archive large volumes of data by vessel using acoustic logging system. Members required to provide post-processing and analysis to produce biomass/density estimates and report to the working groups. Secretariat required to collate and summarise data for use by working groups for review and assessment.

* Questions 1 and 2 relate to Conservation Measure 22-01, paragraph 1(ii)(a), questions 3 and 4 to paragraph 1(ii)(b) and questions 5 to 7 to paragraph 1 (ii)(c) of the measure.

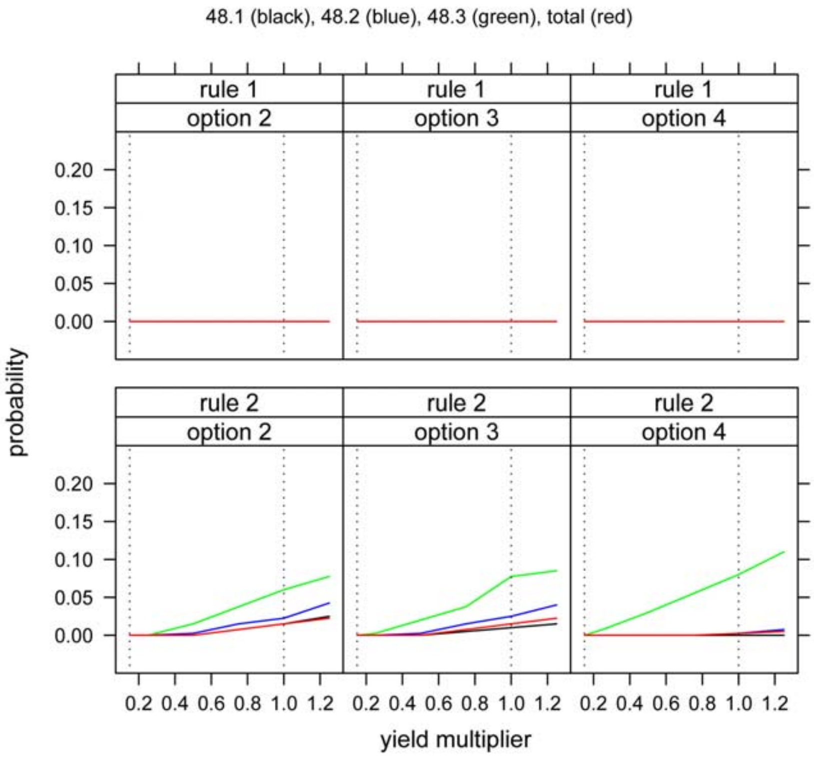

Figure 1*: FOOSA: effects on the krill population. Model-averaged, fishing-option-specific probabilities that minimum krill abundance during the fishing period is <20% of the abundances from comparable no-fishing trials (krill decision rule 1; upper panels) and that krill abundance measured at the end of the fishing period is <75% of the abundances from comparable no-fishing trials (krill decision rule 2; lower panels). Probabilities are averaged across parameterisations in the reference set using equal weights for the four scenarios (described in Figure 2). Results in each panel are aggregated across all SSMUs. The x axis is harvest rate, labelled 'yield multiplier'. Option 2 is the SSMU allocation proportional to predator abundance, Option 3 is the SSMU allocation proportional to the CCAMLR-2000 Survey krill abundance and Option 4 is the SSMU allocation proportional to predator abundance minus krill abundance. The vertical dotted lines mark yield multiplier values of 0.15 (indicating the harvest rate at the trigger level) and 1.0 (indicating the harvest rate at the full precautionary catch limit).

* This figure is available in colour on the CCAMLR website.

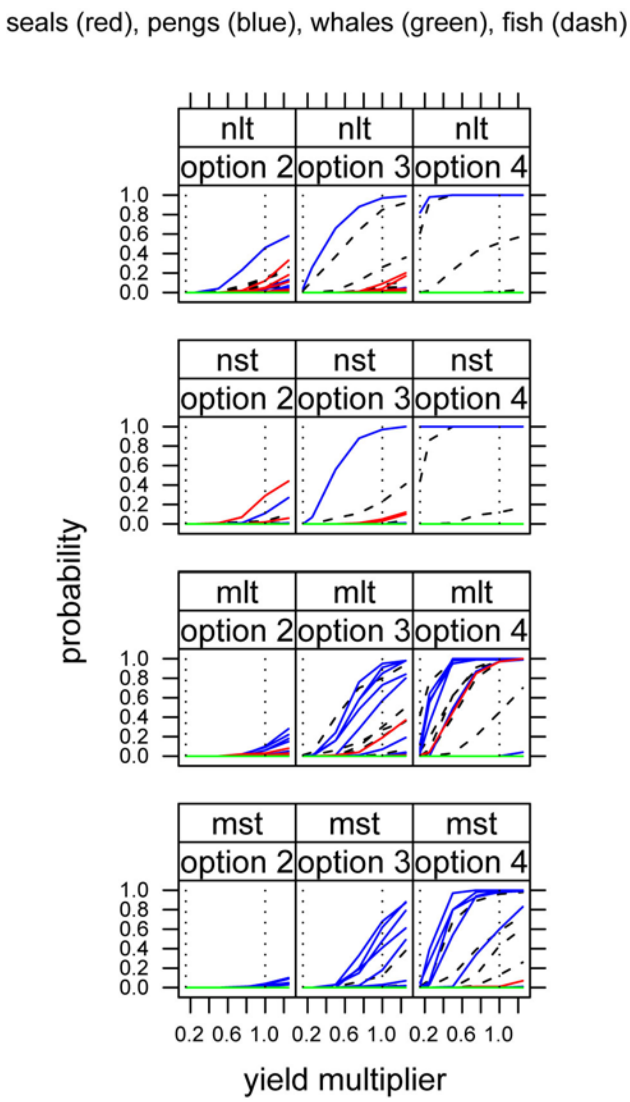

Figure 2*: FOOSA: effects on predators. Parameterisation- and fishing-option-specific probabilities that, at the end of the fishing period, the abundances of predators will be reduced to values less than 75% of abundances predicted from comparable no-fishing trials. The trend lines for each predator group are SSMU-specific. The vertical dotted lines mark yield multiplier values of 0.15 (indicating the harvest rate at the trigger level) and 1.0 (indicating the harvest rate at the full precautionary catch limit). The four scenarios are no movement + linear predator response (nlt) , no krill movement + stable predator response (nst), movement + linear predator response (mlt) and krill movement + stable predator response (mst) .

* This figure is available in colour on the CCAMLR website.

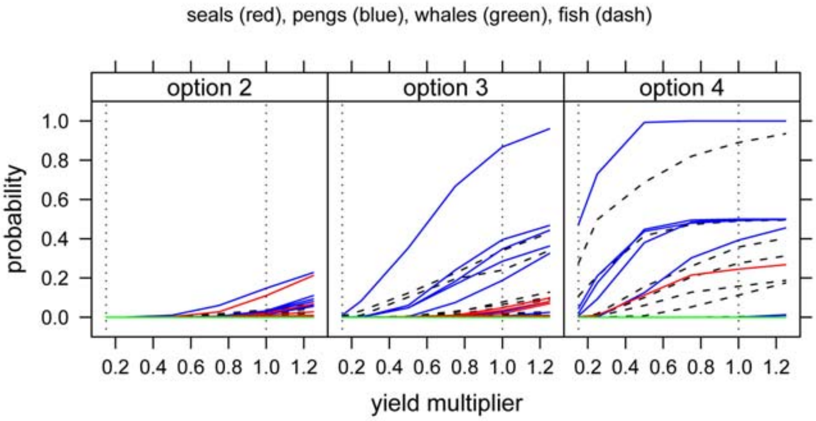

Figure 3*: FOOSA: effects on predators. Model-averaged, fishing-option-specific probabilities that, at the end of the fishing period, the abundances of predators will be reduced to values less than 75% of abundances from comparable no-fishing trials. Other details as in Figure 1.

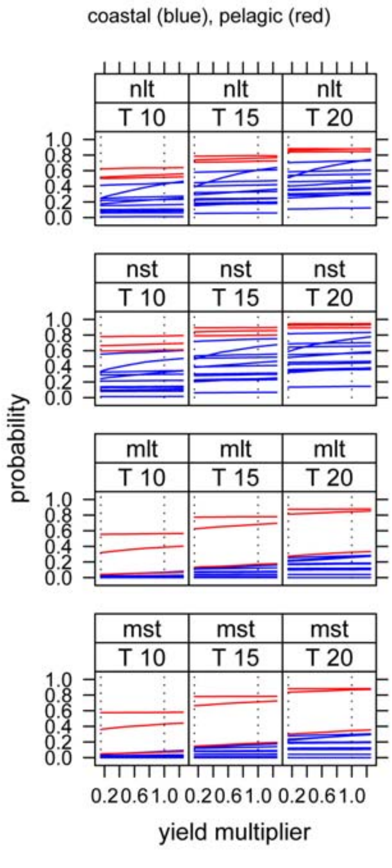

Figure 4*: FOOSA: effects on the fishery. Parameterisation-specific probability across all trials under Option 3 that krill density falls below a specified threshold (*T*) of 10, 15 or 20 g m^{-2} during fishing. The trend lines are SSMU-specific. The vertical dotted lines mark yield multiplier values of 0.15 (indicating the harvest rate at the trigger level) and 1.0 (indicating the harvest rate at the full precautionary catch limit). The four scenarios are described in Figure 2.

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* These figures are available in colour on the CCAMLR website.

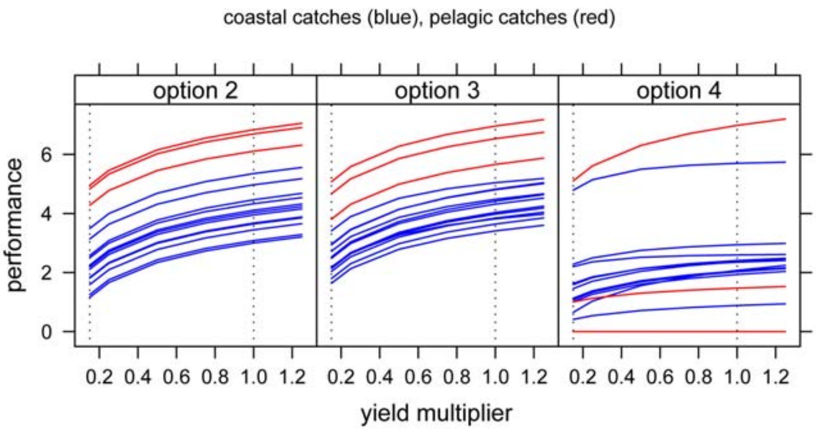


Figure 5*: FOOSA: effects on the fishery. Model-averaged, fishing-option-specific log of mean catches. Probabilities are averaged across parameterisations in the reference set using the equal weights for the four scenarios. The trend lines are SSMU-specific. The vertical dotted lines mark yield multiplier values of 0.15 (indicating the harvest rate at the trigger level) and 1.0 (indicating the harvest rate at the full precautionary catch limit). Note, many SSMU-specific, model-averaged catches predicted from the implementation of Fishing Option 4 were low compared to other options because all the parameterisations in the reference set implicitly describe initial conditions that would prohibit fishing in many SSMUs.

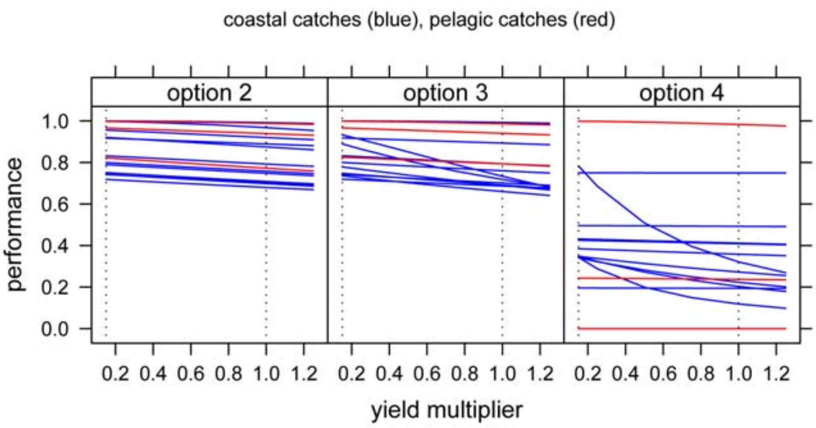
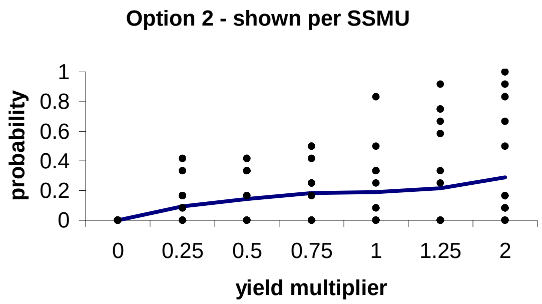


Figure 6*: FOOSA: effects on the fishery. Fishery performance across all trials, expressed as the proportion of the total allocation taken by the fishery. Performance metrics are averaged across parameterisations in the reference set using equal weights for the four scenarios. The trend lines are SSMU-specific. The vertical dotted lines mark yield multiplier values of 0.15 (indicating the harvest rate at the trigger level) and 1.0 (indicating the harvest rate at the full precautionary catch limit).

* These figures are available in colour on the CCAMLR website.



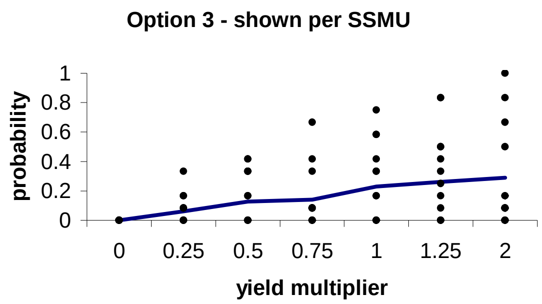
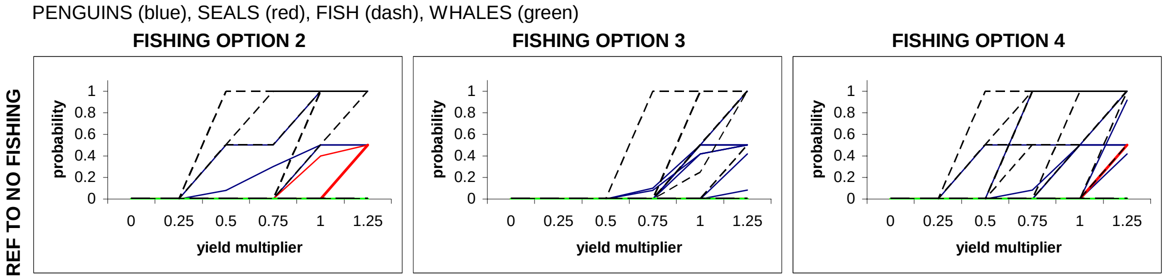


Figure 7: SMOM: effects on the krill population. Probability that krill abundance across all SSMUs measured at the end of the fishing period is <75% of the abundances from comparable no-fishing trials, with results presented for individual SSMUs and the line indicating the average over all SSMUs. Probabilities are averages, assuming equal weighting, from a reference set including 12 alternative paramerisation combinations. Options are defined in Figure 1.

(a)



(b)

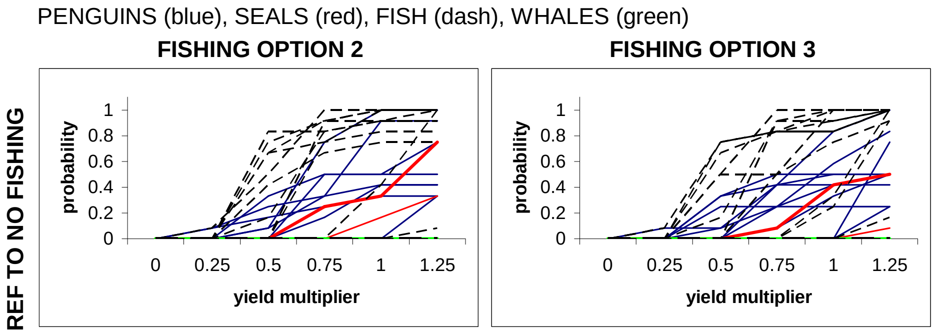


Figure 8*: SMOM: effects on predators. Probability that predator abundance across all SSMUs measured at the end of the fishing period is <75% of the abundances from comparable no-fishing trials, with results presented for individual SSMUs and predator groups. Probabilities are averages, assuming equal weighting, from a reference set including 12 alternative paramerisation combinations. Options are defined in Figure 1. This implementation of SMOM is most similar to the FOOSA 'nst' scenario (see Figure 2). (a) is a simplified diagram showing the general results of the three options. (b) shows the detailed results of Options 2 and 3 when more closely aligning model parameterisation with that used in FOOSA.

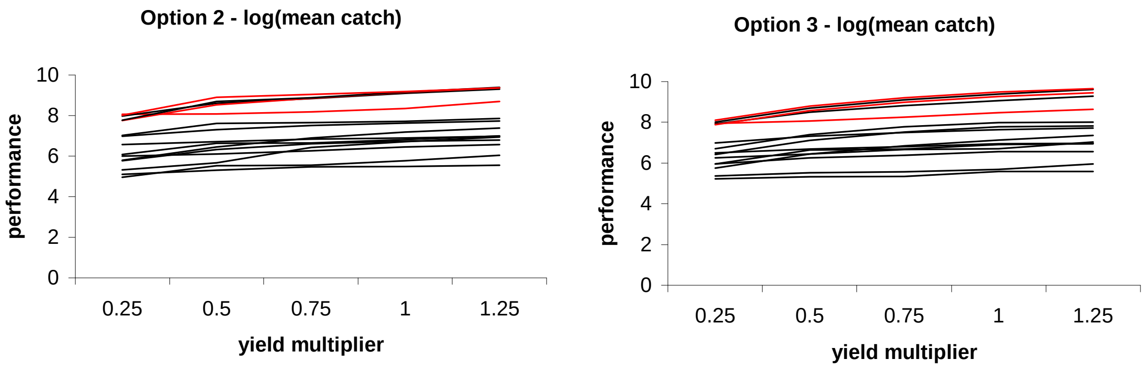


Figure 9*: SMOM: effects on the fishery. Model-averaged, fishing-option-specific natural logarithm of mean catches. The trend lines are SSMU-specific. Red lines are catches in pelagic SSMUs, black are catches in coastal SSMUs.

* These figures are available in colour on the CCAMLR website.

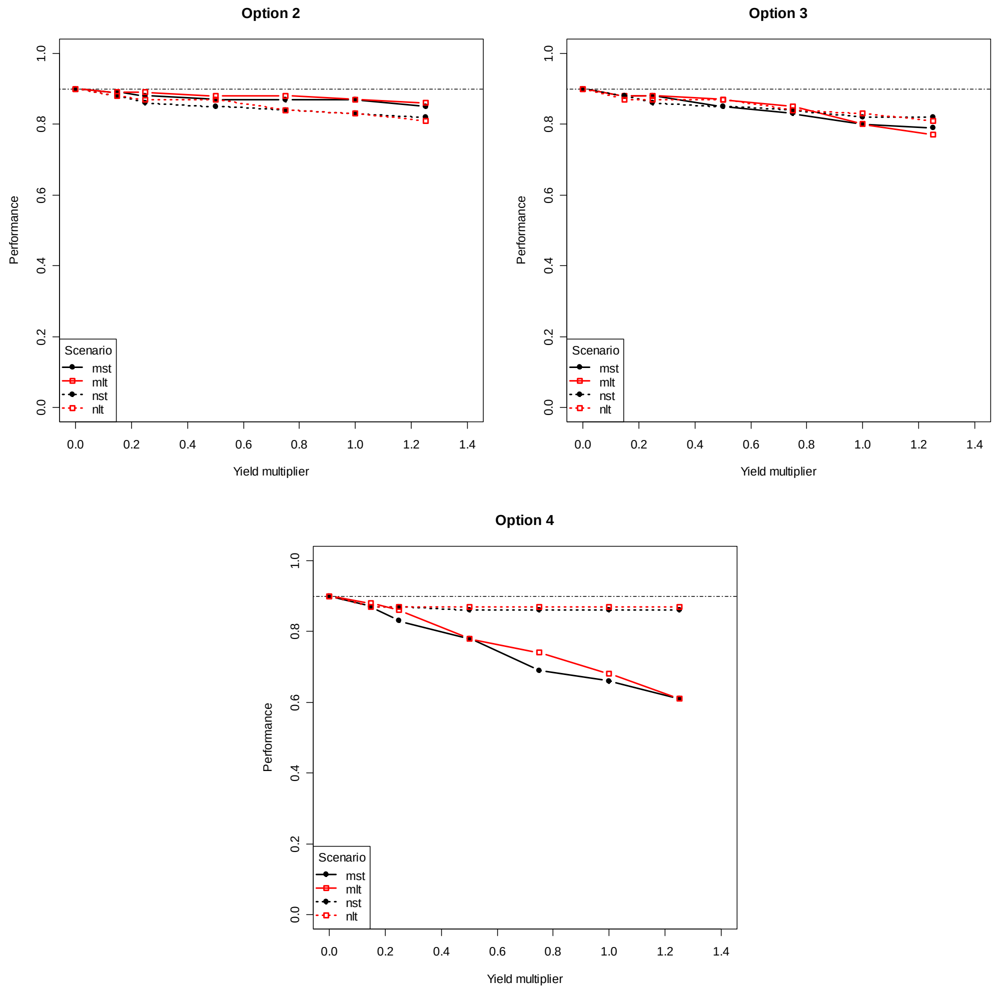


Figure 10: FOOSA predator performance results integrated with the CSI (WG-SAM-08/16). Performance is the probability that the CSI will be above a reference level, defined as the lower 90th percentile of the distribution of CSIs at the end of the fishing period in the absence of fishing. For example, when there is no fishing, there is a 90% probability that the CSI is above this reference level at the end of the prescribed fishing period; for scenario ‘mlt’ when fishing effort is 1.25 × yield, there is approximately an 85% probability that the performance is above this reference level.

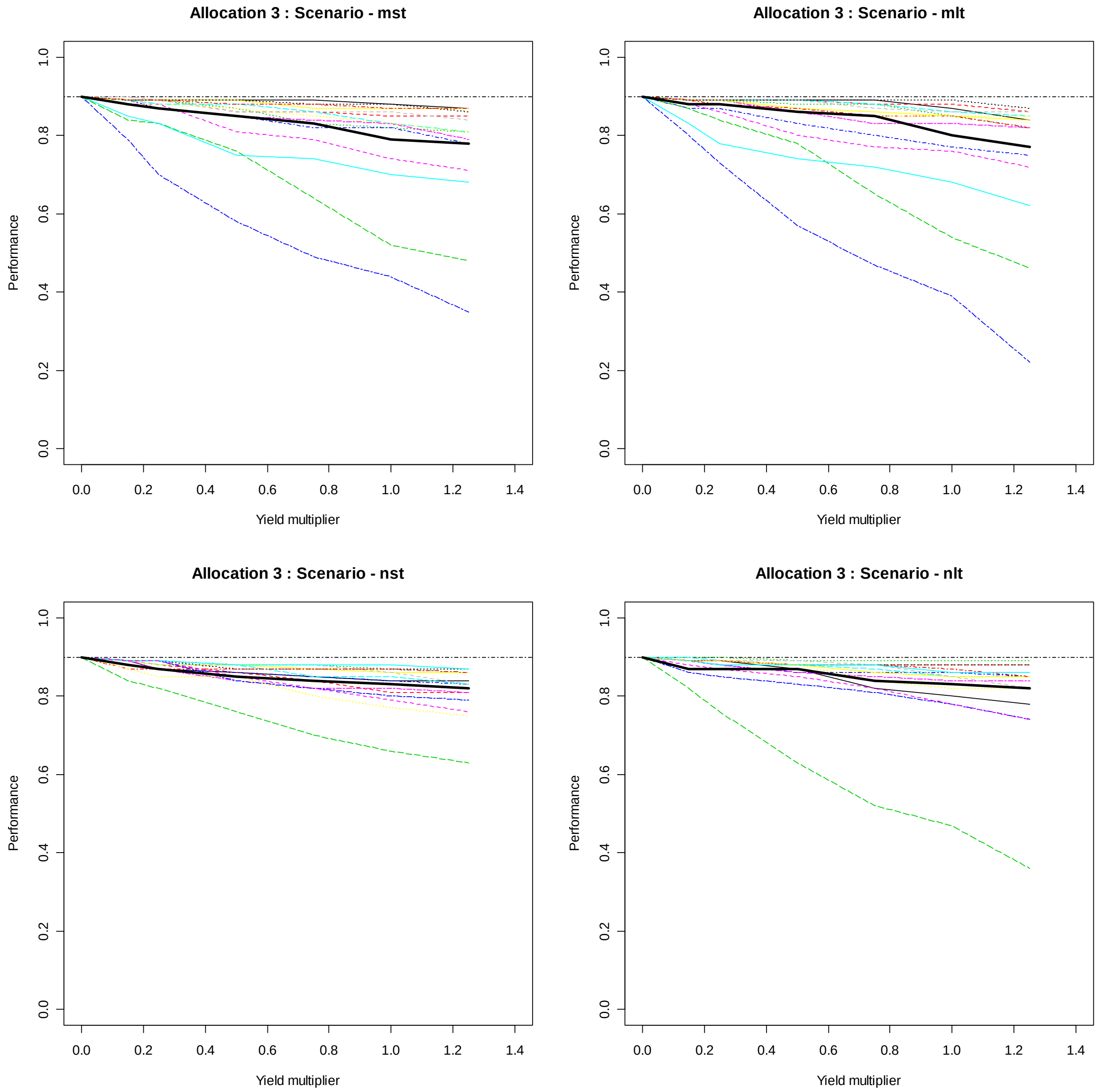


Figure 11*: FOOSA predator performance results integrated with the CSI for each scenario in SSMU allocation Option 3. Thick lines show results as provided in Figure 10. Thin lines are SSMU-specific performance based on SSMU-specific CSIs.

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* This figure is available in colour on the CCAMLR website.

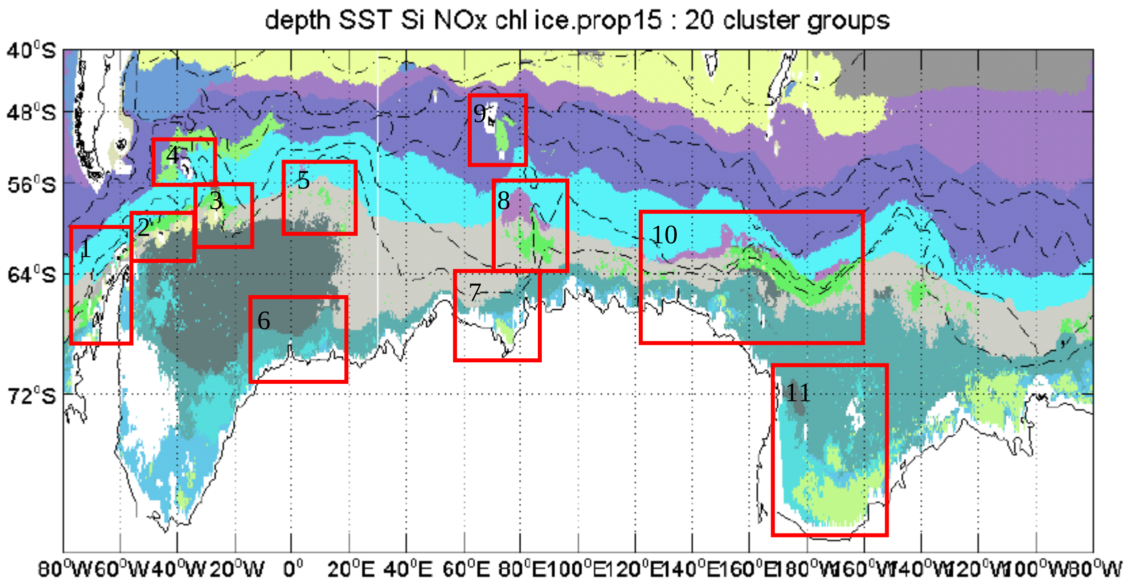

Figure 12*: Secondary regionalisation agreed by the CCAMLR Bioregionalisation Workshop (2007) (analysis based on depth, SST, silicate concentration, nitrate concentration, surface chlorophyll-*a* and ice concentration). Red boxes show areas of highest heterogeneity, which have been identified by the Working Group as priority areas for identifying MPAs as part of a representative system (numbers refer to area descriptions, and are not in any order of priority). 1 = Western Antarctic Peninsula, 2 = South Orkney Islands, 3 = South Sandwich Islands, 4 = South Georgia, 5 = Maud Rise, 6 = Eastern Weddell Sea, 7 = Prydz Bay, 8 = BANZARE Bank, 9 = Kerguelen, 10 = Northern Ross Sea/East Antarctica, 11 = Ross Sea shelf.

* This figure is available in colour on the CCAMLR website.

APPENDIX A

LIST OF PARTICIPANTS

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(St Petersburg, Russia, 23 July to 1 August 2008)

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APPENDIX B

AGENDA

Working Group on Ecosystem Monitoring and Management
(St Petersburg, Russia, 23 July to 1 August 2008)

1. Introduction
    1.1 Opening of the meeting
    1.2 Adoption of the agenda and organisation of the meeting
    1.3 Feedback from previous meetings of the Commission, the Scientific Committee, and the Working Groups

2. Focus Topic: Risk assessment for Stage 1 subdivisions of the precautionary krill catch limit among small-scale management units in Statistical Area 48 – Chair, Dr P. Trathan (UK)
    2.1 Advice from WG-SAM
    2.2 Analyses and risk assessment
    2.3 Key points for consideration by the Scientific Committee and its working groups

3. Focus Topic: Discussion to progress the implementation of spatial management measures that aim to facilitate the conservation of marine biodiversity – Chair, Dr P. Penhale (USA)
    3.1 Background
    3.2 Identifying vulnerable marine ecosystems
    3.3 Defining candidate marine protected areas
    3.4 Developing a harmonised approach
    3.5 Work plan
    3.6 Key points for consideration by the Scientific Committee and its working groups

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 and its working groups

5. Status and trends in the krill-centric ecosystem
    5.1 Report from WG-EMM-STAPP
    5.2 Status of predators, krill resource and environmental influences
        5.2.1 Predators
        5.2.2 Krill
        5.2.3 Environment and climate impacts
    5.3 Other prey species
    5.4 Methods
    5.5 Future surveys
    5.6 Key points for consideration by the Scientific Committee and its working groups

6. Ecosystem effects of fisheries that target finfishes

7. Status of management advice
    7.1 Protected areas
    7.2 Harvesting units
    7.3 Small-scale management units
    7.4 Analytical models
    7.5 Existing conservation measures
    7.6 Key points for consideration by the Scientific Committee and its working groups

8. Future work
    8.1 Second Workshop on Fisheries and Ecosystem Models in the Antarctic
    8.2 Revised agenda and long-term work plan for WG-EMM
    8.3 Joint CCAMLR-IWC Workshop
    8.4 Key points for consideration by the Scientific Committee and its working groups

9. Other business

10. Adoption of the report and close of the meeting.

APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(St Petersburg, Russia, 23 July to 1 August 2008)

WG-EMM-08/1	Draft Preliminary Agenda for the 2008 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-08/2	List of participants
WG-EMM-08/3	List of documents
WG-EMM-08/4	CEMP indices: 2008 update Secretariat
WG-EMM-08/5	Krill fishery report: 2008 update Secretariat
WG-EMM-08/6	Summary of notifications for krill fisheries in 2008/09 Secretariat
WG-EMM-08/7	Demography of Antarctic krill and other Euphausiacea in the Lazarev Sea – LAKRIS the German contribution to CCAMLR-IPY in summer 2008 V. Siegel, J. Edinger, M. Haraldsson, K. Stürmer, M. Vortkamp (Germany)
WG-EMM-08/8	Report of the Predator Survey Workshop (Hobart, Australia, 16 to 20 June 2008)
WG-EMM-08/9	Report from Invited Expert to WG-EMM-PSW-08 R. Fewster (Invited Expert)
WG-EMM-08/10	Reference observations for validating and tuning operating models for krill fishery management in Area 48 S. Hill (United Kingdom), J. Hinke (USA), É. Plagányi (South Africa) and G. Watters (USA)
WG-EMM-08/11	Proposed small-scale management units for the krill fishery in Subarea 48.4 and around the South Sandwich Islands P.N. Trathan, A.P.R. Cooper and M. Biszczuk (United Kingdom)

WG-EMM-08/12	Allocating the precautionary catch limit for krill amongst the small-scale management units in Area 48: the implications of data uncertainties P.N. Trathan and S.L. Hill (United Kingdom)
WG-EMM-08/13	Developing four plausible parameterisations of FOOSA (a so-called reference set of parameterisations) by conditioning the model on a calendar of events that describes changes in the abundances of krill and their predators in the Scotia Sea G.M. Watters, J.T. Hinke (USA) and S. Hill (United Kingdom)
WG-EMM-08/14	Developing models of Antarctic marine ecosystems in support of CCAMLR and IWC A. Constable (Australia)
WG-EMM-08/15	CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models: update on progress 2008 A. Constable and N. Gales (Co-conveners)
WG-EMM-08/16	Distribution of krill at threshold densities suitable for fishing in the Atlantic sector: analysis of the 2000 synoptic survey data S. Hill and D. Agnew (United Kingdom)
WG-EMM-08/17	A re-appraisal of the total biomass and annual production of Antarctic krill A. Atkinson (United Kingdom), V. Siegel (Germany), E.A. Pakhomov (South Africa), M.J. Jessopp (United Kingdom) and V. Loeb (USA) (*Deep-Sea Research*, submitted)
WG-EMM-08/18	Preliminary report of the New Zealand RV Tangaroa IPY-CAML survey of the Ross Sea region, Antarctica, in February–March 2008 S.M. Hanchet, J. Mitchell, D. Bowden, M. Clark, J. Hall, R. O'Driscoll, M. Pinkerton and D. Robertson (New Zealand)
WG-EMM-08/19	Calibration error in the AMLR plankton time series C. Reiss (USA)
WG-EMM-08/20	Letter to Drs Reid, Watters and Jones in regard to 'disappearance of toothfish from McMurdo Sound' D.G. Ainley, S.F. Ackley, K. Arrigo (USA), G. Ballard (New Zealand), J.P. Barry (USA), L. Blight (Canada), P. Broady, B. Davison (New Zealand), P. Dayton, A.L. DeVries, K. Dugger, J.T. Eastman, S.D. Emslie (USA), C. Evans (New Zealand), R.A. Garrott, G. Hofmann, S. Kim, G. Kooyman, S.S. Jacobs (USA), G. Lauriano (Italy), A. Lescroël (France), D.R. MacAyeal (USA), M. Massaro (New Zealand), S. Olmastroni (Italy), P.J. Ponganis (USA), E. Robinson (New Zealand), D.B. Siniff, W.O. Smith (USA), I. Stirling (Canada) and P. Wilson (New Zealand)

WG-EMM-08/21	Decline of the Antarctic toothfish and its predators in McMurdo Sound and the southern Ross Sea and recommendations for restoration A.L. DeVries, D.G. Ainley and G. Ballard (USA)
WG-EMM-08/22	Addressing uncertainty over the importance of Antarctic toothfish as prey of seals and whales in the southern Ross Sea: a review D. Ainley and D. Siniff (USA)
WG-EMM-08/23	Aerial surveys of Weddell seals during 2007/08, with notes on the history of aerial censuses in the Ross Sea and recommendations for continued count effort D. Siniff and D. Ainley (USA)
WG-EMM-08/24	State of Antarctic krill (*Euphausia superba*) fisheries in Statistical Subarea 48.2 in 2008 V.A. Bibik and N.N. Zhuk (Ukraine)
WG-EMM-08/25	Data on feeding and food objects of southern minke whales S.G. Bushuev (Ukraine) (Previously submitted as SC-CAMLR-XXVI/BG/25 Rev. 1)
WG-EMM-08/26	Comparison of the biomass of Antarctic krill (*Euphausia superba*) around the South Shetland and South Orkney Islands in three years: 1999, 2000 and 2008 C. Reiss and A. Cossio (USA)
WG-EMM-08/27	Trophic study of Ross Sea Antarctic toothfish (*Dissostichus mawsoni*) using carbon and nitrogen stable isotopes S.J. Bury, M.H. Pinkerton, D.R. Thompson, S. Hanchet, J. Brown and I. Vorster (New Zealand)
WG-EMM-08/28	The Antarctic krill and ecosystem survey with RV *G.O. Sars* in 2008 S.A. Iversen (Norway), W. Melle, E. Bagøien, D. Chu, B. Edvardsen, B. Ellertsen, E. Grønningsæter, K. Jørstad, E. Karslbakk, T. Klevjer, T. Knutsen, R. Korneliussen, H. Kowall, B. Krafft, S. Kaartvedt, P.B. Lona, S. Murray, L. Naustvoll, L. Nøttestad, M. Ostrowski, V. Siegel, Ø. Skagseth, G. Skaret, H. Søiland, X. Zhao and C.B. Årnes
WG-EMM-08/29	*In situ* measurements of tilt angle distribution and target strength in Antarctic krill (*Euphausia superba*) G. Skaret, S.A. Iversen, T. Knutsen, R.J. Korneliussen, E. Ona, R. Pedersen, A. Totland, T. Torkelsen (Norway) and X. Zhao (China)
WG-EMM-08/30	A risk assessment to advise on strategies for subdividing a precautionary catch limit among small-scale management units during stage 1 of the staged development of the krill fishery in Subareas 48.1, 48.2 and 48.3 G.M. Watters, J.T. Hinke (USA) and S. Hill (United Kingdom)

WG-EMM-08/31	Relationships between oceanographic environment and distribution of 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, T. Iwami and K. Ito (Japan) (*CCAMLR Science*, submitted)
WG-EMM-08/32	Relationship between distribution of Antarctic krill (*Euphausia superba*) and environmental index MTEM-200 in the Antarctic Ocean throughout the year M. Naganobu, T. Kitamura and K. Hasunuma (Japan) (*CCAMLR Science*, submitted)
WG-EMM-08/33	Time series of Drake Passage Oscillation Index (DPOI) during 1952–2008 and its possible influence on environmental variability M. Naganobu, J. Kondo and K. Kutsuwada (Japan)
WG-EMM-08/34	Systematic coverage by scientific observers on krill fishing vessels Delegation of Japan
WG-EMM-08/35	Distribution patterns and biomasses of Antarctic krill (*Euphausia superba*) and ice krill (*E. crystallorophias*) with note on distribution of Antarctic minke whales (*Balaenoptera bonaerensis*) in the Ross Sea in 2005 H. Murase, H. Yasuma, R. Matsukura, Y. Takao, K. Taki, T. Hayashi, T. Yabuki, T. Tamura, K. Konishi, K. Matsuoka, K. Miyashita, S. Nishiwaki and M. Naganobu (Japan)
WG-EMM-08/36	Community structure of copepods in epipelagic layers in the Ross Sea and neighbouring waters Y. Watanabe, S. Sawamoto, T. Ishimaru and M. Naganobu (Japan)
WG-EMM-08/37	A risk management framework for avoiding significant adverse impacts of bottom fishing gear on vulnerable marine ecosystems K. Martin-Smith (Australia)
WG-EMM-08/38	Notification of vulnerable marine ecosystems in Statistical Division 58.4.1 (Submitted by Australia)
WG-EMM-08/39	Krill fishery behaviour in the southwest Atlantic S. Kawaguchi (Australia) (*CCAMLR Science*, submitted)
WG-EMM-08/40	Krill fishery behaviour in the 1999/2000 season S. Kawaguchi (Australia)

WG-EMM-08/41	Updated krill recruitment data for the Elephant Island region of the South Shetland Islands, Antarctica: 2002–2008 C. Reiss (USA)
WG-EMM-08/42	A preliminary balanced trophic model of the ecosystem of the Ross Sea, Antarctica, with emphasis on apex predators M.H. Pinkerton, J.M. Bradford-Grieve and S.M. Hanchet (New Zealand) (*CCAMLR Science*, submitted)
WG-EMM-08/43	Trophic overlap of Weddell seals (*Leptonychotes weddelli*) and Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica M.H. Pinkerton, A. Dunn and S.M. Hanchet (New Zealand)
WG-EMM-08/44	Conditioning SMOM using the agreed calendar of observed changes in predator and krill abundance: a further step in the development of a management procedure for krill fisheries in Area 48 É.E. Plagányi and D.S. Butterworth (South Africa)
WG-EMM-08/45	Potential requirements for scientific data from the krill fishery Secretariat
WG-EMM-08/46	Catch uncertainty in krill fisheries Secretariat
WG-EMM-08/47	Progress towards expert group manuscripts for the CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models: update on progress 2008 A. Constable and N. Gales (Co-conveners)
WG-EMM-08/48	Multiple time scales of variability in the krill population at South Georgia K. Reid, J. Watkins, E. Murphy, P. Trathan, S. Fielding and P. Enderlein (United Kingdom) (*Mar. Ecol. Prog. Ser.*, to be submitted)
WG-EMM-08/49	Proposed approach for the identification of important marine areas for conservation: using 'MARXAN' software to support systematic conservation planning S.M. Grant, J. Tratalos and P.N. Trathan (United Kingdom)
WG-EMM-08/50	Flexible foraging strategies of gentoo penguins help buffer the impacts of interannual changes in prey availability A.K. Miller and W.Z. Trivelpiece (USA)
WG-EMM-08/51	Down-scaling FOOSA to model the Admiralty Bay Pygoscelid penguin colonies: a work in progress J.T. Hinke, G.M. Watters and W.Z. Trivelpiece (USA)

WG-EMM-08/52	Proposal for a Joint CEP-SC-CAMLR Workshop in 2009 Secretariat
WG-EMM-08/53	Preliminary estimation of penguin breeding abundance at spatial-scales of relevance to CCAMLR: incorporating uncertainty in count data H. Lynch, R. Naveen (USA), J. McKinlay, C. Southwell (Australia), P. Trathan (United Kingdom), W. Trivelpiece, S. Trivelpiece (USA) and D. Ramm (CCAMLR Secretariat)
WG-EMM-08/54	Net-based verification of acoustic techniques used to identify Antarctic krill J. Watkins and S. Fielding (United Kingdom) (*CCAMLR Science*, submitted)
WG-EMM-08/55	Properties of krill distribution in pelagic and coastal SSMUs of the South Orkney Islands subarea according to the data of scientific observations and fishery S.M. Kasatkina and V.N. Shnar (Russia) (*CCAMLR Science*, submitted)
WG-EMM-08/56 Rev. 1	Measurements of sound-speed density contrasts of Antarctic krill (*Euphausia superba*) on board RV *Kaiyo Maru* Y. Takao, H. Yasuma, R. Matsukura, K. Amakasu and M. Naganobu (Japan)
WG-EMM-08/57	By-catch of fishes caught by the krill fishing vessel *Niitaka Maru* in the South Georgia area (August 2007) T. Iwami and M. Naganobu (Japan)

Other Documents

WG-EMM-08/P1	Adult Antarctic krill feeding at abyssal depths A. Clarke and P.A. Tyler (*Current Biology*, 18: 282–285 (2008), doi: 10.1016/j.cub.2008.01.059)
WG-EMM-08/P2	Climatically driven fluctuations in Southern Ocean ecosystems E.J. Murphy, P.N. Trathan, J.L. Watkins, K. Reid, M.P. Meredith, J. Forcada, S.E. Thorpe, N.M. Johnston and P. Rothery (*Proc. R. Soc. B*, 274: 3057–3067 (2007), doi: 10.1098/rspb.2007.1180)
WG-EMM-08/P3	Rapid warming of the ocean around South Georgia, Southern Ocean, during the 20th Century: forcings, characteristics and implications for lower trophic levels M.J. Whitehouse, M.P. Meredith, P. Rothery, A. Atkinson, P. Ward and R.E. Korb (*Deep-Sea Res.*, in press)

WG-EMM-08/P4	Oceanic circumpolar habitats of Antarctic krill A. Atkinson, V. Siegel, E. A. Pakhomov, P. Rothery, V. Loeb, R.M. Ross, L.B. Quetin, K. Schmidt, P. Fretwell, E.J. Murphy, G.A. Tarling and A.H. Fleming (*Mar. Ecol. Progr. Ser*., 362: 1–23 (2008), doi: 10.3354/meps07498)
WG-EMM-08/P5	Life history buffering in Antarctic mammals and birds against changing patterns of climate and environmental variation J. Forcada, P.N. Trathan and E.J. Murphy (*Global Change Biology*, in press)
WG-EMM-08/P6	Environmental forcing and Southern Ocean marine predator populations: effects of climate change and variability P.N. Trathan, J. Forcada and E.J. Murphy (*Phil. Trans. R. Soc. B*, 362: 2351–2365 (2007), doi: 10.1098/rstb.2006.1953)
WG-EMM-08/P7	Ecological repercussions of historical fish extraction from the Southern Ocean D. Ainley and L. Blight (*Fish and Fisheries*, in press)
WG-EMM-08/P8	The summertime plankton community at South Georgia (Southern Ocean): comparing the historical (1926/27) and modern (post 1995) records P. Ward, M.P. Meredith, M.J. Whitehouse and P. Rothery (*Progress in Oceanography*, in press)
WG-EMM-08/P9	Histopathology of Antarctic krill, *Euphausia superba*, bearing black spots S. Miwa, T. Kamaishi, T. Matsuyama, T. Hayashi and M. Naganobu (*J. Invertebr. Pathol.* (2008), doi:10.1016/j.jip.2008.04.004, in press)
WG-EMM-08/P10	Horizontal and vertical distribution and demography of euphausiids in the Ross Sea and its adjacent waters in 2004/05 K. Taki, T. Yabuki, Y. Noiri, T. Hayashi and M. Naganobu (*Polar Biol*. (2008), doi: 10.1007/s00300-008-0472-6, in press)
WG-EMM-08/P11	The power of ecosystem monitoring K. Reid, J.P. Croxall and E.J. Murphy (*Aquat. Conserv*., 17 (S1): 79–92 (2008), doi: 10.1002/aqc.909)
WG-EMM-08/P12	Interannual spatial variability of krill (*Euphausia superba*) influences seabird foraging behaviour near Elephant Island, Antarctica J.A. Santora, C.S. Reiss, A.M. Cossio and R.R. Veit (*Fish. Oceanogr*., in press)
WG-EMM-08/P13	Withdrawn

WG-EMM-PSW-08/4	A population estimate of macaroni penguins (*Eudyptes chrysolophus*) at South Georgia P.N. Trathan (United Kingdom)
WG-EMM-PSW-08/5	The white-chinned petrel (*Procellaria aequinoctialis*) on South Georgia: population size, distribution and global significance A.R. Martin, S. Poncet, C. Barbraud, P. Fretwell and E. Foster (United Kingdom)
WG-EMM-PSW-08/6	Abundance estimates for crabeater, Weddell and leopard seals at the Antarctic Peninsula and in the western Weddell Sea (90°–30°W, 60°–80°S) J. Forcada and P.N. Trathan (United Kingdom)
WG-EMM-PSW-08/7	Spatial and temporal variation in attributes of Adélie penguin breeding populations: implications for uncertainty in estimation of the abundance of breeding penguins from one-off counts C. Southwell, J. McKinlay, R. Pike, D. Wilson, K. Newbery and L. Emmerson (Australia)
WG-EMM-PSW-08/8	Estimating the number of pre- and intermittent breeders associated with the Béchervaise Island Adélie penguin population L. Emmerson and C. Southwell (Australia)
WG-EMM-PSW-08/9	Aspects of population structure, dynamics and demography of relevance to abundance estimation: Adélie penguins L. Emmerson and C. Southwell (Australia)
WG-EMM-PSW-08/10	Flying seabirds in Area 48: a review of population estimates, coverage and potential gaps in survey extent and methods D. Wilson (Australia)
WG-EMM-PSW-08/11	Seasonal estimation of abundance by bootstrapping inexact research data (seabird): a method for assessing abundance and uncertainty from historical count data using Adélie penguins as a case study J.P. McKinlay and C.J. Southwell (Australia)
WG-EMM-PSW-08/12	A brief summary of Adélie penguin count data from east Antarctica C. Southwell and J. McKinlay (Australia)
WG-EMM-PSW-08/13	Incomplete search effort as a potential source of bias in broad-scale estimates of penguin abundance derived from published count data: a case study for Adélie penguins in east Antarctica C. Southwell, D. Smith and A. Bender (Australia)

WG-EMM-PSW-08/14	Antarctic fur seal pup production and population trends in the South Shetland Islands with special reference to sources of error in pup production estimates M.E. Goebel (USA), D.E. Torres C. (Chile), A. Miller, J. Santora, D. Costa (USA) and P. Diaz (Chile)
WG-EMM-PSW-08/15	Timing of clutch initiation in *Pygoscelis* penguins on the Antarctic Peninsula: towards an improved understanding of off-peak census correction factors H.J. Lynch, W.F. Fagan, R. Naveen, S.G. Trivelpiece and W.Z. Trivelpiece (USA)
WG-SAM-08/15	Implementation of FOOSA (KPFM) in the EPOC modelling framework to facilitate validation and possible extension of models used in evaluating krill fishery harvest strategies that will minimise risk of localised impacts on krill predators A. Constable (Australia)
WG-SAM-08/16	An ecosystem-based management procedure for krill fisheries: a method for determining spatially-structured catch limits to manage risk of significant localised fisheries impacts on predators A. Constable and S. Candy (Australia)
WG-SAM-08/17	An updated description and parameterisation of the spatial multi-species operating model (SMOM) É.E. Plagányi and D.S. Butterworth (South Africa)
CCAMLR-XXVII/13	Notification of Norway's intention to conduct an exploratory trawl fishery for *Euphausia superba* in the 2008/09 season Delegation of Norway

ASSESSING PERFORMANCE BASED ON COMBINED STANDARDISED INDICES (CSIs)

(by Dr A. Constable, Antarctic Climate and Ecosystems Cooperative Research Centre and the Australian Antarctic Division)

A method for combining many individual responses of predators into an index was first proposed by de la Mare in 1997 (de la Mare, 1997; de la Mare and Constable, 2000) and later termed the 'Combined Standardised Index (CSI)' by Boyd and Murray (1999, 2001). This appendix describes how such an index can be used to measure the probability that a food web may depart from previously observed norms and thereby measure the risk of different yield multipliers causing significant departures from those norms.

AGGREGATING PREDATOR RESPONSES (E.G. RECRUITMENT) INTO CSIs

2. The indicators of predator responses included in a CSI include those metrics for which changes are thought to reflect changes in krill abundance. The indicators observed can be most easily envisaged as those that reflect the reproductive output of a population. The degree of change and the correlation of changes in such responses will vary between predators. In the absence of knowing the dependencies on krill or the changes in krill, the strength of the responses of predators as an aggregate signal across predators is dependent on the correlation that each predator response has with the other responses. Figure 1 illustrates that if they are all highly correlated, then the aggregate signal will be very strong. If they are weakly correlated, then changes in one predator may not be coincident with changes in another predator. Thus, the aggregate predator response captured in the CSI aims to provide an indicator of how much change is shared by all measures.

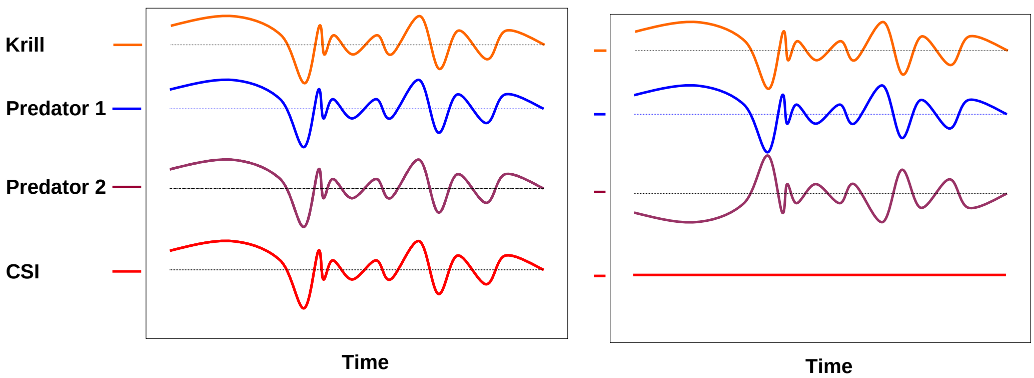

Figure 1: Illustration of the aggregate CSI for highly correlated predators (left – correlation = 1) and inversely correlated predators (right – correlation = –1). In the case of negative correlation with krill, it is suggested that the sign of the predator response is reversed so that changes in all predator responses are in the same direction relative to the change in krill abundance.

USING BASELINES TO ASSESS DEPARTURE FROM BASELINE NORMS

3. The natural variability in the CSI can be determined from a baseline period, i.e. a baseline norm. This may be either prior to the fishing period (or some period of interest) or, in the case of model evaluations, during a period with no fishing. Departures from this range of natural variation can be determined as anomalies (SC-CAMLR-XV, Annex 4; SC-CAMLR-XVI, Annex 4) where such departures could be beyond some confidence interval. This is illustrated in Figure 2.

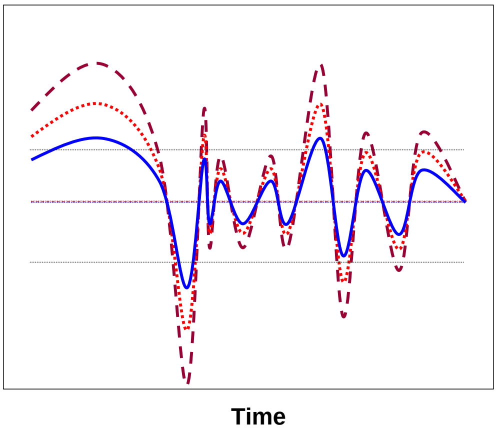

Figure 2: Illustration of departures of a CSI outside the range of natural variation. The solid line indicates the CSI during the baseline period with the mean as the central horizontal line and the upper and lower confidence intervals indicated by the other two lines. Two other CSI time series are shown relative to the baseline indicating an increase in variability in this example and a consequent increase in probability of being outside the natural range of variability. A decline in krill would be expected to cause a decline in the CSI below the lower confidence interval.

PROBABILITY OF DEVIATING FROM THE BASELINE NORMS

4. In the case of an expected decline as a result of decline in krill abundance, the departure can be expected to be below the lower confidence bound. In computer simulations, repeated trials can be used to determine, for a given model scenario, how many trials cause the CSI to fall below a critical value. Figure 3 illustrates the variation in CSI values that may be evident over many trials. The results are presented for 100 trials from a FOOSA scenario. Also indicated is the lower 10th percentile, which could be used as the lower critical value, below which would be considered to be a departure from the baseline norm.

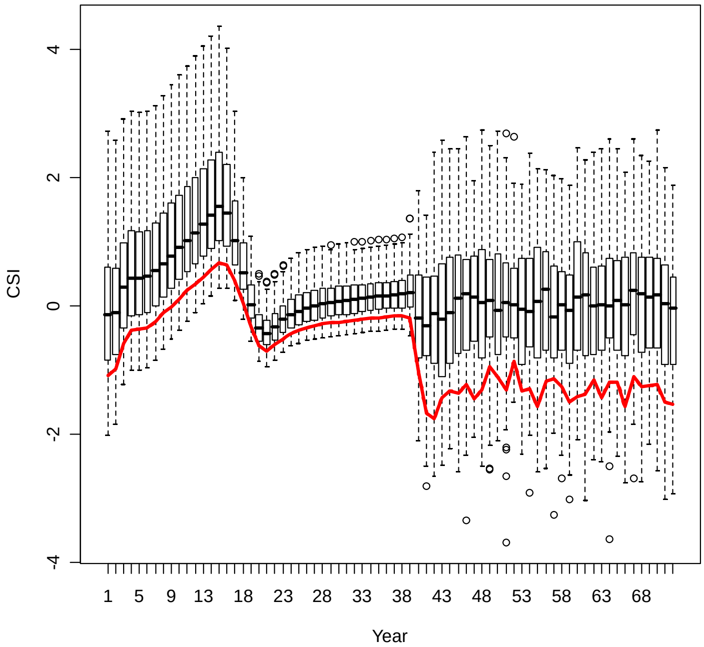

Figure 3: Box plot showing the range of CSIs in each year from 100 trials of a FOOSA scenario. The solid line below the boxes indicates the lower 10th percentile of these distributions.

5. It is expected that the indirect effect of fishing on the predators would be fully evident at the end of the fishing period (after 20 years in the example in Figure 3). Thus, the probability of departure from the baseline norm under a fishing scenario can be determined as the proportion of trials with fishing having a CSI below the critical value (e.g. lower 10th percentile) obtained from the no-fishing trial at the end of the last year of fishing (or some other baseline period).

6. This is determined in the following way:

The distribution of CSI values at the end of the fishing period is determined from the no-fishing trials (Figure 4). The cumulative probability distributions from the no-fishing and fishing trials (Figure 5) can then be used to determine the probability of a fishing trial departing from the baseline norms in the baseline. This is illustrated in Figure 6 for results from FOOSA where the boxplots have been converted to medians and 10th and 90th percentiles for no-fishing and fishing trials.

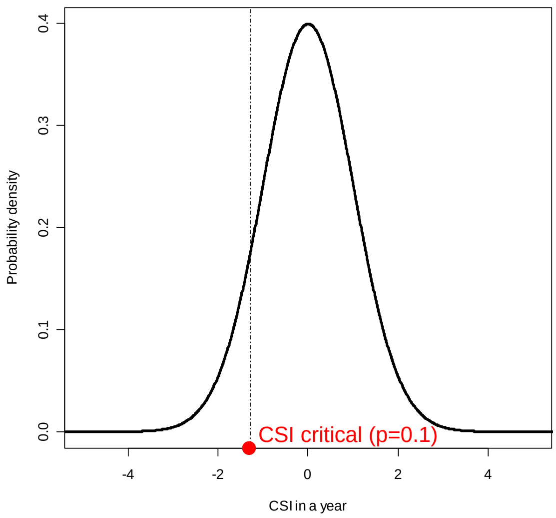

Figure 4: Theoretical distribution of CSI values at the end of a baseline period (the distribution may not always be Gaussian). The vertical line indicates the critical CSI value at the lower 10th percentile.

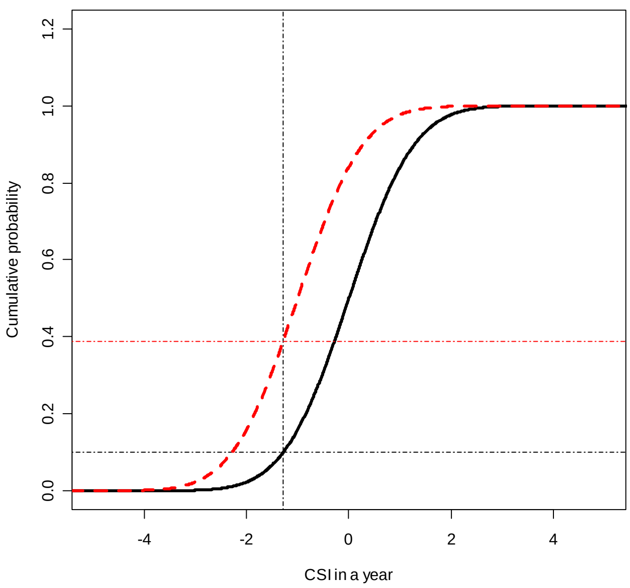

Figure 5: Cumulative probability distributions of CSI values. The baseline distribution is given on the right and a possible fishing scenario on the left. The vertical line indicates the critical CSI value read from the baseline for the lower 10th percentile (bottom horizontal line). The probability of departure from the baseline (natural) norm is shown by the probability of the left line being below the critical CSI, approximately 0.4 in this example.

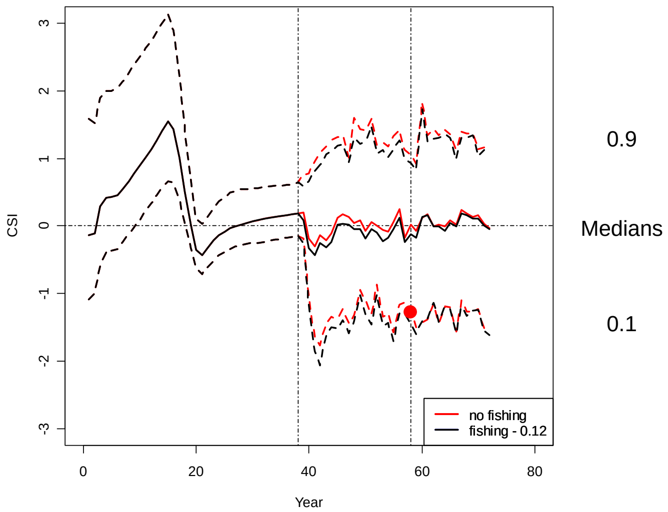

Figure 6: Medians and 10th and 90th percentiles for 100 no-fishing (black) and 100 fishing (grey/red) trials in FOOSA. The horizontal line indicates the mean of the CSI in the no-fishing trials during the fishing period. The vertical lines bound the fishing period. The period to the left of the left-most line is the period during the calendar and the period to the right of the right-most line is the recovery period. (This figure is available in colour on the CCAMLR website.)

ASSESSING RISKS OF DEPARTURE FROM BASELINE NORMS

7. The probability of departure can then be reversed (1 minus that probability) to indicate the performance of the fishing scenario with respect to maintaining the food web within the range of baseline norms. Thus, a no-fishing trial using the lower 10th percentile as the critical CSI will have a performance of 0.9. As the catch of krill increases with increasing yield multipliers, the expectation is that the krill population will decline, causing the predator responses to decline. As such, the probability of the CSI departing from the baseline norms will increase and its consequent performance decrease. This is illustrated in Figure 7.

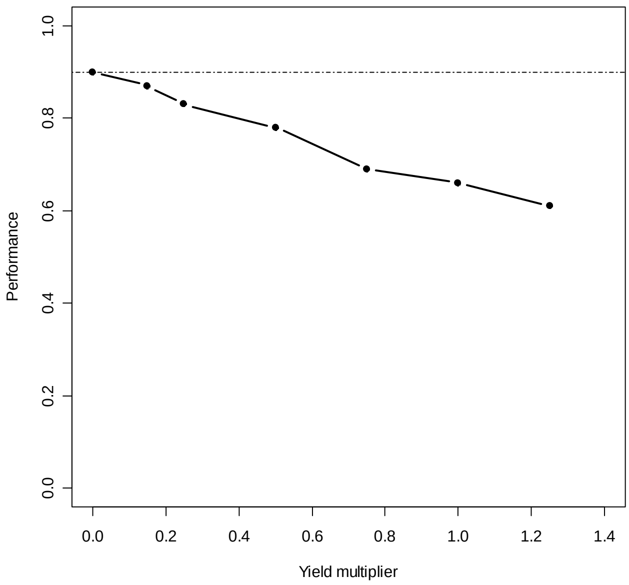

Figure 7: Performance of different yield multipliers applied to a harvest strategy for krill based on a CSI incorporating all predator responses (recruitment) across the SSMUs.

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ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 13 to 24 October 2008)

CONTENTS

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Appendix D[1]: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.1

Appendix E: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.2

Appendix F: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3a

Appendix G: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3b

Appendix H: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Subarea 48.6

Appendix I: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Subareas 88.1 and 88.2

Appendix J: Fishery Report: *Dissostichus eleginoides* South Georgia (Subarea 48.3)

Appendix K: Fishery Report: *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)

Appendix L: Fishery Report: *Dissostichus eleginoides* Heard Island (Division 58.5.2)

Appendix M: Fishery Report: *Dissostichus eleginoides* Crozet Island inside the French EEZ (Subarea 58.6)

Appendix N: Fishery Report: *Dissostichus eleginoides* Prince Edward Islands South African EEZ (Subareas 58.6 and 58.7)

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* South Sandwich Islands (Subarea 48.4)

[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.

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 13 to 24 October 2008)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 13 to 24 October 2008. The Convener, Dr C. Jones (USA), opened the meeting and welcomed participants.

1.2 The Working Group welcomed Dr X. Zhao as the People's Republic of China's first participant in the work of WG-FSA.

1.3 The Working Group joined the Scientific Committee in urging Members to participate fully in its future work, and to send a greater number of experts to the meetings of working groups. The work of the Scientific Committee, including WG-FSA, is expanding and can only be achieved through greater contributions and active participation of Members (SC-CAMLR-XXVI, paragraph 14.10).

1.4 The Working Group recognised the difficulties which may arise from conducting highly technical discussions in only one working language, and emphasised the continuing need to engage all Members in its work. This matter was considered further under Future Work (paragraphs 13.1 to 13.24).

1.5 On completion of its work, the Working Group paused in memory of Dr Edith Fanta, Chair of the Scientific Committee, who passed away in May 2008. Dr Fanta was an exceptional Antarctic biologist, and a long-time participant and leader in the work of CCAMLR. She was a close friend of many in WG-FSA, and will be sorely missed by all.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The agenda of the meeting was discussed and it was agreed to consider data requirements and research protocols using commercial fishing vessels under Item 5.1. The revised agenda was adopted (Appendix A).

2.2 The report was prepared by the participants and includes the List of Participants (Appendix B), the List of Documents considered at the meeting (Appendix C) and Fishery Reports (Appendices D to Q).

REVIEW OF AVAILABLE INFORMATION

Data requirements specified in 2007

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 Commission and the Scientific Committee and its working groups. Work relevant to WG-FSA was highlighted (WG-FSA-08/4) and included:

(i) a revision of the longline data form for fine-scale catch and effort data (C2) to allow the recording of the number of hooks that are lost attached to sections of longline during fishing, the use of vertical droplines and trotlines, and the use of cetacean exclusion devices[2] on trotlines (SC-CAMLR-XXVI, paragraph 13.12). Consequential changes were made to the CCAMLR database. The revised data form was posted on the CCAMLR website in November 2007, and was in use in 2007/08;

(ii) the development of an index of local density of licensed vessels on fishing grounds (CCAMLR-XXVI, paragraph 10.51(iii) and Annex 5, paragraph 6.21). The index (vessel presence) was developed based on the daily positions of fishing vessels reported in fine-scale data. The spatial and temporal scales of this index can be adjusted to suit the analyses (e.g. 5-day to monthly intervals, and fine-scale rectangles to SSRUs, subareas or divisions).

Data processing

3.2 The Secretariat had processed fishery and observer data from 2007/08 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 fishery and observer data from the fishery in the South African EEZ in Subareas 58.6 and 58.7 and Area 51 (Prince Edward and Marion Islands), and fishery data from the French EEZs in Division 58.5.1 (Kerguelen Islands) and Subarea 58.6 (Crozet Island).

3.3 The Secretariat began validation of data from 2007/08 prior to the meeting, and this procedure will be completed in the forthcoming intersessional period.

3.4 Last year, WG-FSA questioned the frequent occurrence of *Dissostichus eleginoides* in catches reported by the then Uruguayan-flagged vessel *Paloma V* which fished in Divisions 58.4.1 and 58.4.3b in 2006/07. The *Paloma V* had reported the majority of its catch from those divisions as being *D. eleginoides* (80% of the catch in Division 58.4.1; 92% in Division 58.4.3b), while the landings reported in the CDS indicated that the catch consisted mostly of *D. mawsoni*. It was also noted that the data submitted by the scientific observer contained observations on both species.

3.5 In 2008 the Secretariat contacted the Uruguayan authorities to seek clarification and advice on the fine-scale data submitted by the *Paloma V* when the vessel fished in Divisions 58.4.1 and 58.4.3b in 2006/07, and to confirm the identity of toothfish species reported in the data. Uruguay confirmed that the catches of *D. eleginoides* reported in the fishery and observer data were correct, and that a discrepancy had occurred in the CDS data; this discrepancy was addressed. The Working Group requested that the Scientific Committee consider this issue further.

[2] The Working Group requested that the Scientific Committee determine a suitable terminology for this device.

Fishery Plans

3.6 The Secretariat has maintained the database which holds information on Fishery Plans and has added the data from 2007/08 to the time series.

Fisheries information

Catch, effort, length and age data reported to CCAMLR

3.7 Under the conservation measures in force in 2007/08, fishing took place in 12 fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*Euphausia superba*) (CCAMLR-XXVII/BG/15). Activities in exploratory fisheries were summarised in WG-FSA-08/4 in Table 2.

3.8 Three other fisheries targeting toothfish were conducted in the Convention Area in 2007/08:

- 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 CAMLR Convention Area in 2007/08 are summarised in Table 1.

3.10 The Working Group noted the Secretariat's work in monitoring fisheries in 2007/08 (CCAMLR-XXVII/BG/15). This had resulted in the closure of four fishing areas and two fisheries. All the closures were triggered when the catches of *Dissostichus* spp. approached their respective catch limits, and no catch limit was exceeded.

3.11 Fishery and scientific observer information, including tables and figures, in WG-FSA's Fishery Reports was updated by the Secretariat, where possible, immediately prior to the 2008 meeting (WG-FSA-08/4, Table 3). Developments during the intersessional period included the implementation of the length–mass parameters used in the assessments (WG-FSA-08/4, Table 4), development of an R script to plot the catch-weighted length frequencies, and plotting of the catch-weighted length frequencies for *D. eleginoides* in Subarea 48.3 in two time series (1984/85 to 1996/97, and 1997/98 to present). Fishery Reports are discussed under Item 5.

Estimates of catch and effort from IUU fishing

3.12 WG-FSA reviewed estimates of IUU catches in the Convention Area prepared by the Secretariat based on information submitted by 8 October 2008 (Table 2 and WG-FSA-08/10 Rev. 2). As in previous years, the agreed deterministic method used by the Secretariat to estimate IUU fishing effort was based on information on the number of vessels sighted. Additional information on fishing trips and catch rates was 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 and Figure 1. The Working Group endorsed these estimates for use in stock assessment and by ad hoc WG-IMAF (see Items 5, 7 and 8).

3.13 WG-FSA noted that it was likely that the majority of IUU vessels sighted were gillnet vessels and that there is currently no information on the likely catch rates of these vessels (see also paragraph 8.4). The Working Group therefore cautioned that the application of longline catch rates to the method used for estimating IUU removals may have resulted in a conservative estimate of IUU catches. Further, gillnets are less selective than longlines and may result in greater catches of by-catch and occurrences of incidental mortality. This matter was referred to ad hoc WG-IMAF and SCIC for further consideration.

3.14 WG-FSA agreed that the number of vessels sighted was fewer than in previous years and noted that this may be as a result of several factors, including those potentially related to economic factors, as well as the effect of CCAMLR measures to deter IUU fishing.

3.15 WG-FSA also considered the case of a vessel which had engaged in licensed fishing operations in the Convention Area in 2007/08, but which was subsequently reported to have engaged in transhipment operations with a number of IUU fishing vessels. WG-FSA considered that this may have an impact on assessments to be undertaken as existing datasets may have been compromised. However, WG-FSA agreed that it was not in a position to determine if the vessel had engaged in IUU fishing activity until the matter had been discussed by SCIC. The Working Group therefore decided to identify the datasets which might be affected and conduct parallel assessments, including and excluding data in respect of the vessel concerned.

3.16 Although there was no significant uncertainty attached to IUU fishing events reported in 2007/08, the Secretariat applied the JAG matrix to the estimate derived from the agreed methodology for the consideration of WG-FSA. All sightings in 2007/08 were of clearly identified IUU fishing vessels and all received a slightly reduced ranking based on the assumption that all were gillnetters. Three of the sightings received a further reduced weighting factor on the basis that they were not sighted fishing at the time. Another two sightings received a further reduced weighting factor on the basis that they were sighted by legal vessels rather than a surveillance platform. The application of the matrix reduced the overall estimate of IUU catches by 81 tonnes (approximately 7%) to 1 088 tonnes (WG-FSA-08/10 Rev. 2, Table 2). The evaluation of the threats arising from IUU fishing activities was discussed under Item 8.

Catch and effort data for toothfish fisheries in waters adjacent to the Convention Area

3.17 Catches of *Dissostichus* spp. in CCAMLR waters which were 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 2006/07 and 2007/08 are summarised in Table 4. The total CDS-reported catch of *Dissostichus* spp. for 2007/08 to October 2008 was 10 291 tonnes.

3.18 WG-FSA noted that most of the catch of *Dissostichus* spp. taken outside the Convention Area was from Areas 41 and 87. The Working Group also noted that the CDS records only processed weights and that the figures provided by the Secretariat were converted to estimated green weight using a standard set of conversion factors.

Scientific observer information

3.19 Scientific observers appointed under the CCAMLR Scheme of International Scientific Observation were deployed on all vessels targeting finfish in the Convention Area, and some vessels targeting krill in 2007/08. Scientific observers have participated in 60 cruises so far in 2007/08: 52 cruises on vessels targeting *Dissostichus* spp. or *C. gunnari* (40 cruises on longliners, 9 cruises on trawlers and 3 cruises on a pot vessel) and 8 cruises on vessels fishing for *E. superba* (see WG-FSA-08/5 Rev. 1 to 08/8 and SC-CAMLR-XXVII/BG/2). Scientific observations were discussed under Items 7 and 11.

Inputs for stock assessment

Catch-at-length/age from fisheries

3.20 The exploratory fishery for *D. mawsoni* has been operating for 11 years in Subarea 88.1 and for six years in Subarea 88.2. Summaries of the large amount of data collected on toothfish and the associated by-catch by all vessels participating in the fishery were presented (WG-FSA-08/22). All SSRUs in the two subareas except for 881D and 882C have now been fished. The catch in the 2007/08 season was the fourth-highest on record with a total of 2 666 tonnes out of a catch limit of 3 207 tonnes. The length-frequency data from the Ross Sea fishery have been very consistent over the past three to four seasons. There is no evidence of any truncation of the overall length-frequency distribution and no evidence for a reduction in fish length in any SSRU over time. Although moderate numbers of small fish are caught in some years, these year classes are not seen in large numbers in later years in the fishery. So at this stage there is no evidence for strong variation in year-class strength in the fishery.

3.21 The Working Group noted that a lower number of sets occurred in the 2007/08 season than had occurred in the previous five years. This was attributed to the severe constraint imposed by the occurrence of very heavy ice in the Ross Sea during this season.

3.22 Although it was noted that the length-frequency distributions were stable, it was not clear if the median was the best measure to be used to pick up changes in size distribution over time. It was agreed that further work investigating this issue was warranted.

3.23 The Working Group also discussed whether heavy ice coverage impacted the distribution of the fish or simply the distribution of fishing effort. It was agreed that this issue should be further investigated.

Research surveys

3.24 In April 2008 the UK conducted a bottom trawl survey of Subarea 48.3 on the FV *Sil*, with 70 bottom trawls undertaken giving good geographic coverage (WG-FSA-08/28). The biomass of *C. gunnari* was estimated by using 10 strata and the updated sea-floor areas and adjusting this for the low headline height of the UK trawl (see SC-CAMLR-XXII, Annex 5). Catch-weighted length frequencies indicated that the icefish population was dominated by 2+ and 3+ fish, with difference in the size between Shag Rocks and South Georgia and with few small fish in the NW South Georgia area. The *D. eleginoides* population was dominated by the same cohort that has been detected by surveys since 2003, with no evidence of new recruitment since. Biomass estimates and length frequencies are reported for other non-target species. Conducting the survey in April, as opposed to previous efforts being conducted in September and January, was successful. The icefish appeared to be dispersed which is amenable to a random trawl survey.

3.25 The Working Group noted the impact on biomass calculations of varying headline height. It was noted that, as bottom topography becomes rougher and towing line length is decreased, the spread of the trawl doors decreases which increases headline height. This changes the proportion of the fish populations that are susceptible to the gear. At present a constant adjustment factor (1.241) is used (SC-CAMLR-XXI, Annex 5).

3.26 The Working Group agreed that the adjustment factor presently used is subjective and for icefish, in particular, the proportion not available to the gear is likely to vary by year and even month. It was agreed that further investigation using acoustic methods should be undertaken.

3.27 The Working Group noted that coverage of areas around South Georgia was much better than during last year. It was recognised that sampling around the southwest and southeast is difficult, so data from other areas are used to extrapolate to these areas (Boxes 18, 19 and 23 not sampled). It was suggested that acoustic data from previous years (e.g. historical Soviet/Russian and UK survey data) may be of use to help interpret icefish biomass in these areas. It was noted that, although there have been limited historical catches in these areas, there have not been catches in the last couple of years.

3.28 New Zealand completed a survey using the NIWA research vessel *Tangaroa* in the Ross Sea in February and March 2008 as part of the IPY (WG-FSA-08/31). The main aim of the survey was to carry out a CAML in this region. The shelf and slope were stratified by depth and at least three random trawls completed in each stratum. Survey effort was severely constrained by the occurrence of heavy ice during the survey period. Catch rates by station are presented for the eight most abundant species, along with catch-weighted length frequencies and biomass estimates of those species.

3.29 The Working Group recognised that the Ross Sea is a very large area to be surveyed and that surveys with such small numbers of trawls in each stratum will yield biomass estimates with large uncertainties. However, the Working Group recognised that this survey was a very valuable contribution because it was the first such effort completed using large commercial-sized nets.

3.30 Australia completed a randomised stratified survey of *C. gunnari* in Division 58.5.2 in the vicinity of Heard Island in July 2008 to provide information for an assessment of short-term annual yield in the 2009 season (WG-FSA-08/56). The Working Group noted that the survey was a significant contribution to a long-term series of surveys in this division. A preliminary assessment of yield for the area of Division 58.5.2 to the west of 79°20'E using standard CCAMLR methods is provided (WG-FSA-08/56). The strong year class detected in last year's survey is now fully recruited as the 2+ cohort and dominates the population.

3.31 The Working Group noted that specific locations of sampling stations were not included in the paper; however, they are available to the Working Group from the CCAMLR database as needed to complete stock assessments. The Working Group recalled that a pro forma outlining the data to be included when presenting the results of a trawl survey had been presented to the Working Group (WG-FSA-SAM-06/15), but that there had not been agreement on this (WG-FSA-06/6). The Working Group agreed that, as a minimum, a description of how the survey data are collected and summaries of the data relevant to assessments be provided. In this way, a record can be maintained explaining how data present in the CCAMLR database are obtained.

3.32 In May 2008 Australia completed a randomised longline survey, consisting of 15 standardised sets over two strata covering areas of commercial fishing activity, using the Australian-flagged longliner FV *Janas* on BANZARE Bank within Division 58.4.3b (WG-FSA-08/57). Catch rates were very low, ranging between 0 and 135 kg/thousand hooks. This is consistent with toothfish being at low densities across the majority of the surveyed area. Catches of toothfish consisted of both species. Data on size distributions and size-at-maturity indicate that the *D. mawsoni* population is almost entirely large mature fish with a bias towards males.

3.33 The Working Group noted that the two species of toothfish were found in separate locations and noted that water masses may be an important variable determining their distribution. The Working Group noted that the measurement of water temperature at the depth at which the different species are caught would greatly assist in understanding the factors influencing their relative distribution

3.34 Japan conducted a research survey for toothfish in SSRUs A, B, C, and D in Division 58.4.4 (Ob and Lena Banks) from July to September 2008 on board the *Shinsei Maru No. 3*. Trotlines were used during fishing operations. Because the survey was not completed until 27 September 2008, Japan could not provide a formal report of the survey results in time for the Working Group meeting. However, it did provide a preliminary short report and verbal information to the Working Group.

3.35 Information provided by Japan indicated that the main objective of the research was to collect various biological data on toothfish in Division 58.4.4 needed for assessing the status of these stocks. No information related to recent stock size exists in this division because of the prohibition of direct fishing since 2002. The vessel had one CCAMLR international and one domestic observer on board.

3.36 To ensure coverage of all SSRUs and to get more information on higher-density areas for toothfish, the survey was conducted in two phases. In phase 1, each SSRU B, C and D was partitioned into four survey areas and five hauls were set in each survey area. In SSRU A five sets were conducted. During phase 2, the research was conducted in the same way as phase 1 except no attempt was made to space the sets 5 n miles apart as was the case in phase 1. Tagging of fish was conducted at the rate of 3 fish per tonne. DNA and otolith samples were collected from toothfish from each SSRU. During phase 1 operations, 65 hauls were set and in phase 2, 53 hauls were set. A total of 76.9 tonnes of toothfish was taken during both phases.

3.37 The Working Group appreciated the provision of information by Japan despite the short preparation time available.

3.38 The Working Group noted that the research effort had been conducted using trotlines designed by Japan. It also noted that their design was most likely different than trotlines used by Russia and others and very different from longlines used in other toothfish fisheries. It agreed that it would be difficult to interpret CPUE data taken from the Japanese trotlines compared to other longline methodologies used to fish for toothfish. Further work was suggested, such as examining data from other subareas/divisions where the trotlines might have been used simultaneous with other longline gear. In addition, CPUE of line set might be investigated to compare the various methods. Until a better understanding of CPUE from trotlines is acquired, it will be very difficult to interpret status of these stocks using these data.

3.39 The Working Group requested Japan to provide all details of the trotlines in its research report so that differences between its method and other methods could be better understood. The Working Group also noted that the by-catch rate of macrourids was about 5% of the catch of toothfish.

3.40 Dr D. Agnew (UK) indicated that the relatively abundant small fish encountered in the Japanese survey may suggest relatively good recruitment in the area.

3.41 Dr T. Ichii (Japan) noted that although the fishing efficiency using trotline gear is different from that of other gear, the CPUE in phase 1 calculated during the Japanese survey was twice as high (60 kg/thousand hooks in 2008 versus 33 kg/thousand hooks in 2001) as that observed when the catch limit was established in 2001.

3.42 Dr Ichii indicated that a single survey was not sufficient to provide data to determine status of fish stocks in Division 58.4.4 and that a minimum of three years would be needed to detect trends in stock status.

3.43 Some members questioned whether more data should be collected at this time given the uncertainty of how to interpret present CPUE data. In addition, there was concern that subsequent annual surveys may impede the ability of the stocks in the closed area to recover. It was suggested that before further data collection was to be made, an experimental design be presented showing how data collection and data analyses would be used to assess the stocks and how the stocks would recover so that a commercial fishery might be executed. This would entail being able to determine standardised CPUE data which can be compared to toothfish data in other subareas/divisions in the Convention Area and also to the historic CPUE in that subarea.

3.44 In the interim, it was suggested that periodic surveys over a long time period might provide relative abundance, cohort strength and tagging data. This would alleviate risk associated with annual takes at the level of exploratory fisheries.

CPUE analyses

3.45 The Working Group recalled that at last year's meetings the Scientific Committee and Commission had agreed that, where appropriate, biennial assessments should be completed. Therefore, the Working Group recognised that this year no assessments would be performed for some toothfish fisheries (Subareas 48.3, 88.1 and 88.2 and Division 58.5.2). However, it was agreed that Fishery Reports should be updated as appropriate as these represent valuable tools in the assessment work. These would include results of CPUE analyses which were available.

Tagging studies

3.46 WG-FSA-08/46 reported on the continuation of the tag-recapture experiment in Subarea 48.4 in 2007/08, and summarised numbers of toothfish and skate tag-recaptures, movement and mixing of tagged fish, catch and by-catch rates in 2007/08. The Working Group noted that this paper included a proposal to continue the tag-recapture experiment, and this was discussed further under Item 5.3.

3.47 The Working Group noted that both species of toothfish were encountered in Subarea 48.4, however, previous hypotheses suggested that *D. mawsoni* would be encountered much further south. The Working Group noted that the oceanography in this area may cause conditions similar to those typical of higher latitudes.

3.48 WG-FSA-08/15 described the Secretariat's progress toward administering toothfish tagging programs for all new and exploratory fisheries from the 2007/08 season. The Working Group noted that there were still difficulties in matching recaptured fish with release records, however, observers submitting photographs of tag-recaptures to the Secretariat had assisted with this issue.

3.49 The Working Group considered that requiring photographs, entering of recapture details in logbooks and returning the tags to the Secretariat involved some redundancy but allowed for improved validation. For example, the Working Group recognised that digital images could be manipulated, therefore photographic evidence may not alone be evidence of a tag-return. The Working Group agreed that the Secretariat should ensure that Members return physical tags, as well as check for correct transcription of returned tags, including all alphanumeric characters. The Working Group was optimistic that the centralisation of the tagging program in new and exploratory fisheries would go some way to addressing these issues into the future.

3.50 In response to the request from the Scientific Committee (SC-CAMLR-XXVI, paragraph 12.9) to present an analysis of the tag-recapture rates on individual vessels, Dr K. Reid (CCAMLR Science Officer) provided a description of the problems encountered in analysing the data held in the CCAMLR database. This included an example of the discrepancies between the numbers of tags reported recaptured in the C2 and observer data for individual vessels, as well as the presence of a large number of duplicate tag numbers (reported from multiple fisheries, in multiple years, and by multiple Flag States) in the database. Dr Reid indicated that the incomplete reporting of tag numbers also meant that a large number (>30%) of tag-recoveries could not be attributed to a specific release event with 100% accuracy.

3.51 The Working Group agreed that there are two types of error to be considered – accidents and non-compliance – and it would be useful to separate detection and remediation methodologies for each type of error. Mr J. Fenaughty (New Zealand) observed that errors between the C2 and observer data are possible because observers work shifts whereas vessels operate 24 hours per day, hence tags detected when the observer is not present may result in a discrepancy.

3.52 The Working Group recalled that data-checking performed by analysts working on the Ross Sea assessment was able to achieve satisfactory matches for all but 10–20 tags, so discrepancy rates of up to 30% were of concern since any tag-recaptures that were unable to be included in tag-based assessments had the potential to create an upward bias on biomass estimates. The Working Group noted that the procedure for inferring a satisfactory match between a tag-recapture and release record should be documented, and be algorithmic to minimise any subjectivity. Further, alterations made by the Secretariat to data after it is submitted should be flagged in the database with the reason why a correction was made (paragraph 11.7).

3.53 The Working Group noted that there is a clear incentive for a vessel to report releases rather than recoveries because they must obtain particular rates of release to comply with conservation measures. However, there is currently no such formal assessment of recapture rates, and it may be possible to manipulate recapture rates by reporting recaptures with incomplete data so as to make matching to a release record difficult or impossible. This may allow a non-compliant vessel to appear broadly consistent with other vessels, without these tag-recaptures being able to be incorporated into stock assessments.

3.54 The Working Group endorsed Fishery Reports summarising all tag-returns, as well as the rates at which they could be matched to a release record. The Working Group also noted the discussions by WG-SAM on relating data quality and tag-recapture rates in the Ross Sea, and requested the Scientific Committee to consider how to achieve full compliance with requirements of the tagging program.

3.55 The Working Group agreed that the Secretariat will undertake to identify the tagging details for all tags recovered, including:

(i) direct comparison of reported recapture details with data available in the tagging database;

(ii) use of digital photographs and actual tags to verify tag identities;

(iii) correspondence with Members to clarify remaining uncertainty.

3.56 The Working Group agreed that in order to facilitate the work of the Secretariat in undertaking steps (i) to (iii), Members who have historically conducted tagging programs in, or adjacent to, the Convention Area are requested to submit inventories of tags released and recaptured.

3.57 The Working Group agreed that the Secretariat should be responsible only for determining exact matches between recaptures and releases. Any inferred matches conducted by Members in the process of further data-checking for assessments should not be used to alter the data held by the Secretariat, however, the procedure should be clearly described such that the checked dataset can be readily recreated by the Secretariat during assessment validation.

3.58 The Working Group recommended that to avoid bias, all unmatched tag-recaptures should be summarised in the Fishery Reports, and incorporated into assessments, and suggested that a way of incorporating them may be to pro-rate the numbers of scanned fish by the ratio of matched recaptures to total recaptures. The Working Group requested WG-SAM consider further ways of incorporating unmatched tag-recaptures into the assessment.

3.59 The Working Group congratulated the Secretariat for its work on the new and exploratory tagging program, and encouraged all Members to consider using the tagging equipment provided by the Secretariat. Dr A. Constable (Australia) noted that, as the CCAMLR tags were produced by the same manufacturer (Hallprint) and of the same type to those used for the last 11 years in the Division 58.5.2 toothfish fishery, Australia would exhaust its current stores of tags before commencing deployment of the new CCAMLR tags.

3.60 The Working Group noted that the Secretariat had purchased tags suitable for tagging skates, with a contrasting colouration and the prefix 's', and recommended that Members purchase these tags to participate in skate tagging during the Year-of-the-Skate.

3.61 WG-FSA-08/16 described tagging by the vessel *Banzare* in Divisions 58.4.1. Due to a lack of fish suitable for tagging in Division 58.4.1, the vessel did not achieve the required tagging rate of three fish per tonne. The vessel then proceeded to fish in Divisions 58.4.3a and 58.4.3b and tag above the required rate.

3.62 The Working Group noted that this issue was more appropriately considered by SCIC. However, the Working Group noted that increased tagging outside Division 58.4.1 did not meet the objectives of the tagging program, and were concerned that such a situation may indicate that sufficient tags were not released throughout the fishing operation, as has been recommended. Furthermore, many vessels still managed to tag fish at the required rate in the Ross Sea, despite poor sea-ice conditions in 2007/08.

3.63 The Working Group also noted that the Secretariat currently monitors the tagging rate based on 5-day reports, so vessels have information they can use to ensure they meet the tagging rates required by conservation measures.

Biological parameters

3.64 WG-FSA-08/17 examined ageing protocols and growth characteristics of *D. mawsoni* based on ages derived from radio-isotope analysis and estimates from otolith growth zone counts. The study broadly confirms the current hypotheses regarding the rates of growth and maximum ages of *D. mawsoni*. Additional discussion of these findings is taken up in paragraph 9.7.

3.65 The Working Group noted differences in the parameters estimated for the von Bertalanffy growth curve, and the fact that the L_∞ estimated was much lower than the maximum size reported for *D. mawsoni*. However, the Working Group noted that caution was required when interpreting L_∞ as the maximum achievable size for the species, since this could be the result of the relative scarcity of large old individuals in age-at-length datasets analysed to date.

3.66 The Working Group considered the hypothesis presented in WG-FSA-08/17 that the lower L_∞ in this study, compared with an earlier study of Horn (2002), provided evidence of truncation in length and age due to fishing. However, the Working Group noted that estimates of k and L_∞ are almost always highly correlated, and hence under-ageing of large fish is likely to be contributing to this effect.

3.67 The Working Group further noted that size-at-age was more variable in this study compared to that of Horn (2002). The Working Group also noted that one 150 cm fish in the dataset aged to be 7 years old was considered to have an unfeasibly rapid growth rate. The Working Group concluded these issues could be due to several factors, including inter-laboratory differences in otolith preparation methodology and interpretation of increments.

3.68 Dr D. Welsford (Australia) stressed that while experienced otolith readers may be internally consistent in their age determinations, this does not necessarily indicate that estimated ages are correct. He emphasised that for an ageing method to be considered valid, a combination of evidence is required, including:

(i) the age at which the first ring is visible
(ii) evidence that rings consistently track a time scale
(iii) rings that are clear enough to be read consistently.

3.69 The Working Group agreed that the radiometric ages presented in WG-FSA-08/17 in part addressed point (ii), albeit with broad confidence intervals. The Working Group noted other studies presented in recent years using otoliths from toothfish with strontium and tetracycline tags provided confidence in current ageing protocols.

3.70 The Working Group agreed that construction of a reference collection, and comparisons between laboratories routinely ageing *D. mawsoni*, was required to address point (iii), and encouraged the authors of WG-FSA-08/17 to pursue this with Mr Horn in New Zealand.

3.71 The Working Group also agreed that studies on small fish were needed, since datasets with clear cohort progression should enable the validation of the position and appearance of the first clear annual increment in otoliths, noting that previous work had shown that the increments laid down in the first five or so years were the hardest to discriminate in toothfish, and that this difficulty affects the accurate allocation of both young and old fish to year classes.

3.72 An analysis of *D. mawsoni* GSI indices in the Ross Sea region was provided in WG-FSA-08/48. Analysis by GLM showed differences due to latitude, fish length and month. Histological analyses also indicated that GSI may be a better proxy for maturity than observer staging data, and the authors were able to determine with good reliability whether a fish had spawned in the previous season, based on the presence of post-spawning structures. However, they are currently unable to distinguish histologically between immature and resting females that have not spawned in the previous season.

3.73 The Working Group expressed concern that macroscopic gonad staging was apparently not effective for determining maturity. The Working Group requested that the histological data detailed in WG-FSA-08/48 be used to develop refined macroscopic characters for staging *D. mawsoni* in the Ross Sea.

3.74 There is still uncertainty as to the proportion of the population existing in different areas. Dr K.-H. Kock (Germany) noted that a median size-at-maturity of 135 cm corresponded to a fish age of 18+ and is larger and older than currently used in the assessment.

3.75 The Working Group noted that, for the purposes of stock assessment, knowing that a fish spawned in the previous year is good evidence of maturity, and so the histology work provided in WG-FSA-08/48 represented a significant improvement in estimating size at maturity for *D. mawsoni* in the Ross Sea. Predicting which fish will spawn next year is less reliable since eggs can be developed, then reabsorbed, depending on exposure to environmental conditions. Data arising from the present study could usefully be applied in the Ross Sea assessment for next year since it represented a good sample size for this species and should improve previous estimates. The Working Group noted that it would be useful to look at the sensitivity of assessments to changes in parameters for length at maturity, and New Zealand had proposed further research to establish the growth of oocytes to further refine understanding of reproduction in the Ross Sea (paragraphs 5.108 to 5.115).

3.76 Dr Constable suggested that it was important to consider the rationale for additional studies as proposed by New Zealand. He suggested they might be useful for developing an advance warning system for recruitment, based on spawning output. However, with respect to current assessment methods, this is less important since recruitment is estimated from the age structure of the catch. He also indicated that it is the maturity ogive that would be most useful in determining the spawning biomass and what the escapement of fish is likely to be from the fishery to the spawning stock.

3.77 WG-FSA-08/12 summarised the maturity level of gonads and feeding behaviour (as inferred from stomach contents) of toothfish from a single observer cruise on board a Spanish longliner in the Ross Sea from November 2007 to March 2008. The Working Group noted that the study confirmed that toothfish are a generalist predator, and further noted the presence of a single toothfish with both male and female gonad lobes. Gonad-staging data and length-frequency distributions were also presented in the paper. The Working Group suggested these data might be usefully combined by the authors to provide information on size at maturity.

3.78 WG-FSA-08/28 summarised diet patterns in *C. gunnari* in Subarea 48.3 and hypothesised that the predominance of amphipods in the diet of younger age classes may buffer the younger fish in the stock against interannual variability in krill abundance. The Working Group noted that older age classes have been shown to have a more demersal habit, eating predominantly fish and mysids.

3.79 The Working Group noted that it may be possible to use dietary information to tune the natural mortality parameter in icefish assessments, and encouraged the development of models that may assist in understanding the impacts of top-down and bottom-up ecosystem effects, as well as fishery impacts on icefish.

3.80 WG-FSA-08/23 was originally listed under this agenda item, however, the Working Group referred it to be addressed under Agenda Item 6.

Depredation

3.81 WG-FSA-08/44 detailed a study of catch and by-catch rates of trotlines with the Chilean cetacean excluders[3], compared with Spanish longlines, in Subarea 48.3. The Working Group noted that this was the first study from within the CAMLR Convention Area with an experimental design to investigate the effectiveness of the 'cachalotera' system[3] for minimising cetacean predation and the effects on catch rates of by-catch and toothfish.

3.82 Differences between gear types provided difficulties for comparing catch rates, however, the Working Group noted that, in the presence of cetaceans, there was some evidence for the effectiveness of cachaloteras on trotlines compared to the Spanish system. Grenadier by-catch, and to some extent skate by-catch, was generally lower on trotlines compared with the Spanish system, however, skates and toothfish were often in poor condition making them unsuitable for tagging and unlikely to survive if released. Dr Welsford noted that anecdotal evidence had been presented at ad hoc TASO that suggested the cachaloteras may rub tags off toothfish as the line is retrieved.

3.83 Dr V. Bizikov (Russia) noted that it had been reported previously to WG-FSA that trotlines can catch less by-catch than the autoline system. The Working Group emphasised that paired experimental fishing trials would be necessary to understand the effects of the configuration of trotlines on catch rates, and that ad hoc TASO had noted that the range of trotline configurations used in the Convention Area was still not well understood.

PREPARATION FOR ASSESSMENTS AND ASSESSMENT TIMETABLE

WG-SAM report

4.1 The sections of the WG-SAM report relevant to the WG-FSA-08 agenda were detailed to the Working Group by the Convener of WG-SAM-08. The concept of version control raised at the WG-SAM meeting was suggested as an issue to be taken up in discussion by the Working Group (Annex 7, paragraphs 7.1 to 7.4).

Review of preliminary stock assessment papers

4.2 WG-FSA-08/28 detailed the preliminary assessment of *C. gunnari* in Subarea 48.3. Seabed areas were obtained from the recently updated South Georgia bathymetry dataset, based primarily on swath bathymetry. With respect to the issue of how the new seabed areas compare to the old estimates, the Working Group noted that although the seabed area has increased, the depth ranges included in the strata were reduced so that the general effect of the change is likely to be neutral. It was noted that some hauls were taken after dark and that the

[3] The Working Group requested that the Scientific Committee determine a suitable terminology for these devices.

inclusion of these data in the analysis might bias the survey biomass results downwards. However, the increased accuracy of having these extra hauls might increase the lower 95% confidence interval which might actually increase the biomass estimate used to calculate a catch limit. The Working Group noted that the effect of including these hauls would not significantly impact the assessment results and that it would be preferable to keep these data in the analysis.

4.3 Given the low sampling frequency in the areas traditionally not fished, the Working Group noted that extrapolating survey results into these regions might inflate the population estimate from the survey. It was noted that the areas with a greater number of samples were not used to infer the density in the low sampling regions. The potential correlation between number of hauls and biomass was raised and the Working Group noted that, while there is a relationship between the lower confidence intervals and the number of hauls, any correlations between the number of hauls and mean biomass seen in the limited sample size are likely to be spurious.

4.4 The Working Group noted slight differences between the length–weight relationship tabled in the previous fishery report and the ones used in the analyses. It was also noted that the coefficients used in the analysis were estimated from the survey data and that differences were very slight and unlikely to have any significant impact.

4.5 The Working Group recalled that there are relationships between krill density and icefish spatial location, and that this could help provide an indication of density in the areas not covered in the survey (WAMI, 2001; see SC-CAMLR-XX, Annex 5, Appendix D). The Working Group noted the existence of information on krill density and that it does tie to a degree with observed icefish locations in the northern areas. The Working Group noted that there was evidence of krill in the regions not covered in the survey.

4.6 The Working Group noted that there was an observable pattern in the distribution of age classes around the survey area and considered whether older fish gathered in regions of higher myctophid density. It noted that there was evidence that this is the case.

4.7 The use of a pelagic trawl gear was suggested to try and detect the presence or otherwise of icefish in the southern South Georgia shelf area. The Working Group agreed that this would be useful. However, a change in gear type used for surveys would not be desirable given the length of the time series with the present gear type. It was also suggested that perhaps a purely icefish-targeted survey might be desirable to improve the estimate of icefish abundance, as opposed to the current multi-species type survey design.

4.8 The Working Group considered whether there were any data from the current survey on the spawning condition of icefish. It was noted that shallow areas are often used for spawning and that the survey may miss spawning animals in these cases.

4.9 WG-FSA-08/56 detailed the preliminary assessment of *C. gunnari* in Division 58.5.2. Given the observed large decline in the numbers of the current dominant cohort over recent years, the Working Group considered whether this could be used to estimate natural mortality. It was noted that there are likely changes in natural mortality over time, and that the resultant estimates are very uncertain but that, in principle, this can be done. Given the lesser dependence on krill of icefish in Division 58.5.2, the Working Group considered whether there was more stability in the icefish natural mortality. It was noted that there are a number of drivers of potential changes in icefish natural mortality (predation and food availability), and there are current trends in predator populations in the region making it difficult to infer stability in natural mortality.

4.10 Given the likely impact of the condition of icefish in Subarea 48.3 on natural mortality, the Working Group considered whether there were data available on the condition of icefish in Division 58.5.2. It noted that observed density-dependent growth changes in Subarea 48.3 made that possibility quite probable but that such detailed data for Division 58.5.2 was not currently available.

4.11 A brief detailing of the pertinent issues and requests from WG-SAM with respect to the assessment model detailed in WG-SAM-08/8 was given to the Working Group. WG-FSA encouraged the authors to undertake the suggested work and to submit the work to WG-SAM in the future.

4.12 WG-FSA-08/43 detailed a revised assessment of toothfish stocks in Divisions 58.4.1 and 58.4.2. Given the apparent uncertainty in CPUE estimates for Divisions 58.4.1 and 58.4.2, the Working Group considered how consistent the CPUE used in the comparative CPUE abundance estimates was with respect to that seen in the Ross Sea. The differences sometimes seen when using vessels that fished in both the Ross Sea and continental areas, and those that fished only in Divisions 58.4.1 and 58.4.2, made it clear that the result of the comparative method in this case should not be treated as anything more than an approximate estimate of abundance. The high error in the standardised CPUE was not included in the biomass estimate confidence intervals, only the Ross Sea biomass uncertainty, and a method of inclusion was suggested which may prove useful in further analyses.

4.13 The Working Group noted that the disparate information in the CPUE analyses (lower biomass levels) and the tag data (higher biomass) levels was similar to that seen in the BANZARE Bank work undertaken the previous year. Depletion estimates directly contradicted the estimates of biomass coming from a simple analysis of the tag-returns. The Working Group agreed that the analyses indicated that the data in these divisions were of poor quality. It was noted that the information may still be useful for the purposes of providing management advice. The Working Group suggested that using the maximum biomass estimates may be more informative, as even under these assumptions the general conclusions of WG-FSA-08/43, with respect to biomass levels and the apparent lack of tag-returns, did not change. The Working Group noted that the currently closed SSRUs may be opened for future fishing on the condition that (i) the issues surrounding the lack of tag-returns could be answered and resolved, and (ii) there was a satisfactory expectation of the Scientific Committee that if (i) was achieved, then a revised tagging program would provide information usable in any future assessments of these stocks. The Working Group thanked the authors of WG-FSA-08/43 for pursuing this work.

4.14 The Working Group noted that the two-stock ‘east and west’ hypothesis could also be simply a differential immature/mature distribution of animals of one stock, as is seen in the Ross Sea. It was agreed that even though the (very low) number of tag-returns might support a two-stock hypothesis, the sample size is currently so low that both hypotheses are equally plausible.

4.15 A proposal for an extension to the mark–recapture experiment in Subarea 48.4 (WG-FSA-08/46) was presented, with respect to assessment-related issues, to the Working

Group. The Working Group considered the risk of removing 75 tonnes catch for one year in order to obtain a more precise estimate of the stock abundance. The Working Group considered whether the tagging rate in this area could simply be adjusted upwards. The Working Group recognised that the required tagging rate in this area was already high (five fish per tonne of green weight caught).

4.16 WG-FSA-08/32 detailed indicative estimates of biomass and yield for *Macrourus whitsoni* on the continental slope of the Ross Sea. The Working Group agreed that this kind of approach, where feasible, was a step forward in terms of assessing the sensibility of the current by-catch conservation measures for this species in this region. As to the sampling coverage (in terms of the depth spread of the species), the Working Group noted that these fish are bottom feeding and that a photographic survey might be useful in further understanding the spatial distribution of *M. whitsoni*.

4.17 The Working Group suggested that, given the low level of evidence for a direct proportionality, the catch limit for macrourids could be de-coupled from the catch limit of the target species. It noted that previous work had looked to assess the impact of such catch levels on the non-target species and that this was a sensible approach. The catch limit can be reassessed as new information becomes available and/or if this limit is repeatedly reached. The Working Group thanked the authors of WG-FSA-08/32 for pursuing this work.

4.18 WG-FSA considered a methodology for assessing data quality (WG-SAM-08/13) which was presented at WG-SAM-08. The paper outlined methods that could be used by SCIC with respect to the identification of vessels which did not comply with the CCAMLR data reporting requirements. The Working Group recommended that the authors of WG-SAM-08/13 continue to develop a series of data quality metrics in conjunction with the Secretariat during the intersessional period, and report progress to WG-SAM. The Working Group noted a standardised approach, whereby the Secretariat reported to the Working Group on the results of an agreed set of data tests, would be worthwhile.

Assessments to be carried out and assessment timetable

4.19 The Working Group considered the preliminary assessments for the fisheries for *C. gunnari* in Subarea 48.3 (WG-FSA-08/28) and Division 58.5.2 (WG-FSA-08/56). It was agreed that these assessments would be reviewed during the meeting, and the information used to develop the management advice for these fisheries.

4.20 The Working Group reviewed the fisheries for *Dissostichus* spp. in Subarea 48.3, Division 58.5.2 and in the Ross Sea and agreed, under the current arrangement for multi-year management, that no new assessments for these fisheries were necessary this year.

ASSESSMENT AND MANAGEMENT ADVICE

New and exploratory fisheries in 2007/08 and notifications for 2008/09

5.1 In 2007 the Commission agreed to seven exploratory longline fisheries for *Dissostichus* spp. in the 2007/08 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 2007/08. Activities in the exploratory fisheries are outlined below and summarised in Tables 5 and 6.

5.2 Notifications for new and exploratory fisheries in 2008/09 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, for an exploratory trawl fishery for *E. superba* in Subarea 48.6, and for new pot fisheries for crab in Subareas 48.2 and 48.4.

5.3 In addition, one Member notified its intention to fish for crabs in Subarea 48.3 in 2008/09 in accordance with Conservation Measure 52-01 (see paragraph 5.173).

5.4 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.

5.5 Unstandardised CPUE data for *Dissostichus* spp. caught in exploratory longline fisheries between 1996/97 and 2007/08 are summarised in Table 8.

5.6 Under Conservation Measure 41-01, each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. in 2007/08 was 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 three fish per tonne in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b (Table 9). In 2007/08, 5 228 *Dissostichus* spp. were reported to have been tagged and released in the exploratory longline fisheries (Table 10), and 261 tags were recovered (Table 11).

Notification for new fisheries for crabs in Subareas 48.2 and 48.4

5.7 One Member (Russia) and one vessel notified their intention to conduct new pot fisheries for crabs in Subareas 48.2 and 48.4 in the 2008/09 season.

5.8 The Working Group recalled that the crab fishery had been carried out in Subarea 48.3 in 1992, 1995, 1996 and 2002, targeting mainly *Paralomis spinosissima* and *P. formosa*. Annual catches have been around 250 to 300 tonnes, with one vessel participating each year. The fishery was conducted using strings of standard crab pots with 60 to 169 pots in each string (mean number 120 pots per string). Pot soak time ranged from 14 to 74 hours, averaging 30 hours. By-catch of finfish never exceeded 9% (mean by-catch was 1.4%). The main by-catch species was *Dissostichus* spp.

5.9 The Working Group noted that no crab fishery has ever been attempted in Subareas 48.2 and 48.4. Noting the issues to be considered in addition to the requirements for the crab fishery discussed below, the Working Group considered that the existing Conservation Measures 52-01 and 52-02 for the crab fishery in Subarea 48.3 could be used as a template to develop an experimental harvest regime for crabs in Subareas 48.2 and 48.4 should they proceed. All aspects of Conservation Measures 52-01 and 52-02 should be applied to conservation measures developed for Subareas 48.2 and 48.4 with the exception of modifications suggested below:

(i) two scientific observers should be present, including at least one international scientific observer;

(ii) the season 2008/09 should be defined as the period from 1 December 2008 to 30 November 2009, or until the catch limit is reached, whichever is sooner.

5.10 The Working Group had no information on which to calculate the sustainable yield for crab fisheries in Subareas 48.2 and 48.4. In the absence of scientific data, the Working Group carried out some comparative calculations based on available information about potential habitat and crab densities, noting that catches for new and exploratory fisheries are only to be as great as that needed to acquire information that would lead to assessments of stock status.

5.11 The following paragraphs outline the special considerations for the proposed crab fishery in each subarea.

Subarea 48.2

5.12 The Working Group noted that there is no information on which to determine a catch limit for crabs in Subarea 48.2 as there is no information on the types of species or abundances that might form the basis of a sustainable fishery. The Working Group considered that an approach consistent with assigning catch limits in exploratory toothfish fisheries would be appropriate, i.e. the catch should be at a nominally low level to provide for doing research on stock distribution and abundance and for helping determine strategies that will lead to an assessment of stock status and sustainable harvest strategies. It agreed that, should the crab fishery proceed in this subarea in the 2008/09 season, the experimental regime adopted for Subarea 48.3 would be appropriate with a catch limit in the order of 250 tonnes.

5.13 Consistent with the experimental harvest regime for crabs in Subarea 48.3, the regime for this subarea would mean that, at the start of fishing operation in Subarea 48.2, every vessel shall expend 200 000 pot hours of effort within a total area defined by 12 blocks of 0.5° latitude by 1.0° longitude (Figure 2). The vessel shall not expend more than 30 000 pot hours in any single block of 0.5° latitude by 1.0° longitude. For each string, pot hours shall be calculated by taking the total number of pots on the string and multiplying that number by the soak time (in hours) for that string. Soak time shall be defined for each string as the time between start of setting and start of hauling.

5.14 The vessel shall not fish outside the area delineated by the 0.5° latitude by 1.0° longitude blocks or continue to fish once the experimental regime had been completed prior to the results of the survey being analysed by WG-FSA.

5.15 The Working Group noted that by-catch of finfish may be problematic in this fishery because of the closure of Subarea 48.2 to the capture of finfish during commercial operations until such time as a survey of finfish had been undertaken and the results analysed by WG-FSA. However, this was not considered to be a problem if the fishery only undertook the experimental regime with no further fishing until the methods for managing by-catch could be assessed by WG-FSA.

5.16 All by-catch of finfish during the experimental fishing regime shall be recorded for length, identified to species and then released to the sea with the least possible handling.

Before the release, all specimens of *Dissostichus* spp. shall be measured and tagged. Full biological data should be taken from dead finfish by-catch and they should be returned to the sea.

Subarea 48.4

5.17 The Working Group recommended that every vessel participating in the crab fishery in Subarea 48.4 in the 2008/09 season should conduct fishing operations in accordance with an experimental harvest regime. This regime would mean that at the start of fishing in Subarea 48.4, every vessel should expend approximately 30 000 pot hours of effort distributed amongst the seven island groups (Figure 3) with no more than 4 500 pot hours in any single island group. For each string, pot hours should be calculated by taking the total number of pots on the string and multiplying that number by the soak time (in hours) for that string. Soak time should be defined for each string as the time between start of setting and start of hauling.

5.18 The vessel shall not fish outside the area of the seven island groups mentioned above (Figure 3) prior to the results of the fishery being analysed by WG-FSA.

5.19 The area of seabed shallower than 500 m in Subarea 48.4 is 2 107 km^2, compared to 42 400 km^2 in Subarea 48.3. On a strictly pro-rata basis this would suggest a catch limit of 79.5 tonnes in Subarea 48.4. However, information from the longline fishery in Subarea 48.4 (WG-FSA-08/46) suggested that in the north of the subarea (north of 57°30'S) the crab catches are likely to be present at lower densities in the south than the north, and that therefore the potential habitat in the north of the subarea should be halved. Additionally, available data on crab by-catch in the longline fishery show that CPUE for crabs in the north is roughly one-third of the CPUE from longline fisheries around South Georgia. Given these considerations, and the fact that there is no information on crabs in Subarea 48.4 south of 57°30'S, the Working Group agreed that should the crab fishery proceed in this subarea, the experimental regime would be appropriate with a precautionary catch limit of 10 tonnes (Table 12).

5.20 All by-catch of finfish during the experimental fishing regime shall be recorded for length, identified to species and then released to the sea with the least possible handling. Before the release, all specimens of *Dissostichus* spp. shall be measured and tagged. Full biological data should be taken from dead finfish by-catch and they should be returned to the sea.

Progress towards assessments of exploratory fisheries

Development of advice on catch limits for *Dissostichus* spp.

Divisions 58.4.1 and 58.4.2

5.21 WG-FSA-08/63 examined expected tag-recapture rates in new and exploratory *Dissostichus* spp. fisheries in the southern Indian Ocean sector. In particular, the paper considered the potential for tagging programs in new and exploratory fisheries to yield sufficient data to be of use in determining catch limits in the early stages of fishery development. Scenarios were developed using a range of tag-release rates, tag-detection rates, natural mortality, fish movement out of the fishery, and IUU removals in order to estimate the expected numbers of tag-returns. Even under 'worst-case' assumptions (e.g. lower detection rates, higher tag mortality, high levels of emigration and high IUU) tag-recaptures were still expected to be considerably higher than currently observed in Divisions 58.4.1 and 58.4.2. The paper concluded that if current tag-recapture rates continue, then tag-based assessments of stock status in Divisions 58.4.1 and 58.4.2 are likely to remain uncertain in the short to medium term, and fishing should remain focused in areas where tag-releases have been concentrated until these uncertainties can be addressed.

5.22 Progress on assessing the exploratory fishery in Divisions 58.4.1 and 58.4.2 was presented in WG-SAM-08/4 and a summary was provided in Annex 7, paragraphs 3.1 to 3.5. WG-SAM recommended that WG-FSA use the methods described in this paper to provide management advice for the *Dissostichus* spp. fishery in this division, once a number of modifications had been made (Annex 7, paragraph 4.3). WG-SAM also recommended that tagging be continued at the current rate in these divisions.

5.23 An updated assessment of the exploratory fisheries in Divisions 58.4.1 and 58.4.2, including the minor modifications requested by WG-SAM, was provided in WG-FSA-08/43 (paragraphs 4.12 and 4.13). The authors compared estimates of abundance for these areas using four methods: comparative CPUE trends, local depletions, a constant recruitment model and mark–recapture data. Recapture rates were so low that a reliable stock assessment based on these data was not possible, and instead they presented estimates of the number of expected tag-returns given the estimated biomass. Estimates of biomass by SSRU were moderately consistent between CPUE comparisons and local depletion methods. However, the predicted estimates of tag-recaptures were much higher than those observed. The paper provided tentative estimates of precautionary yield from Divisions 58.4.1 and 58.4.2, noting that these are substantially lower than the existing catch limits.

5.24 The Working Group noted that the full uncertainty in the longline CPUE in the two areas had not been incorporated into the assessment (paragraphs 4.12 to 4.14). For the purposes of providing advice on potential catch limits for the open SSRUs in Divisions 58.4.1 and 58.4.2, a further analysis was carried out which incorporated the uncertainty in CPUE into the biomass estimates for the SSRUs obtained using the comparative CPUE method detailed in WG-FSA-08/43. SSRU-specific yield calculations were calculated assuming an exploitation rate of 0.05 (which appears to be a sustainable exploitation rate for the assessed *Dissostichus* spp.) multiplied by the biomass estimate. Estimates of yield were also made for SSRUs 5841C, 5842A and 5842E based on depletion-derived biomass estimates. These are the only SSRUs for which depletion estimates were available over several years, from which the most recent best-fit depletion was selected. Yields were calculated separately for the median, 25 percentile and 75 percentile biomass values for each SSRU. The results of the analysis are presented in Table 13.

5.25 The Working Group also noted that the estimates of yield were based on 2006/07 season data and did not include legal and IUU catches from the 2007/08 season.

5.26 Dr L. Pshenichnov (Ukraine) noted that the estimation of fished areas of Divisions 58.4.1 and 58.4.2 has not been corrected for the closed SSRUs of Divisions 58.4.1 and 58.4.2. He noted that the assumption that CPUE is proportional to toothfish density is not correct for a longline fishery, and that this leads to an increase in the uncertainty of the analysis. He further noted that the biomass of toothfish was estimated by means of an unknown constant (the catchability) (WG-FSA-08/43). Catchability of longline as a whole, and longlining of toothfish in particular, is unknown and should not be used for biomass estimation. He also considered that catches of immature (1–4 years old) fish in Division 58.4.2 (WG-FSA-08/23) using bottom trawls are similar to those found in other subareas which suggests that recruitment and biomass of fish in this division is also similar to those subareas. This is inconsistent with the summary of WG-FSA-08/43.

5.27 Dr Constable noted that Dr Pshenichnov was correct in stating that the estimates of biomass related only to the open SSRUs. He also noted that juveniles were caught in a fishery rather than a random trawl survey and therefore the distribution of juvenile fish is not known. Dr Agnew noted that CPUE does reflect local density to some extent, as shown by depletion work. He disagreed that CPUE is not proportional to abundance, particularly at catches which are way lower than saturation levels. The Working Group noted that a key issue was in understanding the catchability of new fishing techniques, not of known gear types.

5.28 The Working Group also reflected on the expected IUU removals for that area, calculated at an order of magnitude higher than expected yields. It commented these calculations might require careful review, in particular the CPUE assumptions.

5.29 The Working Group considered that although the estimates of yield from the analysis were uncertain, the results suggested that the size of the *Dissostichus* spp. population in these two divisions was likely to be small and that the current catch limits were unlikely to be sustainable. The Working Group therefore recommended that the catch limits be reduced in each of the open SSRUs in Divisions 58.4.1 and 58.4.2 to the estimates of yield based on the median biomass estimates provided in Table 13. The Working Group also recalled the work of WG-SAM which considered that catches of 10 tonnes were unable to provide useful information to enable the assessment of a stock except in circumstances of well-designed research programs testing clear hypotheses (Annex 7, paragraph 4.6). Therefore, the Working Group further recommended that SSRUs with a yield of less than 20 tonnes be closed to fishing.

Dissostichus spp. Division 58.4.1

5.30 Four Members (Republic of Korea, Namibia, Spain and Uruguay) and six vessels fished in the exploratory fishery in Division 58.4.1 in 2007/08. The precautionary catch limit for toothfish was 600 tonnes, of which no more than 200 tonnes could be taken in SSRUs C, E and G. The five other SSRUs (A, B, D, F and H) were closed to fishing, and research fishing was permitted with a limit of 10 tonnes of *Dissostichus* spp. and one vessel per SSRU. Fishing was prohibited in depths less than 550 m in order to protect benthic communities. Information on this fishery is summarised in Appendix D.

5.31 The total catch of *Dissostichus* spp. (mostly *D. mawsoni*) reported so far in 2007/08 was 413 tonnes. SSRU G was closed on 30 January 2008 when the catch approached the *Dissostichus* spp. limit of 200 tonnes in that SSRU (final reported catch in that SSRU was 197 tonnes). Research fishing was conducted by Spain in SSRUs D (reported catch:

10 tonnes), F (reported catch: 3 tonnes) and H (reported catch: 10 tonnes). Although the closure date of the fishery is currently under review, the fishery is expected to close on 30 November 2008. Information on IUU activities indicated that 94 tonnes of toothfish were taken in 2007/08.

5.32 A total of 1 134 toothfish were tagged and released in the 2007/08 season, and six tagged toothfish were recaptured during that season (Tables 9 and 11).

5.33 Six Members (Japan, Republic of Korea, New Zealand, South Africa, Spain and Uruguay) and a total of 13 vessels notified their intention to fish for toothfish in Division 58.4.1 in 2008/09 (Table 7a).

5.34 The Working Group considered the preliminary assessment of *Dissostichus* spp. discussed in paragraphs 5.21 to 5.29. It recommended that the catch limits be reduced in each of the open SSRUs in Division 58.4.1 to the estimates of yield based on the median biomass estimates provided in Table 13. The Working Group further recommended that SSRUs with a yield of less than 20 tonnes be closed to fishing (paragraph 5.29).

Dissostichus spp. Division 58.4.2

5.35 Two Members (Republic of Korea and Namibia) and three vessels fished in the exploratory fishery in Division 58.4.2 in 2007/08 and the reported catch was 124 tonnes. The fishery remains open until 30 November 2008. The precautionary catch limit for toothfish was 780 tonnes, of which no more than 260 tonnes could be taken in SSRUs A, C and E. Two other SSRUs (B and D) were closed to fishing. Fishing was prohibited in depths less than 550 m in order to protect benthic communities. Information on this fishery is summarised in Appendix E.

5.36 The fishery targeted *D. mawsoni* and operated in SSRUs A, C and E in 2007/08. There was no evidence of IUU fishing in 2007/08.

5.37 A total of 673 toothfish were tagged and released in 2007/08 and there have been no recaptures of tagged toothfish (Tables 10 and 11).

5.38 Six Members (Australia, Japan, Republic of Korea, New Zealand, Spain and Uruguay) and a total of nine vessels notified their intention to fish for toothfish in Division 58.4.2 in 2008/09.

5.39 The Working Group considered the preliminary assessment of *Dissostichus* spp. discussed in paragraphs 5.21 to 5.24. It recommended that the catch limits be reduced in each of the open SSRUs in Division 58.4.2 to the estimates of yield based on the median biomass estimates provided in Table 13. The Working Group further recommended that SSRUs with a yield of less than 20 tonnes be closed to fishing (paragraph 5.29).

Dissostichus spp. Division 58.4.3a

5.40 One Member (Uruguay) and one vessel fished in the exploratory fishery in Division 58.4.3a in 2007/08. The precautionary catch limit for toothfish was 250 tonnes and the reported catch was 9 tonnes. The fishery was closed on 31 August 2008. Information on this fishery is summarised in Appendix F.

5.41 There was no evidence of IUU fishing in 2007/08.

5.42 A total of 41 toothfish was tagged and released in 2007/08 and two tagged toothfish were recaptured during that season.

5.43 One Member (Japan) and one vessel notified their intention to fish for toothfish in Division 58.4.3a in 2008/09.

5.44 Progress on assessing the exploratory fishery in Division 58.4.3a was presented in WG-SAM-08/5 and a summary was provided in Annex 7, paragraphs 3.6 to 3.8. WG-SAM recommended that WG-FSA use the methods described in this paper to provide management advice for the *Dissostichus* spp. fishery in this division (Annex 7, paragraph 4.4).

5.45 The Working Group considered that there was less uncertainty about using the tagging information in Division 58.4.3a compared with Divisions 58.4.1 and 58.4.2. The reason for this was that, given the number of releases and catch levels (both legal and IUU), if the observed number of tags was an underestimate (e.g. there should have been 10 recaptures rather than the five observed) then there would be a very large chance that the population in the division over the period of the tag experiment would have to have been effectively removed by fishing. The Working Group agreed that this is not the case and this provided some confidence in using the tagging data to estimate population size in this division.

5.46 The preliminary stock assessment detailed in WG-SAM-08/5 employed a biomass dynamic surplus production model to assess the status of the stock, using the release (199) and recapture data (5) for 2005 and 2006 respectively, as well as legal and illegal catches for this division. Resultant stock size estimates were then used to estimate long-term yields (using the CCAMLR decision rules) under four different assumptions about the additional uncertainty in future stock dynamics, beyond that already accounted for in the stock assessment. This gave a range of potential long-term yields: 113, 105, 103 and 86 tonnes, which encompassed a wide-range of future stock dynamic uncertainty assumptions (two recapture probability models (binomial and normal) and three different values for future process error).

5.47 The catch limit for Division 58.4.3a for the 2007/08 fishing year was 250 tonnes. The Working Group agreed that the assessment suggested that this level of catch was not sustainable and that the catch limit for this division be reduced to a level in the range of 86 to 113 tonnes.

Dissostichus spp. Division 58.4.3b

5.48 Three Members (Japan, Namibia and Uruguay) and three vessels fished in the exploratory fishery in Division 58.4.3b in 2007/08, and Australia (one vessel) conducted a scientific research survey. In November 2007, the division was divided into two SSRUs: A north of 60°S; and B south of 60°S. The precautionary catch limit for *Dissostichus* spp. in the fishery was 150 tonnes in SSRU A and SSRU B was closed to fishing. In addition, fishing was not permitted from 16 March 2008 until the end of the notified research survey or 1 June 2008, whichever was sooner. An additional catch limit of 50 tonnes was provided for the research survey in SSRUs A and B. Information on this fishery is summarised in Appendix G.

5.49 The fishery operated in SSRU A and reported a total catch of 139 tonnes of *Dissostichus* spp. (93% of the precautionary catch limit for the fishery); the fishery was closed on 20 February 2008, prior to the start of the notified research survey. The research survey was conducted in May 2008 and a total of 2 tonnes of *Dissostichus* spp. was reported from SSRUs A and B (see also WG-FSA-08/57).

5.50 Information on IUU activities indicated that 246 tonnes of toothfish were taken in 2007/08.

5.51 A total of 417 toothfish was tagged and released in 2007/08, and one tagged toothfish was recaptured during that season.

5.52 Three Members (Japan, Spain and Uruguay) and three vessels notified their intention to fish for toothfish in Division 58.4.3b in 2008/09.

5.53 In 2007, an analysis of longline CPUE was carried out in Division 58.4.3b using a Leslie depletion analysis (SC-CAMLR-XXVI, Annex 5, paragraph 5.7). A random longline survey was carried out in this division by Australia in May 2008 (paragraph 3.32). WG-FSA-08/57 concluded that catch rates of *Dissostichus* spp. were very low, consistent with toothfish being depleted to low densities across the surveyed area. It also noted that only very large *Dissostichus* spp. were present in the area and the only tag-recapture reported for this division in 2007/08 occurred during the survey.

5.54 Dr Ichii questioned whether the sample size of 15 random stations was sufficient to elucidate the stock status of the area. For example, there are strata of both higher and lower density in the area and he expressed concern that the sample size was not large enough to cover both types of strata. For example, one of the important preferred fishing grounds used by a Japanese vessel (58°S 76–78°E) was not covered. He also noted that the CV from the survey was very large. He further considered that it was important to compare commercial CPUE data from the 2007/08 fishing season with that of previous years, and questioned why the commercial CPUE data had not been analysed this year.

5.55 In response, the authors of WG-FSA-08/57 noted that the survey was conducted following a randomised design, and at a scale that was agreed by the Scientific Committee, which was considered appropriate given the concern about the status of the stock (SC-CAMLR-XXVI, paragraphs 4.146 to 4.148 and 9.10). The randomised design gives a more accurate indication of average catch rates across the survey area, which was one of the main objectives of the survey. The precision of the average catch rate was not reported in WG-FSA-08/57 but was further calculated during the Working Group meeting using the methods described in Candy (2004) which gave an approximate 95% confidence bound for *D. mawsoni* of between 17 and 60 kg/thousand hooks. This indicates that catch rates can be considered small relative to other areas such as Subarea 88.1.

5.56 The authors of WG-FSA-08/57 further explained that as the survey strata and sampling stations were allocated to depths where commercial fishing occurs, and broadly covering two of the three main areas were the commercial fishery has concentrated in the past (WG-FSA-07/44), there is no clear reason how the low catch could be an artefact of either the survey design or the level of fishing effort. Furthermore, the gear and crew of the FV *Janas* has a proven track record for catching at rates comparable to other autoliner vessels in the toothfish fisheries in both Division 58.5.2 and Subarea 88.1, and that this data could be used to standardise the catch rates in the survey.

5.57 The Working Group agreed research has shown the following:

(i) Based on fishing information until last year, the fisheries across BANZARE Bank show that the preferred fishing grounds were depleted in the Southern Area (adopted by WG-FSA-07, resulted in the closure of the Southern Area).

(ii) Based on the survey and fisheries across BANZARE Bank, there are very few fish apart from in the preferred fishing grounds.

(iii) The fish found in the preferred fishing grounds are large and likely spawning, there are no small fish and fish are male dominated (79%).

(iv) In the survey, the fish are large and mostly male.

(v) Spawning fish in East Antarctica have only been found on BANZARE Bank (WG-FSA-07/44 and paragraph 3.32).

5.58 The Working Group noted that only two of the three preferred fishing grounds in the area were covered by the random survey. However, the random nature of the survey implies the area was adequately covered. Japan noted it would have liked to see the third preferred fishing grounds surveyed and a larger number of stations sampled to provide a more robust estimate of biomass. The Working Group recommended that WG-SAM should look at how to design longline surveys and in particular with regards to how to deal with preferred fishing grounds, and how to reconcile datasets from different types of fishing gear. It also referred to paragraphs 5.75 to 5.78 which deal with the design of survey research.

5.59 The Working Group was unable to provide management advice on catch limits in this division.

Dissostichus spp. Subarea 48.6

5.60 Four Members notified their intention to fish in the exploratory fishery in Subarea 48.6 in 2007/08; however, to date, none fished and the fishery remains open until 30 November 2008. The precautionary catch limit for *Dissostichus* spp. was 400 tonnes and information on this fishery is summarised in Appendix H.

5.61 The fishery has operated predominantly in SSRU A and the main species caught is *D. eleginoides* over the course of the fishery. SSRU A was divided into A and G in November 2007 (see Conservation Measures 41-01).

5.62 There was no evidence of IUU fishing in 2007/08.

5.63 A total of 366 toothfish have been tagged and released since 2003/04, and a total of five tagged toothfish have been recaptured (Tables 10 and 11).

5.64 Two Members (Japan and Republic of Korea) and a total of three vessels notified their intention to fish for toothfish in Subarea 48.6 in 2008/09 (Table 7a). Dr Ichii noted that Japanese-flagged vessels would begin fishing in this subarea in late October 2008.

5.65 The Working Group noted that there are still very few tag-recaptures from Subarea 48.6, and that no progress could be made on assessments of *D. eleginoides* in this subarea. The Working Group recommended the tagging rate be increased to three toothfish per tonne, in line with other new and exploratory areas with low information.

Dissostichus spp. Subareas 88.1 and 88.2

5.66 In 2007/08, eight Members (Argentina, Republic of Korea, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and 15 vessels fished in the exploratory fishery in Subarea 88.1. Fishing was restricted due to sea-ice and vessels fished between December 2007 and early March 2008; no research fishing was conducted. The fishery was closed on 31 August 2008 and the total reported catch of *Dissostichus* spp. was 2 259 tonnes (84% of the catch limit) (CCAMLR-XXVII/BG/15, Table 2). During the course of fishing, SSRUs B, C and G were closed on 19 December 2007, triggered by the catch of *Dissostichus* spp. (total catch 259 tonnes; 83% of the catch limit). The IUU catch for the 2007/08 season was estimated to be 187 tonnes. Information on this fishery and management advice is summarised below (paragraphs 5.88 to 5.107).

5.67 Nine Members (Argentina, Chile, Republic of Korea, 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 2008/09.

5.68 Four Members (New Zealand, Russia, UK and Uruguay) and four vessels fished in the exploratory fishery in Subarea 88.2. Fishing was restricted due to sea-ice and vessels fished in February and March 2008; no research fishing was conducted. The fishery closed on 31 August 2008 and the total reported catch of *Dissostichus* spp. was 416 tonnes (73% of the limit) (CCAMLR-XXVII/BG/15). SSRU E was closed on 1 February 2008, triggered by the catch of *Dissostichus* spp. (total catch 333 tonnes; 98% of the catch limit). There was no evidence of IUU fishing in 2007/08. Information on this fishery and management advice is summarised below (paragraphs 5.88 to 5.107).

5.69 Nine Members (Argentina, Chile, Republic of Korea, New Zealand, Russia, South Africa, Spain, UK and Uruguay) and a total of 19 vessels notified their intention to fish for *Dissostichus* spp. in Subarea 88.2 in 2008/09.

5.70 The Fishery Report for *Dissostichus* spp. in Subareas 88.1 and 88.2 is contained in Appendix I. By-catch limits of *M. whitsoni* were decoupled from the catch limits of target species based on estimates of biomass for Subarea 88.1 (section 4.2). Current move-on rules were retained.

5.71 In accordance with the advice of the Scientific Committee in 2007, the assessment for Subareas 88.1 and 88.2 was not updated. The Working Group agreed that the management advice on catch limits for Subareas 88.1 and 88.2 could be carried forward from last year (see also paragraphs 5.88 to 5.97).

5.72 The Working Group noted that the move to a biennial assessment of *D. mawsoni* had allowed resources to be directed to other important tasks related to evaluating the toothfish assessment. For example, the development, over the last year, of a spatial population model which could be used to carry out MSE work on aspects such as movement and tagging in the toothfish fisheries, and the review of aspects of the management of the fishery. Biennial assessments are considered further in paragraphs 12.6 and 12.7. The Working Group also agreed that a specific data collection plan could be developed for the fishery.

5.73 The Working Group recommended an additional SSRU in the region to the west of 170°E in the western Ross Sea including Terra Nova Bay and McMurdo Sound (i.e. SSRU 881J west) be created. It further recommended that this SSRU should be closed to fishing because of its importance as a corridor for sub-adult toothfish moving between the shelf and the northern area to spawn.

5.74 The Working Group also recommended that the catch limits for SSRUs 881J (east of 170°E) and 881L be combined. It noted that combined catch limits for these SSRUs would need to be revised based on the reduced seabed areas and CPUE estimates for this region, and that this could be calculated during the week of the 2008 meeting of the Scientific Committee if this recommendation was endorsed.

Development of methods to assess exploratory fisheries in the future

Data requirements for assessing exploratory fisheries

5.75 The Working Group considered that the key requirements for assessing a fish stock are knowledge of stock structure, productivity (natural mortality, age, growth, size at maturity), and abundance. The Working Group then reviewed the data that are required from the fishery to be able to carry out an assessment. This included catch, effort, sex/length (and age) distribution, tags, CPUE and other biological data. It considered that there are a number of issues associated with these data including:

- data quality control and/or weighting of input data;
- representativeness of the data;
- biases associated with data;
- general uncertainty;
- constant *q* in extrapolation of CPUE (the fishery is not uniform, but has high spots and low spots);
- variable units of effort (e.g. number of hooks in trotlines);
- priorities in data collection.

5.76 The Working Group focussed its discussion on estimates of abundance, which is seen as the main issue for exploratory fisheries – particularly those in the Indian Ocean sector (Divisions 58.4.1, 58.4.2 and 58.4.3b) as well as Subarea 48.6. The generally very low recapture rate of tags from these areas has been discussed above. In contrast, the Working Group noted that tag experiments in other areas, such as Subareas 88.1, 88.2, 48.3 and 48.4, have proved more successful and have enabled stock assessments. However, the Working Group noted that even in Subarea 88.1, the very low tag-recapture rates from the tag-releases of some vessels still needed to be addressed (e.g. SC-CAMLR-XXVI, Annex 5; WG-SAM-08/7). The Working Group then reviewed reasons why some of the tagging programs had been more successful than others.

5.77 The Working Group considered the following issues were important in tagging programs: spatial distribution of tags and subsequent fishing effort, number of tags released, shedding rates, mortality of tagged fish, detection rates, consistent fishing vessels and non-compliance with the tagging program.

5.78 The Working Group considered that one of the most important aspects of a tagging program was the spatial distribution of tags and fishing effort. It was recognised that toothfish tend to move only short distances over the first 1–2 years, and that it may take several (five or more) years for toothfish to mix through the population. Therefore, for a tagging program to be effective in the short term, it was necessary for tagging and subsequent fishing effort to be carried out over the same areas. Plots of tag-releases and fishing effort from the tag experiments in Subareas 48.3, 48.4, 88.1 and 88.2 generally show good overlap between tag-releases and subsequent fishing effort (e.g. SC-CAMLR-XXVI; WG-FSA-08/46). It was noted that spatial population models could potentially address some of the tag spatial mixing issues, but that they required considerably more data than were currently available in the southern Indian Ocean sector fisheries. It was also noted that vessels in Subarea 88.1 often tended to catch their own tags as they had their own fishing locations, and that this may lead to higher recapture rates in that area.

5.79 To determine whether the spatial mismatch between tags and subsequent fishing effort was a possible reason for the lack of tag-recaptures in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, the Working Group reviewed the annual distribution of tags and subsequent fishing effort in these areas. The results suggested reasonably good overlap of where the tags were released and where the effort was subsequently carried out, and so spatial overlap was not a problem.

5.80 The Working Group also agreed that the tagging rate had to be sufficiently high to ensure reasonable recoveries of tags to achieve a precise estimate of abundance. An approach for estimating the number of tags required to give a predicted abundance CV was summarised in Annex 7, paragraphs 3.9 and 3.10. Approximate initial estimates of stock size (and hence required number of tag-releases) could be estimated by comparing relative CPUE in the fishery with that derived from the same vessels fishing in Subareas 88.1 and 88.2, from which the tagging rate and catch limit can be adjusted. It was noted that strong heterogeneity in fish abundance within an area is likely to be an issue.

5.81 Tagging rate per vessel was plotted against time to check whether tagging was carried out at the same rate as fishing in accordance with Conservation Measure 42-01. The results were very variable, with some vessels tagging at the correct rate throughout fishing, whilst other vessels initially released very few tags and the tagging rates sharply increased in the middle or at the end of the fishing period (Figure 4). The Working Group was concerned that relatively high tagging rates over very short periods of time could be detrimental to the condition of the fish on release, and was not consistent with the required spreading of tagged fish throughout the area. The Working Group recommended this issue be referred to SCIC and noted attention might need to be drawn to the conservation measure and changes made last year to address this issue.

5.82 The Working Group agreed that in the absence of reliable tagging data, an alternative approach is required for developing stock assessments in the short term. The only other data currently available for developing stock assessments in these areas is CPUE. The Working Group noted CPUE had been used in both depletion studies and by comparison of CPUE between areas in Divisions 58.4.1 and 58.4.2 (paragraphs 5.22 to 5.24). However, there is concern that the CPUE estimates used for such analyses are not directly comparable. This is particularly the case when different vessels are fishing in different locations in different years. The Working Group noted that the fishing design used in Subareas 48.3 and 48.4 for spreading tags and fishing effort across the area would also provide unbiased estimates across the area.

5.83 The Working Group recalled that there is a requirement for vessels fishing in exploratory fisheries to carry out up to 20 research sets, which must have a minimum distance of 5 n miles. However, some of the lines being fished are up to 40 km long which makes the 5 n mile minimum distance ineffective as an effort-spreading mechanism. The Working Group considered that an alternative might be to have a more structured research fishing plan, fishing in a more systematic pattern with shorter lines analogous to the experimental design used for the crab fishery in Subarea 48.3. When first entering the fishery, fishers must carry out experimental research fishing within a number of squares before the commercial phase of the fishing can proceed (Conservation Measure 52-02).

Research designs in exploratory toothfish fisheries

5.84 Issues when considering research designs in exploratory fisheries were considered by WG-SAM (Annex 7, paragraphs 4.1 to 4.9). It recommended WG-FSA consider defining specific research plans, including set positions, and consistent gear configurations. It also noted that in regard to the use of the 10 tonne research exemption, a vessel's operational characteristics should be well known, it should set many short lines, and the positions of the line should be determined prior to the research starting.

5.85 In addition to the discussion outlined above, the Working Group examined the question of how to use research results from these surveys in assessments. Longline research has been very difficult to use because of the non-reproducibility, non-overlap of vessels etc. Standards must be set on how to carry out research, design work and trials have to be carried out prior to further work being done. One main issue is the catchability coefficient (*q*) between vessels, and how it can be determined. This is a particular issue when comparing between different gear methods (e.g. Spanish line, autoline, trotline) (WG-FSA-08/44), as well as within the trotline method which is also very variable between vessels.

5.86 An additional approach is to use data from other areas to extrapolate between areas. This would give an understanding of how variable CPUE might be between years or vessels.

CPUE always needs to be standardised. A more prescriptive and standardised pattern of fishing might be helpful in obtaining representative data, and could include grid fishing with a prescriptive number of hooks etc.

5.87 The Working Group recommended that vessels entering a new SSRU in Subareas 48.6 and 58.4 should be required to carry out 10 research sets with a maximum hook number of 5 000 (as part of Conservation Measure 41-01) on a stratified random basis through prescribed areas within that SSRU before carrying out their commercial fishing. Sets would be carried out on, or close to, supplied positions within strata based on fishable area where that information is available. Alternate positions could be supplied to replace any positions that were unfishable for any reason. It considered that the prescribed areas could be identified and random positions generated during the week of the 2008 meeting of the Scientific Committee if it agreed to this recommendation. It also considered that, if carried out annually by the same vessels, the research sets could be used to develop a time series of relative abundance indices.

Review of the management of *Dissostichus* spp. in Subareas 88.1 and 88.2

5.88 WG-FSA-08/50 focused on the management of the Ross Sea toothfish fishery and summarised the management and conduct of the fishery up to the 2004/05 fishing year (prior to the start of the three-year experiment). This included the reasons why the three-year experiment was initiated and the key objectives of the experiment. The operational changes which formed the framework of the three-year experiment, and the success and/or any problems associated with each of those changes, were reviewed. Key operational and research objectives for the fishery in relation to Article II of the Convention were identified, including uncertainties in our current knowledge which need to be addressed to fulfil the requirements of Article II. These include, for example, uncertainty in the biological parameters and stock assessment of *D. mawsoni*, uncertainty in its ecological relationships with predators and prey, and uncertainty over other ecosystem effects of fishing.

5.89 The paper concluded that the three-year experiment has been very successful, because it has led to an improved stock assessment of *D. mawsoni* and allowed development of techniques for monitoring by-catch species and other potential ecosystem effects of the fishery. The additional move to a biennial assessment of toothfish in 2006/07 has also allowed resources to be redirected into the development of a spatial population model and other research, which will be important for future MSE of the toothfish fishery. WG-FSA-08/50 strongly encouraged the adoption of an operational framework for the medium term (next 3–5 years) which would allow good quality data to be gathered on a stable and consistent basis.

5.90 The paper recommended the following minor changes to the operational framework to meet the science and management objectives of the fishery:

(i) Retain existing network of open and closed SSRUs in Subareas 88.1 and 88.2, and, in addition, consider creating an additional SSRU in the region to the west of 170°E in the western Ross Sea including Terra Nova Bay and McMurdo Sound (i.e. SSRU 881J west).

(ii) Retain the current amalgamation of SSRU catch limits and, in addition, consider amalgamation of catch limits for SSRUs 881J (east of 170°E) and 881L.

(iii) Readjust proportional catch limits in these revised SSRUs based on revised seabed areas and new CPUE.

(iv) Modify research exemption for closed SSRUs (Conservation Measure 24-01). Instead of 10 tonnes for each SSRU for each year, focus on research experiments lasting 2–3 years in a specific SSRU with 60 tonnes per year[4]. Retain tagging at a minimum of three tags per tonne for each year of the experiment. Ensure an appropriate gap (e.g. 5–10 years) between such experiments in the same SSRU to minimise the impact.

(v) Allow retention of catch limits for toothfish and by-catch species for 'out of season' experiments in open SSRUs.

(vi) Continue with biennial assessments of *D. mawsoni* in the two subareas.

(vii) Develop specific data collection plan and research plan for the Subarea 88.1 and 88.2 fisheries.

5.91 The Working Group thanked New Zealand for carrying out this work, and noted that considerable progress had been made on the stock assessment for *D. mawsoni* in Subareas 88.1 and 88.2.

5.92 Some members expressed concern at the level of research fishing that could be carried out in some of the closed SSRUs as a result of recommendation (iv). They were also concerned that this could unduly impact on the assessment if effort were spread too widely. However, it was pointed out that this level of catch (and associated effort) is already available to be fished in the closed SSRUs under the research exemption. The Working Group agreed that it was important that any changes to the operational framework should not impact unduly on the current stock assessment.

5.93 There was disagreement amongst members in the Working Group over the network of open and closed SSRUs.

5.94 Some members considered that the network of open and closed SSRUs should be retained because they considered that progress in the stock assessment had been assisted by the concentration of effort within the open SSRUs. They agreed that recommendations (i), (ii) and (iii) should be implemented. They considered that recommendation (iv) should be modified slightly so that the tonnage available under a research exemption would need to be evaluated on a case-by-case basis, would be subject to review by WG-FSA (in accordance with the survey standards developed in paragraphs 5.84 to 5.87) and be for no more than a maximum of 60 tonnes. They noted that this increased catch should only be available for a period of up to two years after which that SSRU would remain closed for an appropriate time period (e.g. 5–10 years). They also noted that this would replace the 10 tonne research exemption which is currently in place in each closed SSRU.

4 Note 60 tonnes is the sum of the 10 tonne research exemptions from the six closed SSRUs in Subareas 88.1 and 88.2.

5.95 Dr Pshenichnov considered that the three-year experiment had been unsuccessful because it had not led to an improved stock assessment of *D. mawsoni* in these subareas. In particular, the experiment had led to a lack of data from closed SSRUs, the inability to recapture tagged fish which had moved to closed SSRUs, and the inability to tag fish in closed SSRUs. He noted that there were no data on the distribution and size composition of toothfish and on the rate of by-catch (catch composition) in those SSRUs. He considered that the absence of these data meant that the data for use in the stock assessment was incomplete, and that he had drawn this fact to the attention of the Scientific Committee and Commission each year.

5.96 Dr K. Shust (Russia) also expressed doubts over the success of the three-year experiment on toothfish tagging in the Ross Sea. Several sources of substantial uncertainty of stock assessments of toothfish in the Ross Sea based on the tag-returns were pointed out (WG-SAM-08/8). The first source is the absence of data from the closed SSRUs. Another source comes from taking into account tag-returns from the New Zealand fishery only, which operates from year to year within restricted areas of the Ross Sea and adjacent waters. Together, these sources may result in considerable underestimation of toothfish biomass and catch limit in the Ross Sea. Taking into account the reasons mentioned above, continuation of the toothfish tagging program should not be further confined to open SSRUs. The uncertainties related to the current tagging schedule may be amplified even further under three- or five-year experiments of toothfish fishery management. Taking all this into account, Dr Shust suggested that the Scientific Committee consider the possibility of opening all closed SSRUs in order to distribute the fishing effort across the entire area of the fishery.

5.97 The Working Group recommended that the relative merits of the different views on harvest strategies and research programs for toothfish in the Ross Sea (paragraphs 5.89 and 5.94 to 5.96) be evaluated using simulations (see Annex 7, paragraphs 5.1 to 5.6). It recommended that such work be submitted to WG-SAM for review of the simulation and assessment methodologies before submitting the outcomes to WG-FSA for consideration.

Management advice

5.98 The Working Group considered that although the estimates of yield from the analysis were uncertain, the results suggested that the size of the *Dissostichus* spp. population in Divisions 58.4.1 and 58.4.2 was likely to be small and that the current catch limits were unlikely to be sustainable. The Working Group therefore recommended that the catch limits be reduced in each of the open SSRUs in these two divisions to the estimates of yield based on the median biomass estimates provided in Table 13 (paragraph 5.29).

5.99 The catch limit for Division 58.4.3a for the 2007/08 fishing year was 250 tonnes. The Working Group agreed that the assessment suggested that this level of catch was not sustainable and that the catch limit for this division be reduced to a level in the range of 86 to 113 tonnes (paragraph 5.47). The Working Group was unable to provide management advice on catch limits in Division 58.4.3b (paragraph 5.59).

5.100 The Working Group agreed that measures in the research and data collection plans, including the requirement to tag toothfish at the rate of three toothfish per tonne, be retained for the exploratory fisheries in Subarea 58.4 (paragraph 5.22). It further noted that if there are improvements in the release and recapture of tags in these subareas, then these data could form the basis of an assessment in the short to medium term.

5.101 The Working Group recommended that vessels entering a new SSRU in Subareas 48.6 and 58.4 should be required to carry out 10 research sets with a maximum hook number of 5 000 (as part of Conservation Measure 41-01) on a stratified random basis through prescribed areas within that SSRU before carrying out their commercial fishing. Sets would be carried out on, or close to, supplied positions within strata based on fishable area where that information is available. Alternate positions could be supplied to replace any positions that were unfishable for any reason. It considered that the prescribed areas could be identified and random positions generated during the week of the 2008 meeting of the Scientific Committee if it agreed to this recommendation (paragraph 5.87).

5.102 The Working Group was unable to provide further management advice regarding catch limits in Subarea 48.6. It noted that there are still very few tag-recaptures from Subarea 48.6. The Working Group recommended that the tagging rate be increased to three toothfish per tonne, in line with other new and exploratory areas with low information (paragraph 5.65).

5.103 The Working Group agreed that the management advice on catch limits for *Dissostichus* spp. in Subareas 88.1 and 88.2 could be carried forward from last year. However, it noted that it would be expected that the assessment be updated next year.

5.104 The Working Group recommended new catch limits for *Macrourus* spp. in Subarea 88.1 based on the advice given in paragraphs 6.16 to 6.22.

5.105 The Working Group considered the New Zealand proposal on the future management of the *Dissostichus* spp. fishery in Subareas 88.1 and 88.2 but was unable to provide consensus advice on the issue of maintaining the network of open and closed SSRUs in these subareas.

5.106 However, the Working Group recommended an additional SSRU in the region to the west of 170°E in the western Ross Sea, including Terra Nova Bay and McMurdo Sound (i.e. SSRU 881J west) be created, and that this SSRU should be closed to fishing (paragraph 5.73).

5.107 The Working Group also recommended that the catch limits for SSRUs 881J (east of 170°E) and 881L be combined, and noted that the combined catch limits be revised based on the reduced seabed areas and CPUE estimates for this region (paragraph 5.74).

Notifications to conduct research surveys using commercial vessels under Conservation Measure 24-01

Proposal by New Zealand to conduct winter research in Subarea 88.1

5.108 WG-FSA-08/62 presented an application by New Zealand to undertake scientific research during the austral winter in CCAMLR SSRUs 881B, C and G in 2008/09, as the first in a possible three-year time series. The proposal is for a targeted longline survey designed to cover critical gaps in the knowledge of the life cycle of *D. mawsoni* in the Ross Sea by collecting biological samples from a broad spread of locations across the northern Ross Sea (where toothfish are expected to spawn) during the austral winter. The survey is designed to collect information that should assist in the understanding of the early life history and reproduction of *D. mawsoni* in the Ross Sea region, and addresses key questions identified at the 2007 CCAMLR meeting (SC-CAMLR-XXVI, paragraph 4.48; SC-CAMLR-XXVI, Annex 5, paragraphs 3.64 to 3.67). In addition, tag data collected is likely to provide additional information on the timing of the spawning movements of mature *D. mawsoni* and residence times in the northern area.

5.109 The survey proposes to collect data to allow the testing of three scientific hypotheses and has six additional scientific objectives. The results of the research will contribute to an improved understanding of the Ross Sea *D. mawsoni* stock structure, and, in the longer term, lead to improved estimates of length/age of maturity and proportion of mature fish that spawn. Data collected during the survey will provide information that is likely to directly influence future assessments of *D. mawsoni*. The proposed research is in accordance with existing conservation measures, proposes a tagging rate of at least three toothfish per tonne (usually one fish per tonne in this region), and proposes to have two scientists on board (including the option for an international scientist) in addition to the two scientific observers.

5.110 The paper requested that a catch of 150 tonnes, equating to approximately 4 600 fish, be allocated from the northern area (SSRUs 881B, C, G) catch limit of 313 tonnes to allow this research to be conducted. This figure is based on an estimation of the numbers of fish required to investigate the spawning characteristics and maturity cycle, for the investigation of within-season movement, and takes into account the logistical constraints for carrying out the proposed research in this area and at this time of year.

5.111 The Working Group agreed that the immediate results of the research were unlikely to have a direct impact on the assessment in the coming year. However, most members of the Working Group agreed that the survey would provide important information on the reproductive biology and early life history of *D. mawsoni*. They noted that the results from the survey by themselves would not provide estimates of length-at-maturity or proportion of mature fish spawning because the survey will only show what proportion are spawning in the ice-free area. However, they agreed that the maturity status, histological characteristics, and GSI data would all help to further define the developmental cycle of *D. mawsoni*, which was necessary before the length-at-maturity and proportion spawning could be resolved (paragraphs 3.72 to 3.76).

5.112 The Working Group also expressed concern over the size of the proposed catch. Dr S. Mormede (New Zealand) noted that part of the reason for the large tonnage being proposed was the large average weight of toothfish in that area (32 kg) rather than a large number of toothfish proposed to be caught. The numbers required to be scanned for tags and sampled reproductively had been calculated using a power analysis. She noted that it had been estimated that about 3 000 toothfish would need to be scanned in SSRU 881C alone during the survey in order to recover nine tags, with further scanning required in SSRU 881B. Similarly, Dr S. Parker (New Zealand) noted that these numbers of fish were required to be sampled for maturity status so that the lower tail of the length distribution could be adequately sampled. The Working Group noted that a total of 500 fish ovaries and testes would actually be retained and later examined for histological analysis.

5.113 Dr Constable questioned how the survey would help CCAMLR. He considered that the impact of collecting the proposed data on the assessment should first be evaluated through simulations. He noted that this would address some members' concerns regarding the proposed size of the catch. He also questioned the impact on the assessment if these fish were removed during the winter instead of during the traditional summer fishery.

5.114 The Working Group noted that there was no process to determine how a catch may be set aside for this type of research fishing:

(i) Dr Ramm noted the importance of the catch limit in this area for vessels first entering the Ross Sea fishery in December each year, and that in most years all the catch limit in this region was taken.

(ii) One approach would be to subtract the catch from the catch limit at the start of the following season but the Working Group requested the assessment subgroup to look at the impact this would have on the assessment and catch allowance. Dr S. Hanchet (New Zealand) reported that Mr A. Dunn (New Zealand), who carries out the Ross Sea stock assessment, indicated that removal of the catch six months earlier than in the model would have very little impact on the assessment (estimated to be up to a couple of tonnes to the yield on the 35-year projection).

(iii) Another approach suggested by the Working Group was to tender the research out so that other Members had the opportunity to bid for the research (paragraphs 5.75 to 5.83).

5.115 Dr R. Holt (USA) noted that because it is a multi-year proposal, the removal of catch from the northern SSRUs at this time of the year may have more of an impact on the assessment. Dr Agnew noted that the Ross Sea toothfish fishery is still in the fishing-down phase, so the impact of the removal of a small additional catch at this time would be less critical.

Proposal by Japan to conduct a research survey in Division 58.4.4

5.116 Japan submitted a notification to conduct scientific research in 2008/09 (WG-FSA-08/39). The notification is to continue research on the distribution and population structure of toothfish in Divisions 58.4.4a and 58.4.4b started in 2007/08. The survey vessel will again use trotlines and has requested a catch limit of 120 tonnes of toothfish. The notification falls under paragraph 3 of Conservation Measure 24-01. 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 at the rate of three toothfish per tonne 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.

5.117 Dr Ichii noted that research last year suggested that length composition data showed juvenile and adult toothfish in abundance, and that CPUE was twice as high as that used to initially set the catch limit of 103 tonnes. He noted that fishing efficiency of trotlines is expected to be a little higher than that of other longline systems. However, if trotlines were twice as efficient as other longlines, then all vessels would be using trotlines. The research indicated that the stock status might not be in poor condition, and that further research is required for a robust assessment. Dr Ichii also noted that data from a single-year survey are not enough to provide a reliable assessment of fish stocks and that at least three years of survey data are indispensable to provide better temporal coverage. It is proposed that coverage be extended to include depths shallower than <500 m in Ob and Lena Banks to assess more recent recruitment. Regarding the total catch, in order to obtain an appropriate sample size, and considering the economical feasibility, Japan proposed setting a catch limit of 30 tonnes for each SSRU, thus the total catch limit would be 120 tonnes. He further noted that regulated fishing in this division will also monitor and deter IUU vessels.

5.118 Dr Kock asked whether data on the recruitment and recruitment variability of *D. eleginoides* could be obtained from data collected by Ukraine during its trawl fishery in this area. Dr Pshenichnov replied that these data are available on paper but not electronically.

5.119 The Working Group agreed that the research might lead to population estimates if a robust research procedure is in place. It noted that the fishery was closed in 2002 because it was thought that the population had become depleted after high levels of IUU fishing (SC-CAMLR-XXI, paragraph 4.106). Dr Agnew questioned if it would be possible to not only estimate current population size, but also to estimate the level of depletion of the population with regards to initial biomass. He suggested that one approach could be to carry out simulation studies including the tag-recaptures and size-composition data. The Working Group agreed that thought should be given within the next year to methods to be used to understand population depletion in addition to its current size, and potential recovery.

5.120 The Working Group noted that before advice is given to the Scientific Committee, it needed to be confident that the research is not going to impede the recovery of the stock. It needed to see how the data are going to be used, standardised, and how stock status and trajectory can be determined using these data. Importantly, an understanding of how to appropriately use CPUE from trotlines is needed. It was also considered that if the same gear was used as had been used previously in the fishery, then an answer would be much faster to obtain. In this regard, it also noted that the catch limit when the fishery was closed was 103 tonnes, and that a catch proposal of 120 tonnes seemed excessive.

5.121 Dr Ichii thanked the Working Group for its useful comments. He stressed, however, that length-composition data and CPUE indicate the stock status might not be in poor condition, and that further research is required for a robust assessment.

General principles for CCAMLR-sponsored research

5.122 The Working Group considered the general principles and requirements to be met for CCAMLR-sponsored research. It noted that such research:

(i) would be designed to support the Commission in its work to achieve the objectives in Article II;

(ii) needs to be consistent with the precautionary approach of CCAMLR;

(iii) should not undermine initiatives taken in other parts of CCAMLR or in other parts of the Antarctic Treaty System, such as species protection, closed areas and/or ASPAs and ASMAs;

(iv) under such direct sponsorship, could involve, *inter alia*:

(a) special catch allocations from a catch limit to undertake research;

(b) research exemptions to existing conservation measures provided for in Conservation Measure 24-01;

(c) coordination of data acquisition and field programs through the CCAMLR Secretariat;

(d) special requirements to be undertaken by all Members during fishing operations.

5.123 The Working Group noted from the previous experience for designing the CCAMLR-2000 Survey and other work done under the auspices of CCAMLR, that the following steps would be involved in developing and utilising CCAMLR-sponsored research:

(i) Preparation:

(a) Demonstrate need of the research –

It was noted that 'need' can be determined from the consequences that the research will have for the Commission in achieving the objectives in Article II, e.g. is a catch limit too high (conservation objectives may not be met) or too low (conservation may not be an issue and more catch is possible) and not likely to be corrected using the existing process, and would the advice to the Commission be improved by the research? Analyses could be used to help demonstrate need, including management strategy evaluation, power analyses, and/or draft assessments using plausible datasets that may be obtained from research.

(b) Develop a research design to address the need –

It will be important to identify the data needed to be collected to resolve the issue, including the spatial and temporal sampling required, and the number of samples needed to achieve the accuracy and precision of the estimate required.

(c) Evaluate whether there may be short- or long-term effects of the research plan on current advice to the Commission –

It was noted that while the research is being undertaken, the quality of the current advice may be altered. The degree to which that would impact on the Commission achieving its objectives will need to be considered.

(d) Identify the necessary standards to be met during data collection –

Such standards will need to include specifying the data quality requirements (e.g. tagging), vessel and observer capability and standards, survey design and implementation.

(e) Determine any specific requirements to be met for implementing the research program –

Such requirements will include consideration of prospective participants (Members, fishing vessels, research vessels), how the participation will be managed, establishing a capability to meet standards, determining the contribution required from CCAMLR (catch allocation, requirements in conservation measures, research exemptions, Member contributions) and requirements of observers and vessels.

(ii) Implementation.

(iii) Analysis of results.

(iv) Provision of advice to the Commission.

5.124 The Working Group agreed that these would be useful and requested the Scientific Committee consider whether these guidelines could be used for establishing CCAMLR-sponsored research programs.

Dissostichus eleginoides South Georgia (Subarea 48.3)

5.125 The Fishery Report for *D. eleginoides* in Subarea 48.3 is contained in Appendix J.

5.126 Following the advice of the Scientific Committee, the assessment was not updated in 2008.

Management advice

5.127 The Working Group recalled that the Commission had agreed that the catch limit for toothfish in Subarea 48.3 (SGSR stock) should be 3 920 tonnes in each season for the 2007/08 and 2008/09 fishing seasons (CCAMLR-XXVI, paragraph 13.54). No assessment was conducted this year and there is no change to the catch limit agreed for the 2008/09 season.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

5.128 The Fishery Report for *D. eleginoides* in Division 58.5.1 is contained in Appendix K.

5.129 The catch of *D. eleginoides* reported for this division to 31 August 2008 was 2 853 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2007/08 season was zero inside the French EEZ. Some IUU fishing may occur outside the EEZ as reported in WG-FSA-08/10 Rev. 2.

5.130 The CPUE standardisation for Division 58.5.1 was not updated by the Working Group.

Management advice

5.131 The Working Group encouraged the estimation of biological parameters for Kerguelenand the development of a stock assessment for this area. It 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 stocks 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.

5.132 The Working Group recommended that avoidance of fishing in zones of specific high rates of by-catch should also be considered.

5.133 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.

5.134 The Working Group noted that France had made significant progress in mitigating by-catch, including area/season closures (SC-CAMLR-XXVI, 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)

5.135 The Fishery Report for *D. eleginoides* in Division 58.5.2 is contained in Appendix L.

5.136 Following the recommendation by the Scientific Committee, the toothfish assessment for *D. eleginoides* in Division 58.5.2 was not updated. The Working Group noted that the *D. eleginoides* stock assessment in this division will be updated in 2009.

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 2008/09 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 October 2008 was 684 tonnes. Only longlining is currently permitted in the fishery. The estimated IUU catch for the 2007/08 season was zero inside Subarea 58.6 as reported in WG-FSA-08/10 Rev. 2.

5.140 The CPUE series for this fishery was not updated by the Working Group.

Management advice

5.141 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.

5.142 The Working Group recommended that avoidance of zones of high by-catch abundance should also be considered.

5.143 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.

5.144 The Working Group noted that France had made significant progress in mitigating by-catch, including area/season closures (SC-CAMLR-XXVI, 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)

5.145 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 inside the South African EEZ is contained in Appendix N.

5.146 The catch limit of *D. eleginoides* in the South African EEZ for the 2007/08 season was 450 tonnes for the period from 1 December 2007 to 30 November 2008. The catch reported for Subareas 58.6 and 58.7 as of 5 October 2008 was 61 tonnes, all of which was taken by longlines. The IUU catch for the 2007/08 season was assumed to be equal to the IUU catch in 2004/05 at 156 tonnes.

5.147 The CPUE series was not updated by the Working Group in 2008.

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

5.148 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

5.149 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)

5.150 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Appendix O.

5.151 In the 2007/08 fishing season the catch limit set for *C. gunnari* in Subarea 48.3 was 2 462 tonnes. During the 2007/08 season the fishery caught 1 326 tonnes by the end of October 2008. The fishery remains open until 14 November 2008 and it is anticipated that the full catch will be taken.

5.152 In April 2008 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-08/28). The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

5.153 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 2008 survey.

5.154 All input parameters for the assessment remained unchanged from 2007.

Management advice

5.155 The Working Group recommended that the catch limit for *C. gunnari* should be set at 3 834 tonnes in 2008/09 and 2 631 tonnes in 2009/10 based on the outcome of the short-term assessment.

Champsocephalus gunnari Heard Island (Division 58.5.2)

5.156 The Fishery Report for *C. gunnari* in Division 58.5.2 is contained in Appendix P.

5.157 The catch limit of *C. gunnari* in Division 58.5.2 for the 2007/08 season was 220 tonnes for the period from 1 December 2007 to 30 November 2008. The catch reported for this division as of 5 October 2008 was 199 tonnes.

5.158 A large 2+ 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 2008.

5.159 The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass from the 2008 survey. All other parameters were the same as in previous years.

Management advice

5.160 The Working Group recommended that the catch limit for *C. gunnari* in 2008/09 be no more than 102 tonnes.

5.161 The Working Group recommended that other measures in the conservation measure be retained.

Assessment and management advice for other fisheries

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

5.162 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.

5.163 The last three estimates of fish biomass in Subareas 48.1 and 48.2 were obtained in February–March 2006 (Antarctic Peninsula) (Jones and Kock, 2006), December 2006–January 2007 (Elephant Island and the lower South Shetland Islands) (Kock et al., 2007) and in February–March 1999 around the South Orkney Islands (Jones et al., 2000). Results from these surveys do not indicate that fish biomass had increased to the extent that a reopening of the fishery should be considered.

5.164 A new trawl survey will be undertaken in Subarea 48.2 by the US AMLR Program with international participation in February–March 2009.

Management advice

5.165 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)

5.166 The Working Group considered the results of the three-year mark–recapture experiment conducted in the Northern Area of Subarea 48.4 (Conservation Measure 41-03). Between 2005/06 and 2007/08, a total of 929 *D. eleginoides* were tagged and released in Subarea 48.4 and 25 tagged fish were recaptured, including 23 fish in 2007/08 (Appendix Q). The experiment has allowed a preliminary assessment of *D. eleginoides* in the Northern Area, and the vulnerable biomass was estimated to be between 1 000 to 2 000 tonnes (WG-FSA-08/46).

5.167 The Working Group also considered the UK's proposal to continue the mark–recapture experiment in Subarea 48.4 in 2008/09 so as to allow for a full assessment of *D. eleginoides* in the Northern Area in 2009. Additionally, the UK proposed to commence a mark–recapture experiment in the Southern Area of Subarea 48.4 (Figure 5), with the aim of collecting data required for the assessments of the population structure, size, movement and growth of both *D. eleginoides* and *D. mawsoni* in the Southern Area of Subarea 48.4.

5.168 The main elements of the proposal, which is described in WG-FSA-08/48, include:

Northern Area –

(i) a catch limit of 75 tonnes for *D. eleginoides*;

(ii) the continued prohibition of the taking of *D. mawsoni* other than for scientific research purposes;

(iii) the introduction of catch limits for by-catch species, with a limit for macrourids of 12 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 4 tonnes (5% of the catch limit for *D. eleginoides*).

Southern Area –

(i) a catch limit of 75 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined) in the Southern Area;

(ii) the introduction of a move-on rule for by-catch species, with a macrourid trigger set at 16% of the catch of *Dissostichus* spp., and a trigger for rajids set at 5% of the catch of *Dissostichus* spp.

5.169 The Working Group congratulated the UK on this initiative, noting that the three-year mark–recapture experiment and new proposal for 2008/09 provides a staged approach to the assessment of *Dissostichus* spp. in Subarea 48.4. This approach illustrates how new data may be added to existing information to develop assessments in areas where the status of stocks was previously unknown.

5.170 The Working Group noted that last year one *D. eleginoides* which had been tagged in Subarea 48.4 was recaptured in the eastern sector of Subarea 48.3. No fish have yet been detected moving from Subarea 48.3 to 48.4. Dr Agnew advised that the tagging data and genetic samples collected in Subareas 48.3 and 48.4 will be analysed by the UK to determine the relationship between these populations.

Management advice

5.171 The Working Group endorsed the proposed extension to the mark–recapture experiment (paragraph 5.168) and the catch limit of 75 tonnes in the Northern Area and 75 tonnes in the Southern Area. The Working Group agreed that the research undertaken in Subarea 48.4 had been conducted in a manner that allowed the controlled development of a robust assessment of the stock. It also noted that the UK had provided detailed proposals and annual reports throughout the duration of the experiment. Although the catch limit for *D. eleginoides* proposed for 2008/09 in the Northern Area is 50% higher than the estimated sustainable yield (50 tonnes) (see WG-FSA-08/46), this would provide improved precision for a CASAL-type assessment of the subarea when combined with the data from the previous three years of the experiment, and would be consistent with the overall objectives of the research.

5.172 In addition, ad hoc WG-IMAF recommended amending Conservation Measure 24-02 in order to align the mitigation requirements for Subarea 48.4 with the IMAF risk assessment, such that daytime setting would be permitted if bottle tests are undertaken, and the fishing season be extended to run from 1 December to 30 November (Annex 6, paragraph 9.10).

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

5.173 Crabs were not exploited in the 2007/08 season. Russia notified the Commission of its intention to fish for crabs in this subarea during the 2008/09 season. It indicated its intention to conduct fishing operations in accordance with conditions specified under Conservation Measures 52-01 and 52-02.

Management advice

5.174 The Working Group recommended that the existing Conservation Measures 52-01 and 52-02 on crabs remain in force.

Squid (*Martialia hyadesi*) (Subarea 48.3)

5.175 Squid were not exploited in the 2007/08 season. No proposal for the harvest of squid has been received by CCAMLR for the 2008/09 season.

Management advice

5.176 The exploratory fishery on squid was subject to Conservation Measure 61-01. No new information on the species was available. The Working Group recommended that the conservation measure remain in force.

FISH AND INVERTEBRATE BY-CATCH

6.1 The Working Group agreed that discussions on this agenda item would be restricted to issues related to fish by-catch and identification guides.

6.2 The Working Group identified the following areas of particular interest for the 2008 meeting:

(i) review of by-catch in longline and trawl fisheries in the CAMLR Convention Area;

(ii) the efficacy of the changes to Conservation Measure 33-03 (the move-on rule for macrourid by-catch in new and exploratory fisheries);

(iii) implementation of the Year-of-the-Skate in the forthcoming season;

(iv) macrourid by-catch limits for Subarea 88.1;

(v) by-catch mitigation;

(vi) benthic by-catch guides.

Estimation of by-catch in longline fisheries

6.3 Fine-scale data (C2) estimates of total removals of by-catch species reported from longline fisheries within the CAMLR Convention Area during the 2007/08 season are shown in Table 14. By-catch limits were not reached for any species, although limits were approached for some species. The numbers and fate of *Dissostichus* spp., macrourids, rajids and 'other species' reported in 2007/08 in fine-scale data are detailed in Table 15.

Rajids

6.4 Reported retained rajid by-catch (as a percentage of *Dissostichus* spp. catch) in longline fisheries within the Convention Area in 2007/08 was low (<4% *Dissostichus* spp.), except in those areas where almost all rajids are retained and processed (French EEZs: Division 58.5.1 and Subarea 58.6). The Working Group noted that only 4 tonnes of *Dissostichus* spp. were caught in Division 58.4.3a, with a rajid by-catch of 2 tonnes.

6.5 With the exception of the French EEZs and Subarea 58.4, a large proportion of the skates were cut off lines in most regions.

6.6 The total catch of skates was estimated by summing the numbers caught and released (Table 15) and multiplying by the mean weight of skates caught in each subarea derived from corresponding C2 data (Table 16). The Working Group noted that many skates survive being cut off lines and that the estimates in Table 16 represent a 'worst-case scenario' in which released skate suffered 100% mortality.

6.7 Estimates of total catches of rajids in each area (Table 16) were all below the corresponding area catch limits. Estimates of total catch were 83% of the catch limit in Subarea 48.3, 35% in Division 58.5.2 and 53% in Subarea 88.1.

Macrourids

6.8 By-catch rates for macrourids (as a percentage of *Dissostichus* spp. catch) for the 2007/08 fishing season ranged from 1.1 to 15.9%. By-catch limits were not reached in any subarea. The highest catch rates (as a percentage of *Dissostichus* spp.) were in the French EEZs (Division 58.5.1 and Subarea 58.6) and in Subarea 48.4.

6.9 In comparison with the 2006/07 season, the by-catch of macrourids was similar across most areas, with a reduction (as a percentage of *Dissostichus* spp.) in Subareas 48.4 and 58.6.

6.10 The Working Group investigated the effect of the change to the macrourid move-on rule (Conservation Measure 33-03) agreed at last year's meeting (SC-CAMLR-XXVI, paragraph 4.188). The move-on rule was triggered if the catch of *Macrourus* spp. taken by a single vessel in any two 10-day periods in a single SSRU exceeded 1 500 kg and 16% of the *Dissostichus* spp. catch. The new move-one rule was triggered on one occasion (in Subarea 88.1), with 10 instances of the criteria being met in a single 10-day period. Under the previous version of Conservation Measure 33-03, the move-on rule (triggered solely by the *Macrourus* spp. catch exceeding 16% of *Dissostichus* spp.) would have been triggered three times (twice in Subarea 88.1 and once in Subarea 88.2) with 19 instances of the trigger being met in one 10-day period.

6.11 The Working Group noted that the by-catch of *Macrourus* spp. in new and exploratory fisheries had not increased in 2007/08 and recommended that the modified move-on rule be retained.

Other species

6.12 By-catch of other species were generally low (<2% *Dissostichus* spp.). The 36 tonnes attributed to other species in Subarea 48.3 was largely *Antimora rostrata*. The 20 tonnes attributed to other species in Subarea 88.1 was mostly *Muraenolepis* spp.

Estimation of by-catch in trawl fisheries

6.13 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 (C2) data are detailed in Table 17.

6.14 The by-catch in the trawl fishery for *C. gunnari* in Subarea 48.3 was negligible (<0.5% of target species) and similar to 2006/07. The Working Group noted that the fishery is still open and additional low levels of by-catch are likely. In the Division 58.5.2 *C. gunnari* trawl fishery, the by-catch was 9% of the target species, with the main species being *Channichthys rhinoceratus*. In the Division 58.5.2 *D. eleginoides* trawl fishery, the by-catch was 2% of the target species, with macrourids and *A. rostrata* the main by-catch species.

6.15 The Working Group noted the brief information given in WG-FSA-08/23 about the by-catch of juvenile *D. mawsoni* in krill trawls in Division 58.4.2 in 1987 and 1989. The Working Group agreed that information collected in that fishery between 1975 and 1990 would be valuable to the work of CCAMLR. Dr Pshenichnov reported that a large amount of information was available in paper records, but funding was needed to digitise the data.

Precautionary catch limits for *M. whitsoni* in Subarea 88.1

6.16 WG-FSA-08/32 presented estimates of biomass and yield for grenadiers for the Ross Sea fishery (Subarea 88.1 and SSRUs 882A–B). The Working Group welcomed the concept of decoupling by-catch limits from those of target species and agreed to use estimates of biomass for Subarea 88.1, noting that SSRUs 882A–B are currently closed.

6.17 The Working Group noted that the CV of the biomass estimate was 0.3, and agreed that it was appropriate to use the γ value calculated assuming a CV of 0.5 for the estimate of B_0.

6.18 The Working Group agreed to use the constant density assumption when extrapolating the biomass estimate across the slope region, noting that this would provide a more precautionary estimate of yield than one based on extrapolations using longline CPUE data. The resulting biomass estimate for SSRUs 881H, I and L was 21 401 tonnes which gave a yield estimate of 388 tonnes.

6.19 The Working Group noted that the estimated biomass in the paper covered depths from 600 to 2 000 m which included all of SSRUs 881H, I and K, but also extended into small parts of the shelf SSRUs 881J and L. The Working Group therefore agreed that the estimate of grenadier yield of 388 tonnes needed to be apportioned across these five SSRUs.

6.20 Historic catches in SSRUs 881J and 881L have tended to be small (WG-FSA-08/22), and so the proposed catch limits were set slightly higher than the maximum catches in these SSRUs. The remaining yield was placed into the slope SSRUs 881H, I and K.

6.21 No new data were available on grenadier biomass in SSRUs 881B, C and G. The Working Group agreed to reduce the existing catch limit of 50 to 40 tonnes for this region. The biomass estimate for SSRUs 882A–B was 5 491 tonnes which gave an equivalent yield estimate of 100 tonnes.

6.22 The Working Group recommended that the existing move-on rules be retained, but agreed to review macrourid by-catch limits and catches on an annual basis.

Skate biology

6.23 WG-FSA-08/20 presented updated biological parameters for the starry skate (*Amblyraja georgiana*) and proposed minor updates to the observer maturity guide. WG-FSA-08/21 presented revised age and growth estimates for starry skates, with slower early growth and greater longevity (28–37 years compared with 6–11 years). The Working Group noted that the new data was consistent with other studies of cold-water skates. It also noted the lack of validation and recommended validation work be undertaken. The Working Group noted that it would be useful to utilise common methodology and reading methods for skates throughout the CAMLR Convention Area and recommended that the CCAMLR Otolith Network (CON) be tasked with coordinating this.

Macrourid mitigation measures

6.24 WG-FSA-08/52 presented preliminary trials on the use of artificial bait to reduce macrourid by-catch in the longline toothfish fishery. Results show there might be a slight improvement in by-catch in some areas, and further trials are to be carried out. The Working Group noted that there might not be any biological reason why artificial bait is less attractive to macrourids. The Working Group considered the potential environmental impact of introducing artificial bait to the CCAMLR region, but recognised the bait is a macerated form of the usual bait (mackerel).

Year-of-the-Skate

6.25 The Working Group noted the Scientific Committee's endorsement of the Year-of-the-Skate in the 2008/09 season (SC-CAMLR-XXVI, paragraphs 4.181 to 4.184). The Year-of-the-Skate will apply to all *Dissostichus* spp. fisheries in the Convention Area, with a tagging program focused on new and exploratory fisheries. The Working Group also noted the Scientific Committee's recommendation that, during the Year-of-the-Skate, all skates be brought on board prior to release (see paragraphs 6.28 to 6.31).

Skate identification

6.26 The Working Group noted that skate identification remains an issue, particularly with regard to rare species and in specific areas. For instance, WG-FSA-08/13 reported two putative new species of *Bathyraja* spp. from the Crozet Archipelago. The Working Group welcomed the new identification sheets developed for Division 58.5.2 (WG-FSA-08/55).

6.27 The Working Group noted the value of obtaining tissue samples for genetics and voucher specimens of skates from a range of species in different areas.

Skate capture and handling

6.28 WG-FSA-08/30 reviewed the methods of handling skates on a New Zealand autoliner and demonstrated that bringing skates on board was potentially quicker than cutting them off in the water, with less incidence of injury to the skate. This procedure also provided better tag detection and species identification, and allowed assessment of the condition of the skate. The Working Group noted that such results would be dependent on the vessel and crew and the specific procedures used for skate release.

6.29 The Working Group noted that there is no clear scientific evidence that bringing skates on board (or alongside) the vessel improved survival, but noted that bringing skates on board would enable a better assessment of the condition of the skate and permitted improved scanning for tagged fish. The Working Group therefore recommended that, during the Year-of-the-Skate, all skates caught be brought on board or alongside the hauler to be scanned for tags and for their condition to be assessed.

6.30 The Working Group further recommended that, during the Year-of-the-Skate, all vessels assess the state of all captured skates, scan for tags and retain all skates in condition 1 (dead) or 2 (with life-threatening injuries). For skates in condition 3 (alive, with injuries serious enough to possibly reduce survival) or 4 (alive and in good condition), the skate should be released by cutting the snood as close to the hook as possible or cutting the snood and removing the hook from the skate, providing this does not further damage the skate.

6.31 The Working Group recommended that the efficacy of this approach be reviewed during its meeting in 2009.

6.32 The Working Group recommended that, during observation periods, the observer be tasked with assessing the condition of all skates to investigate the likelihood of survival and to scan for tags. These survival data would then be scaled to the total catch to get an estimate of skate removals, whilst tag-detection rates during the observation periods could be compared to those outside the observation period.

Changes to logbooks

6.33 WG-FSA-08/49 presented the New Zealand skate-tagging experiments in 2007/08 and proposed updates to the protocol and logbook for the Year-of-the-Skate. The Working Group recommended a simplification of the forms to reduce the risk of double-reporting of skates.

6.34 The Working Group recommended that the observer logbook be updated to improve ease of recording, capture information required for the Year-of-the-Skate, and make the logbook flexible to accommodate specific by-catch sampling. The Working Group recommended amendments to the form L5 to capture likelihood of survivorship of skates and the removal of form L11 (where that information was previously recorded). It also recommended small changes to form L6 to permit the recording of the biological, tagging or recapture details of any species.

Skate tagging protocols

6.35 The Working Group noted that a primary goal of the Year-of-the-Skate was the establishment of a skate tagging program in new and exploratory fisheries and noted that skate tagging programs are already operational in Subarea 48.3 and Division 58.5.2.

6.36 The Working Group considered the tagging rates necessary to achieve an estimate of biomass. The Working Group employed the methodology detailed in WG-SAM-08/6 to estimate tagging levels required to give a pre-defined abundance estimate precision in the following year, for a given level of catch and with an approximate estimate of the underlying biomass.

6.37 In the Ross Sea, a very preliminary stock assessment suggested the biomass of skates to be about 6 000 tonnes (SC-CAMLR-XXVI, Annex 7), with around 7 500 skates scanned in an estimated catch of 70 tonnes in 2007/08 (Table 16). Estimates of survivorship (given mean depth at which the fish are taken) and of tag shedding were used to define a tag-associated mortality of 0.41 (a survivorship of 66%). Natural morality was assumed to be 0.15. Using the number of skates tagged per skate caught to define tagging intensity (based on the catch and stock size in 2008), the Working Group investigated three candidate CVs of 0.2, 0.3 and 0.5 (representing accurate to moderately accurate to poor estimates). The model predicts that tagging around 1 in 2, 1 in 5 and 1 in 20 skates would achieve CVs of 0.2, 0.3 and 0.5 respectively.

6.38 The Working Group therefore recommended a tagging rate of 1 in every 5 skates caught in new and exploratory fisheries during 2008/09 up to a maximum of 500 skates per vessel. The tagging program will be coordinated by the Secretariat, which will be the repository for skate tagging kits.

6.39 The Working Group noted that there would be a change in tag type in Subareas 88.1 and 88.2 in 2008/09 (WG-FSA-08/30) and that there is potential to confound population assessments due to differing tag-loss rates through time or differences in tag loss between tag types. The Working Group recommended that in new and exploratory fisheries, skates be double-tagged, with one CCAMLR tag (issued by the Secretariat) in each wing. The Working Group further recommended that, where possible, tagging experiments be undertaken to compare different tag types and estimate tag-shedding rates.

6.40 The Working Group recommended that all skates be measured prior to release. Such information is valuable in reducing the uncertainty about skate growth rates.

Skate biological information

6.41 The Working Group noted the requirement to undertake additional biological sampling on skates during 2008/09, but recognised that observers already have a full workload. The Working Group considered the impact on assessments of reducing the number of *Dissostichus* spp. sampled per line, to permit more skates to be analysed per line.

6.42 Applying simple sampling theory (using the basic square root proportionality relationship between precision and sample size), the Working Group estimated that a reduction in sample size from 35 to 20 *Dissostichus* spp. would result in a reduction in precision of 25% around mean values. The Working Group noted that skates were not caught on all lines, so the actual loss of precision would be less than 25%.

6.43 The Working Group noted that the number of biological samples carried out is proposed to change from 35 per line to one per 150 hooks, and endorsed this recommendation (paragraph 11.4(ii)(e)). Therefore, the Working Group proposed that, when skates are caught on a line, they are randomly sampled at a rate of 3 skates/thousand hooks, with the *Dissostichus* spp. sampling reduced to 4 toothfish/species/thousand hooks. If sufficient numbers of skates are not caught to meet this protocol, it is proposed that the total number of biological samples per line should remain constant with the additional sampling carried out on *Dissostichus* spp. The Working Group recommended that this increased recording of biological information for skates initially be limited to the Year-of-the-Skate, but be reviewed at next year's meeting of WG-FSA.

6.44 The Working Group noted that the only biological information requiring sacrifice of the animal is female maturity stage. Therefore, the Working Group recommended that skates should not be sacrificed for biological sampling, and that female maturity stage only be recorded if the skate is dead or has sustained life-threatening injuries (conditions 1 and 2). All live skates which are part of the biological sampling, which have not sustained life-threatening injuries, should be handled with care and released after biological information has been recorded, if they are still suitable for release (i.e. still in condition 3 or 4).

Identification guides for benthic by-catch

6.45 Following a request from the Scientific Committee (SC-CAMLR-XXVI, paragraph 4.190) for the development of area-specific guides for the identification of benthic organisms, the Working Group welcomed the development of guides to the vulnerable Ross Sea benthic fauna (WG-FSA-08/19) and to the HIMI benthic invertebrates (WG-FSA-08/59). The Working Group also noted that an invertebrate guide has been in use in Subarea 48.3 in recent seasons. The Working Group noted that the Ross Sea guide only includes taxa expected to be included in the vulnerable category, which may change when more information is available. The Working Group noted that a guide that encompassed the whole CCAMLR region would be useful, but agreed that this would be costly to achieve in the short term.

6.46 The Working Group discussed the completeness and appropriateness of current CCAMLR codes for VME-related taxa with respect to the hierarchical detail required for identification purposes. The Working Group noted that codes for some taxa do not currently exist within CCAMLR and will need to be created. The Secretariat reported that FAO three-letter codes are associated with a full hierarchical alpha-numeric code. For taxa currently without FAO codes, the Secretariat will issue interim codes and request codes from FAO for updating at a later date. The Working Group recommended that VME-related taxa detailed in WG-FSA-08/19 currently without a code be issued with an interim code for the 2008/09 season.

6.47 Noting that the number of 3-alpha combinations is limited (17 576 combinations) the Working Group recommended that the utility of alternative hierarchical taxon identification systems, such as ITIS, be further investigated.

INCIDENTAL MORTALITY OF MAMMALS AND SEABIRDS ARISING FROM FISHING (AD HOC WG-IMAF REPORT)

7.1 The Co-conveners of ad hoc WG-IMAF presented its report (Annex 6) to WG-FSA. The Working Group discussed the following items.

Marine debris

7.2 The Working Group queried if ad hoc WG-IMAF had noted an increase in frequency of bait box packaging bands as debris and if this is becoming a greater problem in the Convention Area. The Co-conveners noted that this was the first year that ad hoc WG-IMAF has had the topic of marine debris on its agenda. It had addressed several issues relating to marine debris, but had not yet been able to undertake a comprehensive assessment of marine debris trends (Annex 6, paragraphs 12.1 to 12.14). Nevertheless, WG-IMAF noted that from the data reported to the Secretariat there had been an increase in occurrence of packaging bands in marine debris and of entangling material on Antarctic fur seals.

Estimating incidental mortality arising from IUU fishing

7.3 Noting that ad hoc WG-IMAF had not estimated incidental mortality arising from IUU fishing this year, the Working Group queried if it would be more appropriate to use more recent estimates of a fishery not using mitigation measures (e.g. the Division 58.5.1 longline fishery prior to its use of seabird mitigation measures) rather than the observed seabird by-catch rates from longline fishing operations in 1996/97 when few vessels used mitigation measures.

7.4 The ad hoc WG-IMAF Co-conveners agreed that this would be useful in considering future estimations of incidental mortality arising from IUU longline fishing. However, the key issue this year is that the vast majority of reported IUU fishing operations were of gillnet gear or vessels, reliable seabird by-catch rates and information for gillnet applications are not available (Annex 6, paragraphs 5.3 and 5.4).

Fishing methods in use in the Convention Area

7.5 The Working Group enquired if the trotline sink rates achieved to date were sufficient to avoid interactions with seabirds. The Co-conveners of ad hoc WG-IMAF noted the review of several papers last year which indicated trotlines sink relatively rapidly beyond the range of foraging seabirds, one study indicating an average of 0.8 m s^{-1} (SC-CAMLR-XXVI, Annex 6, paragraphs II.81 to II.91 and II.100).

7.6 The Co-conveners of ad hoc WG-IMAF noted that, as a result of the work of ad hoc WG-IMAF this year, SC-CAMLR-XXVII/BG/19 included suggested revisions to Conservation Measures 25-02 and 24-02 to incorporate a line-weighting standard for this newer gear application, as well as a protocol for testing the line sink rate (Annex 6, paragraphs 6.11 and 9.15).

7.7 Both WG-FSA and ad hoc WG-IMAF have identified needed information regarding the trotline longline method (Annex 6, paragraphs 6.1, 6.2 and 7.27; paragraph 11.8). Ad hoc WG-IMAF had found the paper reviewing the autoline method extremely useful (WG-FSA-08/60) and had encouraged Members to submit similar reviews on the trotline method of longlining and other fishing methods used in the Convention Area (Annex 6, paragraph 6.2). The Working Group agreed that this was particularly important work across both working groups and an area for continued cooperation.

Cross-cutting issues

7.8 WG-FSA considered the role ad hoc WG-IMAF might have, along with WG-FSA, in progressing a risk-management framework for avoiding significant adverse impacts of bottom fishing gear on VMEs (an approach that has been successfully used by ad hoc WG-IMAF to minimise the risk of fishery mortalities on seabirds).

7.9 The Co-conveners of ad hoc WG-IMAF welcomed that the risk-assessment approach was being considered to address other incidental mortality issues, such as VMEs, but noted that the current expertise within ad hoc WG-IMAF would have to be broadened to include the appropriate expertise for this topic.

7.10 The Working Group noted that one option would be to hold a VME workshop that would draw the needed and appropriate expertise from all working groups of the Scientific Committee (paragraph 10.54).

7.11 The Working Group noted the ongoing utility of coordination and cooperation between WG-FSA and ad hoc WG-IMAF and concurred with the ad hoc WG-IMAF recommendation that the current practices with respect to joint work continue.

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 the JAG matrix for estimating the uncertainty associated with IUU fishing events, and noted that this work will be reviewed by SCIC (WG-FSA-08/10 Rev. 2; see also paragraph 3.16).

8.2 The Working Group also noted that the Secretariat had developed a measure of the local density of licensed vessels (WG-FSA-08/10 Rev. 2; see also paragraph 3.12 and SC-CAMLR-XXVI, Annex 5, paragraphs 8.2 and 8.3).

Review of historical trends in IUU fishing activity

8.3 The Working Group reviewed the catch history of *Dissostichus* spp. taken by IUU fishing in the Convention Area (Table 3 and Figure 1). This time series had been updated using estimates reported in WG-FSA-08/10 Rev. 2.

8.4 The Working Group noted that the number of IUU fishing vessels observed in 2007/08 had declined (paragraph 3.14). However, the IUU fleet is increasingly dominated by gillnet vessels and there is currently no information to estimate the catch of these vessels, or the impact of gillnets on target and by-catch species, seabirds and marine mammals (Figure 6, paragraph 3.13). This matter had been referred to ad hoc WG-IMAF and SCIC.

8.5 In the absence of information on catch rates, the Working Group concluded that the increase in IUU vessels using gillnets indicates that gillnets are likely to be a more efficient method for catching target species, and noted that gillnets do not require bait and allow vessels to operate with fewer crew. Threats arising from the use of gillnets include non-selective fishing, entanglements and ghost fishing.

8.6 The Working Group agreed that further information on the IUU gillnet fleet and the operation of gillnets was urgently required. It urged Members to increase their efforts to document the IUU gillnet activities in the Convention Area and, where feasible, haul operational IUU gillnets or board IUU gillnet vessels and examine the vessels' catches and logbooks in order to gain an understanding of this IUU fishing method.

8.7 WG-FSA noted that ad hoc WG-IMAF had been unable to provide a reliable estimate of the number of seabirds killed as a result of IUU gillnet operations in 2007/08 (Annex 6, paragraphs 5.3 and 5.4).

8.8 The Working Group agreed that the reduction in the number of IUU fishing vessels sighted recently in the Convention Area was not necessarily an indication that total catches and levels of incidental mortality associated with IUU fishing activities had decreased.

BIOLOGY, ECOLOGY AND DEMOGRAPHY OF TARGET AND BY-CATCH SPECIES

Review of information available to the meeting

9.1 Nineteen papers contained information on the biology and ecology of target species in the fisheries (*D. mawsoni*, *D. eleginoides* and *C. gunnari*), by-catch species (skates), past target species (*Chaenodraco wilsoni*), and on food consumption by Antarctic fish in general. Full papers are available on request from the CCAMLR Secretariat and summaries of these documents will be available in the *CCAMLR Scientific Abstracts* and therefore are not repeated here. Ecosystem effects of fishing and interaction between predators (seals, killer whales) and *D. mawsoni* have been dealt with in Annex 4, paragraphs 6.1 to 6.23.

9.2 Following on from requests of the Scientific Committee (SC-CAMLR-XXVI, Annex 5, paragraph 9.10), some progress has been made with respect to stock structure in *D. eleginoides*, and reconstruction of the life history of *D. eleginoides*, while no further progress was noted with respect to a field guide for skates in the Southern Ocean (see below).

Dissostichus mawsoni

9.3 Results from studies on the distribution and abundance of *D. mawsoni* discussed in this section of the agenda were found to be consistent with hypotheses forming the basis of modelling work currently undertaken for the species and discussed in the remit of WG-SAM (Annex 7, paragraph 5.2).

9.4 WG-FSA-08/12 described the size characteristics of *D. mawsoni* and *D. eleginoides* caught in different areas of the Antarctic shelf, as well as characteristics of the maturity level of their gonads and nutrition (see paragraph 3.77).

9.5 The most likely areas where *D. mawsoni* spawn are the Pacific Antarctic Ridge north of the Ross Sea and the Amundsen Ridge in the Amundsen Sea. In the Cooperation Sea the most likely area of spawning is BANZARE Bank. Spawning occurs in winter and may extend into autumn or spring (WG-FSA-08/14).

9.6 The Working Group noted that results confirm the hypotheses that juvenile fish inhabit mostly the shelf, while larger fish live on the slope and pre-spawning fish are found either on their northward spawning migration or inhabit the deeper slope.

9.7 Age estimates of *D. mawsoni* indicated that they live to at least 39 years. Estimated and radiometric ages were in close agreement, confirming age estimation criteria and an annual periodicity of otolith growth zones. Von Bertalanffy growth function parameters indicate *D. mawsoni* are relatively slow growing (k = 0.111; t_0 = –0.605), especially in relation to their maximum size (L_∞ = 158.9 cm) (WG-FSA-08/17) (paragraphs 3.66 and 3.67).

9.8 The predatory nature of *D. mawsoni* from its early age onwards is underlined for various regions of the high-Antarctic in WG-FSA-08/34. Main prey items are fish and squid in larger fish, while juveniles take invertebrates to some extent. Details are provided on how the depth distribution of fish changes when fish grow larger and older.

9.9 The frequency of *D. mawsoni* females with ovaries in maturity stage IV was 1.2–10% in different regions in late summer. The individual absolute fecundity varied from 0.03 to 0.61 million eggs, and relative fecundity from 11.48 to 42.53 eggs. The diameter of the largest trophoplasmatic oocytes varied from 2.8 to 3.15 mm (WG-FSA-08/35).

9.10 The Working Group noted that previous estimates of absolute and relative fecundity have been higher. It appears as if not all mature eggs assumed to be spawned in the previous study are actually spawned. Close cooperation between New Zealand and Russia is envisaged to further elucidate the spawning of *D. mawsoni*.

9.11 WG-FSA-08/41 presented an analysis of stomachs of *D. mawsoni* caught by the longliner *Yantar* using the Spanish longline method in the Ross and Amundsen Seas during the period from 29 December 2006 to 3 March 2007. During the austral summer, *D. mawsoni* in the Ross and Amundsen Seas fed actively (index of fullness was 1.88). Among fish, *M. whitsoni* was the main food object (up to 18.2%), and among the non-fish items it was squid (8.1–27.3%).

9.12 The Working Group noted that results from this study are consistent with earlier work presented in Stevens (2004, 2006).

9.13 The Working Group also noted the results of studies reported in WG-FSA-08/48 (length-at-maturity) and WG-EMM-08/27 and 08/43 (trophic studies).

Dissostichus eleginoides

9.14 The Working Group noted the results of studies reported in WG-FSA-08/P3, 08/P4 and 08/P5 (otolith chemistry).

9.15 The Working Group noted with concern that some of the hypotheses presented in the three papers are inconsistent with current knowledge on the life cycle of *D. eleginoides*. Knowledge obtained in the course of CCAMLR-related research needs to be better incorporated in non-CCAMLR studies on this species in order to avoid two sets of research, which are not compatible, existing in parallel.

Skates

9.16 Samples of rajids taken in the commercial fishery in the Ross Sea (WG-FSA-08/20) indicated a ratio of 10.75:1 of *A. georgiana* to *B.* cf. *eatonii*, which is consistent with a previous estimate based on a large sample of tagged skates. Revised length–weight regression relationships for male and female *A. georgiana* confirmed that male and female relationships differ significantly. Better estimates of median length-at-maturity were made possible through a combination of improved observer staging of skates, and a moderate-sized sample of whole skates that was examined in the laboratory. There was no significant difference between the median length-at-maturity for male and female *A. georgiana*, which was estimated to be 67.3 cm pelvic length (=96.5 cm TL).

9.17 The Working Group noted that considerable discrepancy still exists in the understanding of how fast skates grow and how old they become. Validated ageing of skates is essential in understanding their potential to withstand even low levels of fishing. The Working Group encouraged the exchange of ageing material and information on ageing techniques in order to approach validation in ageing of skates.

Icefish

9.18 WG-FSA-08/29 investigated ontogenetic, interannual and regional variations in diet in *C. gunnari* around South Georgia in three successive summer seasons. Diet of the 2 239 fish (13–56 cm TL) investigated varied significantly between years and age classes but there was little regional difference in diet. In general, diet was dominated by krill (*E. superba*) and by the amphipod *Themisto gaudichaudii*. Smaller (younger) fish tended to prey on a higher proportion of *T. gaudichaudii* and small euphausiids such as *Thysanoessa* spp. and took smaller quantities of *E. superba*. In a season of poor krill availability, the proportion of krill in the diet, stomach fullness and fish condition were significantly lower than in the other summer seasons. The poor krill season was followed by a large reduction (>80%) in the estimated annual biomass of *C. gunnari* the following year (2005). This may have been a result of mortality of age 2+ and 3+ fish, which were more krill dependent than 1+ fish. Younger fish appear to have survived, leading to an increase in the estimated population biomass in 2006.

9.19 Age determination was conducted on *C. wilsoni* collected off the tip of the Antarctic Peninsula in 2006 and 2007 (WG-FSA-08/33). Preliminary results confirm results from earlier studies that the large majority of the fish were 2–4-year-old fish.

Antarctic fish – general

9.20 WG-FSA-08/42 presented a detailed review on the consumption of pelagic prey by Antarctic fish. The paper had initially been submitted for consideration by the Joint CCAMLR-IWC Workshop in Hobart, Australia, in August 2008. The paper had been updated since then according to comments provided at the meeting. Given that the paper has to be completed by the end of November 2008, members of WG-FSA were strongly encouraged to provide more comments on the paper before the end of CCAMLR-XXVII.

Species profiles

9.21 Species profiles have been completed for two of the species currently being fished in the CAMLR Convention Area: *D. mawsoni* (Dr Hanchet) and *C. gunnari* (Drs K.-H. Kock (Germany) and I. Everson (UK)). The profile of a third species, *D. eleginoides*, will be updated in the course of 2009 (Dr M. Collins (UK)). The Working Group recommended that these three profiles be published on the CCAMLR website in early 2010 and be updated regularly.

9.22 Species profiles of species other than the target species in the fisheries, such as *Gobionotothen gibberifrons* or *Chaenocephalus aceratus*, are currently not envisaged.

CCAMLR Otolith Network

9.23 No new information was available to the Working Group on progress in the calibration work on otolith readings following the 'Second Workshop on Estimating Age of Mackerel Icefish, *Champsocephalus gunnari'* held in Kaliningrad, Russia, in June 2006. The Working Group recommended that the calibration work be completed in 2008/09 and a report on the outcome of the otolith exchange be submitted to WG-FSA at its meeting in 2009.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

10.1 With the exception of section 10.2, most of the Working Group's considerations of ecosystem management were discussed in greater detail in other sections of the report, and cross-references are provided where appropriate.

Ecological interactions

10.2 Ecological interactions were considered during discussion of WG-FSA-08/19 (benthos), papers discussed in section 9 of this report and Annex 4, paragraphs 6.1 to 6.23.

Bottom fishing activities and VMEs

10.3 The Working Group recalled the outcomes of its consideration of this issue last year (SC-CAMLR-XXVI, Annex 5, paragraphs 14.1 to 14.43), including:

(i) agreement on the nature of destructive fishing practices, the concept of vulnerability and what constitutes significant adverse impacts (significant harm) (SC-CAMLR-XXVI, Annex 5, paragraphs 14.4 to 14.6) and the available mechanisms within CCAMLR that could be used to avoid significant adverse impacts on VMEs (SC-CAMLR-XXVI, Annex 5, paragraph 14.7);

(ii) history of bottom fishing in the CCAMLR high-seas areas (SC-CAMLR-XXVI, Annex 5, paragraphs 14.12 to 14.20);

(iii) a proposed annual process and procedure for managing the interactions of bottom fishing with the benthic environment in order to avoid significant adverse impacts on VMEs, noting that avoidance of such 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 (SC-CAMLR-XXVI, Annex 5, paragraph 14.21). The procedure is described in SC-CAMLR-XXVI, Annex 5, paragraphs 14.22 to 14.39, including:

(a) recognition of the insufficiency of data and that, when evidence of VMEs is found, interim protection would be needed while sufficient data are collected to enable the Commission to judge whether continued protection of an area is needed or not;

(b) the need for research and data collection plans, fisheries operation plans, mitigation development strategies, register of vulnerable areas and conservation management plans;

(c) the inverse relationship between trigger levels and the risk of impacting areas, including examples of the use of such levels to trigger actions for research, moving on or interim protection during a season;

(d) approaches to evaluating potential benthic interactions and classification of the areas;

(e) the progression of areas in their classification, and associated data collection requirements and protection, from being 'open' to 'potentially vulnerable' to 'vulnerable';

(f) the need to match the area of the location being protected with the scale of the VME;

(g) the role of observers in acquiring data.

10.4 The Working Group noted the endorsement of its report by the Scientific Committee, which took special note of a number of issues (SC-CAMLR-XXVI, paragraphs 4.162 and 4.163). The Scientific Committee endorsed the procedure and definitions provided by WG-FSA, which is based on existing practices and procedures (SC-CAMLR-XXVI, paragraph 4.164 and Figure 1) and which clearly shows what is needed to develop scientific advice on:

(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.

10.5 The Commission endorsed this framework provided by the Scientific Committee (CCAMLR-XXVI, paragraphs 5.11 and 5.12) and the proposed further work (CCAMLR-XXVI, paragraphs 5.13 to 5.15). It tasked the Scientific Committee with developing pragmatic and flexible guidelines for:

(i) identifying VMEs;

(ii) defining actions taken by vessels which may encounter evidence of VMEs during the course of fishing.

These would be reviewed at its next meeting (CCAMLR-XXVI, paragraph 5.18).

10.6 The Working Group agreed that a suitable test of the guidelines would be whether significant adverse impacts on VMEs would be avoided while the scientific advice and management approaches were developed and refined.

10.7 The Working Group noted that Conservation Measure 22-06 requires Contracting Parties whose vessels wish to engage in any bottom fishing activities, beginning 1 December 2008, shall follow the procedures described in paragraphs 7 to 10 of the conservation measure. In addition, the Scientific Committee shall provide an assessment to the Commission, based on the best available scientific information, whether proposed bottom fishing activities would contribute to having significant adverse impacts on VMEs and what management measures could be taken to prevent such impacts. Following Conservation Measure 22-06, the Working Group identified the following tasks for providing advice to the Scientific Committee:

(i) review preliminary assessments and proposed mitigation measures expected to be submitted by Members proposing to participate in bottom fishing;

(ii) review, refine and, as needed, develop procedures and standards for assessing potential effects of proposals and possible mitigation measures;

(iii) including the use of other information and approaches available to the Working Group, provide advice on possible effects of bottom fishing activities, mitigation measures and data collection plans;

(iv) provide advice on how Members should prepare preliminary assessments and proposed mitigation measures;

(v) collate information on encounters with VMEs and advise on known and anticipated impacts of bottom fishing activities on VMEs and recommended practices when evidence of a VME is encountered in the course of bottom fishing operations.

10.8 In undertaking this task, the Working Group agreed to structure its discussion and advice around the framework endorsed by the Commission.

Encounters with VMEs, known and anticipated impacts of bottom fishing on VMEs

10.9 WG-FSA-08/53 proposed an impact assessment framework for bottom-impacting fishing methods in the CAMLR Convention Area. The paper detailed six steps in an assessment:

(i) description of the fishing gear;

(ii) description of fishing activity, and definition of spatial footprint for a standard fishing event;

(iii) description of non-standard gear deployment scenarios, and associated footprints;

(iv) vulnerability assessment for selected VME taxa;

(v) description of total historical fishing effort;

(vi) calculation of total cumulative impact.

10.10 The Working Group noted that in this impact assessment process:

(i) fishing events are considered not to overlap;

(ii) all VME taxa are assumed to be available throughout an area;

(iii) the proportion of VME taxa estimated to be affected by fishing is determined to be the proportion of the fishable area under consideration that would have been affected by the total footprint discounted by the level of escapement expected by different VME-type taxa;

(iv) consideration needs to be given as to what parts of the gear interact with benthic habitats.

10.11 WG-FSA-08/58 presented direct observations using video footage of the effects of an IWL on the seafloor during a haul. The estimated seabed area affected by the haul of the longline was estimated, based on an estimated sideways sweep of the line as 24 m before leaving the bottom. In his presentation, Dr Welsford noted that:

(i) the video evidence shows that benthos by-catch can be lost from the longlines before they reach the surface;

(ii) despite strong current flows, the lines for which footage was available did not move until hauling began;

(iii) although this is only one observation, footage from two other longlines showed plumes of sediment indicative of lines also moving sideways during hauling.

10.12 The Working Group noted the following points in estimating the footprint of a longline using camera gear:

(i) although the cameras are designed to be neutrally buoyant and evidence reviewed at the meeting indicated that the camera did not impact on the behaviour of the line, the potential for the camera equipment to impact on the behaviour of the line should be monitored, particularly when cameras are being used to assess the footprint of a shot;

(ii) sideways movement of lines could occur because of a vessel not hauling directly over a line or currents moving the line in opposition to the vessel;

(iii) some erect organisms that stand well above the bottom could continue to be affected by sideways moving lines even after the lines are lifted from the bottom, but such calculations should recognise that shorter organisms will be impacted over shorter widths during lifting;

(iv) the degree of sideways movement of the lines and their impacts on benthos will depend on the type of vessel, type of gear and local conditions;

(v) models of line movement, and therefore the area affected by the line, could be improved by factoring in data on location of vessels relative to the line during the haul, along with information on currents at the time of the haul.

10.13 The Working Group agreed that, as a result of this new information, the footprint of an individual autoline longline is unlikely to be as small as estimated in CCAMLR-XXVII/19. It also agreed that the magnitude of the footprint is highly uncertain, noting the observation above that a line may impact benthos up to 25 m.

10.14 The Working Group thanked Australia for developing the camera gear for deployment on longlines, indicating that this work is important for better understanding the dynamics of the fishing gear on the bottom and for estimating the effects that longlines and other gears will have on benthic organisms.

10.15 The Working Group noted that these studies focused on autoliners using IWLs. It was unclear what effects Spanish longline and trotline systems might have on benthic habitats. The Working Group noted that it had no information to consider the impacts of other gears, noting that anchors, clusters of hooks and other elements of these gear types could have impacts and that the effects of these should be evaluated. It noted that the camera gear developed by Australia could be deployed on all benthic fishing gears.

10.16 The Working Group noted that there was no empirical evidence with which to quantify the effects of fishing gear on benthic taxa or habitats in the Convention Area (see paragraph 10.54).

10.17 For the purposes of undertaking an assessment of benthic interactions of bottom fishing (SC-CAMLR-XXVI, paragraph 4.165(iii)), the Working Group reviewed and revised the analysis of the effective fishing footprint from 2007. Instead of presenting the catch in the different management areas, the accumulated effort (thousands of hooks) is summarised in Figure 7 for the period 1985–2007 and for 2008 separately. The Working Group noted that in future years it would be desirable to plot the SSRUs as well as the subarea and division boundaries.

10.18 The Working Group agreed that most attention on evaluating potential impacts of bottom fishing on VMEs needs to be given to locations with the most fishing effort relative to seabed area. It also recognised the need to distinguish between effort in shallow areas compared to deeper areas. In the absence of other information, the maps showing effort in grid cells in each subarea/division are one indicator of where most fishing effort has been deployed. This can be combined with estimates of fishable seabed area to estimate the proportion of fishable area possibly impacted by fishing gear. Table 18 shows the results of such an analysis for SSRUs in Divisions 58.4.1 and 58.4.3b. Fishable seabed areas, total accumulated effort (summed length of lines deployed over the course of the fishery) and the proportion of total effort in each depth stratum were estimated using data from the CCAMLR database according to the depth ranges used in the *CCAMLR Statistical Bulletin*. The potential proportions of seabed areas that may have been affected by longlines were calculated using a low and high value for the estimated width of the area affected by an individual longline – 1 m (consistent with CCAMLR-XXVII/19) and 25 m (consistent with WG-FSA-08/58). Table 18 also shows the same calculations for Subarea 88.1 but only for the depth range 600–1 800 m. The breakdown of seabed area by depth is not available at present. The seabed areas used in the Subarea 88.1 analysis were those provided to New Zealand in 2003 (SC-CAMLR-XXII, Annex 5, Table 5.3). The summary effort data without the seabed calculations for Subarea 88.1 and the other SSRUs in the exploratory toothfish fisheries are also given.

10.19 The Working Group agreed that this approach is a useful foundation for providing advice on the current scales of possible interactions of fishing gears with VMEs in exploratory longline fisheries, noting that some SSRUs in the seamount/ridge areas to the north of Subarea 88.1 may have had larger proportions than other SSRUs of seabed potentially affected by bottom fishing activities.

10.20 The Working Group recommended that updated seabed area information be obtained for the three depth strata from reliable sources for all SSRUs.

10.21 The Working Group noted that these data could be used to assess, as per Conservation Measure 22-06, the possible contributions of proposed fishing activities to impacts in different areas. However, there is insufficient information on the areas proposed to be fished in the coming exploratory fisheries to provide advice on what those contributions to impacts on VMEs might be.

10.22 The Working Group also noted that:

(i) such analyses will need to take account of the potential for lines to be overlapping, such as would be the case in repeat sets, and that, in these cases, consideration will need to be given as to whether the full impact of fishing occurs during the first interaction, with repeat sets having subsequent negligible effects (but see the conclusions in CCAMLR-XXVII/19);

(ii) the degree of impact within the footprint is difficult to ascertain because of the absence of empirical data on the effects of the different types of longlines on benthic habitats and VME-taxa. The Working Group agreed that future work to obtain empirical data was needed to reduce this uncertainty on the degree of impact of an individual line. Also, refinement is needed of the methodologies and calculations for determining the footprint (area) affected by the different types of longlines (WG-FSA-08/58) and for estimating the possible impacts on VME-taxa within the footprint as described in WG-FSA-08/53. These would be useful topics for discussion in the workshop noted in paragraph 10.54.

(iii) observed by-catch from longlines may not be a good indicator of interactions of longlines with VMEs because taxa affected by the longlines may not be observed as by-catch when landed (paragraph 10.11). As a result, no by-catch may not mean that there has been no interaction with a VME. However, presence of VME taxa in by-catch may be indicative of the presence of a VME. Although catch rates of VME taxa cannot be used at present, it may be possible to use such rates to estimate the scale of impacts on VMEs in the future if the catchability of individual VME taxa can be determined.

10.23 The Working Group concluded this discussion noting that reducing the uncertainty in evaluations of accumulated impacts and the potential for proposed fishing activities to contribute to future impacts will be dependent on improving methods for assessing footprints coupled with the developing assessments of risk in different areas as outlined below.

Approaches to avoid and mitigate significant adverse impacts on VMEs

Preliminary assessments and proposed mitigation measures by Members

10.24 Table 19 summarises the relationship between new and exploratory fishing proposals and the submissions on preliminary assessments and proposed mitigation measures by Members. A summary of the available submissions is provided in CCAMLR-XXVII/26. The Working Group noted that only 5 out of 12 proposals contained preliminary assessments. As a consequence, the Working Group was unable to review and advise on the potential impacts of all new and exploratory fishery proposals.

10.25 The Working Group noted the large variation in substance of the preliminary assessments and agreed that a common approach is needed for providing these assessments, similar to the requirements for notifying exploratory fisheries. It agreed that the proposed pro forma given in Table 20 would provide a suitable standard for Members submitting preliminary assessments of the potential for their proposed bottom fishing activities to have significant adverse impacts on VMEs. The pro forma is designed to be consistent with the requirements for proposals on exploratory fisheries and is based on the requirements set out in paragraphs 7(i) and 7(ii) in Conservation Measure 22-06. The Working Group agreed that some consistency is needed in the provision of information on the following:

(i) Scope of the proposed operations –

- (a) fishing method(s) to be used
- (b) statistical area in which fishing will occur
- (c) likely period of operations.

(ii) Proposed fishing activity –

- (a) detailed description of gear;
- (b) scale of proposed activity, including estimates of total numbers of hooks and/or lines to be deployed;
- (c) spatial distribution of activity.

(iii) Mitigation measures to be used.

(iv) Assessment of known/anticipated impacts on VMEs –

   (a) estimated spatial effort footprint;

   (b) summary of potential VMEs present within areas of activity;

   (c) likelihood of impacts;

   (d) likely magnitude/severity of the interaction of the proposed fishing gear with VMEs;

   (e) likely physical and biological/ecological consequences of impact.

(v) Estimated cumulative footprint.

(vi) Research activities related to provision of new information on VMEs –

   (a) previous research, including the collection of direct and indirect evidence of VMEs;

   (b) proposed research activities during the proposed fishing operations;

   (c) proposed follow-on research.

10.26 The Working Group agreed that the requirements for preliminary assessments by Members will change as information on bottom fisheries improves. It is expected that points (i)–(iii) above are likely to be the most important information to be provided with proposals in future years, but at present details are also needed on points (iv)–(vi).

10.27 The summary of benthic by-catch in CCAMLR-XXVII/26 assembled by the Secretariat from the CCAMLR database was reviewed by the Working Group. The Working Group thanked the Secretariat for its work and agreed with the conclusion of the paper that the level of taxonomic detail in the CCAMLR database was insufficient for conducting quantitative analyses of interactions of the fisheries with benthic taxa and the potential effects on VMEs. Also, the variable quality in the identification of benthos would also impede the use of these data. This is discussed further in paragraphs 6.45 to 6.47.

10.28 The Working Group agreed that there are few empirical data to determine what the effects of the proposed activities might be on VMEs in the Convention Area and whether there would be overlap between the proposed fishing activities and VMEs.

Advice on possible effects of bottom fishing activities, mitigation measures and data collection plans

10.29 WG-FSA-08/64 provided a risk-management framework to evaluate the risk of proposed fishing operations contributing to significant adverse impacts on VMEs and for providing advice on management and mitigation measures that might be necessary, particularly for high-risk areas. The framework enables the assessments of risk for specific areas to be updated with new information and knowledge as it arises.

10.30 The Working Group agreed that a risk-assessment approach similar to that used by ad hoc WG-IMAF would be valuable and that the method in WG-FSA-08/64 could be developed further in this regard. It noted that the risk of significant adverse impacts should be evaluated at spatial scales commensurate with the scale of VMEs, i.e. much smaller spatial resolution than that considered by WG-IMAF. The important elements of a risk assessment would include, *inter alia*, the following concepts:

(i) Not all areas are equal with regard to probability of encounters with, or impacts on, a VME but information needed to assess such probabilities is very limited.

(ii) Models of likely habitat can be developed based on geomorphological, oceanographic and other environmental data and relating these to observations of where different VME taxa might be found. Observations can include direct observations (using videos, benthic sampling equipment) or indirect observations such as by-catch from fisheries.

(iii) An appropriate scale for characterising risk would be 0.5° latitude and 1.0° longitude, consistent with CCAMLR fine-scale areas.

(iv) Different areas will have different risks, e.g. higher-risk areas might be seamounts, heads of canyons and depths shallower than 550 m.

(v) There will be different requirements for data collection, research and mitigation for different levels of risk and different gear types.

(vi) The assignment of risk would need to be reviewed as new information becomes available.

10.31 The Working Group was unable to develop a risk assessment map for use in providing advice at this meeting on the possible effects of proposed fishing activities but recommended that the approach be developed further for the next meeting of WG-FSA, based on the considerations in paragraphs 10.29 and 10.30 and in the following section on VMEs.

10.32 The proposals summarised in CCAMLR-XXVII/26 for VME mitigation measures and activities related to VME interactions during fishing operations are summarised in Table 21. These could be naturally divided into three main classes of actions – activities by observers, responses of vessels and reporting requirements.

10.33 The Working Group agreed that observations of benthic by-catch will be important in the coming year. It would be useful for observers to provide information on the following:

(i) the locations and types of taxa being landed, where identification should be at least to the level of morphotypes provided in the poster developed by New Zealand (paragraph 6.45);

(ii) the numbers and, where possible, total mass of each taxon being landed;

(iii) information on the likely geographic origin of the taxa – noting that observations by hook or by magazine could be related to the geographic position of the line on the substratum, although this may require an observer to be provided with a hand-held GPS to note the position of the vessel when a taxon is landed;

(iv) in the future, an increase in the level of detail may be triggered by catches of specific types of taxa but it was recognised that, for the near future, records should be maintained of all landed taxa and that information by observers should be as complete as possible for the periods of observation.

10.34 The Working Group also noted that it would be desirable for observers to obtain information on the operations of the gear and for developing monitoring protocols. However, given the high workload of observers, these were considered to be lower priorities for the coming year.

10.35 The Working Group noted that the level of taxonomic detail requested to be recorded by observers in the coming season was unlikely to identify endemic species. It recommended that this issue be considered further at the workshop proposed in paragraph 10.54. It also requested this be considered by ad hoc TASO to see if practical methods could be adopted for obtaining finer taxonomic resolution in benthos by-catch data.

10.36 Proposed responses of vessels varied between submissions and were also dependent on the level of evidence required before triggering action. Actions proposed were:

(i) only undertaking research when VMEs became evident in landed by-catch
(ii) moving on when any evidence of VMEs was found
(iii) a mixture of the two based on a two-tiered trigger system.

The Working Group agreed that a common strategy was needed that would have specific variations depending on the type of gear being used. However, there was insufficient information to determine an agreed strategy, including the type and level of by-catch that would be required to trigger action and the precise nature of the action that should be taken. It was proposed that such issues would need to be resolved at a VME workshop (paragraph 10.54).

10.37 The Working Group noted the general expectation of Members to report encounters of fishing vessels with VMEs. However, there was variation amongst the submissions on what evidence was required before such an encounter would be reported. Nevertheless, observer data should be reported, along with the data necessary for the preliminary assessments by Members to be submitted in accordance with Conservation Measure 22-06 (Table 20).

10.38 A difficulty in the discussion was resolving the tension between protecting VMEs from significant adverse impacts and obtaining the information on whether those impacts are arising or have arisen. Under such circumstances, a strategy for avoiding significant adverse impacts on VMEs, such as through identifying areas that need to be avoided, will need to be developed taking account of the following issues:

(i) the degree to which by-catch on longlines is likely to be representative of the benthos affected by the longlines is not known but a positive record of VME taxa in the by-catch can be indicative of a VME (paragraph 10.22(iii));

(ii) undertaking research fishing in an area following a large catch of benthos in order to better document the VME is dependent on the spatial effects of the research lines being less than the spatial extent of the VME and that the latter will be appropriately circumscribed by the fishing research activity;

(iii) moving the fishing vessel out of the area following a large catch of benthos may over-interpret the by-catch as being representative of a VME and falsely assume that continued fishing in the area will impact the VME;

(iv) the requirement to use longlines to circumscribe VMEs may be ameliorated by using alternative methods for observing VMEs (see paragraph 10.44).

10.39 It was noted that continuing to fish in areas for which by-catch evidence indicates a possibility of interactions with a VME is contradictory to trying to protect VMEs from significant adverse impacts. Also, continuing such fishing in an area where evidence of a VME has been found may be contrary to Conservation Measure 22-06, paragraph 8.

10.40 The Working Group recognised this conundrum. It also noted that it could not calculate the level of evidence of VMEs to trigger actions for the different vessels at this meeting. The Working Group agreed that full compliance in providing data on benthos by-catch will be important in order to determine vessel-specific recommendations on trigger levels. An alternative strategy to vessel-specific trigger levels would be to identify areas that need to be avoided by all vessels.

10.41 The Working Group noted that data were available in CCAMLR-XXVII/26 to review locations of catches of VME taxa. However, it had insufficient time to make recommendations on areas that may need to be closed to the fleet for the coming season according to Conservation Measure 22-06. The Working Group noted that time should be made available next year to undertake such assessments and encouraged an improvement of data quality and quantity to support this.

10.42 The Working Group agreed that whatever strategy is adopted for the coming year, it will be important to collect as much benthos by-catch data as possible for analysis next year. It also agreed that experience of ad hoc WG-IMAF showed the following to be important in combating the incidental mortality of seabirds in fisheries and will be relevant to avoiding significant adverse impacts on VMEs:

(i) education of the crews of vessels participating in exploratory bottom fisheries will help increase awareness of the value of VMEs, in terms of their marine biodiversity and as habitat to fish assemblages, and the importance of developing mitigation measures to avoid impacts on them;

(ii) continued development of methods to reduce the frequency of gear loss that could impact on VMEs.

10.43 The Working Group noted that it would be useful to undertake simulations of different management approaches to evaluate which avoidance/research approaches may be most useful in avoiding significant adverse impacts on VMEs when there is no information on which to judge a suitable approach.

VMEs and significant adverse impacts

10.44 The Working Group noted that knowledge of VMEs and the types of impacts of bottom fishing activities will be enhanced by observations from a variety of methods, including acoustics, video, benthic sleds, benthic grabs and by-catch in fishing gear. These methods could be used in both fishery and fishery-independent (research) operations. Other fishery-independent data could be obtained from dedicated scientific activities using CTDs, multi-beam sonar and satellites.

10.45 The Working Group noted a number of sources of existing information on the distribution and abundance of benthic fauna and habitats in the CAMLR Convention Area, including:

(i) the benthic bioregionalisation adopted by SC-CAMLR in 2007 (SC-CAMLR-XXVI, paragraphs 3.80 to 3.84), including a map of geomorphological features in the Ross Sea, eastern Antarctica and the greater Kerguelen Plateau, which shows, in particular, seamounts, canyons and variation in shelf areas;

(ii) data and information in the SCARMarBIN database (www.scarmarbin.be);

(iii) data and analyses for specific regions of the Southern Ocean, including:

  (a) habitat maps near the Mertz Glacier (Beaman and Harris, 2005);

  (b) types and general distribution of habitats in the southwestern Ross Sea (Barry et al., 2003);

  (c) maps of habitat features in the Antarctic Peninsula (Lockhart and Jones, 2008);

(iv) analyses of longline benthos by-catch data in the Ross Sea (CCAMLR-XXVII/26).

10.46 The Working Group noted that knowledge to date on the distribution of benthic fauna in the Southern Ocean indicates that there may be a large degree of endemism, i.e. locally restricted distributions of some taxa. This may be because of the particular life histories and dispersal of Antarctic benthic fauna, e.g. brooding versus broadcast spawners. The report on the CCAMLR bioregionalisation (SC-CAMLR-XXVI, Annex 9; SC-CAMLR-XXVI, paragraphs 3.71 to 3.89; SC-CAMLR-XXVI/11) indicated that most species were restricted to one box, indicating endemism at this scale (SC-CAMLR-XXVI, Annex 9, paragraphs 129 and 130).

10.47 The Working Group noted that a conclusion of endemism may not be easily drawn from only a few samples. However, such 'false positives' would result in protection of those VMEs until such time as further information became available when, if endemism was found not to be the case, the protection could be removed. If no protection was given and endemism was the true case, then there could be significant adverse impacts. In the case of seamounts, there is an increasing body of evidence that fauna can be endemic to individual or locally grouped sea mounts (Rogers, 2004).

10.48 The Working Group also recognised that experts other than those usually involved in CCAMLR may have data and knowledge suitable for consideration of VMEs and their vulnerability. It noted that the coordinated efforts in the CAML (www.caml.aq) and the IPY in sampling benthic habitats throughout Antarctica would provide useful data for these analyses, such as that presented to the WG-FSA this year (SC-CAMLR-XXVII/13; WG-FSA-08/31). It encouraged the involvement of SCAR in providing data and advice on these issues.

10.49 The Working Group agreed that the development of a risk-assessment map required the development of a model of habitat types associated with features identifiable in datasets that give synoptic coverage of the CAMLR Convention Area, including bathymetry, geomorphology, oceanography and satellite data sources. Although there will be uncertainty in the application of such a model, it is unlikely that a detailed map of the distribution of VMEs throughout the CAMLR Convention Area from direct observations will ever be available. An example of such a model for an area of Division 58.4.1 is available in Beaman and Harris (2005). This approach uses empirical observations of the relationship between biota and physical attributes and then interpolating that relationship across the synoptic map of the physical environment. Such a process could be undertaken using research programs in other areas. Alternatively, theoretical models of those relationships could be developed from available data and, until such time as sampling is undertaken in an area, these models could be extrapolated to areas for which some physical synoptic data is available.

10.50 The Working Group agreed that direct evidence of VMEs, if available, should be included in the development of risk-assessment maps and in identifying VMEs that need to be avoided. It was agreed that camera evidence is the most compelling for identifying VMEs but that evidence gathered by research sampling devices such as beam trawls, sleds and grabs would be very strong indications of the presence of VME taxa.

10.51 As described above (paragraph 10.22(iii)), fishing gears are likely to be poor sampling devices of VME taxa. The Working Group agreed that the presence of VME taxa, or indicators of VMEs in samples from any of these methods, would be evidence that VMEs could be present. However, it also agreed that the converse of no VME taxa or indicators of VMEs in the samples did not necessarily represent an absence of VMEs. The degree to which this could be concluded would be dependent on the selectivity and sampling efficiencies of the gears.

10.52 The Working Group noted the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries. Consequently, it agreed that, in the first instance, the risk-assessment map will need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs (WG-FSA-08/53, 08/64).

10.53 The Working Group noted that there were only a few experts on benthic ecology available to the meetings and it would be useful to have a broad expert review of the issues surrounding the ecology and vulnerability of VMEs in the Southern Ocean. It also noted the discussion on this topic by WG-EMM (Annex 4, paragraphs 3.27 to 3.33).

10.54 The Working Group endorsed the view of WG-EMM that it would be useful to hold an expert workshop to consider the issues identified in Annex 4, paragraph 3.31. In addition, it requested that the following questions be incorporated into the discussion, noting the development of definitions and concepts in its report from last year (SC-CAMLR-XXVI, Annex 5, paragraphs 14.4 to 14.6):

(i) In the absence of direct observations of VMEs, how might maps be developed indicating where these VMEs are likely to be?

(ii) What are the likely life-history attributes of indicative VME taxa in those VMEs and, as a result, the likely resilience and resistance of those VMEs to bottom fishing impacts; what is the potential vulnerability of those VMEs to different gear types?

(iii) To what degree might benthic taxa be limited in their distribution?

(iv) What is the likely importance of VME taxa to fish assemblages and the degree to which fish diversity could be used as indicators of VMEs?

10.55 The Working Group agreed that the work on identifying VMEs and understanding the risks to VMEs of impacts by bottom fishing activities could be separated as a task from consideration of mitigation measures and data collection plans. It requested that the Scientific Committee consider whether consideration of VMEs and risk could be undertaken by WG-EMM and the consideration of mitigation measures be part of the work of WG-FSA.

Notification of VMEs

10.56 SC-CAMLR-XXVII/13 described VMEs identified by Australia during the CEAMARC-CASO voyage, part of Australia's IPY work. Eighty-nine stations were sampled using various methods, including trawl gear with associated digital video and/or stills cameras, on the continental shelf and slope off George V and Terre Adélie Lands to the west of the Mertz Glacier. Two of the stations were nominated as VMEs in the paper. Station 65 was located between 523 and 827 m at the head of a canyon system leading off the shelf and showed extensive biogenic habitat composed of hydrocorals, sponges and erect bryozoans. Station 79–81 was also located at the head of a canyon system further west at 436–844 m and showed extensive biogenic habitat composed of large sponges, hydrocorals and erect bryozoans. A video of the areas concerned was shown to the Working Group.

10.57 The Working Group agreed that these were obvious cases of VMEs, with clear evidence of well developed benthic communities.

10.58 Dr Ramm introduced the draft VME notification form developed by the Secretariat on the basis of the requirements in Conservation Measure 22-06 and tabular notification in SC-CAMLR-XXVII/13. It was designed in such a way that it could be submitted by Members as part of the 5-day reporting system during fishing operations and could be used by Members undertaking research activities.

10.59 The Working Group thanked the Secretariat for developing this form and recommended that it be used as the means of notifying the Secretariat when evidence of VMEs is encountered. It noted that the type of information that could be included in the form might vary from the data collected by observers. Nevertheless, the Working Group agreed that a Member may collect other data and knowledge not collected by the observers that could be used for notifying the occurrence of a VME.

10.60 The Working Group requested that the Scientific Committee consider the method by which these notifications would be reviewed and the process for adding a VME to the Register of VMEs. It also asked the Scientific Committee whether there was an expectation that WG-FSA be the primary working group where such reviews would be undertaken. The

Working Group noted that the requirements for protecting VMEs may change as more information becomes available, including data on the spatial extent of VMEs, and their vulnerability to fishing.

Advice to the Scientific Committee

Guidelines

10.61 The Working Group recommended the Scientific Committee consider the following in providing advice to the Commission according to its request in CCAMLR-XXVI, paragraphs 5.13 to 5.15.

10.62 The Working Group agreed that a suitable test of the guidelines would be whether significant adverse impacts on VMEs would be avoided while the scientific advice and management approaches were developed and refined.

Identifying VMEs

10.63 The Working Group drew the attention of the Scientific Committee to paragraphs 10.44 to 10.55 on its deliberations on identifying VMEs.

10.64 Knowledge exists on the distribution and abundance of benthic taxa in the Southern Ocean in sufficient form to develop maps of the distribution of some types of taxa (paragraph 10.45). It was noted that there may be a large degree of endemism, particularly on seamounts (paragraphs 10.46 and 10.47). It was also noted that there may be other sources of data on the distribution of VMEs and VME taxa, including data from recent IPY and CAML voyages (paragraph 10.48). Nevertheless, the Working Group agreed that the general distribution of VMEs in the Southern Ocean will need to be inferred using habitat models (paragraph 10.49). These could be used to develop risk-assessment maps for predicting the level of risk of impacting VMEs in different fishing locations.

10.65 The Working Group agreed (paragraph 10.50) that direct evidence of VMEs, if available, should be included in the development of risk-assessment maps and in identifying VMEs that need to be avoided. It was agreed that camera evidence is the most compelling for identifying VMEs but that evidence gathered by research sampling devices, such as beam trawls, sleds and grabs, would be very strong indications of the presence of VME taxa.

10.66 As described in paragraph 10.51, fishing gears are likely to be poor sampling devices of VME taxa. The Working Group agreed that the presence of VME taxa, or indicators of VMEs in samples from any of these methods, would be evidence that VMEs could be present. However, it also agreed that the converse of no VME taxa or indicators of VMEs in the samples did not necessarily represent an absence of VMEs. The degree to which this could be concluded would be dependent on the selectivity and sampling efficiencies of the gears.

10.67 The Working Group noted in paragraph 10.52 the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries. Consequently, it agreed that, in the first instance, the risk-assessment map will need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs.

10.68 The Working Group agreed in paragraph 10.54 to endorse the view of WG-EMM that it would be useful to hold an expert workshop to consider the issues identified in Annex 4, paragraph 3.31. In addition, it requested that the following questions be incorporated into the discussion, noting the development of definitions and concepts in its report from last year (SC-CAMLR-XXVI, Annex 5, paragraphs 14.4 to 14.6):

(i) In the absence of direct observations of VMEs, how might maps be developed indicating where these VMEs are likely to be?

(ii) What are the likely life-history attributes of indicative VME taxa in those VMEs and, as a result, the likely resilience and resistance of those VMEs to bottom fishing impacts; what is the potential vulnerability of those VMEs to different gear types?

(iii) To what degree might benthic taxa be limited in their distribution?

(iv) What is the likely importance of VME taxa to fish assemblages and the degree to which fish diversity could be used as indicators of VMEs?

10.69 The Working Group agreed in paragraph 10.55 that the work on identifying VMEs and understanding the risks to VMEs of impacts by bottom fishing activities could be separated as a task from consideration of mitigation measures and data collection plans. It requested that the Scientific Committee consider whether consideration of VMEs and risk could be undertaken by WG-EMM and the consideration of mitigation measures be part of the work of WG-FSA.

Actions to be taken by fishing vessels encountering VMEs

10.70 The Working Group drew the attention of the Scientific Committee to its deliberations in paragraphs 10.29 to 10.43 on defining actions taken by vessels which may encounter evidence of VMEs during the course of fishing. The outcomes are described further in sections relevant to the implementation of Conservation Measure 22-06 below.

Advice on tasks in Conservation Measure 22-06

10.71 The following advice is provided to the Scientific Committee on tasks identified in Conservation Measure 22-06.

Advice on submissions by Members of preliminary assessments and proposed mitigation measures

10.72 In accordance with the requests of Conservation Measure 22-06, paragraph 7, the Working Group reviewed in paragraphs 10.24 to 10.28 the preliminary assessments and proposed mitigation measures submitted by Members proposing to participate in bottom fishing. The Working Group noted that only 5 out of 12 proposals contained preliminary assessments. As a consequence, the Working Group was unable to review and advise on the potential impacts of all new and exploratory fishery proposals.

10.73 The Working Group noted the large variation in substance of the preliminary assessments and agreed that a common approach is needed for providing these assessments, similar to the requirements for notifying exploratory fisheries (paragraph 10.25). The Working Group recommended that the Scientific Committee adopt the pro forma detailed in paragraph 10.25 and given in Table 20 as a suitable standard for Members submitting preliminary assessments of the potential for their proposed bottom fishing activities to have significant adverse impacts on VMEs. The pro forma is designed to be consistent with the requirements for proposals on exploratory fisheries and is based on the requirements set out in paragraphs 7(i) and 7(ii) in Conservation Measure 22-06. Further considerations are given in paragraph 10.26.

Advice on procedures and standards for assessing potential effects of proposals and possible mitigation measures

10.74 The Working Group noted that the Scientific Committee is tasked to review, refine and, as needed, develop procedures and standards for assessing potential effects of proposals and possible mitigation measures (Conservation Measure 22-06, paragraph 7(iii)). The Working Group considered three types of procedures and approaches:

(i) the magnitude of the existing footprint of bottom fisheries relevant to Conservation Measure 22-06 and the possible impacts that such a footprint may have had on VMEs (paragraphs 10.9 to 10.23);

(ii) the risk of past and future bottom fishing activities contributing to significant adverse impacts on VMEs (paragraphs 10.29 to 10.31, 10.49 and 10.50);

(iii) approaches to the development of mitigation measures for vessels (paragraphs 10.32 to 10.43).

Existing footprint of bottom fisheries

10.75 Two approaches were used in examining the existing footprint of bottom fisheries. In paragraph 10.17, the Working Group reviewed and revised the analysis of the effective fishing footprint from 2007. Instead of presenting the catch in the different management areas, the accumulated effort (thousands of hooks) is summarised in maps for each subarea and division for the period 1985–2007 and for 2008 separately. The Working Group noted that in future years it would be desirable to plot the SSRUs as well as the subarea and division boundaries.

10.76 In paragraph 10.18, the Working Group agreed that most attention on evaluating potential impacts of bottom fishing on VMEs needs to be given to locations with the most fishing effort relative to seabed area. It also recognised the need to distinguish between effort in shallow areas compared to deeper areas. In the absence of other information, the maps showing effort in grid cells in each subarea/division are one indicator of where most fishing effort has been deployed. This can be combined with estimates of fishable seabed area to estimate the proportion of fishable area possibly impacted by fishing gear.

10.77 The potential proportions of seabed areas that may have been affected by longlines were calculated using a low and high value for the estimated width of the area affected by an individual longline – 1 m (consistent with CCAMLR-XXVII/19) and 25 m (consistent with WG-FSA-08/58). The rationale for these values is provided in paragraphs 10.9 to 10.12.

10.78 In paragraph 10.19, the Working Group agreed that this approach is a useful foundation for providing advice on the current scales of possible interactions of fishing gears with VMEs in exploratory longline fisheries.

10.79 The Working Group recommended that updated seabed area information be obtained for the three depth strata from reliable sources for all SSRUs (paragraph 10.20).

10.80 The Working Group noted in paragraph 10.21 that these data could be used to assess, as per Conservation Measure 22-06, the possible contributions of proposed fishing activities to impacts in different areas. However, there is insufficient information on the areas proposed to be fished in the coming exploratory fisheries to provide advice on what those contributions to impacts on VMEs might be.

10.81 The Working Group also drew the attention of the Scientific Committee to general points surrounding these methods noted in paragraph 10.22 that:

(i) such analyses will need to take account of the potential for lines to be overlapping, such as would be the case in repeat sets, and that, in these cases, consideration will need to be given as to whether the full impact of fishing occurs during the first interaction with repeat sets having subsequent negligible effects (but see the conclusions in CCAMLR-XXVII/19);

(ii) the degree of impact within the footprint is difficult to ascertain because of the absence of empirical data on the effects of the different types of longlines on benthic habitats and VME-taxa (paragraph 10.16). The Working Group agreed that future work to obtain empirical data was needed to reduce this uncertainty on the degree of impact of an individual line. Also, refinement is needed of the methodologies and calculations for determining the footprint (area) affected by the different types of longlines (paragraphs 10.11 to 10.14) and for estimating the possible impacts on VME-taxa within the footprint as described in paragraphs 10.9 and 10.10.

(iii) observed by-catch from longlines may not be a good indicator of interactions of longlines with VMEs (paragraph 10.11) because taxa affected by the longlines may not be observed as by-catch when landed. As a result, no by-catch may not mean that there has been no interaction with a VME. However, presence of VME taxa in by-catch may be indicative of the presence of a VME. Although catch rates of VME taxa cannot be used at present, it may be possible to use such rates to estimate the scale of impacts on VMEs in the future if the catchability of individual VME taxa can be determined.

10.82 The Working Group concluded this discussion in paragraph 10.23 noting that reducing the uncertainty in evaluations of accumulated impacts and the potential for proposed fishing activities to contribute to future impacts will be dependent on improving methods for assessing footprints coupled with the developing assessments of risk in different areas.

Risk-assessment approaches

10.83 The Working Group agreed that a risk-assessment approach similar to that used by ad hoc WG-IMAF would be valuable and that the method considered in paragraphs 10.29 and 10.30 could be developed further in this regard. It noted that the risk of significant adverse impacts should be evaluated at spatial scales commensurate with the scale of VMEs, i.e. much smaller spatial resolution than that considered by ad hoc WG-IMAF. The important elements of a risk assessment would include, *inter alia*, the following concepts:

(i) Not all areas are equal with regard to probability of encounters with, or impacts on, a VME but information needed to assess such probabilities is very limited.

(ii) Models of likely habitat can be developed based on geomorphological, oceanographic and other environmental data and relating these to observations of where different VME taxa might be found. Observations can include direct observations (using videos, benthic sampling equipment) or indirect observations such as by-catch from fisheries.

(iii) An appropriate scale for characterising risk would be 0.5° latitude and 1.0° longitude, consistent with CCAMLR fine-scale areas.

(iv) different areas will have different risks, e.g. higher-risk areas might be seamounts, heads of canyons and depths shallower than 550 m.

(v) There will be different requirements for data collection, research and mitigation for different levels of risk and different gear types.

(vi) The assignment of risk would need to be reviewed as new information becomes available.

10.84 The Working Group was unable to develop a risk-assessment map for use in providing advice at this meeting on the possible effects of proposed fishing activities, but recommended that the approach be developed further for the next meeting of WG-FSA, based on the considerations in paragraphs 10.29 and 10.30 and in the workshop recommended in paragraph 10.68.

10.85 The Working Group agreed in paragraph 10.50 that direct evidence of VMEs should be included when available in the development of risk-assessment maps and in identifying VMEs that need to be avoided.

10.86 The Working Group noted in paragraph 10.52 the lack of empirical evidence of the vulnerability of benthic taxa to the different bottom fishing gears used in exploratory fisheries. Consequently, it agreed that, in the first instance, the risk-assessment map will need to rely on expert opinion on vulnerability and possible impacts of fishing gears on different habitat types and VMEs. This would be facilitated by the workshop recommended in paragraph 10.68.

10.87 In considering approaches to the development of mitigation measures, the Working Group noted that these approaches could be naturally divided into three main classes of actions – activities by observers, responses of vessels and reporting requirements (paragraph 10.32).

10.88 The Working Group agreed that observations of benthic by-catch will be important in the coming year and recommended, in paragraph 10.33, a number of measurements to be taken. The Working Group also noted that it would be desirable for observers to obtain information on the operations of the gear and for developing monitoring protocols. However, given the high workloads of observers, these were considered to be lower priorities for the coming year (paragraph 10.34).

Mitigation measures

10.89 The Working Group drew the attention of the Scientific Committee to its consideration in paragraphs 10.36 to 10.40 of how vessels should respond to evidence of VMEs. In paragraph 10.36, the Working Group agreed that a common strategy was needed that would have specific variations depending on the type of gear being used. However, there was insufficient information to determine an agreed strategy, including the type and level of by-catch that would be required to trigger action and the precise nature of the action that should be taken. It was proposed that such issues would need to be resolved at the VME workshop recommended in paragraph 10.68.

10.90 In paragraph 10.37, the Working Group noted the general expectation of Members to report encounters of fishing vessels with VMEs. However, there was variation amongst the submissions on what evidence was required before such an encounter would be reported. Nevertheless, observer data should be reported along with the data necessary for the preliminary assessments by Members to be submitted in accordance with Conservation Measure 22-06.

10.91 A difficulty in the discussion was resolving the tension between protecting VMEs from significant adverse impacts and obtaining the information on whether those impacts are arising or have arisen. Under such circumstances, a strategy for avoiding significant adverse impacts on VMEs, such as through identifying areas that need to be avoided, will need to be developed taking account of the issues in paragraph 10.38.

10.92 The Working Group noted that fishing is prohibited in all areas shallower than 550 m in Divisions 58.4.1 and 58.4.2 (Conservation Measures 41-04 and 41-05) because of the higher risk to benthic habitats (paragraph 10.83(iv)).

10.93 It was noted in paragraph 10.39 that continuing to fish in areas for which by-catch evidence indicates a possibility of interactions with a VME is contradictory to trying to protect VMEs from significant adverse impacts. Also, continuing such fishing in an area where evidence of a VME has been found may be contrary to Conservation Measure 22-06, paragraph 8.

10.94 The Working Group recognised this conundrum in paragraph 10.40. It also noted that it could not calculate the level of evidence of VMEs to trigger actions for the different vessels at this meeting. The Working Group agreed that full compliance in providing data on benthos by-catch will be important in order to determine vessel-specific recommendations on trigger levels. An alternative strategy to vessel-specific trigger levels would be to identify areas that need to be avoided by all vessels (see paragraph 10.97).

10.95 In paragraph 10.43, the Working Group noted that it would be useful to undertake simulations of different management approaches to evaluate which avoidance/research approaches may be most useful in avoiding significant adverse impacts on VMEs when there is no information on which to judge a suitable approach.

Advice on the occurrence of VMEs

10.96 In addition to the following advice, the Working Group drew the attention of the Scientific Committee to its advice on identifying VMEs in paragraphs 10.63 to 10.69 for consideration in the requirement in Conservation Measure 22-06, paragraph 12.

10.97 The Working Group noted in paragraph 10.41 that data were available in CCAMLR-XXVII/26 to review locations of catches of VME taxa. However, it had insufficient time to make recommendations on areas that may need to be closed to the fleet for the coming season according to Conservation Measure 22-06. The Working Group noted that time should be made available next year to undertake such assessments and encouraged an improvement of data quality and quantity to support this.

10.98 The Working Group reviewed two notifications of VMEs in Division 58.4.1 (SC-CAMLR-XXVII/13) in paragraphs 10.56 and 10.57 and agreed that these were obvious cases of VMEs, with clear evidence of well developed benthic communities.

10.99 In paragraphs 10.58 and 10.59, the Working Group reviewed a draft VME notification form developed by the Secretariat on the basis of the requirements in Conservation Measure 22-06 and tabular notification in SC-CAMLR-XXVII/13. It was designed in such a way that it could be submitted by Members as part of the 5-day reporting system during fishing operations and could be used by Members undertaking research activities. The Working Group recommended that it be used as the means of notifying the Secretariat when evidence of VMEs is encountered.

10.100 In paragraph 10.60, the Working Group requested that the Scientific Committee consider the method by which these notifications would be reviewed and the process for adding a VME to the Register of VMEs. It also asked the Scientific Committee whether there was an expectation that WG-FSA be the primary working group where such reviews would be undertaken. The Working Group noted that the requirements for protecting VMEs may change as more information becomes available, including data on the spatial extent of VMEs and their vulnerability to fishing.

Advice on known and anticipated impacts

10.101 On the basis of its discussion in paragraphs 10.9 to 10.22, the Working Group noted that no advice could be provided this year on actual or potential encounters with VMEs by exploratory longline fishing, including no advice on known and anticipated impacts, but that some depth strata in some SSRUs may have experienced higher levels of interactions with bottom fishing gear than other areas in Subarea 88.1.

10.102 In paragraph 10.28, the Working Group agreed that there are few empirical data to determine what the effects of the proposed activities might be on VMEs in the Convention Area and whether there would be overlap between the proposed fishing activities and VMEs.

10.103 The Working Group recommended that a report akin to the Fishery Reports on 'Bottom Fisheries and Vulnerable Marine Ecosystems' be developed for collating the available knowledge on VMEs, the potential for significant adverse impacts, risk assessments and potential for impacts arising from bottom fisheries. Given the large amount of work this will entail and the varying types of expertise required to undertake the different sections of such a report, the Working Group advised that it may not be appropriate for WG-FSA to be solely responsible for its development and updating. It requested the Scientific Committee to consider what might be needed in such a report to address the requirements of the Commission and how this work might be undertaken.

Advice on practices when evidence of VMEs is encountered

10.104 With respect to Conservation Measure 22-06, paragraphs 7(iii) and 9, the Working Group had no advice for the 2008/09 season on specific practices when evidence of VMEs is encountered during bottom fishing activities, but drew the attention of the Scientific Committee to the discussion in paragraphs 10.32 to 10.43.

Advice on other mitigation measures

10.105 With respect to Conservation Measure 22-06, paragraph 7(iii), the Working Group has no advice on other mitigation measures for the 2008/09 season.

Advice on research and data collection plans

10.106 With respect to research and data collection plans for bottom fisheries under Conservation Measure 22-06, the Working Group agreed that whatever strategy is adopted for the coming year, it will be important to collect as much benthos by-catch data as possible for analysis next year (paragraph 10.42). It also agreed that experience of ad hoc WG-IMAF showed the following to be important in combating the incidental mortality of seabirds in fisheries and will be relevant to avoiding significant adverse impacts on VMEs (paragraph 10.42):

(i) education of the crews of vessels participating in exploratory bottom fisheries will help increase awareness of the value of VMEs, in terms of their marine biodiversity and as habitat to fish assemblages, and the importance of developing mitigation measures to avoid impacts on them;

(ii) continued development of methods to reduce the frequency of gear loss that could impact on VMEs.

10.107 The Working Group agreed that it would be useful for observers to provide information on the following (paragraph 10.33):

(i) the locations and types of taxa being landed, where identification should be at least to the level of morphotypes provided in the poster developed by New Zealand (paragraph 6.45);

(ii) the numbers and, where possible, total mass of each taxon being landed;

(iii) information on the likely geographic origin of the taxa – noting that observations by hook or by magazine could be related to the geographic position of the line on the substratum, although this may require an observer to be provided with a hand-held GPS to note the position of the vessel when a taxon is landed;

(iv) in the future, an increase in the level of detail may be triggered by catches of specific types of taxa but it was recognised that, for the near future, records should be maintained of all landed taxa and that information by observers should be as complete as possible for the periods of observation.

10.108 The Working Group wished to draw the attention of the Scientific Committee to paragraph 10.27 which identifies the need to improve reporting of benthic by-catch in order for such data to be useful for analyses on the interaction of bottom fishing activities with VMEs.

General

10.109 The Working Group noted that, in the absence of (i) direct observations of impacts by fishing gear, (ii) censuses of the distribution and abundance of benthic habitats, and (iii) evaluation of the ecological consequences of the effects of fishing on those habitats and critical ecological processes, a precautionary strategy will need to be adopted that will successfully avoid significant adverse impacts on VMEs in the interim of impact assessments being completed and long-term mitigation strategies being developed. The Working Group also noted that the following issues need to be considered in formulating such a strategy:

(i) Many VME taxa are expected to be sessile, slow growing and long-lived, which means that if such taxa are depleted they are unlikely to recover in two to three decades as required in Article II. Therefore, escapement of VME taxa in space is an important consideration in maintaining viable VMEs.

(ii) Precautionary strategies need to be adopted to avoid significant adverse impacts on VMEs and VME taxa that are restricted in their distribution, such as, for example, locally endemic taxa.

(iii) Consistent with the precautionary approach, controlled acquisition of data will be needed.

(iv) A single fishing event is unlikely to cause significant adverse impacts on VMEs but cumulative effects between assessments and management decisions could give rise to significant adverse impacts. Strategies are needed to limit cumulative effects between assessments as it will ultimately be a single fishing event that will cause the significant adverse impact in the course of a fishing period between assessments.

(v) Interim strategies could include:

  (a) large-scale closures of areas with a reasonable likelihood of including representative VMEs;

  (b) small-scale closures of areas on the basis of a limited by-catch of benthos during fishing operations, noting that benthos affected by longline systems may not be well represented in landed by-catch;

  (c) temporary closures of areas as in (b) while research is undertaken to establish the spatial extent of habitats and VMEs.

(vi) Without appropriate knowledge, it will be very difficult to predict when the effects of bottom fishing will have accumulated to cause significant adverse impacts on VMEs. Under such circumstances, significant adverse impacts may not be detected until after such impacts have obviously occurred.

(vii) If bottom fishing activities must overlap significantly with areas in which VMEs occur because of the distribution of fish, then the escapement of VMEs may need to be greater than expected. This is because of the need to allow for inadvertent impacts on VMEs, which could accumulate to cause significant adverse impacts.

Interactions with WG-EMM

10.110 Discussion on this matter is reported in section 9.

Development of ecosystem models

10.111 WG-EMM-08/42 reported on the further development of a mass-balanced carbon-budget trophic model of the Ross Sea as a step towards investigating ecosystem effects of the fishery for *D. mawsoni*. The Working Group noted WG-EMM's discussion of this paper in Annex 4, paragraphs 6.6 and 6.7, and underlined the importance of the paper for discussion at FEMA2 (paragraphs 13.12 to 13.17).

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-08/5 Rev. 1, 08/6 Rev. 1, 08/7 Rev. 2 and 08/8.

11.3 The following cruises were conducted during the 2007/08 season:

(i) Longline: 40 cruises with scientific observers (international and national) on board all vessels. Eleven cruises were undertaken in Subarea 48.3 by 10 vessels, two cruises were undertaken in Subarea 48.4 by two vessels, nine cruises were undertaken by eight vessels in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, four cruises were conducted by two vessels in Division 58.5.2, one cruise was conducted in Subareas 58.6 and 58.7 and 13 cruises were undertaken in Subareas 88.1 and 88.2 by 13 vessels. In addition, one cruise was also conducted in Area 51 outside the Convention Area.

(ii) Trawl – finfish: five vessels conducted nine trawl cruises targeting finfish. All trawlers fishing for finfish carried scientific observers. In total, three national and six internationally designated scientific observers participated in these operations.

(iii) Trawl – krill: eight scientific observation programs were conducted by one nationally and seven internationally designated scientific observers on board krill vessels operating in the Convention Area. All of the krill trawl operations observed were in Area 48, with four cruises conducted in Subareas 48.1 and 48.2 and four cruises conducted in Subarea 48.3. A total of 3 935 trawls were conducted, with 314 trawls (8%) observed. The majority of these trawls were a result of the continuous pumping reporting method, where a single continuous haul is broken down into two-hour periods. (For an explanation of this apparently low observation rate, see Annex 6, paragraph 2.21.)

(iv) Three pot cruises targeting *D. eleginoides* were conducted during the 2007/08 season. These cruises were undertaken in Subarea 48.3, two cruises were undertaken by the Korean-flagged vessel *Jung Woo No. 2* and one by the Uruguayan vessel *Punta Ballena*. All cruises were conducted with an international scientific observer on board.

11.4 The Working Group reviewed the report of the first meeting of ad hoc TASO held in St Petersburg, Russia, on 19 and 20 July 2008 (SC-CAMLR-XXVII/BG/6), and considered the various questions referred to it by TASO.

(i) Characterisation of fishing gear:

(a) Detailed descriptions of the fishing gear per set (or haul) are essential for appropriate analysis of catch and effort data.

(b) Responsibility of reporting of these data be moved from the observer to the vessel and that appropriate changes be made to the C2 form to enable the vessels to report this information on a per set basis. However, the observer should still comment on the general characteristics of the gear used in the final report and the logbook.

(c) There is not sufficient information on the extent of variability within different gear types, especially trotlines, to reflect all parameters that may be important to standardising CPUE across different gear types. The Working Group requested that all vessels include detailed descriptions of the gear that they intend to use along with their notifications to fish. The Working Group recognised that these type of data are commercially sensitive, and that all fishery and observer data are held in confidentiality in the CCAMLR database. Access to these data is subject to the Rules for Access and Use of CCAMLR Data.

(d) As an interim measure, the Working Group recommended that the following five columns (suggested by ad hoc TASO) be added to the C2 form to capture variability in trotlines:

- the number of hooks in a cluster
- the number of clusters on a dropline
- the spacing between the droplines
- the spacing between the hook clusters
- the distance of the lowest cluster of hooks above the bottom.

(e) The Working Group endorsed the recommendation made in WG-FSA-08/60 that when a vessel sets two sections of line that are joined under water, they should be reported as two independent sets, the geographical start and finish positions of these sets being the positions of the anchors or grapnels.

(ii) Consideration of data collection requirements:

(a) As it is not always practical to count the number of individuals per species (particularly icefish) in the catch (SC-CAMLR-XXVII/BG/6, paragraph 3.18), WG-FSA recommended that form T3 be modified to enable the observer to record the total catch by weight and either the total number or the mean weight. The mean weight of fish should be obtained from a subsample of the catch.

(b) The Working Group recognised that macroscopic (field) maturity staging in *Dissostichus* spp. is still uncertain and that further work is required to improve this (paragraphs 3.72 and 3.73). It recommended that macroscopic staging still be carried out in the meantime and that GSI be measured when motion-compensated balances are available.

(c) The Working Group noted that the current sampling level for *Dissostichus* spp. in new and exploratory longline fisheries of 35 fish per set stems from a combination of a recommendation that one fish should be sampled per 150 hooks (WG-FSA-05/49) and the mean number of hooks per line in Subarea 88.1.

Where both species of *Dissostichus* spp. are sampled on a single line, this requirement potentially doubles sampling effort to 70 fish per line. The Working Group noted that in situations where both species are caught, it is uncommon for both species to be taken in equal proportions and thus it is unlikely that sampling of 70 fish would be required. Nevertheless it is important that the catch of both species is sampled in proportion to the catch. Where the catch of one of the species is a very small proportion of the catch, this may mean that individuals of the less frequent taxa are not selected for biological sampling. It is, however, important to collect information on the species which occurs in a smaller proportion of the catch.

(d) The Working Group has referred the question of the number of toothfish to be sampled for biological, age and length data to WG-SAM for re-evaluation.

(e) In the interim, the Working Group recommended a sampling rate of one *D. eleginoides* and one *D. mawsoni* per 150 hooks with a minimum of five *D. eleginoides* and five *D. mawsoni* per line. The required sample size should be determined once the line has been set and, where possible, the sample should be taken in one contiguous collection. However, see paragraph 6.43 for the recommended reduction in *Dissostichus* spp. sampling in the coming season to accommodate the additional requirements associated with the Year-of-the-Skate.

(f) It is noted that modifications to the forms in the observer logbook for the recording of skate in paragraphs 6.33 and 6.34 will simplify the observer tasks.

(g) It was agreed that data such as sea state, sea temperature and other meteorological parameters were better recorded by vessels if required (SC-CAMLR-XXVII/BG/6, paragraph 3.19). They had never been used in any analysis and should be removed from the observer logbooks.

11.5 The Working Group noted that the guides for identification of by-catch species (paragraph 6.45) are simple and easy for observers to use. It also noted that WG-FSA-08/59 is more comprehensive and was developed for both observer and scientific use, however, it has retained the facility to stop at a higher taxonomic grouping if desired.

11.6 The Working Group recommended that the requirement for vessels to report the total number of hooks lost per line should be removed from form L5. However, vessels using traditional longlines must report the number of hooks lost attached to sections of backbone on a set-by-set basis, and vessels deploying trotlines must report the number of droplines lost per set.

11.7 The Working Group recalled that the Secretariat conducts routine checks and validation of all data submitted and, where required, makes factual corrections to the data in consultation with data owners/providers. In the case of scientific observer data, the initial contact point for consultations is the technical coordinators of Designating Members. In the case of fine-scale data, the initial contact point for consultations is the data provider of the Flag States. All changes are documented in the database and the original data and amendments are archived by the Secretariat.

Advice to the Scientific Committee

11.8 The Working Group recommended that:

(i) all vessels include detailed descriptions of the gear that they intend to use along with their notifications to fish;

(ii) detailed descriptions of the fishing gear per set (or haul) be made a vessel responsibility and that the following five columns be added to the C2 form to capture variability in trotlines:

- the number of hooks in a cluster
- the number of clusters on a dropline
- the spacing between the droplines
- the spacing between the hook clusters
- the distance of the lowest cluster of hooks above the bottom;

(iii) when a vessel sets two sections of line that are joined under water, they be reported as two independent sets, the geographical start and finish positions of these sets being the positions of the anchors or grapnels;

(iv) form T3 be modified to record the total catch weight, total number caught and the mean weight of fish in the catch;

(v) photographic guides to macroscopic maturity staging of *Dissostichus* spp. be developed and that GSI be measured when motion-compensated balances are available;

(vi) a statistical analysis of the required sampling level of *Dissostichus* spp. for the collection of biological, age and length data be requested from WG-SAM;

(vii) in the interim, a sampling rate of one *D. eleginoides* and one *D. mawsoni* per 150 hooks with a minimum of five fish of each species per line be set;

(viii) data such as sea state, sea temperature and other meteorological parameters be recorded by vessels if required and no longer by observers;

(ix) the requirement for vessels to report the total number of hooks lost per line be removed from form L5. However, vessels using traditional longlines must report the number of hooks lost attached to sections of backbone on a set-by-set basis, and vessels deploying trotlines must report the number of droplines lost per set.

FUTURE ASSESSMENTS

12.1 The Working Group recalled that it had requested some refinements of the Subarea 48.3 icefish survey which would assist the assessment, in particular establishing from acoustics and pelagic trawl data the distribution of icefish to the south of South Georgia and the proportion of the population that is unlikely to be sampled by the bottom trawl used in the survey (paragraphs 3.25 and 4.7). It was further suggested that dietary information and condition might be used to tune the natural mortality parameter in icefish assessments (paragraph 3.79).

12.2 To follow 2009 as the Year-of-the-Skate, WG-FSA is considering designating 2011 as the 'Year-of-the-Grenadier'. WG-SAM was requested for advice on what assessments would be appropriate for grenadiers, and to provide advice on the research and data collection that would be required to enable WG-FSA to develop such assessments.

12.3 The mark–recapture experiments in Divisions 58.4.1 and 58.4.2 have so far failed to deliver information that will support an assessment (paragraphs 5.21 and 5.22). WG-FSA requested that WG-SAM continue to investigate alternative assessment methods such as those developed this year utilising CPUE (paragraph 5.24; WG-FSA-08/43) and, in particular, longline research surveys (WG-FSA-08/57), that may deliver robust assessments of toothfish stock status and trends in the absence of reliable tagging data.

12.4 If the Japanese research proposed in WG-FSA-08/39 is successful, an assessment of stock size in Division 58.4.4 may be possible in a few years. WG-FSA noted that it is assumed that this stock is depleted and CCAMLR's objective is to ensure its recovery. WG-SAM was requested to examine methods for determining the relative depletion and recovery status of the stock, taking into consideration that the gear being used for the experiment is not the same as gear used when the fishery was last exploited, and to advise on the data and research requirements which will enable this determination.

12.5 Given that three major longline gear types are in use in the Convention Area (Spanish, autoline and trotline), WG-SAM was asked to consider designs that would be capable of standardising gear effectively between surveys.

Frequency of assessments

12.6 The Working Group agreed that the move to a biennial assessment for three stocks (Subarea 48.3, Division 58.5.2 and the Ross Sea) had been extremely successful in releasing time both intersessionally and at the meetings of WG-SAM and WG-FSA. This additional time had allowed the development of the first assessments for three exploratory fisheries (Divisions 58.4.1, 58.4.2 and 58.4.3a) and detailed consideration of other issues of high importance to the Commission and the Scientific Committee, such as VMEs and the Year-of-the-Skate.

12.7 The Working Group noted that for none of the stocks under biennial assessment were the Scientific Committee's three criteria for returning to annual assessments satisfied (SC-CAMLR-XXVI, paragraph 14.6). However, there had been no formal consideration of this other than by individual Members. The Working Group called for consideration to be given by WG-SAM to a formal procedure for doing this, although it acknowledged that for some stocks it may be difficult to make this decision at WG-SAM because of the timing of the fishery.

General considerations

12.8 Concern was expressed at the non-participation of many Members in the work of WG-FSA, and in particular of those whose first language is not English. Part of the problem was attributed to the difficulty of understanding what are now fairly complex stock assessment methods, although attendance by scientists with a wide range of statistical and biological expertise provides the confidence to use such methods.

12.9 Dr Holt suggested if existing members of WG-FSA were to mentor new members on a one-to-one basis, this would accelerate their integration into the group and their understanding of CCAMLR stock assessments.

FUTURE WORK

Organisation of intersessional activities of subgroups

13.1 Future work identified by the Working Group is summarised in Table 22, 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 the tasks identified at the meeting or associated with established meeting procedures, do not include ongoing tasks undertaken by the Secretariat, such as data processing and validation, publications and routine preparations for meetings.

13.2 WG-FSA thanked all subgroups for their contributions and encouraged each one to continue its work in the forthcoming intersessional period, focusing, where possible, on key issues identified in Table 22. The Working Group re-emphasised that the membership to the subgroups was open to all participants (new participants are encouraged to contact the Secretariat for further information on the subgroups). The following subgroups met during the meeting:

- Subgroup on Assessments (coordinator: Dr R. Hillary (UK))
- Subgroup on Biology and Ecology (coordinator: Dr Kock)
- Subgroup on By-catch (coordinator: Dr Collins)

- Subgroup on New and Exploratory Fisheries (coordinator: Drs Hanchet and Bizikov)
- Subgroup on Observers (coordinator: Dr R. Leslie (South Africa))
- Subgroup on Tagging (coordinator: Dr Welsford)
- Subgroup on VMEs (coordinator: Dr Constable)
- Subgroup on Year-of-the-Skate (coordinators: Drs R. Mitchell (UK) and Mormede).

13.3 Dr Jones agreed to contact potential subgroup coordinators two weeks prior to the next meeting of the Working Group in order to review subgroup work plans for that meeting in light of the Working Group's priorities, meeting agenda and submitted papers.

13.4 The Working Group noted with concern that its workload, and that of other working groups, has increased in recent years, while the number of participants and Members represented had decreased over the same period. As a result, the growing workload was shared by fewer participants, and the Working Group was no longer able to address all of its tasks to the level of detail expected by the Scientific Committee.

13.5 The Working Group anticipated that it would need to consider two major topics at its 2009 meeting:

(i) revision of assessments for icefish and toothfish fisheries, including fisheries in Subareas 48.3, 88.1 and 88.2 and Division 58.5.2, and the exploratory fisheries in Subarea 58.4;

(ii) further development of approaches to avoid and mitigate significant adverse impacts of bottom fishing on VMEs.

13.6 In addition, the Working Group recognised that some recommendations from the CCAMLR Performance Review may require detailed consideration by WG-FSA in 2009.

13.7 The work on VMEs had significantly altered the workload of WG-FSA, as well as that of other working groups, and consideration of recommendations from the Performance Review also had the potential to add significantly to the Working Group's workload.

13.8 The Working Group urged the Scientific Committee to develop a medium- to long-term Science Plan in order to address the competing demands of the Commission, facilitate coordination among working groups and assign research priorities. In the absence of a Science Plan, WG-FSA would continue to address topics which it thought were of a high priority to the Scientific Committee. Such work would be limited by the time available at meetings, and by the number of participants and their areas of expertise.

13.9 The Working Group also urged its membership and that of the Scientific Committee to consider ways of augmenting participation in the work of WG-FSA and other working groups.

13.10 The Working Group recalled a proposal to conduct the Year-of-the-Grenadier in 2010 (SC-CAMLR-XXVI, Annex 5, paragraph 6.39). However, the Working Group agreed to defer this activity provisionally until 2011 as the procedures established for the Year-of-the-Skate, and the ensuing results, can then be evaluated.

13.11 Instead, the Working Group proposed that the Scientific Committee may wish to designate 2010 as the Year-of-the-VMEs in order to focus further research activities aimed at developing approaches to avoid and mitigate significant adverse impacts of bottom fishing on VMEs (section 10.2).

Second Workshop on Fisheries and Ecosystem Models in the Antarctic

13.12 The Working Group considered the set of topics for FEMA2 which had been developed by the conveners of WG-EMM and WG-FSA and discussed at WG-EMM-08 (Annex 4, paragraphs 8.1 to 8.4).

13.13 Four topics had been proposed for FEMA2:

(i) Evaluate whether the level of escapement currently espoused in existing decision rules for toothfish in the Ross Sea is sufficiently precautionary when these fish are viewed as important prey as well as predators. Such an evaluation should include a comparative analysis of the importance of toothfish as prey in different regions throughout the Southern Ocean.

(ii) Evaluate whether the existing boundaries of SSRUs in the Ross Sea could be revised on the basis of overlap between the spatial distribution of the fishery, the foraging areas of predators on toothfish, and other information such as the presence or density of VMEs. Such an evaluation should include work similar to that used for defining SSMUs in Area 48 (SC-CAMLR-XXI, Annex 4, Appendix D).

(iii) Evaluate whether the existing basis for distributing the precautionary catch limits for toothfish among SSRUs in the Ross Sea could be revised on the basis of the information considered in (ii) above.

(iv) Evaluate whether steps to implement possible revisions evaluated in (ii) and (iii) above would impact results from the ongoing tagging studies that are important components of the research plan and stock assessment process for exploratory fisheries for toothfish in the Ross Sea.

13.14 WG-FSA agreed with WG-EMM's advice that FEMA2 would need to focus on topics (i) and (ii), and that topics (iii) and (iv) would need to be addressed at a later stage (Annex 4, paragraphs 8.4 to 8.6).

13.15 Following further discussion, WG-FSA recommended that FEMA2 focus primarily on topic (i), and in particular the evaluation of the precautionary and ecosystem-based elements of the escapement levels used in managing toothfish in the Ross Sea.

13.16 The Working Group encouraged the Scientific Committee to form a small group to elaborate the terms of reference of FEMA2.

13.17 The Working Group also noted that the IWC held cetacean data and information collected by the former USSR, and that such information may be available to FEMA2.

Intersessional meetings

Meeting of WG-SAM

13.18 During the course of its meeting, the Working Group identified a number of matters which it referred to WG-SAM: paragraph 3.58 (unmatched tag-recaptures); paragraph 4.18 (data quality metrics), paragraph 5.97 (harvest strategies and research programs), paragraph 11.4(ii)(d) (sampling fish on longlines) and paragraphs 12.1 to 12.9 (future assessments).

Meeting of ad hoc TASO

13.19 During the course of its meeting, the Working Group identified a number of matters which it referred to ad hoc TASO: paragraph 10.35 (taxonomic details of observations).

Meeting of SG-ASAM

13.20 During the course of its meeting, the Working Group identified a number of matters which it referred to SG-ASAM: paragraph 3.26 and Appendix O, paragraph 7 (trawl headline height correction factor).

Notification of scientific research activities

13.21 The Working Group noted that the following Members would be conducting scientific research activities in 2009 and in accordance with Conservation Measure 24-01:

Australia:	demersal fish survey in Division 58.5.2 in May–June 2009
Japan:	research fishing in Division 58.4.4 (paragraphs 5.116 to 5.121; see also CCAMLR-XXVII/BG/15)
New Zealand:	research fishing in Subarea 88.1 (paragraphs 5.108 to 5.115; see also CCAMLR-XXVII/BG/15)
UK:	demersal fish survey in Subarea 48.3 in January–February 2009
USA:	demersal fish survey in Subarea 48.2.

13.22 Dr Constable advised that Australia would be conducting a multi-disciplinary benthic survey, primarily using camera gear, of Bruce Rise in Division 58.4.1, using various types of sampling gear, including research hookless longlines and trawls.

13.23 Dr Holt advised that the USA survey in Subarea 48.2 will also include the collection of acoustic data, net sampling for krill and video-photographic transects of benthic habitats.

13.24 The Working Group noted that Members participating in scientific research activities which fall under Conservation Measure 24-01 are required to submit the following to the Secretariat:

- a notification of research vessel activity (Conservation Measure 24-01, Annex A, Format 1 or Format 2);
- 5-day catch and effort reports during the research activity;
- annual STATLANT returns which include catches taken during the research activity;
- a summary report within 180 days of the completion of the research activity and a full report within 12 months.

OTHER BUSINESS

Letter on *D. mawsoni* in McMurdo Sound

14.1 The Working Group considered a letter, addressed to the Science Officer and the conveners of WG-EMM and WG-FSA, authored by 25 Antarctic scientists on the decline of *D. mawsoni* from McMurdo Sound (WG-EMM-08/20; see also WG-EMM-08/21), and noted the deliberations of WG-EMM on this matter (Annex 4, paragraphs 6.23 to 6.27).

14.2 The Working Group noted that WG-EMM had identified several inconsistencies in WG-EMM-08/21 and had been unable to adequately assess the conclusions of the paper. WG-EMM had requested the authors to provide further information on fishing effort and catches, biological data, including length-frequency distributions, and details of the two sampling sites (Annex 4, paragraph 6.24).

14.3 WG-FSA encouraged the scientists involved in this work to submit the data and information identified above to the CCAMLR Secretariat so that a GLM-type analysis may be used to review the conclusions reported in WG-EMM-08/21. The Working Group agreed to conduct such a review at its next meeting if the data were made available in sufficient time.

CCAMLR Science

14.4 In 2007 the Scientific Committee requested that the Editor of *CCAMLR Science*, in consultation with the Chair of the Scientific Committee and the conveners of the working groups, prepare a revision of the publication policy of *CCAMLR Science*, including consideration of the procedure for selecting papers (SC-CAMLR-XXVI, paragraphs 13.24 and 13.25). The revised policy is outlined in SC-CAMLR-XXVII/6, and Dr Reid presented the key points to the Working Group.

14.5 The Working Group supported the revised editorial process and policy.

14.6 The Working Group recognised the potentially important contribution to CCAMLR's work which is provided by scientists from outside the CCAMLR membership and that current procedures may not allow CCAMLR to gain the maximum benefit of this work.

14.7 The Working Group urged the Scientific Committee to consider allowing scientific contributions from outside the CCAMLR membership to be submitted to working groups for consideration. Further, and if so desired by the authors, such contributions could be considered for publication in *CCAMLR Science*. Such contributions also provide opportunities for the introduction of new ideas into the work of CCAMLR.

14.8 The Working Group agreed that contributions by scientists from outside the CCAMLR membership would need to be made under separate guidelines for the submission of meeting documents. Such contribution would need to be provided well in advance of meetings (e.g. two months) in order to allow sufficient time for participants to consider the findings and develop their work plans.

Joint SC-CAMLR–CEP Workshop

14.9 The Working Group discussed the proposal for a joint workshop between SC-CAMLR and the CEP ('Opportunities for collaboration and practical cooperation between the CEP and SC-CAMLR'), noting the deliberations of WG-EMM on this matter (Annex 4, paragraphs 9.1 to 9.5; WG-EMM 08/52), and the information circulated by the Secretariat (SC CIRCs 08/47 and 08/65). This workshop is currently scheduled to be held in early April 2009, immediately prior to the CEP XII meeting in Baltimore, USA.

14.10 The Working Group supported the recommendations of WG-EMM, including the suggestions for further consultation during the forthcoming meeting of the Scientific Committee.

ADOPTION OF THE REPORT

15.1 The report of the meeting was adopted.

CLOSE OF MEETING

16.1 Dr Jones 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 Dr Constable, on behalf of the Working Group, thanked Dr Jones for stepping up to convene the Working Group. The deliberations of WG-FSA can be intense at times, and Dr Jones led the meeting with new energy, direction and insight.

16.3 Dr Zhao expressed his thanks to the Working Group for welcoming him to the meeting and providing assistance in understanding its work.

16.4 Mr N. Smith (New Zealand), on behalf of the Working Group, noted Dr Holt's imminent retirement. The Working Group thanked Dr Holt for his outstanding leadership and contribution to the work of CCAMLR. The Working Group looked forward to Dr Holt's further involvement with its work.

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 2007/08. **Bold**: fishery closed. (Source: catch and effort reports to October 2008 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-07	14-Nov-08[a]	42-01 (2007)	1 326	2 462	54
	58.5.2	Trawl	01-Dec-07	30-Nov-08[a]	42-02 (2007)	199	220	90
Dissostichus eleginoides	48.3	**Longline**, pot	01-Dec-07	30-Nov-08[a]	41-02 (2007)	3 856[b]	3 920	98
	48.4	**Longline**	01-Apr-08	**14-May-08**	41-03 (2006)	98	100	98
	58.5.1 French EEZ[c]	Longline	ns	ns	ns	2 853	ns	
	58.5.2	Longline, pot, trawl	01-Dec-07	30-Nov-08[a]	41-08 (2007)	1 496	2 500	60
	58.6 French EEZ[c]	Longline	ns	ns	ns	684	ns	
	58 South African EEZ	Longline	ns	ns	ns	54	ns	
Dissostichus spp.	48.6	Longline	01-Dec-07	30-Nov-08[a]	41-04 (2007)	0	400	0
	58.4.1	Longline	01-Dec-07	30-Nov-08[a]	41-11 (2007)	413	600	69
	58.4.2	Longline	01-Dec-07	30-Nov-08[a]	41-05 (2007)	217	780	28
	58.4.3a	**Longline**	01-May-08	31-Aug-08	41-06 (2007)	9	250	4
	58.4.3b	**Longline**	01-May-08	**20-Feb-08**	41-07 (2007)	141	150[d]	94
	58.4.4	Research	20-Jun-08	27-Sep-08	24-01 (2005)	77	0[d]	-
	88.1	**Longline**	01-Dec-07	31-Aug-08	41-09 (2007)	2 259	2 700	84
	88.2	**Longline**	01-Dec-07	31-Aug-08	41-10 (2007)	416	567	73
Euphausia superba	48	Trawl	01-Dec-07	30-Nov-08	51-01 (2007)	125 063	620 000	20
	58.4.1	Trawl	01-Dec-07	30-Nov-08	51-02 (2002)	0	440 000	0
	58.4.2	Trawl	01-Dec-07	30-Nov-08	51-03 (2007)	0	452 000	0
Lithodidae	48.3	Pot	01-Dec-07	30-Nov-08	52-01 (2007)	0	1 600	0
Martialia hyadesi	48.3	Jig	01-Dec-07	30-Nov-08	61-01 (2007)	0	2 500	0

[a] Under review
[b] Does not include 2 tonnes taken during trawl survey
[c] Fine-scale data to August 2008
[d] Excluding research survey/research fishing limit (50 tonnes)
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 2007/08. The estimates are derived from information on longliners and gillnetters (source: WG-FSA-08/10 Rev. 2).

Subarea/ division	Estimated start of IUU fishing	No. of vessels sighted	Additional no. of vessels extrapolated to end of season	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 (not extrapolated)	Estimated IUU catch extrapolated to end of season
		1	2	3	4	5	6	7	8
48.3	1991	0							
58.4.1	2005	1	0.3	1.3	55	82	1.7	94	139
58.4.2	2002	0							
58.4.3a	2003	0							
58.4.3b	2003	3	0.9	3.9	164	246	1.5	246	369
58.4.4	1996	0							
58.5.1	1996	3	0.9	3.9	164	246	3.0	489	737
58.5.2	1997	0							
58.6	1996	1	0.3	1.3	55	82	2.8	153	229
58.7	1996	0							
88.1	2002	1	0.3	1.3	55	82	3.4	187	279
88.2	2006	0							
Total		9	2.7	11.7	493	738		1169	1753

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-08/10 Rev. 2 and SC-CAMLR reports).

Season	Subarea/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		146					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
2007/08		0	94	0	0	246	0	489	0	153	0	187	0	1169
All seasons	844	17 945	1 303	1 065	98	5 703	7 116	36 129	23 485	26 975	13 673	542	15	134 893

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 2006/07 and 2007/08 (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-08/10 Rev. 2: CDS catch – data to October 2008).

2006/07 season

Inside	Subarea/division	Reported catch	IUU catch	Total CCAMLR	*Catch limit**
	48.1	<1**		<1	*0*
	48.3	3 539		3 539	*3 554*
	48.4	54		54	*100*
	48.6	112		112	*910*
	58.4.1	634	612	1 246	*600*
	58.4.2	124	197	321	*780*
	58.4.3	255	2 293	2 548	*550*
	58.4.4	0	109	109	*0*
	58.5.1	5 201	404	5 605	*0 outside EEZ*
	58.5.2	2 387		2 387	*2 584*
	58.6	436		436	*0 outside EEZ*
	58.7	148		148	*0 outside EEZ*
	88.1	3 091		3 091	*3 072*
	88.2	347		347	*567*
	88.3	0		0	*0*
	Total inside	16 329	3 615	19 944	
Outside	**Area**	**CDS catch EEZ**	**CDS catch high seas**	**Total outside CCAMLR**	
	41	2 224	3 831	6 055	
	47		593	593	
	51	15	20	35	
	57			0	
	81	299	2	301	
	87	5 440	258	5 698	
	Total outside	7 978	4 704	12 682	
Global total				32 626	

2007/08 season

Inside	Subarea/division	Reported catch	IUU catch	Total CCAMLR	*Catch limit**
	48.3	3 856		3 856	*3 920*
	48.4	98		98	*100*
	48.6	0		0	*400*
	58.4.1	413	94	507	*600*
	58.4.2	217		217	*780*
	58.4.3	150	246	396	*450*
	58.4.4	77**		77	*0*
	58.5.1	2 853	489	3 342	*0 outside EEZ*
	58.5.2	1 496		1 496	*2 500*
	58.6	704	153	857	*0 outside EEZ*
	58.7	34		34	*0 outside EEZ*
	88.1	2 259	187	2 446	*2 700*
	88.2	416		416	*567*
	88.3	0		0	*0*
	Total inside	12 573	1 169	13 742	

(continued)

Table 4 (continued)

Outside	Area	CDS catch EEZ	CDS catch high seas	Total outside CCAMLR
	41	3 435	2 826	6 261
	47	13	187	200
	51	20	83	103
	57			0
	81	378		378
	87	3 232	117	3 349
	Total outside	7 078	3 213	10 291
Global total				24 033

* Includes catch limits for research fishing
** Research fishing/survey

Table 5: Participation in exploratory fisheries for *Dissostichus* spp. in 2007/08. Participating Members includes Members who submitted notifications but did not fish. (Source: WG-FSA-08/4)

Subarea/division	Participating Member	Number vessels fishing	*Dissostichus* spp. catch (tonnes)	
			Limit	Reported
Exploratory fisheries in Area 48 (Atlantic Ocean sector)				
48.6	Japan	-		
	Korea, Republic of	-		
	New Zealand	-		
	South Africa	-		
Total		0	400	0
Exploratory fisheries in Area 58 (Indian Ocean sector)				
58.4.1	Australia	-		
	Japan	-		
	Korea, Republic of	2		
	Namibia	2		
	New Zealand	-		
	Spain	1		
	Ukraine	-		
	Uruguay	1		
Total		6	600	413
58.4.2	Australia	-		
	Japan	-		
	Korea, Republic of	1		
	Namibia	2		
	New Zealand	-		
	South Africa	-		
	Spain	-		
	Ukraine	-		
	Uruguay	-		
Total		3	780	217
58.4.3a	Uruguay	1		
Total		1	250	9

(continued)

Table 5 (continued)

Subarea/division	Participating Member	Number vessels fishing	*Dissostichus* spp. catch (tonnes)	
			Limit	Reported
58.4.3b	Australia	1		
	Japan	1		
	Korea, Republic of	-		
	Namibia	1		
	Spain	-		
	Uruguay	1		
Total		4	150	139
			(50)*	(2)
Exploratory fisheries in Area 88 (Southwest Pacific sector)				
88.1	Argentina	1		
	Korea, Republic of	3		
	Namibia	-		
	New Zealand	4		
	Russia	1		
	South Africa	1		
	Spain	1		
	UK	3		
	Uruguay	1		
Total		14	2 700	2 259
88.2	Argentina	-		
	New Zealand	1		
	Russia	1		
	South Africa	-		
	Spain	-		
	UK	1		
	Uruguay	1		
Total		4	567	416

* Research survey

Table 6: 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	126	105	297	3 105	411	4 575
2005/06	163	421	164	89	361	2 969	514	4 680
2006/07	112	634	124	4	251	3 091	347	4 562
2007/08		413	217	9	141	2 259	416	3 455
Total	333	1 948	767	207	1 057	18 526	2 209	25 047

Table 7: Summary of Members and vessels notified in 2008/09 in (a) exploratory longline fisheries for *Dissostichus* spp. (with corresponding number of participating Members, number of vessels and catch limits agreed in conservation measures in force in 2007/08), (b) exploratory trawl fisheries for krill, and (c) new pot fisheries for crab. (Source: CCAMLR-XXVII/12)

Member notifications	Number of vessels notified by subarea/division						
	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2
(a) Notifications for exploratory longline fisheries for *Dissostichus* spp. in 2008/09							
Argentina						2	2
Australia			1				
Chile						1	1
Japan	1	1	1	1	1		
Korea, Republic of	2	5	4			4	2
New Zealand		4	1			4	4
Russia						3	3
South Africa		1				1	1
Spain		1	1		1	1	1
UK						3	3
Uruguay		1	1		1	2	2
Number of Members	2	6	6	1	3	9	9
Number of vessels	3	13	9	1	3	21	19
Corresponding conservation measures in force in 2007/08							
Number of Members	4	8	9	1	6	9	7
Number of vessels	1*	15	15	1	1*	21	15
Target species catch limit (tonnes)	400	600	780	250	150**	2700	567

Member notifications	Number of vessels notified by subarea/division
	48.6
(b) Notifications for exploratory trawl fisheries for krill in 2008/09	
Norway	1
Total	1

Member notifications	Number of vessels notified by subarea/division	
	48.2	48.4
(c) Notifications for new pot fisheries for crab in 2008/09		
Russia	1	1
Total	1	1

* Maximum number per Member at any one time
** Excluding research fishing

Table 8: Unstandardised CPUE (kg/hook) of *Dissostichus* spp. in exploratory longline fisheries reported between 1996/97 and 2007/08. (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	2007/08
48.6	A								0.04	0.07	0.11	0.15	
	D											0.05	
	E									0.08		0.13	
	G								0.02	0.07	0.16	0.07	
58.4.1	C									0.13	0.18	0.15	0.19
	D												0.09
	E									0.22	0.10	0.13	0.12
	F												0.05
	G									0.20	0.22	0.24	0.12
	H												0.15
58.4.2	A									0.08	0.08	0.13	0.20
	C							0.10		0.07	0.17		0.42
	D							0.19	0.06		0.03		
	E							0.21	0.11	0.14	0.22	0.15	0.21
58.4.3a	A									0.05	0.05	0.02	0.08
58.4.3b	A								0.04	0.07	0.11	0.13	0.15
	B								0.14	0.23	0.17	0.12	
88.1	A	0.01				0.02		0.16			0.08	0.05	
	B	0.05	0.03			0.16	0.25	0.26	0.11	0.55	0.07	0.33	0.15
	C					0.44	0.87	0.58	0.31	0.53	1.07	0.71	0.36
	E		0.07	0.06		0.03		0.05	0.08	0.28		0.02	
	F		0.00					0.03				0.16	
	G		0.06	0.02		0.13	0.12	0.16	0.12	0.15	0.63		
	H		0.17	0.26	0.38	0.41	0.72	0.45	0.21	0.73	0.60	0.38	0.40
	I		0.37	0.23	0.28	0.28	0.43	0.20	0.16	0.44	0.39	0.34	0.44
	J			0.09	0.18	0.04			0.04	0.21	0.36	0.36	0.30
	K		0.32	0.15	0.39		0.45		0.01	0.32	0.50		0.28
	L					0.12			0.10	0.14	0.16		0.17
88.2	A						0.82		0.11	0.48	0.54		
	B								0.06				
	D										0.43	0.31	0.19
	E							0.35	0.42	0.70	0.33	0.22	0.49
	F										0.26	0.02	0.39
	G										0.03		

Table 9: 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 2007/08 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. (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	(252)	5.12
	UK	*Argos Froyanes*	252	(252)	5.17
	Total		504	(504)	
48.6 (1)	No fishing				
58.4.1 (3)	Korea, Republic of	*Insung No. 1*	370	(0)	2.99
		Insung No. 2	449	(8)	2.93
	Namibia	*Antillas Reefer*	56	(0)	1.23
		Paloma V	47	(5)	3.38
	Spain	*Tronio*	202	(7)	3.03
	Uruguay	*Banzare*	10	(0)	1.03
	Total		1134	(20)	
58.4.2 (3)	Korea, Republic of	*Insung No. 1*	248	(0)	3.01
	Namibia	*Antillas Reefer*	48	(1)	5.44
		Paloma V	377	(9)	3.01
	Total		673	(10)	
58.4.3a (3)	Uruguay	*Banzare*	41	(41)	4.68
	Total		41	(41)	
58.4.3b (3)	Australia	*Janas*	15	(9)	6.45
	Japan	*Shinsei Maru No. 3*	346	(120)	3.19
	Namibia	*Antillas Reefer*	13	(1)	0.61
	Uruguay	*Banzare*	43*	(0)	4.53
	Total		417*	(130)	
88.1 (1)	Argentina	*Antartic III*	0	(0)	0
	Korea, Republic of	*Hong Jin No. 707*	255	(0)	1.20
		Insung No. 2	13	(8)	1.24
		Jung Woo No. 2	212	(11)	1.05
	New Zealand	*Avro Chieftain*	50	(0)	1.20
		Janas	179	(0)	1.03
		San Aotea II	196	(3)	1.22
		San Aspiring	370	(0)	1.08
	Russia	*Yantar*	283	(0)	1.13
	South Africa	*Ross Mar*	128	(3)	1.06
	Spain	*Tronio*	46	(38)	1.00
	UK	*Argos Froyanes*	370	(0)	1.06
		Argos Georgia	196	(14)	1.32
		Argos Helena	181	(1)	1.30
	Uruguay	*Ross Star*	95	(1)	1.56
	Total		2574	(79)	
88.2 (1)	New Zealand	*Avro Chieftain*	349	(0)	1.01
	Russia	*Yantar*	0	(0)	0
	UK	*Argos Froyanes*	38	(0)	1.09
	Uruguay	*Ross Star*	2	(0)	0.21
	Total		389	(0)	

* Includes *Dissostichus* spp. (species not identified)

Table 10: Number of *Dissostichus* spp. tagged and released in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR.)

Subarea/ division	Season								Total
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	
48.6				4	62	171	129		366
58.4.1					462	469	1 507	1 134	3 572
58.4.2					342	136	248	673	1 399
58.4.3a					199	104	9	41	353
58.4.3b					231	175	289	417	1 112
88.1	326	756	1 068	1 951	3 221	2 977	3 608	2 574	16 481
88.2		12	94	433	341	444	278	389	1 991
Total	326	768	1 162	2 388	4 858	4 476	6 068	5 228	25 274

Table 11: Number of tagged *Dissostichus* spp. recaptured in exploratory longline fisheries. (Source: scientific observer data submitted to CCAMLR.)

Subarea/ division	Season								Total
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	
48.6						3	2		5
58.4.1							4	6	10
58.4.2									0
58.4.3a						6		2	8
58.4.3b					1	6	1	1*	9
88.1	1	4	13	32	59	70	206	216	601
88.2				18	17	28	33	36	132
Total	1	4	13	50	77	113	246	261	765

* Reported during longline survey in May 2008.

Table 12: Precautionary catch limits for crabs and effort limits for conducting exploratory surveys in Subareas 48.2 and 48.4.

	Subarea		
	48.3	48.2	48.4
Area of depth stratum 0–500 m (km^2)	42 400[a]	32 175[a]	2 107[a]
Provisional catch limit for crabs (tonnes)	1 600.0[b]	250	10
Time/efforts for conducting exploratory survey (pots*hours)	200 000[b]	200 000	30 000

[a] Data provided by CCAMLR Secretariat.
[b] Data from existing Conservation Measures 52-01and 52-02.

Table 13: Yield estimates (tonnes) assuming a 5% exploitation rate by SSRU using the median, 25 percentile (25%), and 75 percentile (75%) biomass levels calculated using the comparative CPUE and depletion-derived methods. Estimates are relative to the 2006/07 fishing season.

SSRU:	5841C		5841E	5841G	5842A		5842C	5842E	
Method:	CPUE	Depletion	CPUE	CPUE	CPUE	Depletion	CPUE	CPUE	Depletion
Median	98	95	43	51	24	10	9	37	42
25%	58	90	4	13	1	9	0	24	36
75%	138	100	83	88	47	12	18	50	48
Current catch limit	200		200	200	260		260	260	
2007/08 catch	177		16	197	54		37	125	
Range in historic catches	177–249		16–186	144–206	4–62		4–37	14–156	

Table 14: Catches for macrourids, rajids and other species taken as by-catch from longline fisheries in 2007/08, 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	3807	161	4.2	196	12	0.3	196	36	0.9	-
48.4	98	16	15.9	-	4	3.6	-	0	0.5	-
48.6	0	0	0.0	64	0	0.0	100	0	0.0	140
58.4.1	410	36	8.8	96	0	0.0	50	1	0.4	60
58.4.2	217	12	5.3	124	0	0.2	50	1	0.5	60
58.4.3a	9	0	1.1	26	2	17.5	50	0	0.0	20
58.4.3b	138	7	5.0	80	1	0.4	50	1	1.1	20
58.5.1 French EEZ	2853	453	15.9	na	230	8.1	na	0	0.0	na
58.5.2	715	66	9.3	360	9	1.2	120	2	0.2	50
58.6 French EEZ	684	103	15.1	na	39	5.7	na	0	0.0	na
58 South African EEZ	54	4	7.5	na	0	0.0	na	1	1.5	na
88.1	2259	112	4.9	426	4	0.2	133	20	0.9	160
88.2	416	17	4.2	88	0	0.0	50	4	1.1	100

Table 15: Number of macrourids, rajids and other species caught or released from longline fisheries in 2007/08, and reported in fine-scale data.

Subarea/division	*Dissostichus* spp.		Macrourids		Rajids		Other species	
	Caught	Released	Caught	Released	Caught	Released	Caught	Released
48.3	574 593	4 430	109 460	310	1 598	19 558	29 550	8
48.4	5 926	496	14 946	4	724	8 276	510	133
48.6	0	0	0	0	0	0	0	0
58.4.1	12 586	688	35 425	0	11	0	2 453	2
58.4.2	6 628	633	9 648	0	74	0	1 548	0
58.4.3a	1 805	43	185	0	332	0	1	0
58.4.3b	5 184	399	10 463	0	152	155	1 839	0
58.5.1 French EEZ	608 099	1 629	285 150	0	53 151	2 461	0	0
58.5.2	138 317	802	56 090	10	1 425	5 542	14 946	0
58.6 French EEZ	123 337	462	81 065	0	10 844	9 299	0	0
58 South African EEZ	6 124	119	3 815	0	0	0	810	0
88.1	101 618	2 543	83 929	1	431	7 190	57 230	17
88.2	10 869	386	20 287	0	0	0	5581	0

Table 16: Estimated total catch of rajids (including those cut off or released) in longline fisheries in 2007/08 derived from fine-scale (C2) data.

Subarea/division	Rajids					
	Number caught	Number released	Estimated total catch (tonnes)	Mean weight (kg)	Catch limit (tonnes)	% of catch limit
48.3	1 598	19 558	162.5	7.68	196	82.9
48.4	724	8 276	43.6	4.84	-	-
48.6	0	0	0.0	-	100	0
58.4.1	11	0	0.1	8.34	50	0.2
58.4.2	74	0	0.5	6.41	50	0.9
58.4.3a	332	0	1.5	4.62	50	3.1
58.4.3b	152	155	1.0	3.41	50	2.1
58.5.1 French EEZ	53 151	2 461	240.8	4.33*	na	
58.5.2	1 425	5 542	42.3	6.07	120	35.2
58.6 French EEZ	10 844	9 299	72.5	3.60*	na	-
58 South African EEZ	0	0	0.0	-	na	-
88.1	431	7 190	70.4	9.24	133	52.9
88.2	0	0	0.0	-	50	0.0

* Derived from the total reported catch divided by numbers retained.

Table 17: Proposed catch limits of grenadiers in Subarea 88.1 assuming a CV of 0.5 for the estimate of B_0 and that the grenadier density was constant across the entire slope (WG-FSA-08/32).

Region	Current catch limit	Estimated yield	Maximum historic catch	Proposed catch limit
881B, C, G	50	-	34	40
881H, I, K	271	388	390	320
881J	79		46	50
881L	24		6	20
882A, B	0	100	8	0
Total	424	488		430

Table 18: Accumulated longline fishing effort, seabed areas and estimated proportions of effort (Prop. effort in stratum) in depth strata in SSRUs in exploratory toothfish fisheries.

(a) SSRUs for which seabed area has been estimated, the potential proportion of a depth stratum affected by the accumulated longlines to date (Prop. area effect) is estimated using two assumed widths of the area affected by a line – 1 m and 25 m. (Source: effort – C2 fine-scale data; seabed areas – Sandwell and Smith, GEBCO and GEODAS, see *Statistical Bulletin*, Vol. 20, Table 18.)

Division	SSRU	No. years of fishery	Accumulated length (km)	Depth 500–600 m				Depth 600–1 500 m				Depth 1 500–1 800 m			
				Seabed area (km^2)	Prop. effort in stratum	Prop. area effect (1m wide)	Prop. area effect (25m wide)	Seabed area (km^2)	Prop. effort in stratum	Prop. area effect (1m wide)	Prop. area effect (25m wide)	Seabed area (km^2)	Prop. effort in stratum	Prop. area effect (1m wide)	Prop. area effect (25m wide)
58.4.1	C	4	9 323	6 107	0.001	0	0	25 504	0.194	0	0.002	7 603	0.805	0.001	0.025
	D	1	173	6 076	0	0	0	35 165	1	0	0	8 640	0	0	0
	E	4	4 178	3 792	0	0	0	32 425	0.497	0	0.002	6 823	0.503	0	0.008
	F	1	93	6 390	0	0	0	31 190	0.833	0	0	3 398	0.167	0	0
	G	4	6 437	9 147	0.029	0	0.001	25 357	0.662	0	0.004	4 040	0.309	0	0.012
	H	1	108	13 673	0	0	0	15 844	0.429	0	0	2 410	0.571	0	0.001
58.4.3b	A	5	6 167	90	0	0	0	51 178	0.482	0	0.001	61 424	0.518	0	0.001
	B	4	6 707	0	0			3 598	0.011	0	0.001	15 951	0.989	0	0.01

(b) Subarea 88.1 – Accumulated longline fishing effort, seabed areas and estimated proportions of effort (Prop. effort in stratum) in SSRUs in exploratory toothfish fisheries in Subarea 88.1 for depths between 600 and 1 800 m (seabed areas in the depth ranges shown in (a) were not available). Proportion of effort in each of the depth strata in (a) are also given. na – no substratum in that range. (Source: effort – C2 fine-scale data; seabed areas – SC-CAMLR-XXII, Annex 5, paragraph 5.37 and Table 5.3.)

SSRU	No. years of fishery	Accumulated length (km)	Depth 600–1800 m			Proportion of effort in depth strata		
			Seabed area (km^2)	Prop. area effect (1m wide)	Prop. area effect (25m wide)	500–600 m	600–1 500 m	1 500–1 800 m
A	5	232	4 908	0	0.001	na	0.595	0.405
B	10	5 526	4 318	0.001	0.032	na	0.448	0.552
C	8	7 104	4 444	0.002	0.04	na	0.529	0.471
E	7	1 740	14 797	0	0.003	0.023	0.9	0.077
F	3	34	18 398	0	0	0.292	0.708	0
G	8	3 318	7 110	0	0.011	0.068	0.854	0.077
H	11	27 802	19 245	0.001	0.035	0.023	0.86	0.117
I	11	19 293	30 783	0.001	0.016	0.001	0.937	0.063
J	8	7 135	43 594	0	0.004	0.053	0.947	0
K	8	7 674	24 695	0	0.008	0.026	0.939	0.035
L	5	4 722	16 807	0	0.004	0.437	0.563	0

Table 18 (continued)

(c) Areas for which SSRU-specific seabed areas were not available. (Source: effort – C2 fine-scale data.)

Subarea/ division	SSRU	No. years of fishery	Accumulated length (km)	Proportion of effort in depth strata		
				500–600 m	600–1 500 m	1 500–1 800 m
48.6	A	4	1 825	0	0.931	0.069
	D	1	62	0	0.4	0.6
	E	2	153	0	0.431	0.569
	G	4	3 856	0.016	0.773	0.211
58.4.2	A	4	2 634	0.006	0.796	0.199
	C	4	767	0.062	0.741	0.197
	D	3	2 189	0	0.795	0.205
	E	6	4 056	0.012	0.528	0.46
58.4.3a	A	4	7 498	0	0.813	0.187
58.4.4a	A	2	1 643	0.723	0.262	0.015
58.4.4b	B	2	284	0.709	0.291	0
	C	1	195	0	0.638	0.362
	D	1	684	0	1	0
88.2	A	4	875	0	0.908	0.092
	B	1	23	0	1	0
	D	3	488	0	0.515	0.485
	E	6	7 228	0	0.786	0.214
	F	3	575	0	0.39	0.61
	G	1	35	0.25	0.75	0
88.3	B	1	60	0	0.86	0.14
	C	1	24	0	0.846	0.154
	D	1	20	0	0.762	0.238

Table 19: Summary table of notifications for bottom fisheries relevant to Conservation Measure 22-06. X – notification of a new or exploratory fishery by a Member. Notifications including preliminary assessments of potential impacts of bottom fishing activities are shown as A (subscripts: g – general assessment, a – area specific). M – proposed mitigation measures are also provided.

Fishery/Member	Subarea/division							
	48.2	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2
Toothfish fisheries:								
Argentina							X	X
Australia				A_a M				
Chile							X	X
Japan		A_g	A_g	A_g	A_g	A_g		
Korea, Republic of		X	X	X			X	X
New Zealand			A_g M	A_g M			A_a M	A_a M
Russia							X	X
South Africa			X				X	X
Spain			A_a M	A_g M		A_g M	A_a M	A_g M
UK							A_a M	A_g M
Uruguay			X	X		X	X	X
Pot fisheries:								
Russia	X							

Table 20: Proposed pro forma for Members submitting preliminary assessments of the potential for their proposed bottom fishing activities to have significant adverse impacts on VMEs. The pro forma is designed to be consistent with the requirements for proposals on exploratory fisheries and is based on the requirements set out in paragraph 7(i) in Conservation Measure 22-06.

1. Preliminary assessment of bottom fishing activities – Required Information

1.1 Scope

1.1.1 Fishing method(s) to be used

Longline type (Spanish/auto/trotline/pots)

1.1.2 Subarea/division

e.g. 88.1 and 88.2

1.1.3 Period of application

Year

1.2 Proposed fishing activity

1.2.1 Detailed description of gear

Please provide a detailed diagram of the gear configuration to be used (see WG-FSA-08/60 for example or diagrams available in the CCAMLR observer logbook). Include details of line type; line length (length range if necessary); hook type(s); numbers per line and spacing of hooks within a line (per vertical line for trotlines); weight material and mass; spacing of weights; anchor type; floats and spacing etc. for ***each vessel*** *included in this application/notification.*

1.2.2 Scale of proposed activity

Please provide estimates of total numbers of hooks and/or lines to be deployed.

1.2.3 Spatial distribution of activity

Please provide details of SSRUs or geographical regions within the subarea/division in which activities will take place including the depth range of fishing activities.

1.3 Mitigation measures to be used

Please provide details of modifications to gear configuration or methods of deployment aimed at preventing or reducing adverse impacts to VMEs.

2. Preliminary assessment of bottom fishing activities – Supporting Information

2.1 Assessment of known/anticipated impacts on VMEs

Please provide data or information available on the current state of knowledge of impacts of proposed fishing activities on VMEs within the area of activity.

2.1.1 Estimated spatial effort footprint

Please provide details of % area covered by fishing effort.

2.1.2 Summary of potential VMEs present within areas of activity

e.g. biogenic/geological; habitat area coverage/distribution; fragility/ vulnerability and resilience of habitats; species composition/endemism; life-history traits. Please provide details.

2.1.3 Probability of impacts

e.g. low/medium/high/unknown. Please provide details.

2.1.4 Magnitude/severity of the interaction of the proposed fishing gear with VMEs

e.g. associated mortality and spatial extent of impacts. Please provide details.

2.1.5 Physical and biological/ecological consequences of impact

e.g. loss of physical habitat structure or of keystone species or extinctions.

2.2 Estimated cumulative footprint

Please provide an estimated cumulative impact derived from information provided under 2.1.1 to 2.1.5 above and any additional information available from the Secretariat (e.g. historical fishing effort; habitat maps).

(continued)

Table 20 (continued)

2.3 Research activities related to provision of new information on VMEs

2.3.1 Previous research

Please provide a summary of research previously carried out in the proposed area of activity by your Member State (including national/regional/international research programs). This should include data collected in the previous season under 2.3.2 and details of data submitted to the Secretariat such as:

- *Indirect evidence (e.g. by-catch observation; species identification through sample collection and genetic and morphological analysis; acoustic or geomorphic data collection; other)*
- *Direct evidence (e.g. observations using camera gear or ROVs; other)*

2.3.2 In-season research

Please summarise details of the research planned during the proposed fishing activities by your Member State (including national/regional/international research programs). Please provide details of what data will be collected in order to document evidence of, or further knowledge on, VMEs within the areas of activities, including:

- *Indirect evidence (see examples above)*
- *Direct evidence (see examples above)*

2.3.3 Follow-on research

Please provide details of potential future research resulting from previous/in-season research, including collaborative work with other Member States or as part of national/regional/international research programs, including:

- *Indirect evidence (see examples above)*
- *Direct evidence (see examples above)*

Table 21: Summary table of mitigation measures and other actions for implementing Conservation Measure 22-06 in the 2008/09 season proposed by Members who submitted preliminary assessments of potential impacts of bottom fishing activities in 2008.

	Gear type in proposal	Summary of proposed actions by Members
Observer requirements	Autoline 1	By-catch of VME-related organisms would be monitored. Camera equipment would be deployed on longline sets.
	Autoline 2	Additional data collection by observers on by-catch on lines for which there are ≥5 specimens/thousand hooks.
Vessel requirements	Autoline 1	Cease fishing in any location where evidence is encountered (by-catch or video).
	Autoline 2	Education of observers and crew. Take steps to reduce loss of fishing gear. Move vessel from area where >25 specimens/thousand hooks are taken on a line.
	Autoline 3	≥20 specimens/thousand hooks on a line triggers research to document extent of VME.
	Spanish system	Evidence of VME – 15 specimens/thousand hooks when found together; 20 specimens/thousand hooks when observed far apart. Mitigation – not fish on same location (buffer of 1 n mile) when evidence is found. Research – parallel lines (at least 1 n mile apart) (100% observer coverage).
	Trotline	No mitigation measures needed.
Reporting requirements	Autoline 1	Report location of encounter with VME.
	Autoline 3	Single line encounter of ≥20 organisms/thousand hooks triggers notification and research plan.
	Spanish system	Report location where evidence of VME is found.

Table 22: List of tasks identified by WG-FSA for the 2008/09 intersessional period. The paragraph numbers (Ref.) refer to this report. * – priority tasks.

	Ref.	Task	Group	Members	Secretariat
		Review of available information			
	3.5	Consider catches of *D. eleginoides* reported from Divisions 58.4.1 and 58.4.3b.	SC-CAMLR		
	3.26	Review the application of the adjustment factor for trawl headline height used in surveys for *C. gunnari*.	SG-ASAM		
	3.38	Develop a better understanding of CPUE from trotlines.			
*	3.49	Return all physical tags and check for correct transcription of returned tags, including all alphanumeric characters.		✓	✓
	3.52	Procedure for inferring a satisfactory match between a tag recapture and release record should be documented and be algorithmic to minimise any subjectivity.		✓	✓
*	3.55	Undertake to identify the tagging details for all tags recovered.			✓
	3.58	Consider further ways of incorporating unmatched tag recaptures into the assessment.	WG-SAM		
	3.59	Consider using the tagging equipment provided by the Secretariat in all CCAMLR fisheries.		✓	✓
	3.60	Purchase tags from the Secretariat and participate in skate tagging during the Year-of-the-Skate.		✓	✓
	3.70	Construct an otolith reference collection for *D. mawsoni*.		✓	
		Preparation for assessments			
	4.7	Consider modifications to the design of surveys used to estimate the abundance of *C. gunnari*.		✓	
*	4.18	Develop a series of data quality metrics.		✓	✓
		Assessment and management advice			
	5.58	Consider how to design longline surveys and how to reconcile datasets from different types of fishing gear.	SG-SAM		
*	5.81	Tagging fish at the same rate as fishing in accordance with Conservation Measure 42-01.	SCIC		
	5.94, 5.97	Review harvest strategies and research programs for toothfish in the Ross Sea.	WG-SAM		
	5.124	Consider guidelines for establishing CCAMLR-sponsored research programs.	SC-CAMLR		

(continued)

Table 22 (continued)

	Ref.	Task	Group	Members	Secretariat
		Fish and invertebrate by-catch			
	6.23	Develop common methodology and reading methods for skates.	CON		
*	6.25–6.40	Participate in the Year-of-the-Skate in all *Dissostichus* spp. fisheries, with a tagging program focused on exploratory fisheries.		✓	✓
*	6.34	Revise observer logbook forms.			✓
*	6.46	Investigate coding systems for VME-related taxa.			✓
		Evaluation of threats arising from IUU fishing activities			
*	8.6	Investigate and document IUU gillnet activities.	SCIC	✓	
		Biology, ecology and demography of target and by-catch species			
	9.21	Update the Species Profile for *D. eleginoides.*	Subgroup on Biology and Ecology		
	9.23	Complete calibration work for ageing *C. gunnari* using otoliths and submit report.	CON		
		Consideration of VMEs			
	10.17	Include SSRU, subarea and division boundaries in map of fishing footprints.	WG-FSA		✓
*	10.20	Obtain updated seabed area information for the three depth strata from reliable sources for all SSRUs.			✓
	10.23	Improve methods for assessing footprints coupled with the developing assessments of risk in different areas.		✓	
	10.25	Develop a pro forma for the submission of preliminary assessments.	SC-CAMLR		
*	10.35	Consider the taxonomic detail requested to be recorded by observers.	TASO		
*	10.41	Improve the quality and quantity of data on benthos by-catch.		✓	
	10.48	Provide data and advice on VMEs and their vulnerability.	SCAR		✓
*	10.55	Consideration of VMEs and risk could be undertaken by WG-EMM and the consideration of mitigation measures be part of the work of WG-FSA.	SC-CAMLR		

(continued)

Table 22 (continued)

	Ref.	Task	Group	Members	Secretariat
		Scheme of International Scientific Observation			
*	11.8(i)	Include detailed descriptions of the gear that vessels intend to use along with their notifications for exploratory fisheries.		✓	
*	11.8(ii)	Update C2 data form.			✓
*	11.8(iii)	Report sections of line that are joined under water as two independent sets.		✓	
*	11.8(iv) 11.8(ix)	Update observer logbook forms.			✓
	11.8(v)	Develop photographic guides to macroscopic maturity staging of *Dissostichus* spp.		✓	
	11.4(ii)(d) 11.8(vi)	Undertake a statistical analysis of the required sampling level of *Dissostichus* spp. for the collection of biological, age and length data.	WG-SAM		
	11.8(vii)	Implement a sampling rate of one *D. eleginoides* and one *D. mawsoni* per 150 hooks with a minimum of five fish of each species per line.		✓	
		Future assessments			
	12.1	Consider using dietary information and condition to tune the natural mortality parameter in *C. gunnari* assessments.		✓	
	12.2	Advice on what assessments would be appropriate for grenadiers, and advice on the research and data collection.	WG-SAM		
	12.3, 12.4, 5.119	Examine methods for determining the relative depletion and recovery status of the stock of *Dissostichus* spp.	WG-SAM		
	12.5	Consider designs that would be capable of standardising gear effectively between surveys.	WG-SAM		
*	12.7	Develop a formal procedure for biennial assessments.	WG-SAM		
*	12.8–12.9	Encourage participation in the work of WG-FSA.		✓	

(continued)

Table 22 (continued)

	Ref.	Task	Group	Members	Secretariat
		Future work			
	13.2–13.5	Activities of subgroups.			
*	13.8	Develop a Science Plan.	SC-CAMLR		
	13.24	Notify scientific research activities in accordance with Conservation Measure 24-01, and meet reporting requirements.		✓	
		Other business			
	14.3	Submit the data on *D. mawsoni* in McMurdo Sound.		✓	

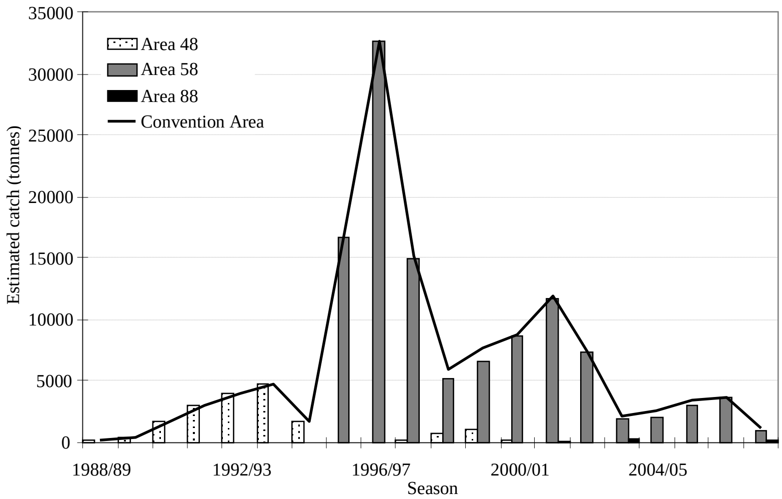


Figure 1: Catch history of *Dissostichus* spp. taken by IUU fishing in the Convention Area. IUU fishing was first detected in 1988/89, and estimates are derived from longlining and gillnetting activities. (Source: WG-FSA-08/10 Rev. 2 and SC-CAMLR reports.)

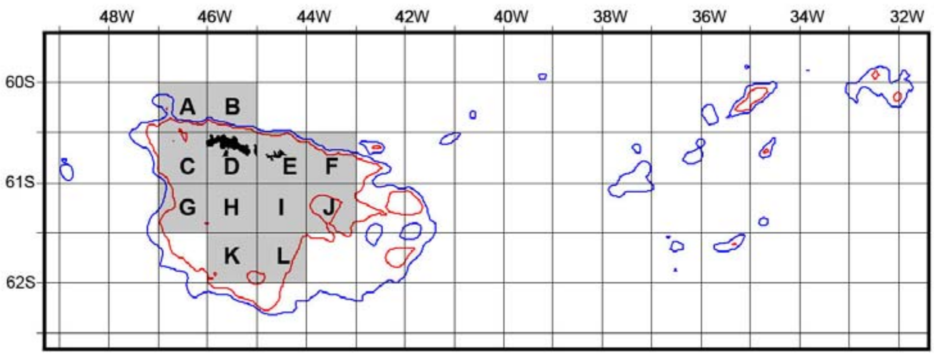


Figure 2: Operational area for phase I of the experimental harvest regime for the crab fishery in Subarea 48.2.

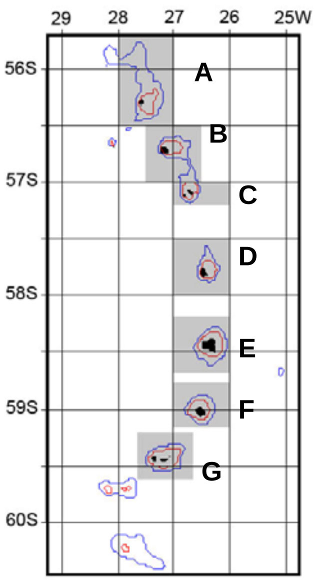


Figure 3: Operational area for phase I of the experimental harvest regime for the crab fishery in Subarea 48.4.

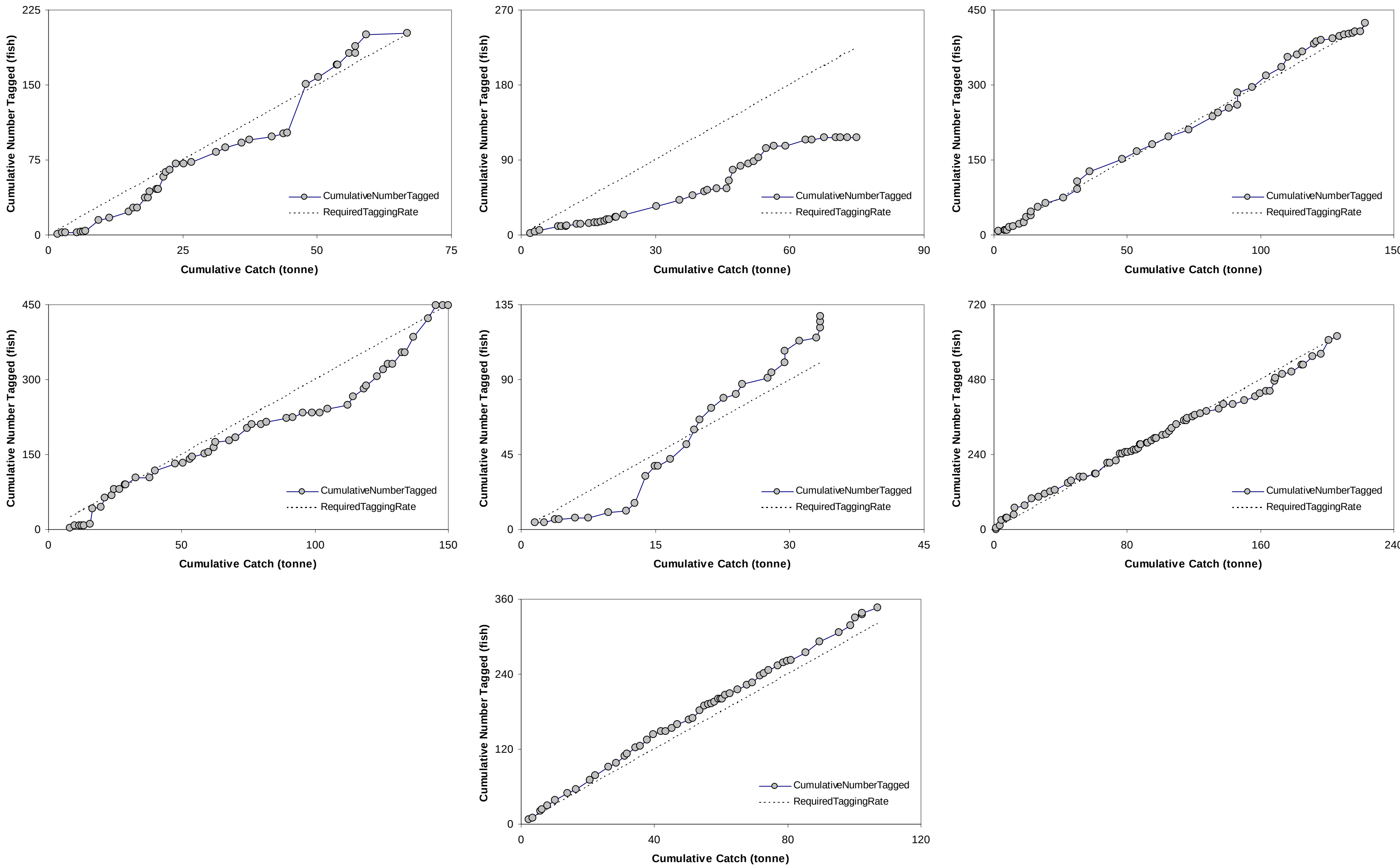


Figure 4: Cumulative catch of *Dissostichus* spp. versus cumulative number of *Dissostichus* spp. tagged for each vessel engaged in the exploratory fisheries for *Dissostichus* spp. in Subarea 58.4 in 2007/08 (source: catch – C2 data; number of fish tagged – scientific observer data). **NB: Figure 4 was corrected subsequent to the WG-FSA-08 meeting. The corrigendum follows on the next page.**

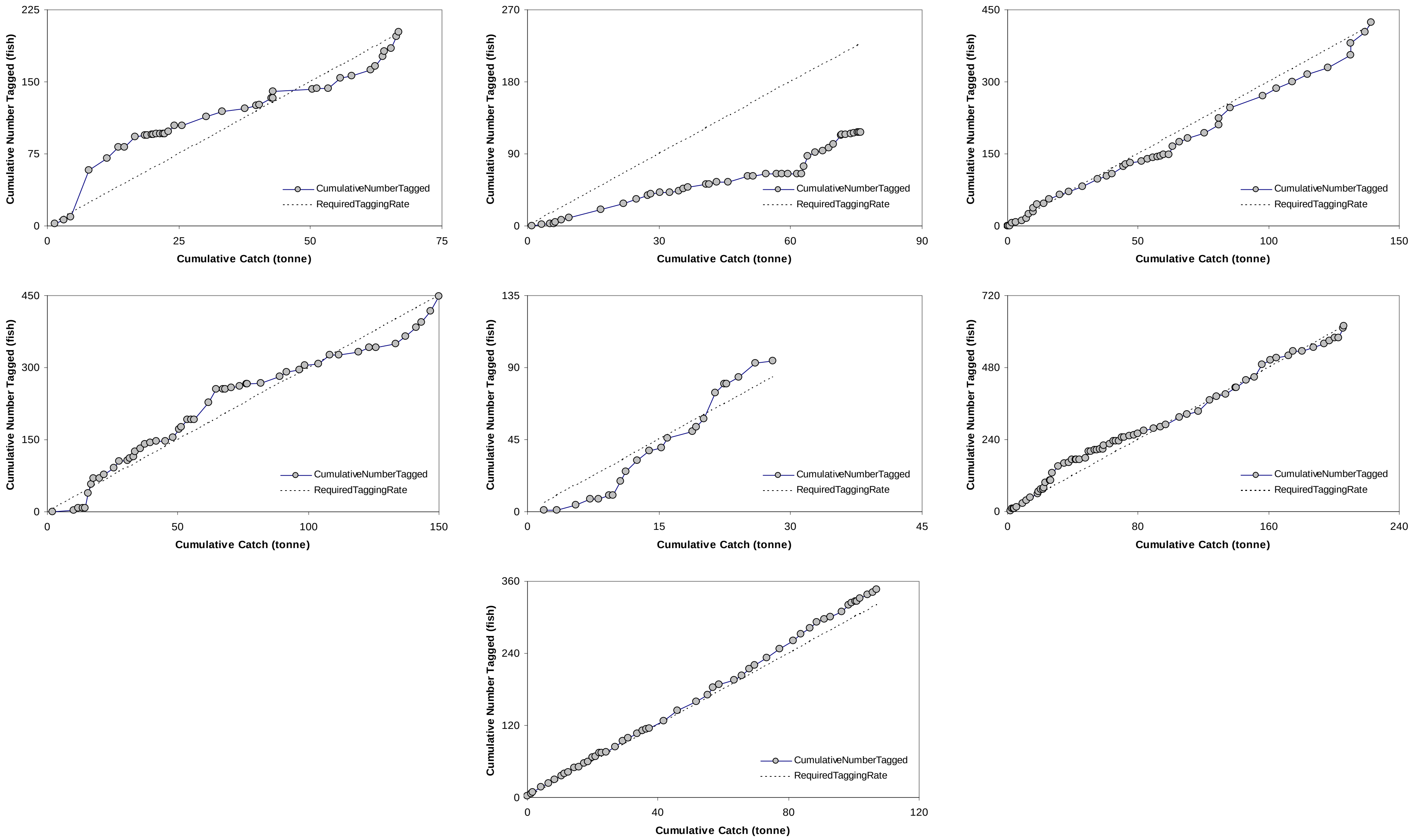


Figure 4 corrigendum

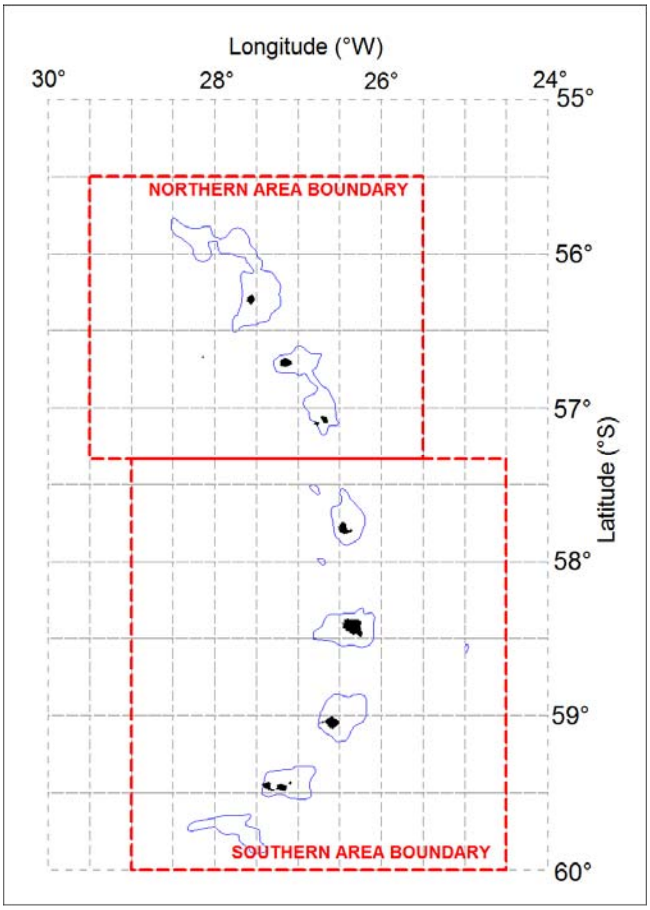


Figure 5: Positions of the boundaries of the Northern Area and Southern Area in Subarea 48.4. The 1 000 m depth contour is indicated.

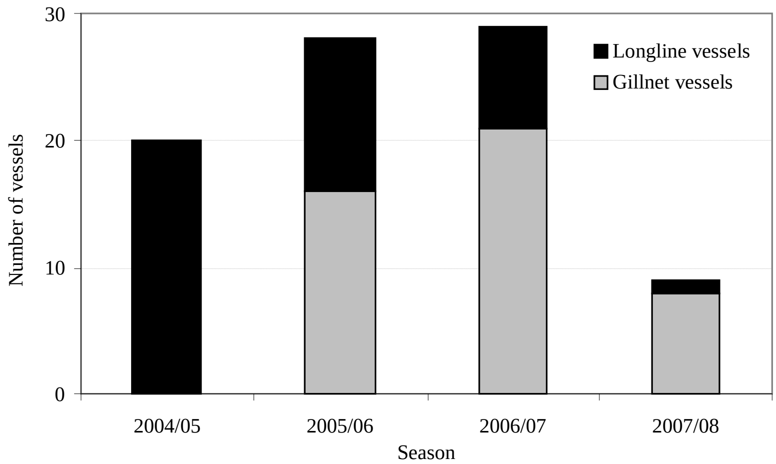
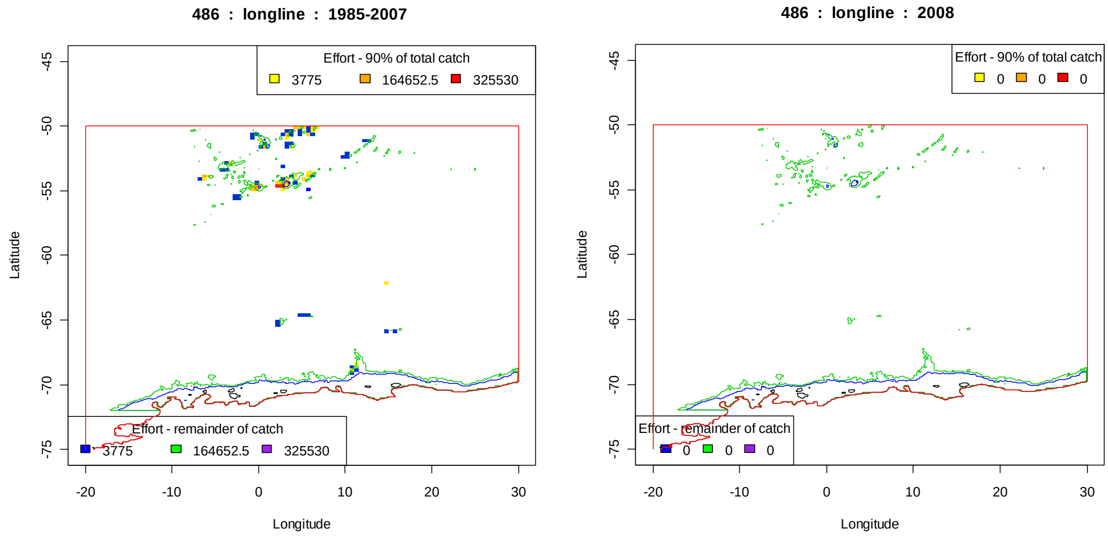


Figure 6: Estimated number of longline and gillnet vessels engaged in IUU fishing in the Convention Area since 2004/05. Note that some vessels have the capacity to deploy gillnets and longlines. (Source: WG-FSA-08/10 Rev. 2 and SC-CAMLR reports.)

(a) Subarea 48.6



(b) Division 58.4.1

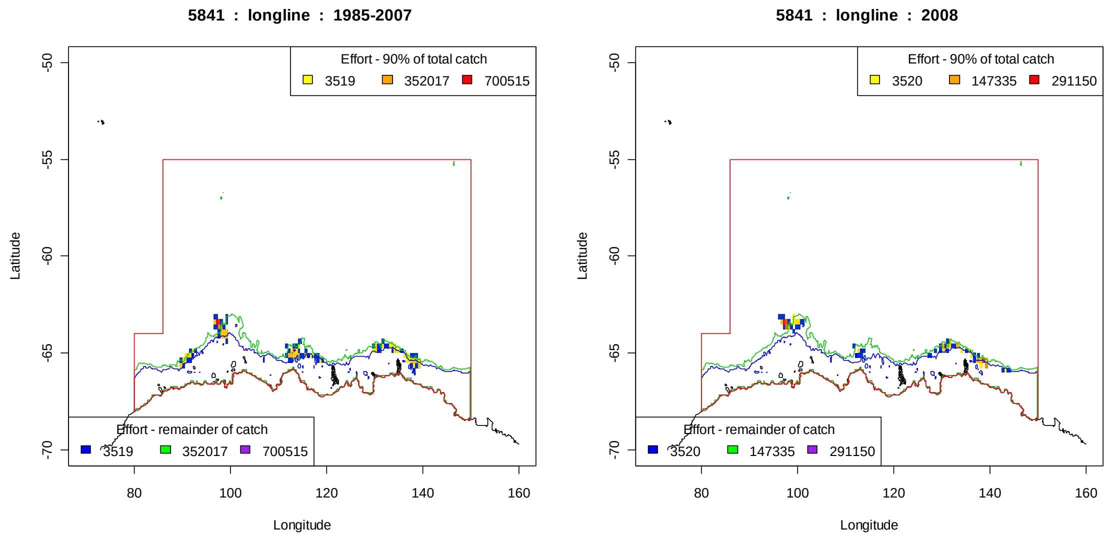
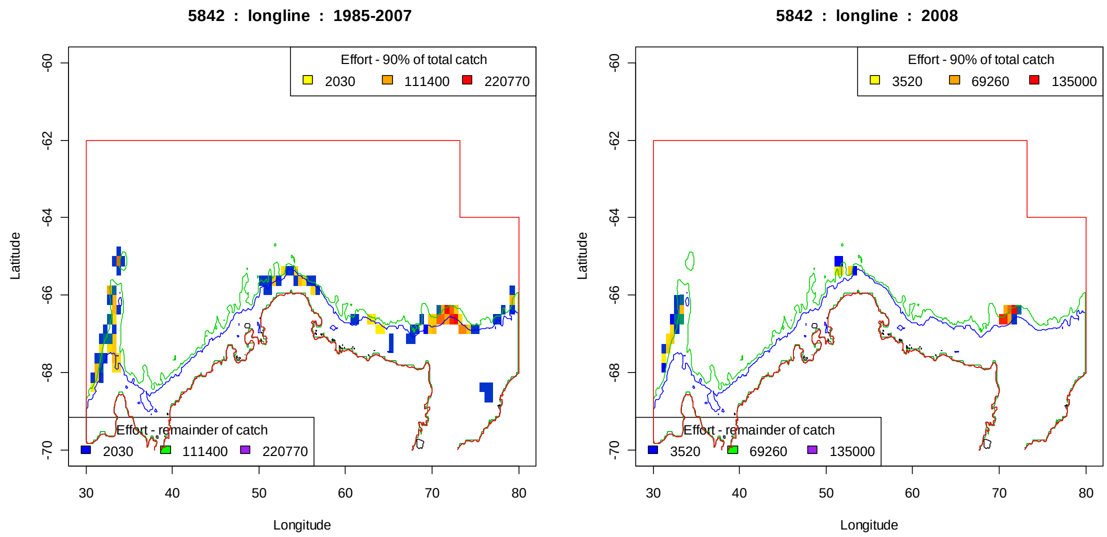


Figure 7: Maps showing longline effort (aggregate number of hooks), subdivided to show effort contributing to 90% of the total catch (target and by-catch species) and effort responsible for the remaining 10% of the catch. In each map, two 3-colour colour ramps are used to distinguish values within each of these groups. 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. An aggregate map for effort from 1985–2007 is shown along with a separate map for effort in the 2007/08 season. This figure is available in colour on the CCAMLR website.

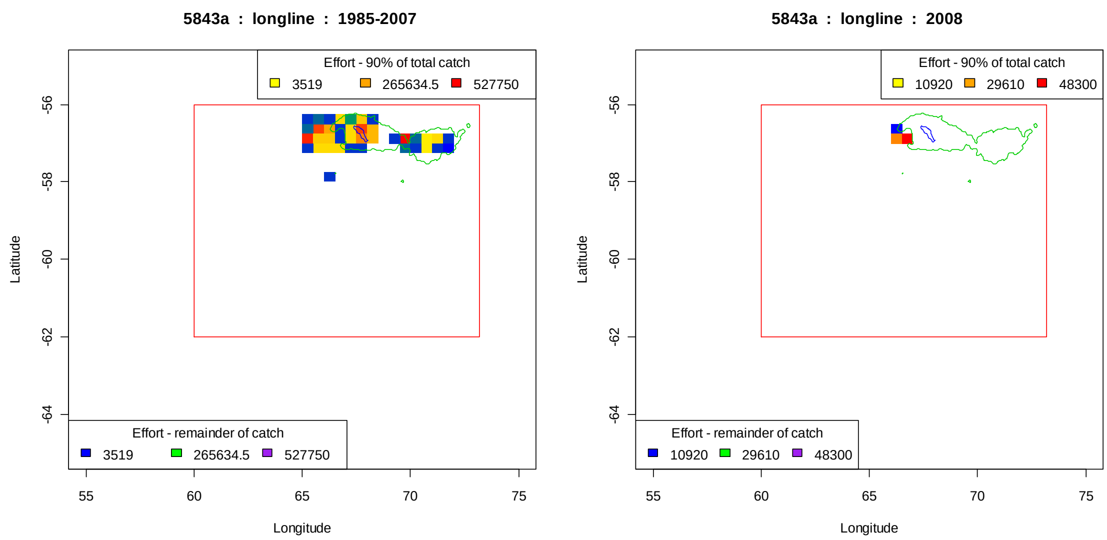
(continued)

Figure 7 (continued)

(c) Division 58.4.2



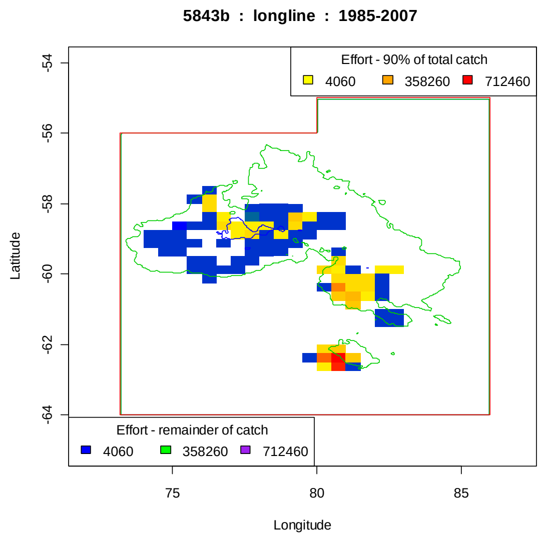
(d) Division 58.4.3a

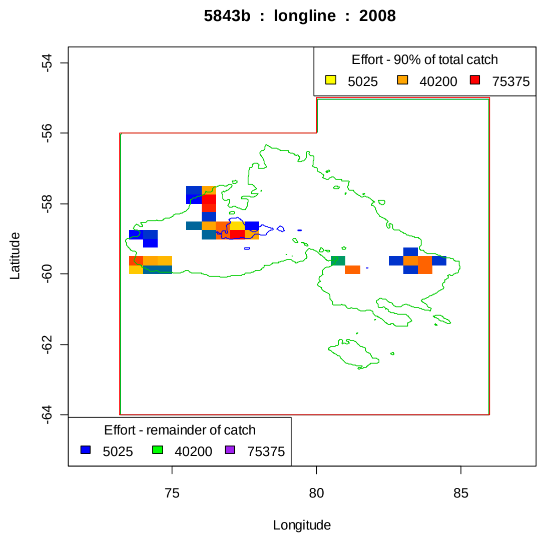


(continued)

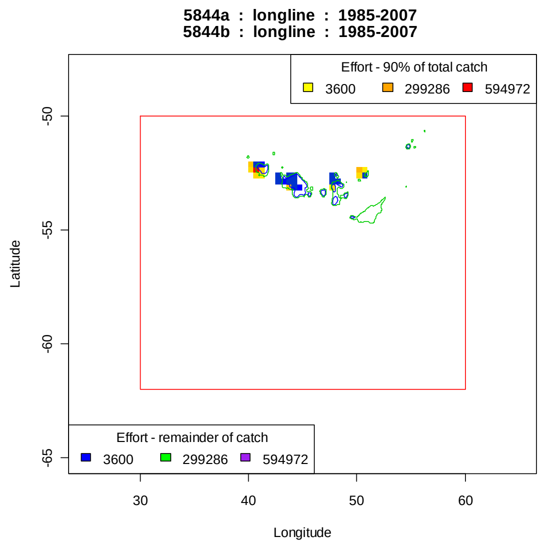
Figure 7 (continued)

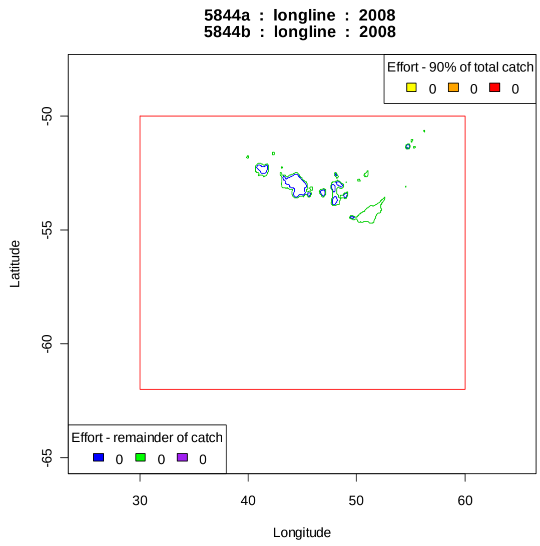
(e) Division 58.4.3b





(f) Divisions 58.4.4a and 58.4.4b

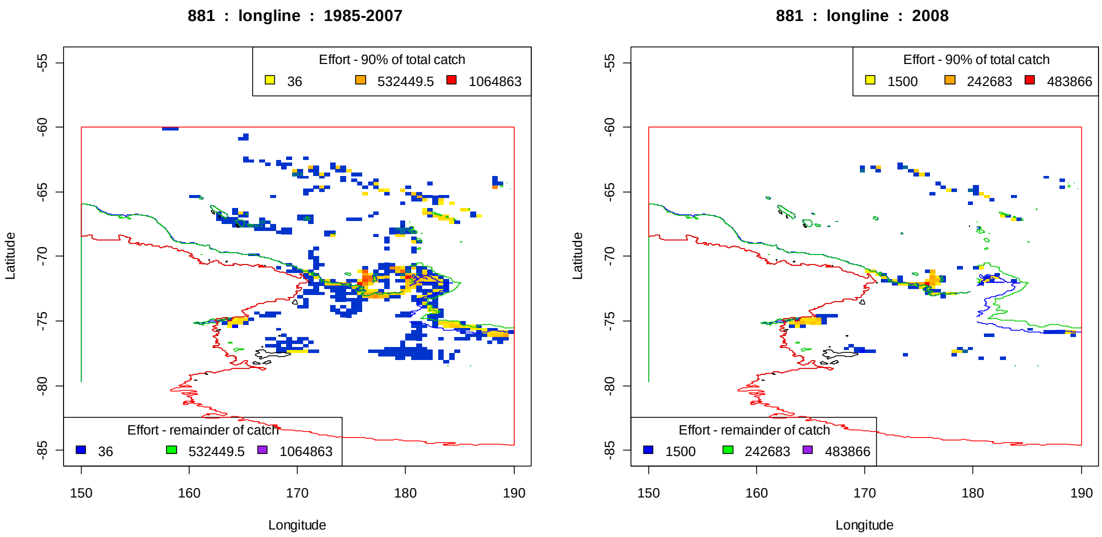




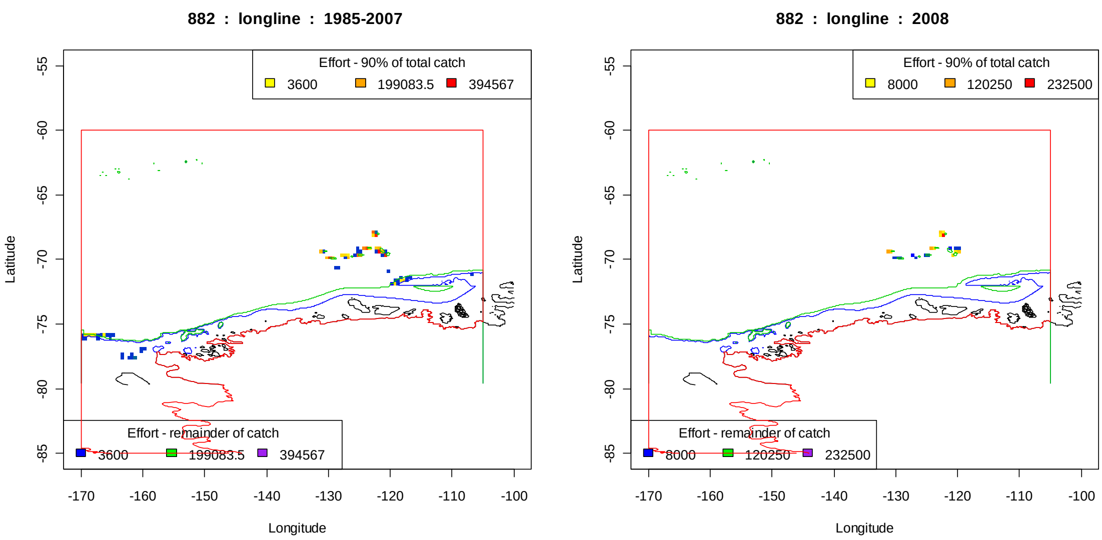
(continued)

Figure 7 (continued)

(g) Subarea 88.1



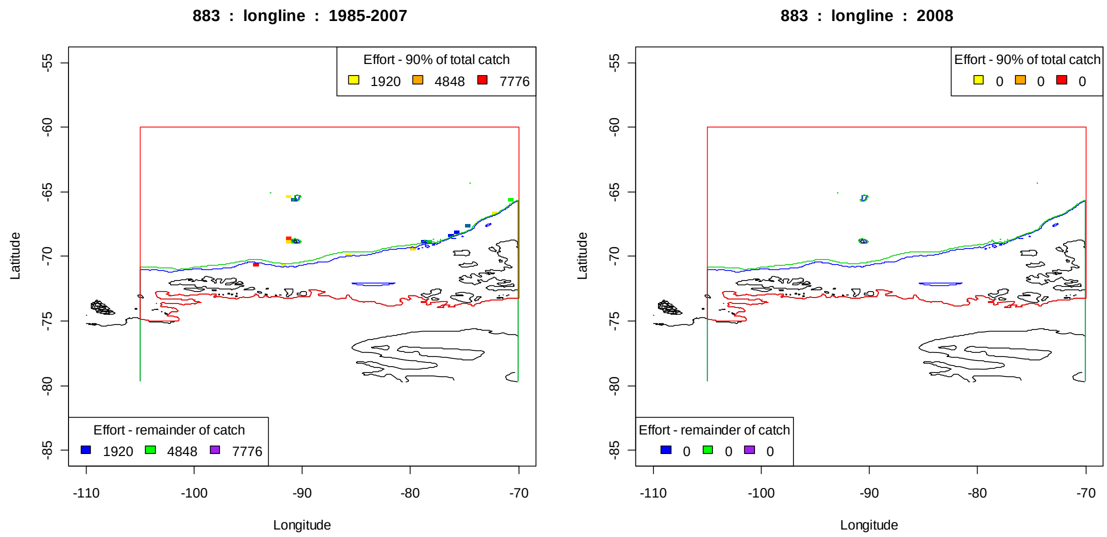
(h) Subarea 88.2



(continued)

Figure 7 (continued)

(i) Subarea 88.3



APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 24 October 2008)

1. Opening of the meeting

2. Organisation of the meeting and adoption of the agenda

   2.1 Organisation of meeting
   2.2 Subgroup organisation and coordination

3. Review of available information

   3.1 Data requirements specified in 2007
      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 the Working Group on Statistics, Assessments, and Modelling (WG-SAM)
   4.2 Review of preliminary stock assessment papers
   4.3 Assessments to be carried out and assessment timetable

5. Assessments and management advice

5.1 New and exploratory fisheries
5.1.1 New and exploratory fisheries in 2007/08
5.1.2 New and exploratory fisheries notified for 2008/09
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
5.1.7 Research protocols for commercial fishing vessels

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 Bottom fishing activities and vulnerable marine ecosystems(VMEs)
    10.3 Interactions with WG-EMM
    10.4 Development of ecosystem models

11. Scheme of International Scientific Observation

    11.1 Report from the Technical Group for At-Sea Observations (TASO)
    11.2 Summary of information extracted from observer reports and/or provided by technical coordinators
    11.3 Implementation of observer program
        11.3.1 *Scientific Observers Manual*
        11.3.2 Sampling strategies
        11.3.3 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 Second Workshop on Fisheries and Ecosystem Models in the Antarctic
    13.3 Intersessional meetings
        13.3.1 Meeting of WG-SAM
        13.3.2 Meeting of ad hoc TASO
        13.3.3 Meeting of SG-ASAM

14. Other business

15. Adoption of the report

16. Close of the meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 24 October 2008)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 24 October 2008)

WG-FSA-08/1	Provisional Agenda and Provisional Annotated Agenda for the 2008 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-08/2	List of participants
WG-FSA-08/3	List of documents
WG-FSA-08/4	CCAMLR fisheries: 2008 update Secretariat
WG-FSA-08/5 Rev. 1	A summary of observations on board longline vessels operating within the CCAMLR Convention Area during the 2007/08 season Secretariat
WG-FSA-08/6 Rev. 1	Summary of observations aboard trawlers operating in the Convention Area during the 2007/08 season Secretariat
WG-FSA-08/7 Rev. 2	A summary of scientific observations related to Conservation Measures 25-02 (2007), 25-03 (2003) and 26-01 (2006) Secretariat
WG-FSA-08/8	Summary of observations aboard pot vessels operating in the Convention Area during the 2007/08 season Secretariat
WG-FSA-08/9	Review of CCAMLR activities on monitoring marine debris in the Convention Area Secretariat
WG-FSA-08/10 Rev. 2	Estimation of IUU catches of toothfish inside the Convention Area during the 2007/08 fishing season Secretariat
WG-FSA-08/11	Fishing activity and seabird-vessel attendance near the northern Antarctic Peninsula J.A. Santora, K.S. Dietrich (USA) and D. Lombard (Canada) (submitted to *Mar.Ornithol.*)

WG-FSA-08/12	Comparative characteristics of basic biological parameters of two toothfish species in high-latitude seas of the Antarctic A.K. Zaytsev (Ukraine)
WG-FSA-08/13	New records of deep-sea skates (Rajidae, Chondrichthyes) from the Crozet Archipelago S.P. Iglésias, N. Gasco and G. Duhamel (France)
WG-FSA-08/14	Some field materials on area and season of Antarctic toothfish spawning V. Prutko (Ukraine) (*CCAMLR Science*, submitted)
WG-FSA-08/15	CCAMLR tagging program Secretariat
WG-FSA-08/16	Operational difficulties in implementing the CCAMLR tagging protocol in Division 58.4.1 in 2007/08 A.T. Lozano and O. Pin (Uruguay)
WG-FSA-08/17	Age estimation and lead-radium dating of Antarctic toothfish (*Dissostichus mawsoni*) C.M. Brooks, A.H. Andrews, J.R. Ashford, G.M. Cailliet, N. Ramanna and C. Lundstrom (USA)
WG-FSA-08/18	Spatial distribution and age structure of the Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica C.M. Brooks and J.R. Ashford (USA) (*CCAMLR Science*, submitted)
WG-FSA-08/19	Classification guide for potentially vulnerable invertebrate taxa in the Ross Sea longline fishery S. Parker, D. Tracey, E. Mackay, S. Mills, P. Marriott, O. Anderson, K. Schnabel, D. Bowden and M. Kelly (New Zealand)
WG-FSA-08/20	Updated biological parameters for the Antarctic starry skate (*Amblyraja georgiana*) from the Ross Sea M.P. Francis and S. Mormede (New Zealand)
WG-FSA-08/21	Revised age and growth estimates for Antarctic starry skate (*Amblyraja georgiana*) from the Ross Sea M.P. Francis (New Zealand) and M.J. Gallagher (*CCAMLR Science*, submitted)
WG-FSA-08/22	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2007/08 M.L. Stevenson, S.M. Hanchet and A. Dunn (New Zealand)

WG-FSA-08/23	Preliminary analysis of *Dissostichus mawsoni* by-catch during bottom and krill fishing (Statistical Division 58.4.2) L.K. Pshenichnov (Ukraine)
WG-FSA-08/24	Beach debris survey – Main Bay, Bird Island, South Georgia 2006/07 F. Le Bouard (UK)
WG-FSA-08/25	Fishing equipment, marine debris and hydrocarbon soiling associated with seabirds at Bird Island, South Georgia, 2007/08 D. Fox (UK)
WG-FSA-08/26	Beach debris survey and incidence of entanglement of Antarctic fur seals (*Arctocephalus gazella*) at Signy Island, South Orkney Islands, 2007/08 M.J. Dunn and C.M. Waluda (UK)
WG-FSA-08/27	Entanglement of Antarctic fur seals (*Arctocephalus gazella*) in man-made debris at Bird Island, South Georgia, during the 2007 winter and 2007/08 breeding season E.W.J. Edwards (UK)
WG-FSA-08/28	Groundfish survey in CCAMLR Subarea 48.3 in April 2008 with preliminary assessment of mackerel icefish M.A. Collins, R.E. Mitchell, C.E. Main, J. Lawson, J. Watts, J. Slakowski, L. Featherstone and O. Rzewuski (UK) (submitted to *Polar Biol.*)
WG-FSA-08/29	Identifying patterns in diet of mackerel icefish (*Champsocephalus gunnari*) at South Georgia using bootstrapped confidence intervals of a dietary index C.E. Main, M.A. Collins, R. Mitchell and M. Belchier (UK) (*Polar Biol.*, submitted)
WG-FSA-08/30	A review of the methods used to release skates (rajiids), with or without tags, in Antarctic exploratory fisheries J.M. Fenaughty (New Zealand)
WG-FSA-08/31	Biomass estimates and size distributions of demersal finfish on the Ross Sea shelf and slope from the New Zealand IPY-CAML survey, February–March 2008 S.M. Hanchet, M.L. Stevenson (New Zealand), C. Jones (USA), P.M. Marriott, P.J. McMillan, R.L. O'Driscoll, D. Stevens, A.L. Stewart and B.A. Wood (New Zealand) (*CCAMLR Science*, submitted)

WG-FSA-08/32	Indicative estimates of biomass and yield of Whitson's grenadier (*M. whitsoni*) on the continental slope of the Ross Sea in Subareas 88.1 and 88.2 S.M. Hanchet, D. Fu and A. Dunn (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-08/33	Age and growth of spiny icefish (*Chaenodraco wilsoni* Regan, 1914) off Joinville-D'Urville Islands (Antarctic Peninsula) M. La Mesa, A. De Felice (Italy), C.D. Jones (USA) and K.-H. Kock (Germany) (*CCAMLR Science*, submitted)
WG-FSA-08/34	Feeding and food interrelationships of Antarctic toothfish (*D. mawsoni* Norman, 1937) (Perciformes, Nototheniidae) in near-continental waters of the Indian Ocean Antarctic area and on the BANZARE Bank A.F. Petrov and I.G. Istomin (Russia) (*CCAMLR Science*, submitted)
WG-FSA-08/35	On the study of fecundity and eggs size of Antarctic toothfish (*Dissostichus mawsoni* Norman 1937) S.V. Piyanova. A.F. Petrov and N.V. Kokorin (Russia) (*CCAMLR Science*, submitted)
WG-FSA-08/36	Proposal to vary the requirement to test sink rates for integrated weight longline (IWL) gear prior to entering the Convention Area I. Hay (Australia)
WG-FSA-08/37 Rev. 1	Report on Australian fishing effort and seabird by-catch in fisheries outside the Convention Area T. Hewitt and I. Hay (Australia)
WG-FSA-08/38	Effect of stern-setting tunnel on the sink rate of integrated weight longline (IWL) I. Hay and G. Robertson (Australia)
WG-FSA-08/39	Research plan for toothfish by *Shinsei Maru No. 3* in 2008/09 Delegation of Japan
WG-FSA-08/40	Proposal for revising Conservation Measure 41-04(2007): Limits on the Exploratory Fishery for *Dissostichus* spp. in Statistical Subarea 48.6 in the 2008/09 Season Delegation of Japan
WG-FSA-08/41	The analysis of feeding activity and diet composition of Antarctic toothfish (*D. mawsoni*) in the Ross and Amundsen Seas in the fishing season 2006/07 N.V. Kokorin (Russia)

WG-FSA-08/42	The role of fish as predators of krill (*Euphausia superba*) and other pelagic resources in the Southern Ocean K.-H. Kock (Germany), D.J. Agnew (UK), E. Barrera-Oro (Argentina), M. Belchier, M.A. Collins (UK), S. Hanchet (New Zealand), L. Pshenichnov (Ukraine), K.V. Shust (Russia), D. Welsford and R. Williams (Australia)
WG-FSA-08/43	Revised assessment of toothfish stocks in Divisions 58.4.1 and 58.4.2 D.J. Agnew, C. Edwards, R. Hillary, R. Mitchell (UK) and L.J. López Abellán (Spain) (*CCAMLR Science*, submitted)
WG-FSA-08/44	Preliminary results of trials testing modified longline gear 'trotlines' in presence of cetaceans in Subarea 48.3 R.E. Mitchell, J. Clark, P. Reyes, L. Jones, J. Pearce, C.E. Edwards and D. Agnew (UK)
WG-FSA-08/45	Proposal for revising Conservation Measures 24-02 (2005) and 41-03 (2006) in relation to Subarea 48.4 Delegation of the United Kingdom
WG-FSA-08/46	Proposal for an extension to the mark–recapture experiment to estimate toothfish population size in Subarea 48.4 J. Roberts and D. J. Agnew (UK)
WG-FSA-08/47	Update on items of interest to WG-IMAF N. Walker (New Zealand)
WG-FSA-08/48	Investigating length at maturity of Antarctic toothfish (*Dissostichus mawsoni*) based on scientific observers' data S. Mormede, S. Parker and P. Grimes (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-08/49	Year of the Skate sampling protocol: learning from the 2007/08 season sampling protocol on NZ vessels S. Mormede (New Zealand)
WG-FSA-08/50	The Ross Sea Antarctic toothfish fishery: review of the 3-year experiment and development of medium-term research objectives and an operational framework for the fishery Delegation of New Zealand
WG-FSA-08/51	Updated preliminary results of an ecological risk assessment for seabirds and marine mammals with risk of fisheries interactions S. Waugh, D. Filippi, N. Walker (New Zealand) and D.S. Kirby

WG-FSA-08/52	An assessment of artificial bait (NORBAIT™) as a means of reducing the incidental catch of *Macrourus* and other by-catch species in high-latitude toothfish fisheries J.M. Fenaughty (New Zealand)
WG-FSA-08/53	Methods for implementing Conservation Measure 22-06: an impact assessment framework for bottom-impacting fishing methods in the CCAMLR Convention Area B. Sharp, S. Parker and N. Smith (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-08/54	A non-hierarchical taxonomic key for seabird identification in the Heard Island and McDonald Islands and Kerguelen Island fisheries J. Fielding, T. Lamb, B. Wienecke (Australia) and N. Gasco (France)
WG-FSA-08/55	The Australian skate tagging program at Heard Island and McDonald Islands, CCAMLR Division 58.5.2 G.B. Nowara and T. Lamb (Australia)
WG-FSA-08/56	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 2008, using the generalised yield model D.C. Welsford (Australia)
WG-FSA-08/57	Report on a longline survey conducted by the FV *Janas* in may 2008 on BANZARE Bank, and an assessment of the status of *Dissostichus* spp. in Division 58.4.3b D. Welsford, T. Robertson and G. Nowara (Australia) (*CCAMLR Science*, submitted)
WG-FSA-08/58	Estimating the swept area of demersal longlines based on *in situ* video footage D. Welsford and R. Kilpatrick (Australia) (*CCAMLR Science*, submitted)
WG-FSA-08/59	Field identification guide to Heard Island and McDonald Island (HIMI) benthic invertebrates T. Hibberd and K. Moore (Australia)
WG-FSA-08/60	The autoline system – an updated descriptive review of the method with recommendations to clarify CCAMLR conservation measures regulating longline fisheries within the Convention Area J.M. Fenaughty (New Zealand)

WG-FSA-08/61	Report of the Second Meeting of the Seabird Bycatch Working Group (Hermanus, South Africa, 17–18 August 2008) ACAP Seabird Bycatch Working Group
WG-FSA-08/62	Application to undertake winter scientific research in CCAMLR Subarea 88.1 (SSRUs 881B, 881C and 881G) in the 2008/09 season Delegation of New Zealand
WG-FSA-08/63	Expected tag–recapture rates from new and exploratory fisheries for *Dissostichus* spp. J.P. McKinlay and D.C. Welsford (Australia) (*CCAMLR Science*, submitted)
WG-FSA-08/64	A risk management framework for avoiding significant adverse impacts of bottom fishing gear on Vulnerable Marine Ecosystems K. Martin-Smith (Australia) (*CCAMLR Science*, submitted)
WG-FSA-08/65	Conveners' Report of the WG-IMAF Workshop K. Rivera and N. Smith (Co-conveners of ad hoc WG-IMAF)

Other Documents

WG-FSA-08/P1	Population subdivision in the Antarctic toothfish (*Dissostichus mawsoni*) revealed by mitochondrial and nuclear single nucleotide polymorphisms (SNPs) K. Kuhn and P.M. Gaffney (*Ant. Sci*., 20 (4): 327–338 (2008) doi:10.1017/S0954102008000965)
WG-FSA-08/P2	Recruitment and body size in relation to temperature in juvenile Patagonian toothfish (*Dissostichus eleginoides*) at South Georgia M. Belchier and M.A. Collins (*Mar. Biol.*, 155 (5): 493–503 (2008) 10.1007/s00227-008-1047-3)
WG-FSA-08/P3	Oxygen and carbon stable isotopes in otoliths record spatial isolation of Patagonian toothfish (*Dissostichus eleginoides*) J.R. Ashford and C.M. Jones (*Geochimica et Cosmochimica Acta*, 71: 87–94 (2007) doi:10.1016/j.gca.2006.08.030)

WG-FSA-08/P4	Otolith chemistry reflects frontal systems in the Antarctic Circumpolar Current J.R. Ashford, A.I. Arkhipkin and C.M. Jones (*Mar. Ecol. Progr. Ser.*, 351: 249–260 (2007) doi: 10.3354/meps07153)
WG-FSA-08/P5	Otolith chemistry indicates population structuring by the Antarctic Circumpolar Current J.R. Ashford, C.M. Jones, E.E. Hofmann, I. Everson, C.A. Moreno, G. Duhamel and R. Williams (*Can. J. Fish. Aquat. Sci.*, 65: 135–146 (2008) doi:10.1139/F07-158)
WG-FSA-08/P6	Slope currents around the Kerguelen Islands from demersal longline fishing records Y.-H. Park, N. Gasco and G. Duhamel (France) (*Geophys. Res. Lett.*, 35 L09604 (2008) doi:10.1029/2008GL033660)
CCAMLR-XXVII/12	Summary of notifications for new and exploratory fisheries 2008/09 Secretariat
CCAMLR-XXVII/13	Notification of Norway's intention to conduct an exploratory trawl fishery for *Euphausia superba* in the 2008/09 season Delegation of Norway
CCAMLR-XXVII/14	Notifications of Argentina's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Argentina
CCAMLR-XXVII/15	Notification of Australia's intention to conduct an exploratory longline fishery for *Dissostichus* spp. in the 2008/09 season Delegation of Australia
CCAMLR-XXVII/16	Notifications of Chile's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Chile
CCAMLR-XXVII/17	Notifications of Japan's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Japan
CCAMLR-XXVII/18	Notifications of the Republic of Korea's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of the Republic of Korea

CCAMLR-XXVII/19	Notifications of New Zealand's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of New Zealand
CCAMLR-XXVII/20	Notifications of Russia's intention to initiate new pot fisheries for crab in the 2008/09 season Delegation of Russia
CCAMLR-XXVII/21 Rev. 1	Notifications of Russia's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Russia
CCAMLR-XXVII/22	Notifications of South Africa's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of South Africa
CCAMLR-XXVII/23	Notifications of Spain's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Spain
CCAMLR-XXVII/24	Notifications of the United Kingdom's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of the United Kingdom
CCAMLR-XXVII/25	Notifications of Uruguay's intention to conduct exploratory longline fisheries for *Dissostichus* spp. in the 2008/09 season Delegation of Uruguay
CCAMLR-XXVII/26	Preliminary assessments of known and anticipated impacts of proposed bottom fishing activities on vulnerable marine ecosystems Collated by the Secretariat
CCAMLR-XXVII/BG/15	Implementation of conservation measures in 2007/08 Secretariat
SC-CAMLR-XXVII/5	Report of the Working Group on Statistics, Assessments and Modelling (St Petersburg, Russia, 14 to 22 July 2008)
SC-CAMLR-XXVII/8	Action plan aimed at reducing seabird by-catch in the French EEZs in Statistical Division 58.5.1 and Subarea 58.6 Delegation of France

SC-CAMLR-XXVII/10	Récapitulatif des contributions françaises concernant les recommandations du comité scientifique sur la mortalité accidentelle des oiseaux marins Délégation française
SC-CAMLR-XXVII/12	Environmental, spatial, temporal and operational effects on the incidental mortality of birds in the longline fishery in the Crozet and Kerguelen areas 2003–2006 Delegation of France
SC-CAMLR-XXVII/13	Notification of vulnerable marine ecosystems in Statistical Division 58.4.1 Delegation of Australia
SC-CAMLR-XXVII/BG/1	Catches in the Convention Area in the 2006/07 and 2007/08 seasons Secretariat
SC-CAMLR-XXVII/BG/6	Report of the ad hoc Technical Group for At-Sea Operations (St Petersburg, Russia, 19 and 20 July 2008)
SC-CAMLR-XXVII/BG/7	Attendance of Science Officer at the Second Meeting of the ACAP Seabird Bycatch Working Group (Hermanus, South Africa, 17 to 18 August 2008) Secretariat
SC-CAMLR-XXVII/BG/8	Etude 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-XXVII/BG/10	Seabird by-catch in the French toothfish fishery: report of a cooperative study in 2008 Delegation of France
SC-CAMLR-XXVII/BG/11	Instruments de réglementation en vigueur pour réduire la mortalité des oiseaux de mer directement ou indirectement Délégation française
SC-CAMLR-XXVII/BG/12	Mise en place d’un système d’effarouchement au poste de virage sur les palangriers exploitant la légine dans les ZEE françaises incluses dans les sous-zones statistiques 58.5.1 et 58.6 – Campagne de pêche 2007-2008 Délégation française

WG-EMM-08/27	Trophic study of Ross Sea Antarctic toothfish (*Dissostichus mawsoni*) using carbon and nitrogen stable isotopes S.J. Bury, M.H. Pinkerton, D.R. Thompson, S. Hanchet, J. Brown and I. Vorster (New Zealand)
WG-EMM-08/42	A preliminary balanced trophic model of the ecosystem of the Ross Sea, Antarctica, with emphasis on apex predators M.H. Pinkerton, J.M. Bradford-Grieve and S.M. Hanchet (New Zealand)
WG-EMM-08/43	Trophic overlap of Weddell seals (*Leptonychotes weddelli*) and Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica M.H. Pinkerton, A. Dunn and S.M. Hanchet (New Zealand)
WG-SAM-08/8	Towards the balanced stock assessment of Antarctic toothfish in the Ross Sea D. Vasilyev and K. Shust (Russia)
WG-SAM-08/13	Development of a methodology for data quality assessment D.A.J. Middleton and A. Dunn (New Zealand)

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
(Hobart, Australia, 13 to 17 October 2008)

CONTENTS

REPORT OF THE AD HOC WORKING GROUP ON INCIDENTAL MORTALITY ASSOCIATED WITH FISHING

(Hobart, Australia, 13 to 17 October 2008)

OPENING OF THE MEETING

1.1 The meeting of ad hoc WG-IMAF was held in Hobart, Australia, from 13 to 17 October 2008.

1.2 The Co-conveners, Ms K. Rivera (USA) and Mr N. Smith (New Zealand), opened the meeting and welcomed participants, including the invited experts from ACAP and BirdLife International.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

1.3 The agenda of the meeting was discussed and it was agreed to add emphasis on marine mammals, a new item on the review of action plans relating to areas of high incidental mortality, and to clarify that mitigation discussions should include review of the use of fishing methods. The revised agenda was adopted (Appendix A).

1.4 The report was prepared by the participants, and includes the agenda (Appendix A) and list of participants (Appendix B). The list of documents considered at the meeting is given in the report of WG-FSA (Annex 5, Appendix C).

INTERSESSIONAL WORK OF AD HOC WG-IMAF

1.5 The Secretariat reported on the intersessional activities of ad hoc WG-IMAF according to the agreed plan of intersessional activities for 2007/08 (SC-CAMLR-XXVI, Annex 6, Table 21).

1.6 The Working Group thanked the Secretariat for its work on the coordination of ad hoc WG-IMAF intersessional activities and the technical coordinators of national observer programs for their support. It also thanked the Secretariat for its work on the processing and analysis of data submitted to the Secretariat by international and national observers during the course of the 2007/08 fishing season.

1.7 The Working Group concluded that most tasks planned for 2007/08 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 2008/09, compiled by the Co-conveners and the Science Officer, be appended to its report (Table 1).

1.8 The Working Group especially welcomed to the meeting Mr J. Moir Clark (UK), Ms F. Graham (France) and Ms K. O'Regan (Australia) who were attending the meeting for the first time. The Working Group encouraged expert advice on operational aspects of fishing from Members, in particular in relation to trotline and trawl fisheries, in future.

1.9 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 Members engaged in fishing activities in, or adjacent to, the Convention Area who have not recently participated in ad hoc WG-IMAF.

Advice to the Scientific Committee

1.10 The plan of intersessional work for 2008/09 (Table 1) summarises requests to Members and others for information of relevance to the work of ad hoc WG-IMAF (paragraph 1.7). Members are particularly invited to review participation in the Working Group and to facilitate attendance of their representatives at meetings, especially technical coordinators and Members engaged in fishing activities in, or adjacent to, the Convention Area who have not recently participated in ad hoc WG-IMAF (paragraph 1.9).

INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS IN FISHERIES IN THE CONVENTION AREA

Seabirds

Seabirds in longline fisheries

2.1 Data were available from all longline cruises conducted in the Convention Area, excluding those within the French EEZs in Subarea 58.6 and Division 58.5.1, during the 2007/08 season (WG-FSA-08/5, Table 1).

2.2 The proportions of hooks observed were similar to those observed last year, ranging from 13 to 100% with an average of 47% (Table 2).

2.3 The total extrapolated seabird mortalities due to interactions with fishing gear during longline fishing for *Dissostichus* spp. in the Convention Area in 2007/08 were estimated to be 1 355 petrels (91% white-chinned petrels (*Procellaria aequinoctialis*), 7% grey petrels (*Procellaria cinerea*) and 2% *Macronectes* species) (Table 3; WG-FSA-08/5 Rev. 1, Table 11).

2.4 The Working Group noted that this is the third consecutive year that no albatrosses were observed captured in longline fisheries in the Convention Area and the second consecutive year that the only incidental mortality of seabirds observed captured in longline fisheries in the Convention Area was from the French EEZs.

2.5 The total number of seabirds observed caught and released uninjured was 121 (Tables 2 and 4), all caught during hauling. Of these, 20 were caught within Subarea 48.3, 2 in Subareas 58.6, 58.7 and Area 51, and 99 from within the French EEZs in Subarea 58.6 and Division 58.5.1. All vessels recorded the use of a haul scaring device. The types of devices described by observers included: water cannon/fire hose, single boom with single attached object/streamer, single boom with multiple attached object/streamers, multiple booms and attached objects (Brickle curtain) and noise (WG-FSA-08/5 Rev. 1, paragraphs 6 and 7).

2.6 At the time of the meeting, Australia provided information on one additional observed mortality of a southern giant petrel (*M. giganteus*) on 23 August 2008 on the longline vessel *Austral Leader II* in Division 58.5.2. The observer data will be provided to the Secretariat once the cruise is completed.

Seabird incidental mortality in the French EEZs in Subarea 58.6 and Division 58.5.1

2.7 Data were available from 15 cruises in Subarea 58.6 and 21 cruises in Division 58.5.1 in 2007/08. All vessels in the French EEZs were autoliners using at least 50 g m^{-1} IWLs. The proportion of hooks observed was 24.6% in each of the areas (Table 5) and the total reported observed seabird incidental mortality was 34 and 304 birds respectively (sum of dead and injured birds) (Table 5). The corresponding incidental mortality rates were 0.0305 and 0.0585 birds/thousand hooks (Table 5) and the extrapolated total seabird mortalities for Subarea 58.6 and Division 58.5.1 were 131 and 1 224 respectively (Table 3).

2.8 The Working Group noted that this represented a 53 and 27% reduction in by-catch rates for Subarea 58.6 and Division 58.5.1 respectively, compared to the previous season; a reduction of 40% from the combined total estimated by-catch from these areas (Table 3).

2.9 The Working Group noted that 32% of seabirds observed captured were caught alive, indicating that they were taken on the haul (Table 5). This compares to 48% of the total number of birds that were caught on hauling last year. Most (77%) of the birds captured during the haul were taken at the start of the fishing season prior to the implementation of a haul mitigation device. The majority of birds caught were giant petrels (*Macronectes* species). The mid-season introduction of a requirement to use a haul-mitigation device considerably reduced captures.

2.10 The Working Group noted that the haul-mitigation device should be improved in order to further reduce capture rate during hauling. Based on evidence from the nearby Division 58.5.2 (Heard Island), where the combination of full offal retention and haul mitigation devices has virtually eliminated seabird captures (including giant petrels), the Working Group noted that it should be possible to reduce haul interactions to zero with an improved haul-mitigation device and offal management practices.

2.11 The Working Group discussed the definition of an injured bird (CCAMLR-XXII, paragraph 5.1; SC-CAMLR-XXII, paragraph 5.39 and Annex 5, paragraphs 6.213 to 6.217) to determine if the interpretation of the definition was uniform across the Convention Area (SC-CAMLR-XXVII/BG/10). It was agreed to clarify the issue by adding text to the definition to indicate that any open wound, with or without the presence of blood, should be considered an injury. The Working Group requested that the Secretariat revise the scientific observer e-logbook instructions for all fisheries to reflect this revised definition of an injured bird.

Seabirds in trawl fisheries

Subarea 48.3 icefish

2.12 Data were available from all six trawl cruises conducted within Subarea 48.3 during the 2007/08 season (WG-FSA-08/6 Rev. 1). The Working Group noted that there was 100% observer coverage of fishing vessels in this fishery with 89% of tows observed (WG-FSA-08/6 Rev. 1, Table 2).

2.13 For 2007/08, five seabird mortalities (three white-chinned petrels and two king penguins (*Aptenodytes patagonicus*)) were reported in Subarea 48.3 from four vessels (WG-FSA-08/6 Rev. 1, Table 3). Two of the white-chinned petrels were killed on hauling and one on setting, it was unclear at what stage of the fishing process the penguins were killed as they were cold when hauled on board. In addition, five seabirds were released alive in Subarea 48.3 (four black-browed albatrosses (*Diomedea melanophrys*) and one grey-headed albatross (*D. chrysostoma*)) (WG-FSA-08/6 Rev. 1, Table 3).

2.14 The Working Group noted that this compares to six seabird mortalities (three released alive) in 2007 and 33 seabird mortalities (89 released alive) in 2006. The rate of mortality in Subarea 48.3 in 2008 was 0.024 birds per trawl compared to 0.07, 0.07 and 0.14 in 2007, 2006 and 2005 respectively (Table 6). One warp strike was recorded – an unidentified albatross on the *Betanzos*.

2.15 Observers recorded a number of different mitigation measures used. These included: net cleaning, streamer lines, Brady bafflers, water jets, net binding and net weighting (WG-FSA-08/6 Rev. 1, paragraph 10). The use of net bindings was reported on all vessels for all sets. Net bindings were spaced between 1 and 4 m apart, with the mesh sizes which were bound ranging from 96 to 800 mm. In the case of net weighting, three vessels, the *Betanzos*, *Robin M Lee* and the *Insung Ho*, reported on the use of net weights. The *Betanzos* attached 37.5 kg chains to each side of the mouth of the codend but increased this to 54.5 kg after five seabird entanglements were observed. They also had a second pair of chains weighing 95 kg each towards the rear of the codend. The *Insung Ho* attached 250 kg weights to either side of the mouth of the net, and 322 kg in the codend. The *Robin M Lee* used integrated weight rope, which added approximately 400 kg to the net. In addition, the *Robin M Lee* turned when hauling to close the net meshes.

2.16 The Working Group noted that the level of seabird mortality remains low in this subarea and requested additional information to isolate the success factors. The Working Group recommended that observers provide a more detailed description of the mitigation measures in place, including specific fishing techniques used by vessels (e.g. shorter trawls to reduce the size of the net when hauling) (paragraph 7.29(iv)(b)).

Division 58.5.2 toothfish/icefish

2.17 Data were available from one vessel which conducted three trawl cruises within Division 58.5.2 during the 2007/08 season (WG-FSA-08/6 Rev. 1, Table 2). The Working Group noted that there was 100% observer coverage of fishing vessels in this fishery with 97% of tows observed (Table 7).

2.18 No seabird mortalities were reported and one Cape petrel (*Daption capense*) was captured and released alive (WG-FSA-08/6 Rev. 1, Table 3). The vessel used net cleaning and minimal deck lighting to reduce seabird interactions and fully implemented Conservation Measure 25-03 (WG-FSA-08/6 Rev. 1, paragraph 15).

Krill

2.19 Data were available from eight[1] trawl cruises conducted within Area 48 during the 2007/08 season (WG-FSA-08/6 Rev. 1). In the krill fishery, 50% of vessels fishing in Subarea 48.1, 20% of vessels fishing in Subarea 48.2 (two cruises) and 67% 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 (WG-FSA-08/6 Rev. 1, Table 2).

2.20 The Working Group noted that no seabird mortality was reported on the *Saga Sea* while fishing with continuous trawls in Subareas 48.1, 48.2 and 48.3 (Table 7). Similarly, no mortalities were recorded on the *Dalmor II* and *Juvel* in Subarea 48.3 or the *Konstruktor Koshkin* in Subareas 48.1 and 48.2 using traditional krill pelagic trawl methods (Table 7). *Maksim Starostin* used both continuous and traditional systems in Area 48 with no bird mortalities recorded (Table 7).

2.21 The Working Group noted that the apparent low proportion of tows observed on some vessels in the krill fishery was due to the method used to record trawls during continuous trawling. Current CCAMLR protocols require these vessels to record every two-hour period when the net is in the water as a separate trawl, a vessel continuously trawling over a period of several days may record several hundred trawls although the net will only have been observed deployed and retrieved once. It was also noted that proportion of tows observed for the periods when observers were on board was still low on some vessels using conventional trawl (33% on the *Konstruktor Koshkin*, 20% on the *Dalmor II*).

Seabirds in pot fisheries

2.22 During pot fishing in 2007/08, no seabird mortalities were recorded during any of the cruises targeting *D. eleginoides* (WG-FSA-08/8, paragraph 7) or crabs in Subarea 48.3 (WG-FSA-08/5 Rev. 1, paragraph 17).

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[1] One logbook was submitted by a national observer on board the *Konstruktor Koshkin*.

Marine mammals

Marine mammals in longline fisheries

2.23 Three seal mortalities were recorded in the Convention Area during the 2007/08 season (WG-FSA-08/5 Rev. 1, paragraph 5). One Antarctic fur seal (*Arctocephalus gazella*) was reported hooked through the bottom lip, presumably on setting, in Area 48, another one was recorded entangled on the backbone of a mainline and drowned in Division 58.5.2, and a crabeater seal (*Lobodon carcinophagus*) was caught on the line in Subarea 88.1.

2.24 At the time of the meeting, Australia provided information on one additional observed mortality of a southern elephant seal (*Mirounga leonina*) on 13 September 2008 on the longline vessel *Austral Leader II* in Division 58.5.2. The observer data will be provided to the Secretariat once the cruise is completed.

Marine mammals in trawl fisheries

Krill

2.25 Six marine mammal mortalities were recorded in the krill trawl fishery in 2007/08, all in Subarea 48.3 (Table 8). Five were fur seals and one was recorded as unidentified. This is an increase from the 2006/07 season where no mortalities were recorded (Table 9). Observers reported on the use of seal excluder devices and routine net cleaning (WG-FSA-08/6 Rev. 1, paragraph 5).

2.26 The Working Group noted that observed marine mammal mortalities are currently not extrapolated to estimated totals as they are for seabirds (paragraphs 7.4 to 7.8).

Finfish

2.27 No marine mammal entanglements were observed in finfish trawl fisheries (Table 8; WG-FSA-08/6 Rev. 1, paragraph 14). This was also the case for 2006/07 season.

Marine mammals in pot fisheries

2.28 No marine mammal mortalities were reported for pot fisheries in the Convention Area (WG-FSA-08/8). This was also the case for 2006/07 season.

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

2.29 Information from observer reports relating to the implementation of Conservation Measures 26-01, 25-02 and 25-03 in 2007/08 was provided by the Secretariat (WG-FSA-08/7 Rev. 2). The data reported exclude fishing activity within the French EEZs in Subarea 58.6 and Division 58.5.1 for which data were not available.

Conservation Measure 26-01 'General environmental protection during fishing'

Plastic packaging bands

2.30 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. On such vessels all bands must be cut and disposed of using this facility. Information from observer reports indicated that plastic packaging bands to secure bait boxes were on board during seven cruises: *Antarctic Bay, Argos Froyanes* and *Koryo Maru No. 11* in Subarea 48.3, *Argos Froyanes* in Subarea 48.4, *Shinsei Maru No. 3* in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b, *Austral Leader II* in Division 58.5.2, and *Koryo Maru No. 11* in Subareas 58.6 and 58.7 (WG-FSA-08/7 Rev. 2, Table 1). Observers reported that on all vessels where plastic packaging bands to secure bait boxes were present, they were cut and retained or incinerated. There was full compliance with Conservation Measure 26-01 with respect to the use of other plastic packaging bands.

Gear debris and garbage

2.31 The Working Group noted the discharge of gear debris from the *Viking Bay* and the *Koryo Maru No. 11* in Division 48.3 (WG-FSA-08/7 Rev. 2, Table 1). This included fishing gear, such as snoods and hooks. The Working Group noted that these discharges would have 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

2.32 For Spanish-system vessels, two vessels did not meet the line-weighting regime as specified in Conservation Measure 25-02, paragraph 3, as weights were spaced beyond the 40 m maximum spacing: the *Hong Jin No. 707* in Subarea 88.1 and the *Koryo Maru No. 11* in Subareas 58.6 and 58.7 (WG-FSA-08/7 Rev. 2, Figure 1).

2.33 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, met the requirement to achieve a consistent minimum line sink rate as described in Conservation Measure 24-02 (WG-FSA-08/7 Rev. 2, Table 7 and Figure 1). As in previous years, this line-weighting requirement has been fully achieved by all vessels. For 2007/08, the Working Group noted that one autoline vessel (*Antartic III* in Subarea 88.1) used clip-on weights to achieve the sink rate requirements. All other autoline vessels were using IWLs (WG-FSA-08/7 Rev. 2, Figure 1).

2.34 The Working Group noted that a line-weighting specification for the trotline method of longlining is not currently provided in Conservation Measure 25-02.

Night setting

2.35 There was 100% compliance with night setting in all areas where this was required (Subareas 48.3, 48.4, 58.6 and 58.7) (Table 10).

2.36 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 fully implemented one or both of these requirements (WG-FSA-08/7 Rev. 2, Table 7).

Offal discharge

2.37 All longline vessels fully implemented 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 2007/08 season (Table 10).

Discard of hooks

2.38 Observers reported hooks being present in offal discharge from one of 37 longline cruises (WG-FSA-08/7 Rev. 2, Table 1). The observer on board the *Viking Bay*, fishing in Subarea 48.3, reported that for the first two days of fishing operations no attempt was made to remove hooks from offal, and this only changed when it was brought to the attention of the Fishing Master. This compares to three of 39 cruises last year with reports of hooks in offal discharge (SC-CAMLR-XXVI, Annex 6, paragraph II.52).

2.39 The Working Group expressed continued concern at the discarding of hooks in offal, given that nest surveys had once again found a high level of hooks around nests of wandering albatrosses (*D. exulans*) on Bird Island, South Georgia (WG-FSA-08/25) (paragraph 12.5). The Working Group stressed that hook ingestion persists as a severe impact on Convention Area seabirds; these hooks come from longline fisheries inside and outside the Convention Area.

Streamer lines

2.40 Full implementation of all elements of the streamer line specification increased from 80% (29 of 37 longline cruises) in 2005/06 to 87% (34 of 39 cruises) in 2006/07 and to 94.5% in 2007/08 (35 of 37 cruises) (Table 10).

2.41 The cruises where streamer lines did not meet the specification failed on streamer lengths (two cruises: *Insung No. 1* in Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b; *Antartic III* in Subareas 88.1 and 88.2) (Table 11).

2.42 The Working Group noted that these small deviations from full implementation with streamer line configuration had not led to any observed seabird incidental mortality. Nevertheless, the Working Group encouraged vessels to strive for full implementation.

Haul-scaring devices

2.43 Paragraph 8 of Conservation Measure 25-02 requires that a device designed to discourage seabirds 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.

2.44 Apart from one vessel (*Punta Ballena*, 96%) on one cruise in Subarea 48.3, which did not use haul-scaring devices on all hauls due to the haul-scaring device being considered dangerous on those occasions, there was full implementation of this requirement by all other vessels (Table 11).

Conservation Measure 25-03 'Minimisation of the incidental mortality of seabirds and marine mammals in the course of trawl fishing in the Convention Area'

2.45 A range of mitigation measures were used on board icefish vessels in Subarea 48.3 and Division 58.5.2 (WG-FSA-08/6 Rev. 1, paragraph 10) and implementation of Conservation Measure 25-03 was generally good.

Net sonde cables

2.46 There was a report of one vessel, the *Maksim Starostin,* which used a net sonde cable in the Convention Area during the 2007/08 season (WG-FSA-08/7 Rev. 2). The Working Group recalled its clarifications of what constitutes a net sonde cable in SC-CAMLR-XXV, Annex 5, Appendix D, paragraph 48 and SC-CAMLR-XXVI, Annex 6, paragraph II.60, and noted that this latest report was in contravention of Conservation Measure 25-03, although the observer recorded that this only occurred on one continuous trawl lasting 26 hours, which did not result in any observed seabird mortalities.

Offal discharge

2.47 One krill vessel, the *Dalmor II,* fishing in Subarea 48.3 was observed discarding offal during net hauling. The observer on board reported that the offal discharge was due to accidents and technical problems (WG-FSA-08/7 Rev. 2, Table 6). The observer reported that in normal circumstances, to avoid discarding offal when the net is on the surface near the vessel, a red light is turned on in the factory and meal and meat production is halted.

2.48 The Working Group noted that the nature, type and definition of discharges varies both within and between finfish and krill trawl fisheries. This difference should be evaluated in considering the application of paragraph 3 of Conservation Measure 25-03 in the krill fishery.

Summary of conservation measure implementation

2.49 The Working Group noted that in 2005 it had explicitly identified those vessels that had fully implemented the requirements of Conservation Measures 25-01, 25-02 and 25-03 (SC-CAMLR-XXIV, Annex 5, Appendix O, paragraphs 48, 61 and 62). The Working Group further noted COMM CIRC 08/109 which outlined the provision in Conservation Measure 41-02 for an extension to the fishing season for toothfish in Subarea 48.3 for those vessels that have exhibited full compliance with Conservation Measure 25-02. In order to facilitate any such assessment of compliance in the coming season, the Working Group noted that the following vessels did not fully implement the requirements of Conservation Measures 26-01, 25-02 and 25-03:

(i) *Antarctic Bay, Argos Froyanes, Shinsei Maru No. 3, Austral Leader II* and *Koryo Maru No. 11* which had plastic packing bands to secure bait boxes on board during cruises in the Convention Area (paragraph 2.30);

(ii) gear debris from the *Viking Bay* and the *Koryo Maru No. 11* and the discharge of garbage from the *Viking Bay* (paragraph 2.31);

(iii) *Koryo Maru No. 11* and the *Hong Jin No. 707* which exceeded the maximum spacing between weights on longlines (paragraph 2.32);

(iv) *Viking Bay* due to the discharge of hooks in offal (paragraph 2.38);

(v) *Insung No. 1* and *Antartic III* which used streamers that did not meet the minimum length specified (paragraph 2.41);

(vi) *Punta Ballena* which did not use haul-scaring devices on all hauls (paragraph 2.44);

(vii) *Maksim Starostin*, which used a net monitor cable during one krill trawl (paragraph 2.46);

(viii) *Dalmor II* which discharged offal during net hauling while trawling for krill (paragraph 2.47).

Advice to the Scientific Committee

2.50 The total extrapolated seabird mortalities due to interactions with fishing gear during longline fishing for *Dissostichus* spp. in the Convention Area in 2007/08 were estimated to be 1 355 petrels (91% white-chinned petrels, 7% grey petrels and 2% *Macronectes* species). All these estimated mortalities were from within the French EEZ, with 131 seabirds in Subarea 58.6 and 1 244 in Division 58.5.1 (paragraphs 2.3 and 2.4).

2.51 A total of five seabird mortalities (3 white-chinned petrels and 2 king penguins) were reported during trawling for finfish in the Convention Area, all occurring in the icefish fishery in Subarea 48.3. No seabird mortalities were reported during trawling for krill or during pot fishing (paragraphs 2.13, 2.18, 2.19 and 2.22).

2.52 Nine seal mortalities were recorded in the Convention Area during the 2007/08 season (WG-FSA-08/5 Rev. 1, paragraph 5); comprising 2 Antarctic fur seals and 1 crabeater seal in the longline fishery and 5 Antarctic fur seals and 1 unidentified seal in the trawl fishery (paragraphs 2.23 to 2.26).

2.53 The Working Group recommended that the Scientific Committee refer to SCIC the information about less than full implementation of Conservation Measures 26-01, 25-02 and 25-03 (paragraph 2.49 and references therein).

2.54 Recalling the development during 2008 of a CCAMLR poster to educate fishers about the need to avoid discarding of hooks in offal, the Working Group recommended that the Scientific Committee request Commission Members to actively circulate this poster, and (when developed) the CCAMLR marine debris poster, to their fishers operating in areas where Convention Area seabirds and marine mammals occur, and ensure display of the posters on their vessels (paragraphs 2.31, 2.39 and 12.12).

REVIEW OF ACTION PLANS TO ELIMINATE SEABIRD MORTALITY

France's action plan to reduce/eliminate seabird mortality in Subarea 58.6 and Division 58.5.1

3.1 The Working Group reviewed France's action plan developed to reduce seabird incidental mortality in Subarea 58.6 and Division 58.5.1 (SC-CAMLR-XXVII/8). As noted by France last year (SC-CAMLR-XXVII, paragraph 5.7), the objective of the action plan is to reduce the level of incidental mortality (noted in SC-CAMLR-XXVI, paragraph 5.3) by a factor of two by 2010. The plan contains action details for the following five elements:

- prescription of conservation measures
- regulatory instruments
- education and training
- data collection
- research and development.

3.2 Key actions to note include: a cooperative study to evaluate the seabird incidental mortality problem in the French fishery and develop recommendations and solutions; an analysis of the environmental, spatial, temporal and operational effects on the incidental mortality of white-chinned and grey petrels in the longline fishery in Subarea 58.6 and Division 58.5.1; substantial improvements to the mitigation measures being used (particularly haul-mitigation devices and streamer lines), use of seasonal/area fishery closures, improvements to observer data collection and reporting, coordination between TAAF and ad hoc WG-IMAF, and formation of an independent technical working group to advise TAAF.

3.3 Mr C. Marteau (France) reported that in response to recommendations (SC-CAMLR-XXVII/BG/10) to improve the performance of streamer lines, modifications were made in the latter part of the 2007/08 season to use multiple streamer lines and to increase the aerial coverage of the lines. The Working Group noted that vessels were operating with up to 10 streamer lines, including outboard extensions to increase the breadth of aerial coverage and that this would likely be more effective at reducing white-chinned and grey petrel mortality than installing a boom and bridle system as recommended (SC-CAMLR-XXVI, Annex 6, paragraph II.26(v)). It was also noted that in the 2008/09 season the attachment height of the streamer lines would be increased to maximise the aerial extent of streamer lines.

3.4 The Working Group also understood that offal management practices have been modified and vessels may only discard offal twice during fishing operations: between the end of setting operations for the day and the start of hauling operations; and, in the period between completing the haul of one line and starting the haul of the next line. The Working Group reiterated that full offal retention is best practice for reducing the attractiveness of the vessel to seabirds and avoiding interactions between seabirds and fishing gear.

3.5 Mr Marteau presented data that demonstrated the overlap between annual incidental mortality by fishing effort in the French EEZs and the breeding season of white-chinned petrels and he stated that there will be additional closure in Division 58.5.1 from 1 February to 10 March 2009 (closure in the 2007/08 season: from 15 February to 15 March) in order to cover the most sensitive time for the white-chinned petrels. In the context of fisheries management and potential seasonal closures to reduce seabird incidental mortality in the peak breeding season, the Working Group considered this very useful information. The Working Group requested that France submit similar figures in 2009 for both Subarea 58.6 and Division 58.5.1, based on an incidental mortality rate calculated for each week of the season, overlaying fishing effort and the breeding seasons of white-chinned and grey petrels.

3.6 The Working Group reviewed the action plan as well as six other papers containing information and analyses on seabird incidental mortality in the French EEZ (SC-CAMLR-XXVII/10, 12 and BG/8, 10, 11 and 12). These papers were submitted in French and the Working Group acknowledged that the translation into English undertaken by the Secretariat greatly facilitated discussion by ad hoc WG-IMAF. The Working Group summarised the progress in implementing the recommendations contained in these papers and the Scientific Committee's recommendations (SC-CAMLR-XXVI, paragraph 5.6) in Table 12.

3.7 The Working Group assumed that the observed reduction in incidental mortality is mainly attributable to the intensified management efforts and implementation of the action plan. As several measures were newly implemented simultaneously, it is not possible to quantify the contributions of each individual measure to reduced by-catch rates. While this suite of measures may ultimately be effective in reducing the incidental mortality to targeted levels, the lack of understanding of the contribution of each measure to the overall mitigation outcome may create difficulties in the future should fishing practices change.

3.8 The Working Group was not able to ascertain the specific incidental mortality thresholds used in the real-time management controls. The Working Group recognised the complexity of these management decisions and the need to maintain real-time flexibility. Some of these factors include: weekly or daily reports of vessel-specific by-catch rates and numbers of birds taken, area and date of fishing (with respect to risks associated with interactions with white-chinned and grey petrels), the vessel's target fish catch amounts and quota.

3.9 The Working Group thanked Mr Marteau and Dr S. Waugh for their work on the cooperative study and the considerable assistance of Ms Graham at the meeting.

Advice to the Scientific Committee

3.10 The Working Group requested France to submit an English translation of SC-CAMLR-XXVII/BG/8 to WG-SAM (SC-CAMLR-XXVI, paragraph 5.6(ii)) in order to allow that Working Group to consider the modelling approach in the context of providing management advice (paragraphs 3.6 and 8.7).

3.11 The Working Group is very encouraged by these interim results and France's progress in implementing the action plan. The Working Group recognised that some of the recommendations are still under consideration and many have already been implemented. It appears that significant reductions, and perhaps near-zero mortalities, can be realised with continued diligence and strict attention to adherence with the action plan. The Working Group looked forward to intersessional work with TAAF and providing assistance as needed.

3.12 The Working Group requested that when France submits its progress report on action plan implementation in 2009 to CCAMLR, figures be included to show the overlap between weekly fishing effort by sector and seabird incidental mortality rates. Similar figures were presented to ad hoc WG-IMAF this year and were informative to its discussions (paragraph 3.5).

3.13 The Working Group noted that its advice remained that were France to fully implement all elements of CCAMLR's best-practice advice for mitigation of incidental mortality of seabirds, the levels of mortality observed in the French EEZ would be substantially reduced to near-zero levels.

INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS IN FISHERIES OUTSIDE THE CONVENTION AREA

4.1 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.

4.2 Written reports were provided by New Zealand (WG-FSA-08/47) and Australia (WG-FSA-08/37 Rev. 1). The Working Group welcomed these reports noting that both Members had applied mitigation measures and processes that had been used by CCAMLR to significantly reduce seabird incidental mortality in the Convention Area.

Advice to the Scientific Committee

4.3 Given that considerably greater levels of mortality of Convention Area seabirds continue to occur in areas north of the Convention Area, compared to levels within the Convention Area, the Working Group again urged all Members to comply with the request to report on incidental mortality of Convention Area seabirds and marine mammals arising from fisheries conducted outside the Convention Area (Resolution 22/XXV, paragraph 3; SC-CAMLR-XXV, Appendix D, Table 20, item 3.2). Members submitting reports in 2009 are encouraged to give emphasis to information on incidental mortality, numbers by species wherever possible, and the use of mitigation measures and management approaches similar to those used in CCAMLR fisheries or potentially relevant to such fisheries.

4.4 No data were received relating to fisheries' incidental mortality of Convention Area marine mammals outside the Convention Area.

INCIDENTAL MORTALITY OF SEABIRDS DURING IUU FISHING IN THE CONVENTION AREA

5.1 As no information is available on rates of incidental mortality of seabirds from the IUU 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. Notwithstanding this, in previous years the Working Group has prepared estimates of seabird incidental mortality in IUU longline fisheries 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. 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.

5.2 Estimates of IUU seabird incidental mortality in longline fisheries have been prepared every year since 1996. The most recent estimates (2007) of potential IUU seabird incidental mortality in the Convention Area for longline vessels are provided in SC-CAMLR-XXVI/BG/32.

5.3 The Working Group noted that during the 2007/08 season, at least five of the six IUU vessels sighted in the Convention Area were reported to be using gillnets (WG-FSA-08/10 Rev. 2). There was discussion on how estimates of IUU seabird incidental mortality could be estimated, in the absence of a clear understanding of:

(i) the types and extent of gillnet gear being used, and how the gear was deployed;

(ii) the composition of seabird species impacted by gillnets, noting that penguins may be more likely to be caught in gillnets than in longline and trawl gear operations;

(iii) the likely incidental mortality rates occurring in gillnet operations in Antarctic waters;

(iv) an appropriate method of estimating incidental mortality for gillnet gear.

5.4 It was concluded that it was not possible to develop reasonable estimates without such knowledge. The Working Group would welcome any additional information from Members with a regulated gillnet fishery that would provide some empirical data and guidance to assist in this purpose in the future.

5.5 The assessment of the risk from fishing in CCAMLR subareas and divisions that is reviewed annually by ad hoc WG-IMAF (SC-CAMLR-XXVI/BG/31) currently considers albatrosses and petrels as species at risk from trawl and longlines, but no consideration has been given to gillnet operations.

5.6 Irrespective of the level of knowledge about the incidental mortality on IUU gillnet vessels, the Working Group expressed serious concern that there would likely be interactions with seabirds, particularly if fishing was occurring in high-risk areas and at times of the year when albatrosses, petrels and penguins were breeding. It is important to recognise that the inability to estimate incidental mortality associated with IUU gillnet fishing does not imply that it is lower than would be anticipated had all of those IUU vessels deployed longlines.

5.7 Because many seabird 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 IUU vessels in the forthcoming fishing season.

Advice to the Scientific Committee

5.8 Estimates of seabird incidental mortality during IUU fishing within the Convention Area, previously estimated for longline effort, have not been prepared this year because most IUU effort was observed to be from vessels using gillnets and information from which to make extrapolations for this gear type were not available (paragraph 5.3).

5.9 The Working Group would welcome any additional information from Members with a regulated gillnet fishery that would provide some empirical data and guidance to assist in this purpose in the future (paragraph 5.4). Further, information from actions against IUU vessels should provide information of utility for ad hoc WG-IMAF in describing the interaction between gillnet fishing and seabirds.

5.10 The Working Group expressed serious concern that there would likely be seabird incidental mortality arising from IUU gillnet fishing and recognised that the inability to estimate incidental mortality associated with this fishing activity does not imply that it is lower than would be anticipated had all of the reported IUU vessels deployed longlines (paragraph 5.6).

RESEARCH INTO AND EXPERIENCE WITH MITIGATION MEASURES

Longline

6.1 WG-FSA-08/44 reported the results of a preliminary comparison conducted in Subarea 48.3 of Spanish system longlines and trotlines with respect to the CPUE of toothfish and selected non-target species. Toothfish CPUE (kg/thousand hooks and kg/set) was greater for trotlines than Spanish system lines when cetaceans were present. This difference increased with increasing abundance of cetaceans, highlighting the potential of this gear to reduce cetacean depredation. By-catch to catch ratio was greater by number for Spanish system lines when cetaceans were present during hauling. However, there was an increase in the incidence of injury to skates and toothfish associated with trotlines fitted with 'cachalotera'. The Working Group supported further trials with larger sample sizes in the future and encouraged that, as far as is practicable, future comparisons of the two fishing methods include not only effects on target and non-targeted fish species, but environmental attributes, such as seabirds and seals, the benthos, gear loss, marine pollution and operational considerations.

6.2 WG-FSA-08/60 provided a descriptive review of the autoline method to clarify CCAMLR conservation measures relating to the autoline method of fishing. The paper provided useful descriptions of gear used and operational procedures, including diagrams and a glossary of terms appropriate to autolining. The Working Group acknowledged the usefulness of the document and encouraged Members to submit similar reviews of the other fishing methods used in the Convention Area, such as the Spanish system and trotline methods of longlining, use of pots and trawl methods for mackerel icefish, toothfish and krill, including the continuous trawling variation.

6.3 The Working Group discussed the line-weighting regime that might be required for the trotline method of longlining (paragraph 2.34). The Working Group recommended, based on previous descriptions of the gear and its line sink rate (SC-CAMLR-XXVI, Annex 6, paragraphs II.81 to II.91 and II.100), that a line-weighting regime be specified for this gear type. The specification is as follows: vessels using the trotline system exclusively (not a mix of trotlines and the Spanish system within the same longline) shall deploy weights on the hook-end of all droppers in the trotline. Weights shall be traditional weights of at least 6 kg or solid steel weights of at least 5 kg. Vessels alternating between the use of the Spanish system and trotline method shall use: (i) for the Spanish system, line weighting shall conform to the provisions in paragraph 3 of Conservation Measure 25-02; (ii) for the trotline method, line weighting shall be either 8.5 kg traditional weights or 5 kg steel weights attached on the hook-end of all droppers in the trotline at no more than 80 m intervals.

Trawl

6.4 The Working Group reviewed the data from cruise reports on mitigation measures used in trawl fisheries and developed advice for minor changes to the observer logbooks to capture improved detail on the use of mitigation measures used during shooting and hauling. The recommended changes were provided directly to the Secretariat.

6.5 The Working Group noted that data from four seasons of operational experience indicate that net binding is a highly effective and simply applied mitigation measure and that, in combination with net cleaning and net weighting, it was considered to be largely responsible for the continued reduction in incidental mortality in the icefish trawl fishery. Noting that changes adopted to Conservation Measure 42-01 last year made net binding mandatory in the icefish trawl fisheries in Subarea 48.3 in 2007/08 (CCAMLR-XXVI, paragraph 13.72; Conservation Measure 42-01, paragraph 7 (Subarea 48.3)), the Working Group reiterated the Scientific Committee's recommendation to test its utility as appropriate in other Convention Area pelagic trawl fisheries (SC-CAMLR-XXVI, paragraph 5.29(v)).

6.6 Mr B. Baker (ACAP) updated the Working Group on the Second Meeting of the ACAP Seabird Bycatch Working Group (SBWG) held in Hermanus, South Africa (22 to 25 August 2008) (WG-FSA-08/61). At that meeting, New Zealand tabled a review of measures to reduce seabird incidental mortality in trawl fisheries (AC4 Doc 55, www.acap.aq), with the view to ACAP developing best-practice recommendations for mitigating seabird incidental mortality in trawl fisheries. The review highlighted work conducted in CCAMLR trawl fisheries, particularly offal management and measures to reduce net entanglements in pelagic trawl fisheries.

6.7 The ACAP SBWG identified the following four research priorities to reduce seabird incidental mortality in trawl fisheries:

(i) offal discharge management
(ii) methods to reduce seabird entanglement during hauling
(iii) improving the performance of streamer lines
(iv) investigating effectiveness of net binding and net weighting.

Advice to the Scientific Committee

6.8 The Working Group recommended that the incidental mortality and depredation mitigation measure developed by Chile be reported as trotlines fitted with 'cachaloteras' (paragraph 6.1).

6.9 The Working Group requested that the Scientific Committee seek from ad hoc TASO a technical description of the continuous trawling methods used in Convention Area krill fisheries that includes gear used, fishing operations and details of on-board processing and overboard discharges, and detailed descriptions of other gear types (paragraph 6.2).

6.10 The Working Group reiterated the Scientific Committee's recommendation (SC-CAMLR-XXVI, paragraph 5.29(v)) to test the utility of net binding, as appropriate, in other Convention Area pelagic trawl fisheries (paragraph 6.5).

6.11 The Working Group recommended that Conservation Measure 25-02 be modified to include line-weighting specifications for vessels using the trotline method of longlining (paragraph 6.3).

OBSERVER REPORTS AND DATA COLLECTION

Banded bird observation data

7.1 The Working Group noted that although several observers on longline vessels had reported seeing banded seabirds in the 2007/08 season, only three observers were able to record the band details (WG-FSA-08/5 Rev. 1, paragraph 10). No banded birds were observed from trawlers (WG-FSA-07/8 Rev. 1, paragraph 11). Information on banded birds is recorded in the observer's cruise report.

7.2 The Working Group noted that at-sea observations of banded seabirds from fishing vessels have allowed useful research into the provenance and activity of seabirds interacting with fishing fleets (e.g. Croxall et al., 1999; Otley et al., 2007).

7.3 The Working Group recommended that in future the observers record the following information on any observed banded birds in their cruise reports: date of observation, location of observation (latitude and longitude is preferred), number of bands, identification number on each band, colour of each band, whether each band is plastic or metal, attachment location of each band (e.g. left or right leg), any other visible text or identifying feature on each band, photo of band/s if possible, status of the bird at the time of observation (e.g. on water, flying, caught on fishing gear), and what happened to the bird and band since the encounter (e.g. bird died and band removed, released alive with the band).

Extrapolation of total marine mammal incidental mortality

7.4 The Working Group noted that due to the nature of marine mammal incidental mortality events, observers are likely to be aware of and record all such events that occur while they are on board. Therefore only fisheries that do not have 100% coverage of cruises require any extrapolation of observed marine mammal incidental mortality to total marine mammal incidental mortality for the fishery. Therefore, the Working Group only considered the requirements and design of a protocol for the extrapolation of the total marine mammal incidental mortality of the krill trawl fishery.

7.5 The Working Group noted that observer coverage in the krill fishery has been limited in scope and representation of vessels and areas, subareas and divisions. This limited observer coverage does not allow full consideration of the factors that influence the occurrence of marine mammal incidental mortality.

7.6 Factors that the Working Group considered may be important for determining an overall estimate of marine mammal incidental mortality are: fishing method, duration of trawl, trawl speed, size of wing mesh, design and location of seal exclusion device, different styles and nature of processing, vessel turning behaviour, and relative seal abundance in the area fished.

7.7 The Working Group noted that due to the operational differences between continuous and traditional trawling for krill, extrapolation should be done separately for the two methods. The Working Group considered that an initial scalar for the continuous trawling method could be hours trawled and for traditional trawling the number of tows, and those extrapolations should ideally be calculated within vessel and fishing area stratifications. The Working Group noted that an indicative extrapolation of total incidental mortality of marine mammals could be based on a gear type and fishing area stratification given systematic observer coverage from the krill fishery.

7.8 The Working Group noted that once more observer information is available, it should examine whether there is a difference in interactions within fisheries between various marine mammal groups (e.g. between pinniped families, *Phocidae* and *Otaridae*).

Progress on a trawl warp strike data collection protocol for inside the Convention Area

7.9 The Working Group evaluated data collected on seabird warp strikes in Convention Area trawl fisheries in 2007/08. Warp-strike data were collected in 157 of 227 (69%) icefish trawls in Subarea 48.3. One warp strike was recorded with an albatross on the water. These data suggest that warp strikes pose minimal risk to seabirds in the Subarea 48.3 icefish trawl fishery. Warp-strike data were also collected for 49 of 347 (14%) trawls for toothfish and icefish in Division 58.5.2 and for 248 of 375 (66%) krill trawls (including conventional and continuous gear types) in Subareas 48.1, 48.2 and 48.3.

7.10 The Working Group noted that warp-strike data were collected in almost 70% of icefish and krill trawls in Subareas 48.1, 48.2 and 48.3. This is an increase from the 59% achieved in 2006/07 from the icefish trawl fishery in Subarea 48.3 and an increase from 0 to 66% in the krill trawl fishery (SC-CAMLR-XXVI, Annex 6, paragraph II.122). The Working Group congratulated observers and technical coordinators on the improved implementation of 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.

7.11 The Working Group noted that advice provided in 2007/08 (SC-CAMLR-XXVI, Annex 6, paragraph II.123) to improve the quality of data collected on specific issues related to the warp-strike protocol resulted in improved data quality. However, a review of the data indicated that when recording data, care needed to be taken to ensure that the presence of birds (‘yes/no’) corresponded correctly with the data field of their estimated abundance.

Modification of the warp-strike protocol for krill continuous trawling

7.12 The Working Group was requested by ad hoc TASO (SC-CAMLR-XXVII/BG/6, paragraph 3.7) and WG-EMM (Annex 4, paragraph 4.53) to clarify the application of the warp-strike protocol for use on krill vessels using the continuous trawl method.

7.13 Noting the successful implementation of warp-strike protocols in the majority of trawl fisheries, the Working Group recommended that the protocol be adapted for continuous trawl vessels targeting krill. Current protocols only stipulate monitoring the warps at least once per day during daylight hours for a 15-minute period after the shot. In the case of a continuous trawl this may only happen once over a period of several days, leaving extended periods of trawling unmonitored.

7.14 The Working Group considered that the protocol should be used during 2008/09 to detect if there is any risk of warp strike from continuous trawling for krill. Therefore, it was decided that the warps should be monitored at times of potentially higher risk, i.e. after the net had entered the water and the deck is washed down, when offal is being discharged, when the vessel is turning and during any other similar events as noted by the observer.

7.15 The Working Group noted that observations should be made on a daily basis for a 15-minute period during one of these higher-risk events and after the net has been shot. If a 15-minute period during one of these higher-risk events is not possible, then one random 15-minute period during daylight hours should be selected to monitor the trawl warp. The data collected will be reviewed and analysed at future ad hoc WG-IMAF meetings with subsequent reviews of the protocol where necessary.

7.16 The Working Group recommended that a change be made to the current reporting protocols for observers operating on krill vessels using the continuous trawl system as information needs to differentiate between when the net enters and leaves the water and when the net remains in the water but a trawl is recorded every two hours (paragraph 2.21).

Data collection of aerial extent of streamer lines

7.17 The Working Group recommended several revisions to the aerial extent estimation methods to standardise and improve the quality of data collected by observers on the L2 forms in the scientific observer e-logbook in accordance with the appendix to Conservation Measure 25-02. These methods for estimating aerial extent are:

(i) record accurately the spacing between streamers and count the streamers until the streamer line touches the water;

(ii) stream a separate rope graduated in metres with a ‘tension device’ on end to the point where the streamer line touches the water (suggested for use where multiple or V-type streamer lines are deployed);

(iii) when conducting sink rate trials using bottles, record the time from the stern to when it passes the point where the streamer line touches the sea surface. Calculate the aerial extent taking into account the speed of the vessel.

7.18 The Working Group recommended that the L2 data form in the e-logbook be revised to include reporting on the method used to assess aerial extent.

7.19 Where vessels deploy more than one streamer line at a time, the vessel must advise the observer which line is deployed in accordance with Conservation Measure 25-02. The specifications of this line are to be measured and recorded in the L2 datasheet at least once every seven days. Observers are also to be encouraged to record additional environmental data, i.e. wind and sea conditions, as well as a description of the towed object that may affect aerial extent.

7.20 The Working Group requested that Members report on the use and efficacy of multiple streamer line combinations.

Ad hoc WG-IMAF priorities for data collection by observers

7.21 The Working Group revised Table 21 from SC-CAMLR-XXVI, Annex 5, to provide more detail on its priorities for observer data collection (Table 13).

Trawl

7.22 The Working Group reiterated its needs and priorities for data collection in the finfish trawl fisheries as stated in SC-CAMLR-XXVI, Annex 6, Table 19 (Table 14).

7.23 The Working Group identified the needs and priorities for data collection in the krill trawl fisheries to be the following:

(i) observe 100% of hauls to record any incidental mortality of seabirds and marine mammals;

(ii) record the use and design of mitigation devices;

(iii) warp-strike observations at least once per 24-hour period.

Longline

7.24 Noting that ad hoc TASO requested that all working groups consider required statistical power and importance of coverage levels (SC-CAMLR-XXVII/BG/6, paragraph 3.27), the Working Group recalled that it had considered statistical power previously (e.g. WG-FSA-05/50) which led to the guidance contained within SC-CAMLR-XXVI, Annex 6, Tables 19 and 20).

7.25 The Working Group again reviewed its needs and priorities for data collection in the longline fisheries and clarified in detail its requirements and revised its advice (Table 15). Noting the current recommended proportion of observer coverage for hauling and setting operations (SC-CAMLR-XXVI, Annex 6, Table 20) and concerns expressed about the relative proportion of time that observers spend on ad hoc WG-IMAF-related tasks during a day (SC-CAMLR-XXVII/BG/6, paragraph 3.23), the Working Group revised its advice with respect to observations during longline setting as follows:

(i) for 100% of sets, at least one observation should be undertaken to record the use of mitigation measures and offal management practices;

(ii) observers are no longer requested to observe 100% of hooks set.

7.26 The Working Group recommended the percentage of hooks observed hauled (SC-CAMLR-XXVI, Annex 6, Table 20) remain unchanged and noted that the time spent on hauling observations for ad hoc WG-IMAF is also used to collect information for other working groups and committees.

7.27 The Working Group reiterated that, when reporting on longline fishing, there was a need to distinguish which of the three fishing methods, Spanish system, autoline system or trotline system, or combination thereof, were used on a vessel. In addition, if a trotline system was in use, it was important to report whether ‘cachaloteras’ were used.

Marine debris data collection

7.28 To assist in tracing the source of debris, observers are requested to provide details and photographs of the fishing gear used within the Convention Area. Observers are requested to record if plastic packaging bands are on board and any observations of accidental or intentional loss of fishing gear, plastic packaging bands or any other non-biodegradable material. The Working Group requested that ad hoc TASO develop a protocol for the collection of a photo library of fishing gear used (see also paragraph 12.9).

Advice to the Scientific Committee

7.29 The Working Group recommended that:

(i) with respect to general issues –

(a) in future the observers record detailed information on any observed banded birds in their cruise reports in order that the Secretariat can investigate the provenance of those birds (paragraph 7.3);

(b) its updates to the matrix of observers' tasks and priorities (SC-CAMLR-XXVI, Annex 5, Table 21) and the recommendations of observer coverage required by risk level (SC-CAMLR-XXVI, Annex 6, Table 20) in Tables 13 to 15 be noted (paragraphs 7.21, 7.22 and 7.25);

(c) observers be requested to provide photographs of gear used within the Convention Area and any accidental or intentional loss of fishing gear, plastic strapping or any other non-biodegradable material (paragraph 7.28);

(d) ad hoc TASO develop a protocol for the collection of a photo library of fishing gear used (paragraphs 7.28 and 12.9);

(ii) with respect to krill fisheries –

(a) systematic observer coverage in the krill fishery is required to allow extrapolation of total marine mammal incidental mortality (paragraphs 7.4 to 7.8);

(b) the modified warp-strike protocol be used in 2008/09 on continuous trawl vessels targeting krill (paragraphs 7.14 and 7.15);

(c) the data required to address the priorities of the Scientific Committee for observer data collection on krill trawl vessels pertaining to incidental mortality of seabirds and marine mammals (paragraph 7.23) are:

- observe 100% of vessels with the proportion of sets and hauls to be observed identified in Table 14;
- record the use and design of mitigation devices;
- warp-strike observations at least once per 24-hour period;

(iii) with respect to longline fisheries –

(a) technical coordinators encourage observers to undertake measurements of the streamer line once every seven days, and that the L2 form and appropriate instructions are modified to include the measurement technique used to estimate aerial extent (paragraphs 7.17 and 7.18);

(b) when reporting on longline fishing, there was a need to distinguish which of the three fishing methods, Spanish system, autoline system or trotline system, or combination thereof, were used on a vessel. In addition, if a trotline system was in use, it was important to report whether 'cachaloteras' were used (paragraph 7.27);

(iv) with respect to trawl fisheries –

(a) the warp-strike protocol in all Convention Area trawl fisheries (SC-CAMLR-XXVI, Annex 6, paragraph II.124) should be implemented in 2008/09, particularly in trawl fisheries in Division 58.5.2 (paragraphs 7.9 to 7.11);

(b) observers provide a more detailed description of the mitigation measures used in the icefish fishery in Subarea 48.3 (paragraph 2.16).

RESEARCH INTO THE STATUS AND DISTRIBUTION OF SEABIRDS AND MARINE MAMMALS

8.1 The Working Group welcomed an update on the Fourth Meeting of the ACAP Advisory Committee and was encouraged by the progress in the work of the Status and Trends Working Group (AC4 and STWG reports at www.acap.aq). Significant progress has been achieved with the ACAP Species Assessments (SC-CAMLR-XXVI, Annex 6, paragraph II.127) which are due to be completed and available on the ACAP website before the April 2009 ACAP Meeting of Parties. The Working Group agreed that the information presented in the Species Assessments (which include up-to-date data on population status and trends, foraging distributions and interactions with fisheries) will be very useful to ad hoc WG-IMAF's future work.

8.2 In order to maintain assessments of risk in CCAMLR subareas and divisions, ad hoc WG-IMAF requires comprehensive and current information on the foraging distribution of seabirds in the Convention Area. To assist with this, BirdLife International offered to provide a brief annual information paper describing new data added to the BirdLife Global Procellariiform tracking database and a more detailed summary every 3–4 years. The Working Group welcomed this offer and planned to consider the first annual report in 2009.

8.3 The Working Group received a presentation on SeaBird, a generalised age-and/or stage-structured seabird population dynamics model (WG-SAM-08/P3). The model has been applied to population data for Buller's albatross (*Thalassarche bulleri*) and will also be applied to black petrels (*P. parkinsoni*). The Working Group noted the potential for application of this modelling approach, in particular that, as it had been reviewed by WG-SAM, it might be used to develop management advice in future.

8.4 The Working Group noted that the text of SC-CAMLR-XXVII/BG/8 was available in French but that a substantial part of that paper was available in part in English as Barbraud et al. (2008). The results of this paper indicate a 37% decline in white-chinned petrels at Crozet Island and that this decline could be attributed to climate change and, to a lesser extent, fishing-related mortality.

8.5 The Working Group made the following comments on the analysis:

(i) the modelling approach did not detect any effect of incidental mortality on adult survival (one of the most sensitive model parameters for population growth rate), despite there being the evidence of an interaction as indicated by adults feeding chicks on fisheries waste;

(ii) the effects of rat eradication (which is limited to this particular colony) on the improved breeding success in the study colony and the potential impact of this on the extrapolation of the findings to other colonies in the archipelago;

(iii) the lack of any inclusion of the effects of IUU fishing in the model.

8.6 The Working Group thanked the authors for their comprehensive approach and noted that the conclusions of the paper were based on one model scenario and that the relative impact of fishing versus climate change on the population decline may differ given different plausible parameterisation.

8.7 In recognising the importance of this type of work, the Working Group reiterated its advice of last year (SC-CAMLR-XXVI, Annex 6, paragraph II.20) that the authors should submit an English translation of SC-CAMLR-XXVII/BG/8 (as this contains population modelling of both white-chinned and grey petrels) to WG-SAM (SC-CAMLR-XXVI, paragraph 5.6(ii)) in order to allow that Working Group to consider the modelling approach in the context of providing management advice. The Working Group suggested that this was an appropriate process for similar studies that may be submitted in the future.

8.8 The Working Group considered the information presented in WG-EMM-PSW-08/5 regarding the population size of white-chinned petrels at South Georgia (an estimated 70% of the global population (Brooke, 2004)). Comprehensive population surveys at South Georgia were conducted during 2005/06 and 2006/07. It was estimated that the current population of white-chinned petrels at South Georgia comprises just under one million pairs. The Working Group noted that this population estimate is 50% of the estimate from the 1980s. However, uncertainty in the confidence intervals associated with the earlier estimate precludes the determination of the magnitude of the decline. Nevertheless, had a decline of 50% occurred over the last 20 years, this would represent a catastrophic reduction in the population of white-chinned petrels.

8.9 The Working Group noted that more white-chinned petrels are incidentally killed in more fisheries than any other seabird, but the population impact of this mortality is poorly understood, partly because there are few estimates of white-chinned petrel population abundance. The Working Group thus welcomed the survey information from South Georgia and highlighted the importance of obtaining estimates of white-chinned petrel population abundance for other breeding sites, and ongoing monitoring of white-chinned petrel population abundance at all breeding sites.

8.10 Of relevance to Convention Area seabirds, the Working Group noted the 2008 update of the IUCN Red List that has resulted in changes to the status of Tristan albatross (*D. dabbenena*), which was up-listed from Endangered to Critically Endangered, and Buller's albatross which was down-listed from Vulnerable to Near-Threatened (ACAP-AC4, 2008). Of the 19 species of albatross currently listed in Annex 1 of the ACAP Agreement, four (21%) are listed as Critically Endangered, five (26%) are listed as Endangered, six (32%) are Vulnerable and four (21%) are Near-Threatened. For the seven petrel species, four (57%) are currently listed as Vulnerable and three (43%) as Near-Threatened (AC4 doc 48, Attachment A). The Working Group concurred with ACAP in recognising the significance of fisheries incidental mortality, invasive species and disease as threats influencing the survival and conservation of these species.

8.11 The Working Group noted the progress in estimating population size and status of marine mammals and seabirds made by the WG-EMM Predator Survey Workshop (WG-EMM-08/8) and data made available to the Joint CCAMLR-IWC Workshop (SC-CAMLR-XXVII/14 and BG/16).

Advice to the Scientific Committee

8.12 The Working Group noted the fundamental importance of up-to-date information on the status and distribution of seabirds in the development of risk assessments of interactions in fisheries. The Working Group welcomed continued cooperation and coordination with ACAP and BirdLife International, including the standing invitation to experts from ACAP and BirdLife International (SC-CAMLR-XXVI, paragraph 5.56) to ensure the best available scientific information was available to CCAMLR (paragraph 8.2).

ASSESSMENT OF RISK IN CCAMLR SUBAREAS AND DIVISIONS

New information relating to risk assessment

9.1 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 increases in seabird incidental mortality (paragraphs 10.2 to 10.9).

9.2 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.

9.3 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. However, there was no additional information provided this year on the at-sea distribution of seabirds. Accordingly, the assessments and advice reviewed in 2007 and combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31) were again endorsed by the Working Group.

9.4 A summary of ad hoc WG-IMAF's assessment of risk to seabirds posed by trawl and longline fisheries in the Convention Area can be found in Tables 14 and 15 respectively and Figure 1.

Risk assessment methodology

9.5 Ad hoc WG-IMAF noted that New Zealand provided documents detailing a risk assessment methodology, known as a Productivity-Susceptibility Assessment, which examines the potential for adverse effects of fishing mortality for selected seabird and marine mammal species (WG-FSA-08/47 and 08/51). This methodology has been modified from previous assessments to include distributional overlap of the species and fisheries for five fishing methods within the New Zealand EEZ. There is interest in WCPFC to conduct such a risk assessment for the entire WCPFC Convention Area. New Zealand suggested that this method could, at some point in the future, provide a validation for the current risk methodology used within CCAMLR.

Proposals for changes to conservation measures and management advice to minimise fisheries impact on seabirds

9.6 WG-FSA-08/39 proposed to continue scientific research carried out in 2007/08 by the *Shinsei Maru No. 3* in Division 58.4.4 over the 2008/09 fishing season. The proposal incorrectly notes that this area has been assessed by CCAMLR as having a low to average risk of potential interaction between seabirds and longline fisheries, when in fact, the area is considered to have an average risk (SC-CAMLR-XXVI/BG/31). No mention is made of conservation measures relating to seabird incidental mortality in the application and the Working Group has assumed that the research will be conducted in full compliance with Conservation Measure 25-02.

9.7 WG-FSA-08/36 proposed that, for fishers whose vessels comply with certain conditions, the requirement in Protocol C1 of Conservation Measure 24-02 to test the sink rate of IWLs before entering the Convention Area is an impost on fishers that is no longer warranted. The proposal suggested that testing could instead be conducted in the first week of fishing inside the Convention Area, subject to a number of conditions. Other requirements of Conservation Measure 24-02, including the requirement for regular sink rate testing of IWL gear during fishing in the Convention Area and reporting of sink rate test results, would remain unchanged, as would the requirements applicable to fishers using other types of longlines.

9.8 The Working Group discussed the likely risk posed by initial sink rate testing within the Convention Area. It was agreed that such a change, subject to the testing being carried out with unbaited hooks, posed no additional risk to seabirds at this stage. However, maintaining a near-zero by-catch level within CCAMLR's fisheries was paramount, and failure to maintain such levels would warrant a reconsideration of this relaxation. The Working Group recommended revision of Conservation Measure 24-02 to incorporate this change to Protocols A, B and C.

9.9 WG-FSA-08/40 proposed that the Japanese-flagged vessel *Shinsei Maru No. 3* be exempted from the requirement to conduct longline sink rate tests outside the Convention Area when fishing at the end of the 2007/08 season and into the 2008/09 season, provided that the vessel conducted regular longline sink rate testing and met line sink rate requirements in 2007/08. This is because the vessel is proposing to continue fishing without leaving the Convention Area at the end of the 2007/08 season. The Working Group agreed that this proposed exemption did not present an additional risk to seabirds in the Convention Area.

9.10 WG-FSA-08/45 advised that the provisions for fishing season and mitigation measures in Conservation Measure 41-03 regulating fishing in Subarea 48.4 do not currently conform to the ad hoc WG-IMAF risk assessment advice given in CCAMLR-XXIV/BG/26. The UK proposed text that should be added to Conservation Measure 41-03 to bring the measure into line with the risk assessment, which would allow fishing outside the season (April–September) if it is conducted in accordance with Conservation Measure 24-02. The recommended small change to the first paragraph of Conservation Measure 24-02 to recognise Subarea 48.4 was endorsed by the Working Group and recommended for inclusion in a draft revision of the conservation measure.

9.11 Noting that Conservation Measure 24-02 does not currently include a protocol for trotline systems, with or without 'cachaloteras', the Working Group recommended the inclusion of a new protocol within the conservation measure for these gear types.

Advice to the Scientific Committee

9.12 Revisions to the comprehensive assessments on the potential risk of interaction between seabirds and fisheries for all statistical areas in the Convention Area were not carried out this year as no new relevant information on the at-sea distribution of seabirds was provided. Accordingly, the assessments and advice provided in 2007 and combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XXVI/BG/31) were again endorsed by the Working Group (paragraph 9.3).

9.13 The Working Group recommended the research proposed in Division 58.4.4 by Japan be conducted in full compliance with Conservation Measure 25-02 (paragraph 9.6).

9.14 The Working Group noted that the proposal from Japan to be exempted from the requirement to conduct longline sink rate tests outside the Convention Area when fishing at the end of the 2007/08 season and into the 2008/09 season in Subarea 48.6, did not present an additional risk to seabirds in the Convention Area (paragraph 9.9).

9.15 The Working Group recommended that Conservation Measure 24-02 be modified to include:

(i) relaxation of the need to conduct initial sink rate testing outside the Convention Area, thus allowing such testing to be carried out within CCAMLR waters subject to the testing being undertaken with unbaited hooks. This would be applied to existing protocols A, B and C (paragraph 9.8);

(ii) Subarea 48.4 be added to paragraph 1 (paragraph 9.10);

(iii) a new protocol for the trotline and trotlines fitted with 'cachaloteras' systems (paragraph 9.11).

INCIDENTAL MORTALITY OF SEABIRDS IN RELATION TO NEW AND EXPLORATORY FISHERIES

New and exploratory fisheries operational in 2007/08

10.1 Of the 44 applications for exploratory longline fisheries for 2007/08, 23 were undertaken (WG-FSA-08/4). 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 incidental mortality of seabirds. One seal, probably a crabeater, was reported caught in the exploratory fishery in Subarea 88.1 (WG-FSA-08/5 Rev. 1).

New and exploratory fisheries proposed for 2008/09

10.2 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 15 and Figure 1. Table 15 also includes an assessment of recommended levels of observer coverage.

10.3 Thirty-seven notifications for exploratory longline fisheries, submitted by 11 Members, were received by CCAMLR in 2008. The areas for which longline proposals were received (CCAMLR-XXVII/12, Table 1) 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.

10.4 All longline notifications provided sufficient information to indicate that the proposals fully comply with relevant seabird incidental mortality minimisation measures (Conservation Measures 24-02 and 25-02, and the relevant measures in the 41-series), and do not conflict with the ad hoc WG-IMAF assessment.

10.5 One notification for an exploratory trawl fishery for krill was received by CCAMLR in 2008. The area for which a trawl proposal was received (Subarea 48.6, CCAMLR-XXVII/12, Table 2) was assessed in relation to the risk of seabird incidental mortality according to the approach and criteria set out in SC-CAMLR-XXVI/BG/31.

10.6 The Working Group noted that Norway advised it would apply Conservation Measure 25-03 in this fishery. Due to the paucity of information about seabird and marine mammal interactions in this area and the assessed risk level (SC-CAMLR-XXVI/BG/31), the Working Group recommended that marine mammal exclusion devices, designed to prevent pinnipeds from entering the net, be used in this fishery, and that observation of 25% of sets and 75% of hauls be undertaken (Table 14).

10.7 Two notifications for new pot fisheries for crabs were received by CCAMLR in 2008. The areas for which these proposals were received (CCAMLR-XXVII/12, Table 3) have not been assessed in relation to the risk of seabird incidental mortality in pot fisheries. A risk assessment for pot fisheries may be possible in future, but at this time insufficient information is available to undertake such an exercise.

10.8 The Working Group agreed that in the interim, observation of pot fishing was required to collect descriptive information about the potential for seabird and marine mammal incidental mortality using this fishing method. Observation should focus on hauls for incidental mortality events and description of any entanglements.

10.9 The Working Group welcomed the improvements in notifications this year, in particular that all longline notifications provided sufficient information compared with 15% of proposals that had insufficient information in 2007.

10.10 In 2005 the Working Group developed a checklist to assist Members when completing their longline notifications (SC-CAMLR-XXIV, Annex 5, Appendix O, paragraph 193). Given the success with that method this year, the Working Group recommended that a similar checklist be developed for trawl and pot fishery notifications.

10.11 The Working Group noted that it had not undertaken a risk assessment for marine mammals to date and that this was an identified item of future work for ad hoc WG-IMAF. Completion of such a risk assessment would allow the provision of more complete advice on incidental mortality associated with fishing.

Advice to the Scientific Committee

10.12 The Working Group reiterated its recommendation that vessels fishing in new and exploratory longline and trawl fisheries have the required level of observer coverage for incidental mortality and associated information as detailed in Tables 13 to 15 (paragraph 10.2).

10.13 The Working Group recommended that marine mammal exclusion devices designed to prevent pinnipeds from entering the net be used in the exploratory krill fishery to be undertaken by Norway in Subarea 48.6, and that observation of at least 25% of sets and 75% of hauls be undertaken. The Working Group further recommended that marine mammal exclusion devices designed to prevent pinnipeds from entering the net be used in all krill fisheries (paragraph 10.6).

10.14 The Working Group recommended observation to collect descriptive information about the potential for incidental mortality in the proposed pot fisheries (paragraph 10.8).

10.15 The Working Group recommended that a checklist similar to that used for longline notifications for new and exploratory fisheries be designed by the Secretariat specifically for notifications for other new and exploratory fisheries (paragraph 10.10).

INTERNATIONAL AND NATIONAL INITIATIVES RELATING TO INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS IN FISHING

ACAP

11.1 The ACAP representative (Mr Baker) presented a report on ACAP activities in the last year; those of most relevance to ad hoc WG-IMAF are ACAP's outreach efforts with tuna RFMOs to reduce seabird incidental mortality in those fisheries and the second meeting of the ACAP Advisory Committee's Seabird Bycatch Working Group. This meeting, and meetings of ACAP's Advisory Committee, the Status and Trends Working Group and the Breeding Sites Working Group, were held in South Africa in August 2008.

11.2 The report of ACAP's Seabird Bycatch Working Group meeting was discussed (WG-FSA-08/61). Key outcomes from that meeting included:

(i) the development of a plan to guide ACAP's interactions with RFMOs and individually tailor them to each RFMO;

(ii) an agreement to appoint an ACAP 'coordinator' for each RFMO meeting who would represent ACAP at those meetings and coordinate the efforts of other ACAP Parties that are also members of that RFMO;

(iii) agreed priority ACAP 'products' for RFMOs, principally expert information and advice about seabird distribution and population trends, strategies to reduce incidental mortality, use of best-practice risk-assessment methodologies to assess seabird incidental mortality, observer data collection protocols and desirable research on mitigation measures.

11.3 CCAMLR was represented at ACAP's Seabird Bycatch Working Group meeting by the Science Officer (Dr K. Reid) who gave a presentation on the CCAMLR seabird incidental mortality risk assessment approach. The comprehensive nature of the CCAMLR data collection and assessment methodology was noted by the ACAP Working Group which also agreed that it formed a useful model for ACAP. ACAP noted that an observer program with high levels of coverage has been critical to understanding incidental mortality problems and underpinned CCAMLR's success in reducing incidental mortality in its fisheries. ACAP further agreed that the model was entirely relevant to other RFMOs and could also be adopted by ACAP for assessment of summary incidental mortality information provided by ACAP Parties. The ACAP representative thanked CCAMLR for its support for the work of ACAP and Dr Reid's attendance.

International initiatives

Implementation of CCAMLR Resolution 22/XXV

11.4 The Working Group recalled that in previous years, the Chair of the Commission wrote to their counterpart in several other RFMOs detailing the Commission's interest in reducing the by-catch of Convention Area seabirds in fisheries outside the Convention Area, and seeking information on several matters, including seabird by-catch assessments those organisations may have conducted and mitigation measures in use in their fisheries. This correspondence had been acknowledged by one RFMO's Secretariat.

11.5 The Working Group noted that, as part of efforts in the 2007/08 intersessional period, to encourage effective implementation of Resolution 22/XXV, the CCAMLR Secretariat wrote to the designated CCAMLR observers for meetings of RFMOs with responsibility for fisheries adjacent to the Convention Area (IOTC, ICCAT, WCPFC). The CCAMLR observers were provided with a package of information to assist them to undertake the activities described in Resolution 22/XXV, paragraphs 1 (to encourage RFMOs to collect, report and disseminate annual data on seabird incidental mortality), 3 (adding seabird mortality issues to the agenda of RFMOs) and 5 (regarding measures to reduce or eliminate seabird incidental mortality). The package included the paper by Waugh et al. (2008) which describes the CCAMLR seabird incidental mortality risk assessment methodology.

11.6 In reviewing outcomes during the 2007/08 period, the Working Group noted that: (i) IOTC had agreed to a proposal for stronger and binding by-catch mitigation measures; (ii) WCPFC had adopted a proposal by some CCAMLR Parties for improved mitigation measures; and (iii) WCPFC and ICCAT are currently developing an agreed risk assessment for seabird by-catch. Thus, the Working Group concluded that, in conjunction with the efforts of CCAMLR Members who are also members of those RFMOs and had tabled proposals in those fora regarding seabird incidental mortality, this had been a more productive approach and that the earlier correspondence between the CCAMLR Secretariat and its counterparts could be usefully repeated.

11.7 Additionally, with regard to the effectiveness of Resolution 22/XXV, the Working Group recalled its previous advice 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. The Working Group applauded Contracting Parties and NGOs 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. The Working Group encouraged continued reporting as required under paragraph 5 of Resolution 22/XXV in the future.

FAO IPOA-Seabirds

11.8 Dr B. Sullivan (BirdLife International) updated the Working Group on the UN FAO Expert Consultation held in Bergen, Norway, from 2 to 5 September 2008, to develop best-practice technical guidelines for IPOA/NPOA-Seabirds. The Consultation was chaired by Ms Rivera and the achievements of CCAMLR in reducing seabird by-catch featured prominently in the report of the Consultation. As reported in 2007 (SC-CAMLR-XXVI, Annex 6, paragraph I.65(ii)), these guidelines will extend the application of IPOA-Seabirds beyond longline fisheries and will provide guidance on best-practice to other relevant gear (trawl and gillnet fisheries) and for regional plans developed by RFMOs. CCAMLR Members are encouraged to support the adoption of these FAO Technical Guidelines at the Twenty-eighth Session of COFI (2 to 6 March 2009).

RFMOs and international governmental organisations

WCPFC

11.9 The Working Group noted that, continuing from the adoption of a binding conservation and management measure (WCPFC-CMM 2006-02) for reducing seabird by-catch in 2006, the WCPFC meeting in December 2007 adopted minimum technical specifications for each of the seabird by-catch mitigation methods listed in the measure, based on advice and recommendations from the WCPFC's Scientific Committee and the Technical and Compliance Committee.

ICCAT

11.10 ICCAT has continued to develop and undertake its risk assessment methodology, including at a meeting in March 2008 at which, *inter alia*, seabird-tracking analysis, by-catch and population modelling was discussed. Its methodology is described in SC-CAMLR-XXVI, Annex 6, paragraph II.179. Species of interest to CCAMLR at highest risk from ICCAT fisheries include six species of albatross from South Georgia (Islas Georgia del Sur) and the Tristan da Cunha Islands, and black-browed albatross from the Falkland/Malvinas Islands.

CCSBT

11.11 The Working Group noted that CCSBT was currently meeting in New Zealand and that proposals to improve management and mitigation of seabird by-catch in CCSBT fisheries had been submitted. The Working Group reiterated its historic concerns that these fisheries are a major source of mortality for Convention Area seabirds. Given the recent adoption of mitigation measures by IOTC and WCPFC, the lack of progress in adopting such measures by CCSBT is in stark contrast with the practice in other tuna RFMOs and global best practice. The Working Group again considered that urgent action is required by CCSBT to address seabird incidental mortality.

IOTC

11.12 The Working Group noted that the IOTC, at its annual meeting in June 2008, had adopted Resolution 08/03 which contained binding seabird by-catch mitigation measures. The Working Group noted advice from the ACAP Seabird Bycatch Working Group (WG-FSA-08/61) that seabird by-catch mitigation measures in pelagic longline fisheries required further improvements and 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. However, this IOTC Resolution represented current best practice amongst tuna RFMOs and was a useful refinement of IOTC Resolution 06/04.

11.13 Reflecting on the earlier discussions with WG-FSA about how to estimate the impact of IUU gillnet fishing, and the need for information from a regulated gillnet fishery (paragraphs 5.1 to 5.7), the Working Group noted information that suggested the IOTC was responsible for managing a gillnet fishery.

National initiatives

11.14 The Working Group noted that South Africa launched its National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries during the hosting of the 4th Advisory Committee meeting of ACAP on 22 August 2008.

11.15 The Working Group noted that New Zealand has implemented additional regulatory measures to reduce incidental mortality on longline vessels, and also considered new measures for trawl vessels (WG-FSA-08/47). Building on previous measures (use of streamer lines and night setting), pelagic longline vessels are now able to day-set with a streamer line and prescribed line-weighting regime. Demersal longliners must now use streamer lines and either night-set or employ specified line-weighting regimes when day-setting. In addition, demersal longliners must not discharge on setting, and must only discharge on the opposite side of the vessel to the hauling location. Larger trawl vessels are already required to use warp strike mitigation (e.g. streamer lines), and New Zealand is continuing to develop voluntary measures to reduce incidental mortality of seabirds in trawl fishing.

11.16 New Zealand has also streamlined reporting by fishers of seabird, marine mammal, and other protected species by-catch using a standardised mandatory reporting form. Previously, such reporting was mandatory and several different reporting methods could be used.

11.17 The Working Group noted that the newly regulated mitigation measures would benefit Convention Area seabirds, as these species occurred in New Zealand waters and encountered fisheries there, and that the reporting changes should improve understanding of the nature and extent of incidental mortality.

11.18 The Working Group welcomed a range of information and papers submitted by France to ad hoc WG-IMAF-08 (Agenda Item 3).

11.19 Mr I. Hay (Australia) reported on the second year of a trial of demersal longlining for toothfish off Macquarie Island, which lies adjacent to the Convention Area, and the seabird by-catch mitigation measures used during the trial (WG-FSA-07/19). No seabirds have been caught during the two years of the trial, which is expected to continue in 2009.

Advice to Scientific Committee

11.20 The Working Group recommended that:

(i) Members are encouraged to support the adoption of the FAO Technical Guidelines at the Twenty-eighth Session of COFI (2 to 6 March 2009) (paragraph 11.8);

(ii) the Commission be requested to consider what additional actions might be undertaken to expedite the adoption of measures to avoid or mitigate the incidental mortality of Convention Area seabirds during fishing managed by CCSBT (paragraph 11.11);

(iii) the Secretariat be asked to explore the possibility of obtaining incidental mortality and effort data, and other details, from the IOTC Secretariat about gillnetting regulated by the IOTC (paragraph 11.13);

(iv) the Scientific Committee note the increasing and beneficial role being played by ACAP in improving RFMOs' management of incidental mortality of Convention Area seabirds outside the Convention Area (paragraphs 8.1 and 11.1 to 11.3);

(v) in addition to any other activities that might routinely occur:

(a) the CCAMLR Executive Secretary be requested to write to the Executive Secretaries of the RFMOs listed in Appendix 1 of Resolution 22/XXV, again reiterating the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area (paragraphs 11.5 and 11.6);

(b) the CCAMLR Executive Secretary be requested to seek the inclusion of an agenda item, reflecting the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area, on the agenda of the meeting of RFB secretariats to be held in March 2009;

(c) relevant CCAMLR Parties be encouraged to undertake, or continue to undertake, the actions described in paragraphs 1, 3 and 5 of Resolution 22/XXV (paragraph 11.5).

MARINE DEBRIS AND ITS IMPACTS ON MARINE MAMMALS AND SEABIRDS IN THE CONVENTION AREA

12.1 Ad hoc WG-IMAF noted that CCAMLR's current priorities to address incidental mortality of seabirds and marine mammals include consideration of the impact of marine pollution (including lost fishing gear) and that this had been referred to ad hoc WG-IMAF by the Scientific Committee in 2007 (SC-CAMLR-XXVI, paragraph 6.2).

12.2 Ad hoc WG-IMAF also noted the deliberations of the workshop held before the ad hoc WG-IMAF meeting (WG-FSA-08/65), and agreed that the ad hoc WG-IMAF scope should be amended. Consequently, ad hoc WG-IMAF agreed to modify its terms of reference to include the review and analysis of data on the level and significance of direct impacts of marine debris in the Convention Area. The Working Group considered that, in the next two to five years, ad hoc WG-IMAF could consider the development of risk assessment methodologies for direct impacts of marine debris on Convention Area seabirds and marine mammals (data sources on gear loss, beach surveys etc.).

12.3 With respect to marine debris, ad hoc WG-IMAF considered WG-FSA-08/9, 08/24, 08/25, 08/26 and 08/27. The Working Group agreed that it would be beneficial to clarify the definition of 'debris associated with seabird colonies' as proposed in WG-FSA-08/9 to distinguish between debris brought to colonies by seabirds compared to those debris washed up at colony sites. The Working Group also agreed to simplify the categories used to record debris at seabird colonies to material found 'in/on seabirds' and those items that have been 'regurgitated' and are found in or near the nest.

12.4 With respect to the reporting of entanglement of marine mammals, the Working Group agreed to adopt the definitions of age and sex of Antarctic fur seals as follows: adult males are defined as large animals capable of holding territory (≈7+ years old), sub-adult males are smaller males that were easily distinguished from females, adult females can be recognised by the absence of a thickened neck and the presence of smaller canine teeth (compared to sub-adult males), juveniles are all small, post-weaning seals where the sexes are indistinguishable by simple observation. The category of pup would remain as it currently stands.

12.5 When reviewing WG-FSA-08/25, the Working Group considered that while seabird chicks may be able to digest hooks wholly or in part, the digestion of metal could have a harmful impact and that the effects of metal digestion on chicks were unknown.

12.6 In considering WG-FSA-08/24 to 08/27, all reporting on the UK debris monitoring scheme, the Working Group requested that for future meetings the UK consolidate these into one paper.

12.7 The Working Group considered it informative to link the type and occurrence of debris with particular fishing practices and data on lost gear. This linking of debris with fisheries of origin would highlight the need for strengthened debris management measures in those fisheries. Mr Moir Clark noted that fishers in Subarea 48.3 were very concerned about the prevalence of debris, and are interested in linking fishing operations to debris recorded when possible.

12.8 To better understand the origin of marine debris and consider current data collection processes, the Working Group requested that the Secretariat prepare, intersessionally, a compilation of recent observer information on gear recorded as lost by vessels (e.g. two years or as appropriate, depending on the volume and nature of information, from cruise reports and observer e-logbooks). The Working Group requested that this compilation include an indication of the type and detail of information reported.

12.9 To facilitate the identification of fishing-related debris, the Working Group considered it valuable to develop a digital library of images of fishing gear. This library could be developed with photographs of fishing gear taken by observers on vessels. The Working Group requested that ad hoc TASO develop a protocol for observers taking and cataloguing such photographs. The Working Group also requested that, when undertaking data collection on debris, photos of fishing-related debris be taken (with a size scale) to facilitate the identification of the origin of debris. The Working Group requested that the Secretariat archive these photos.

12.10 In noting that not all debris recorded was from fishing vessels, the Working Group agreed that it may be appropriate for CCAMLR to communicate with appropriate international bodies to more broadly address debris discharge in, and adjacent to, the Convention Area. The Working Group recommended that CCAMLR include reference, to and advice on, management of marine debris when communicating with RFMOs and other appropriate international bodies.

12.11 Coincident with the incidence of wildlife entanglements and debris at colonies, and the findings of WG-FSA-08/26 and 08/27, the Working Group emphasised the need for ongoing diligence on vessels, both observed and unobserved, in complying with conservation measures including those relating to marine debris.

12.12 The Working Group agreed that, following the success of the hook discard poster, a similar poster should be produced to increase the profile of debris management on vessels, and highlight the danger to wildlife of debris disposal in the Convention Area. This poster should comprise photographs of entangled wildlife such as seals, and debris from beaches. It should be produced in A3 size, at a minimum laminated, and in all CCAMLR languages, as well as Indonesian, Korean and Japanese. The cost of printing laminated posters in A3 size would be ≈A$2 270 (A$4.50 each) for 500 posters, and ≈A$3 930 (A$3.93 each) for 1 000 posters. The Working Group recommended that it would be preferable to print posters with Perspex backing (like the hook discard poster) and noted this would cost ≈A$8.50/poster, plus A$250 set-up fee. The Working Group also noted there would be an additional higher cost in mailing these heavy Perspex-backed posters.

12.13 In considering the incidence of entanglement of seals in plastic packaging bands, the Working Group noted that it is very easy to cut bands and then to knot them for convenience of disposal, i.e. recreating a loop. In order to avoid this, the Working Group suggested that Conservation Measure 26-01 be amended to cut all plastic packaging bands into 10 cm sections prior to incineration.

12.14 The Secretariat reiterated its previous request to Members to submit any data relating to marine debris, noting that data held by the Secretariat is currently limited to Area 48 and Subarea 58.7 (Marion Island). The Working Group agreed that the collection and submission of debris data to the Secretariat was the priority for ad hoc WG-IMAF work on marine debris.

Advice to the Scientific Committee

12.15 Ad hoc WG-IMAF recommended that the Scientific Committee:

(i) note that ad hoc WG-IMAF's revised terms of reference include consideration of marine debris in the Convention Area, specifically the direct impacts of marine debris on seabirds and marine mammals (paragraph 12.2);

(ii) note the general increase in the incidence of marine debris (paragraph 12.11);

(iii) agree to implement the revised definitions of debris associated with seabird colonies (paragraph 12.3), and the age and sex of Antarctic fur seals for reporting of marine debris (paragraph 12.4);

(iv) support the development of a photo library of debris found, and inclusion of photos of fishing gear taken by observers, in this library (paragraph 12.9);

(v) support the inclusion of advice on marine debris when CCAMLR makes contact with other international organisations, including RFMOs (paragraph 12.10);

(vi) endorse the production of an A3 Perspex-backed poster to emphasise the importance of managing debris in accordance with conservation measures, and the consequences to marine life of not managing debris effectively (paragraph 12.12);

(vii) advise the Commission to amend Conservation Measure 26-01 to ensure plastic packaging bands are cut into small (~10 cm) sections prior to incineration (paragraph 12.13);

(viii) urge Members to provide data on marine debris to the Secretariat (paragraph 12.14).

INTERACTION WITH OTHER SCIENTIFIC COMMITTEE WORKING GROUPS

13.1 The Working Group noted that WG-EMM and WG-FSA have considered using a risk management framework for avoiding significant adverse impacts of bottom fishing gear on VMEs similar to that used by ad hoc WG-IMAF to minimise the risk of fishery mortalities on seabirds (e.g. Annex 4, paragraph 3.22). Ad hoc WG-IMAF acknowledged the utility of using such a risk-based approach for the krill fishery and thus considering various management actions with the knowledge of associated risks and contingencies.

13.2 The Working Group concurred with WG-EMM's noted priorities for data collection from the krill fishery (Annex 4, paragraph 4.66) with respect to incidental mortality of seabirds and marine mammals and information on trawl warp strikes. These priorities are consistent with ad hoc WG-IMAF's previous advice as endorsed by the Scientific Committee (SC-CAMLR-XXV, paragraph 5.32) with respect to krill trawl fisheries.

13.3 The Working Group addressed a request from ad hoc TASO (SC-CAMLR-XXVII/BG/6, paragraph 3.7) to provide clarity on the application the CCAMLR trawl warp-strike protocol on krill vessels, including those operating a continuous fishing method (paragraphs 7.12 to 7.16).

13.4 The Working Group welcomed the formation of ad hoc TASO and valued the participation of a TASO Co-convener and several observer technical coordinators at this year's ad hoc WG-IMAF meeting. Ad hoc WG-IMAF looked forward to continued collaborations with this group.

13.5 The Working Group received input from WG-SAM with respect to a generalised age- and/or stage-structured seabird population dynamics model (paragraph 8.3) and anticipated interacting with WG-SAM with respect to a population model analysis of impacts on white-chinned and grey petrels (paragraph 8.7).

13.6 As part of efforts to consider the streamlining of the Scientific Committee, ad hoc WG-IMAF held a one-day workshop in Hobart, Australia, on 10 October 2008 (paragraphs 15.1 and 15.5) to address its future work. Participants from other Scientific Committee working groups (WG-FSA, WG-SAM and ad hoc TASO) were in attendance and provided helpful insights as to ad hoc WG-IMAF's coordinated efforts to advise the Scientific Committee.

FISHERY REPORTS

14.1 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 incidental mortality of seabirds and marine mammals contained within the reports.

14.2 The Working Group updated the Fishery Reports based on the information contained in SC-CAMLR-XXVI, Annex 6, and the information contained in WG-FSA-08/5 Rev. 1, 08/6 Rev. 1, 08/7 Rev. 2 and 08/8.

Advice to the Scientific Committee

14.3 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

15.1 The Working Group discussed the report of the Co-conveners of the one-day workshop to review the future of ad hoc WG-IMAF (WG-FSA-08/65) held in Hobart, Australia, on 10 October 2008. The Working Group noted that the workshop had addressed its terms of reference (SC-CAMLR-XXVI, paragraph 5.59) as endorsed by the Commission (CCAMLR-XXVI, paragraph 4.92) and had discussed a range of issues relevant to the future work of ad hoc WG-IMAF.

15.2 The Working Group welcomed the use of the ad hoc WG-IMAF 'risk assessment approach' by other working groups to tackle other incidental mortality issues facing CCAMLR. However, it noted that, should the terms of reference of ad hoc WG-IMAF be expanded to include such work, this would require additional expertise, not currently available within ad hoc WG-IMAF.

15.3 The Working Group recommended that within the broader conservation objectives of CCAMLR (CAMLR Convention, Article II), ad hoc WG-IMAF should continue to focus annually on core functions of:

(i) annual review and monitoring of incidental mortality of seabirds and marine mammals in Convention Area fisheries;

(ii) annual review and monitoring of information relating to the performance of implementation of specific conservation measures;

(iii) research into and experience with fishing gears and mitigation methods;

(iv) evaluate and advise on changing needs for observer reports and data collection;

(v) conduct assessments of risk to seabirds in CCAMLR areas, subareas and divisions;

(vi) coordinate and collaborate with ACAP;

(vii) review the level and significance of direct impacts of marine debris in the Convention Area.

15.4 The Working Group discussed the ad hoc WG-IMAF meeting frequency, duration and cycle needed to address these core functions and new requirements to consider marine debris, and concluded that there is no need to change the current meeting schedule, however, this should be re-evaluated on a continuing basis.

15.5 The Working Group highlighted the importance of interactions with the other Scientific Committee working groups (WG-FSA, WG-SAM, ad hoc TASO and WG-EMM), and recommended that ad hoc WG-IMAF remain flexible with respect to meeting times in consultation with the Secretariat on matters relating to the resourcing of meetings.

15.6 The Working Group noted that it should include an item on its annual agenda to address and review its terms of reference.

15.7 The Working Group recommended the following revised terms of reference for ad hoc WG-IMAF:

The purpose of WG-IMAF is to contribute to the conservation of Convention Area seabirds and marine mammals through the provision of advice to the CCAMLR Scientific Committee. To achieve this, WG-IMAF will address the following terms of reference:

(i) review and analyse data on the level and significance of direct impacts of interactions and incidental mortality associated with fishing;

(ii) review the efficacy of mitigating measures currently in use in the Convention Area, and consider improvements to them, taking into account experience both inside and outside the Convention Area;

(iii) review and analyse data on the level and significance of direct impacts of marine debris in the Convention Area;

(iv) collaborate and coordinate with ACAP on achieving a favourable conservation status for Convention Area seabirds;

(v) prepare a summary of the above for the consideration of the Scientific Committee;

(vi) provide the Scientific Committee with advice for:

(a) improvements to the reporting requirements currently in use in the Convention Area;

(b) improvements to the measures in use to avoid incidental mortality and interactions associated with fisheries within the Convention Area;

(c) cooperation with ACAP;

(d) approaches to improve the conservation status of Convention Area seabirds and marine mammals directly impacted by fishing outside the Convention Area.

15.8 The Working Group recommended that, to reflect the duration of its existence, its current annual meeting schedule and the ongoing nature of the work of ad hoc WG-IMAF, it should simply be referred to as WG-IMAF.

15.9 The Working Group recommended that to reflect its status as a distinct Scientific Committee working group, documents submitted for the meetings of ad hoc WG-IMAF should be labelled as WG-IMAF papers instead of WG-FSA papers as is current practice.

15.10 The Working Group continued to see the importance and necessity of interacting with the other Scientific Committee working groups. Regardless of ad hoc WG-IMAF's distinct status, the Working Group recommended continuing to hold joint sessions with WG-FSA, and with other working groups as needed, to discuss issues of joint concern.

Advice to the Scientific Committee

15.11 The Working Group seeks the Scientific Committee's endorsement of the revised terms of reference for ad hoc WG-IMAF (paragraph 15.7), the core tasks to be addressed annually (paragraph 15.3), the recommendation to change the name of the Working Group (paragraph 15.8), the change to the naming of WG-IMAF papers (paragraph 15.9) and joint sessions of WG-IMAF with other Scientific Committee working groups as needed (paragraph 15.10).

OTHER BUSINESS

16.1 Mr Smith was retiring as Co-convener at the end of the present meeting, Ms Rivera will continue as Co-convener. Mr Smith was thanked for all his work and significant contributions to ad hoc WG-IMAF over the last four years as Co-convener. The Working Group recommended that Mr N. Walker (New Zealand) should be appointed as a Co-convener of WG-IMAF to work with Ms Rivera.

Advice to the Scientific Committee

16.2 Mr Walker should be appointed as a Co-convener of WG-IMAF, following the retirement of Mr Smith.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

17.1 The report of the 2008 meeting of ad hoc WG-IMAF was adopted.

17.2 The Working Group paused in memory of Dr Edith Fanta who passed away in May 2008. Dr Fanta will be remembered for her thoughtful contributions to the work of ad hoc WG-IMAF over many years and her gentle and dedicated leadership of the Scientific Committee which she chaired from 2005 until her death.

17.3 In closing the meeting, Ms Rivera and Mr Smith thanked participants for a successful and constructive meeting and thanked the Secretariat for their dedicated professional support.

17.4 Mr Hay, on behalf of the Working Group, thanked Ms Rivera and Mr Smith for their skill and dedication in guiding ad hoc WG-IMAF through its work this year. The Co-conveners were also commended for their efforts in ensuring the successful workshop to review the future of ad hoc WG-IMAF.

17.5 The meeting was closed.

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Table 1: Intersessional work plan for ad hoc WG-IMAF for 2008/09.

	Task/Topic	Paragraphs of WG-IMAF report	Priority	Members	Secretariat	Delivery	Specific action
1.	**Planning and coordination of work**						
1.1	Develop checklist similar to that used for longline notifications for new and exploratory fisheries, specifically for notifications for other new and exploratory fisheries.	10.15	Medium		Secretariat		
2.	**Integrate work of WG-IMAF and ACAP**						
2.1	Maintain dialogue with ACAP on issues of common interest and plan for migration of tasks as appropriate.		High	Co-conveners	Secretariat		ACAP
3.	**Research and development activities**						
3.1	Request BirdLife International to provide brief annual summary data on distribution of Southern Ocean seabirds from its tracking database. Plan with BirdLife for more detailed three-year review of tracking database to be provided in 2010/11.	8.2	for IMAF-09	Co-conveners	Science Officer	Jul 09	Request information from BirdLife International in July 09 for paper presented to WG-IMAF-09. Circulate any new information to WG-IMAF. Co-conveners to liaise with BirdLife International with respect to three-year review.
3.2	Develop a methodology paper on steps required to conduct a risk assessment for marine mammals.	9.5	for IMAF-09	Australia, New Zealand	Science Officer (coordinator)		R. Gales, B. Baker, N. Walker
3.3	Produce and distribute a marine debris outreach poster.	2.54, 12.12	2009		Secretariat	Dec 08/ Jan 09	Secretariat distribute poster via technical coordinators to all longline vessels operating in the Convention Area.
3.4	Report on implementation of action plan. Submit progress report of action plan. Include figures to show the overlap between the weekly fishing effort by sector and seabird incidental mortality rates. Note status of implementation with recommendations from Table 12.	3.11, 3.12, Table 12	High	France		Report to IMAF-09	

(continued)

Table 1 (continued)

	Task/Topic	Paragraphs of WG-IMAF report	Priority	Members	Secretariat	Delivery	Specific action
3.5	Submit English translation of evaluation of the impact of fisheries on the populations of petrels in the French EEZs (i.e. SC-CAMLR-XXVII/BG/8) to WG-SAM.	3.10	High	France		WG-SAM July 09 meeting	
4.	**Information from outside the Convention Area**						
4.1	Develop standard format for reporting data from outside the Convention Area about Convention Area marine mammal and seabird incidental mortality.	4.3	Medium	Co-conveners	Science Officer		ACAP
5.	**Cooperation with international organisations**						
5.1	Correspond with Executive Secretaries of RFMOs listed in Appendix 1 of Resolution 22/XXV reiterating the Commission's interest in reducing the incidental mortality of Convention Area seabirds outside the Convention Area. When communicating with RFMOs and other appropriate international bodies, address marine debris discharge in, and adjacent to, the Convention Area.	11.20(v)(a) and 12.1	High		Executive Secretary	Nov 08 Sep 09	Brief CCAMLR observers on desired feedback on IMAF matters (seabird by-catch levels and mitigating measures).
5.2	Seek inclusion of agenda item for the RFB meeting in March 2009 to reflect the Commission's interest in RFMOs addressing the incidental mortality of seabirds.	11.20(v)(b)	High		Executive Secretary		

(continued)

Table 1 (continued)

	Task/Topic	Paragraphs of WG-IMAF report	Priority	Members	Secretariat	Delivery	Specific action
6.	**Data acquisition and analysis**						
6.1	Request information on gillnet gear operations, associated seabird incidental mortalities etc. to inform a process to be able to estimate seabird mortalities associated with IUU gillnet fishing in the Convention Area.	5.3, 11.13, 11.20(iii)	High	Members, IOTC	Secretariat	Nov 08 Sep 09	
6.2	Compile observer information (including cruise reports and C2 data) on gear reported as lost by vessels during the past three years.	12.8	High		Secretariat		
6.3	Detailed descriptive review of continuous trawl fishing method, including offal discharge and management issues.	6.9	High	Members (Norway)			
6.4	Descriptive review of fishing methods in the Convention Area, such as Spanish system and trotline methods of longlining, use of pots and trawl methods for mackerel icefish. Review would be similar to that done for autoline method in 2008 (WG-FSA-08/60) and would be submitted as a working group paper.	6.2	Medium	Members			

Table 2: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Area 51, Subareas 48.3, 48.4, 58.6, 58.7, 88.1, 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3 and 58.5.2 during the 2007/08 season, including related mitigation information. A – auto, Sp – Spanish, T – trotline, 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 (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	28/5–22/8/08	Sp	247	0	247	100	302.6	1215.8	24	0	0	0	0	2	0	0	0	0	99.6		(1)	O (99)
Argos Froyanes	14/5–28/8/08	A	281	0	281	100	556.1	1790.4	31	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Argos Georgia	3/5–31/8/08	A	300	0	300	100	478.1	1539.0	31	0	0	0	0	1	0	0	0	0	100		(0)	O (0)
Argos Helena	1/5–31/8/08	A	360	0	360	100	395.6	1759.0	22	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Tronio	1/5–29/8/08	Sp	200	0	200	100	393.9	1702.0	23	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Jacqueline	4/5–23/8/08	Sp	281	0	281	100	385.2	1548.5	24	0	0	0	0	0	0	0	0	0	100		(0)	O (100)
Koryo Maru No. 11	2/5–6/9/08	Sp	215	0	215	100	545.9	2097.6	26	0	0	0	0	0	0	0	0	0	100		(0)	O (95)
Punta Ballena	15/5–7/9/08	A	193	0	193	100	256.3	1184.7	21	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
San Aspiring	1/5–5/6/08	A	77	0	77	100	318.7	725.0	43	0	0	0	0	0	0	0	0	0	100		(0)	O (33)
San Aspiring	18/6–12/8/08	A	133	0	133	100	547.1	1200.0	45	0	0	0	0	0	0	0	0	0	100		(0)	O (31)
Viking Bay	1/5–28/8/08	Sp	263	0	263	100	397.4	1538.4	25	0	0	0	0	17	0	0	0	0	100		(0)	O (0)
Total						100	4576.9	16300.4	28							0	0	0				
Subarea 48.4																						
Argos Froyanes	21/4–12/5/08	A	63	0	63	100	111.8	313.2	35	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
San Aspiring	3/4–23/4/08	A	45	0	45	100	142.5	342.0	41	0	0	0	0	0	0	0	0	0	100		(0)	O (27)
Total						100	254.3	655.2	39							0	0	0				
Area 51																						
Banzare	16/4–9/6/08	T	32	42	74	43	410.4[2]	410.4	100	0	0	0	0	0	0	0	0	0	100	100	(0)	O (100)
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b																						
Tronio[3]	2/12–16/2/08	Sp	18	95	113	16	581.1	922.3	63	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Antillas Reefer	16/12–21/2/08	Sp	28	69	97	29	136.5	765.7	17	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Banzare	6/1–27/2/08	T	11	39	50	22	304.9[2]	304.9	100	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Paloma V	21/12–17/2/08	Sp	0	69	69	0	261.8	814.5	32	0	0	0	0	0	0	0	0	0		100	(0)	O (100)
Janas	18/5–26/5/08	A	15	0	15	100	40.6	75.0	44	0	0	0	0	0	0	0	0	0	100		(0)	O (0)
Insung No. 1	20/12–12/3/08	Sp	0	138	138	0	888.1	980.0	90	0	0	0	0	0	0	0	0	0		100	(0)	O (0)
Shinsei Maru No. 3	30/12–19/2/08	T	53	81	134	40	339.8	673.4	50	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Insung No. 2[3]	4/12–25/2/08	Sp	6	125	131	5	671.4	918.9	73	0	0	0	0	0	0	0	0	0	100	100	(0)	O (0)
Total						18	3224.2	5454.7	59							0	0	0				
Division 58.5.2																						
Austral Leader II	25/5–28/6/08	A	36	30	66	55	132.6	336.6	39	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Janas	29/5–2/7/08	A	45	69	114	40	347.9	743.0	44	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Total						45	480.5	1079.6	45							0	0	0				
Subareas 58.6, 58.7, Area 51																						
Koryo Maru No. 11	9/2–30/3/08	Sp	76	0	76	100	269.2	667.7	40	0	0	0	0	2	0	0	0	0	100		(0)	O (100)
Total						100	269.2	667.7	40							0	0	0				

(continued)

Table 2 (continued):

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks (thousands)			No. of birds observed caught[1]						Observed seabird mortality (includes injured birds)[1] (birds/thousand hooks)			Streamer line in use %		Offal discharge during	
										Dead		Injured		Uninjured								
			N	D	Total	%N	Obs.	Set	% Observed	N	D	N	D	N	D	N	D	Total	N	D	Set (%)	Haul (%)
Subarea 88.1, 88.2																						
Avro Chieftain	24/12–14/2/08	A	0	108	108	0	393.8	876.7	45	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Janas	1/12–20/2/08	A	0	89	89	0	261.7	556.0	47	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Jung Woo No. 2	5/12–17/2/08	Sp	0	81	81	0	620.0[2]	652.9	94	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Ross Mar	1/12–1/2/08	A	0	88	88	0	208.2	475.2	43	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Ross Star	14/1–1/3/08	A	5	52	57	9	186.2	350.7	53	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
San Aotea II	11/1–20/2/08	A	0	71	71	0	203.2	472.9	42	0	0	0	0	0	0	0	0	0		100	(0)	(0)
San Aspiring	2/12–16/2/08	A	0	76	76	0	266.6	491.5	54	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Antartic III	8/12–8/12/08	A	0	1	1	0	1.0	3.0	33	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Argos Georgia	1/12–15/2/08	A	12	71	83	15	247.5	486.0	50	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Argos Helena	1/12–11/2/08	A	0	135	135	0	377.9	697.5	54	0	0	0	0	0	0	0	0	0		100	(0)	(0)
Argos Froyanes	1/12–28/2/08	A	81	76	157	52	448.1	983.4	45	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Hong Jin No. 707	3/12–19/2/08	Sp	10	71	81	12	592.6[2]	647.5	91	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Yantar	10/1–10/3/08	T	4	73	77	5	416.8	562.6	74	0	0	0	0	0	0	0	0	0	100	100	(0)	(0)
Total						11	4223.6	7255.9	58							0	0	0				

1 Bird ‘caught’ as defined by the Commission at CCAMLR-XXIII, paragraphs 10.30 and 10.31.
2 Information obtained from cruise report.
3 These vessels also conducted a small amount of fishing in Subarea 88.1 during this cruise.

Table 3: 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, Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b, 58.5.1 and 58.5.2 from 1997 to 2008 (- indicates no fishing occurred).

Subarea	Year											
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Subarea 48.3												
Extrapolated mortality	5 755	640	210*	21	30	27	8	27	13	0	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	0
Subarea 48.4												
Extrapolated mortality	-	-	-	-	-	-	-	-	0	0	0	0
Observed mortality rate	-	-	-	-	-	-	-	-	0	0	0	0
Subarea 48.6												
Extrapolated mortality	-	-	-	-	-	-	-	0	0	0	0	-
Observed mortality rate	-	-	-	-	-	-	-	0	0	0	0	-
Subareas 58.6, 58.7												
Extrapolated mortality	834	528	156	516	199	0	7	39	76	0	0	0
Observed mortality rate	0.52	0.194	0.034	0.046	0.018	0	0.003	0.025	0.149	0	0	0
Subarea 58.6 French EEZ												
Extrapolated mortality	no data	no data	no data	no data	-	1243+	720+	343+	242	235	314	131
Observed mortality rate					-	0.1672	0.1092	0.0875	0.0490	0.0362	0.065	0.0305
Subareas 88.1, 88.2												
Extrapolated mortality	-	0	0	0	0	0	0	1	0	0	0	0
Observed mortality rate	-	0	0	0	0	0	0	0.0001	0	0	0	0
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b												
Extrapolated mortality	-	-	-	-	-	-	-	0	8	2	0	0
Observed mortality rate	-	-	-	-	-	-	-	0	<0.001	0.0002	0	0
Division 58.5.1 French EEZ												
Extrapolated mortality	no data	no data	no data	no data	1917+	10814+	13926+	3666+	4387	2352	1943	1224
Observed mortality rate					0.0920	0.9359	0.5180	0.2054	0.1640	0.0920	0.0798	0.0585
Division 58.5.2												
Extrapolated mortality	-	-	-	-	-	-	0	0	0	0	0	0
Observed mortality rate	-	-	-	-	-	-	0	0	0	0	0	0
Total seabird mortality	6589	1168	366	537	229	27	15	67	97	2	0	1355$^{\Delta}$

* Excluding *Argos Helena* line-weighting experiment cruise.
\+ The number of hooks has not been collected and the values given are from the total number of hooks set.
$^{\Delta}$ Beginning in 2008, total seabird mortality number includes birds reported from Subarea 58.6 and Division 58.5.1 (SC-CAMLR-XXVI, paragraph 5.6(iii)).

Table 4: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2007/08 season (September–August). N – night-time setting, D – daytime setting (including nautical dawn and dusk).

Vessel	Dates of fishing	No. of birds observed caught: Dead		Injured		Uninjured		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: Total length (m)	Estimated length out of water (m)	Diameter (mm)	Streamers: Minimal length (m)	Maximal length (m)
		N	D	N	D	N	D	N	D									
Subarea 58.6																		
Ship 1	6/4–22/5/08	0	0	0	0	1	0	100	0	7	3.6	16	7	200	50	12	3.5	5.5
Ship 2	12/11–24/11/07	0	0	1	0	5	0	100	0	7	1.2	60	6	190	75	14	3.5	7
Ship 2	8/2–24/2/08	0	0	0	0	0	0	100	0	7	1.4	?	6	300	70	11	2	3
Ship 2	1/5–20/5/08	0	0	0	0	0	0	100	0	7	1.2	150	6	200	70	12	1	1.75
Ship 3	15/2–27/2/08	15	0	0	0	0	0	100	0	7	2.5	17	2	200	150	10	2	6
Ship 3	7/5–31/5/08	0	0	0	0	0	0	100	0	9	2.6	24	2	150	100	8	1.5	7
Ship 5	5/2–20/2/08	1	0	0	0	1	0	100	0	5.5	4	12	3	260	40	13	1.5	4
Ship 5	29/3–8/4/08	6	0	0	0	1	0	100	0	4	3.5	17	3	200	80	13	2.5	3.5
Ship 6	22/2–17/3/08	7	0	0	0	2	0	100	0	7	1.2	130	10	165	60	12	0.8	1.5
Ship 6	7/7–15/7/08	0	0	0	0	0	0	100	0	10	2.5	77	3	220	150	5	0.2	8
Ship 7	31/10–8/11/07	0	0	0	0	0	0	100	0	8	3	8	6	150	100	12	4	8
Ship 7	3/2–11/2/08	0	0	0	0	0	0	100	0	8	24	15	6	220	70	12	6	12
Ship 7	7/5–26/5/08	0	0	0	0	1	0	100	0	7	3.5	15	6	150	60	8	3	8
Ship 11	25/10–01/11/07	0	0	0	0	0	0	100	0	5	3.5	15	3	100	50	6	1	4
Ship 11	16/02, 15/04, 11/03, 17/05/08	3	0	1	0	0	0	100	0	7	4	13	4	100	55	10	0.5	6.5
		32		2		11												
Division 58.5.1																		
Ship 1	7/9–13/11/07	23	0	2	0	14	0	100	0	7	3.6	16	7	200	50	12	3.5	5.5
Ship 1	13/12–13/2/08	61	0	0	0	2	0	100	0	8	3.6	15	7	160	50	12	3.5	7
Ship 1	1/5–13/6/08	12	0	0	0	1	0	100	0	7	3.6	16	7	200	50	12	3.5	5.5
Ship 2	18/9–9/11/07	3	0	0	0	5	0	100	0	6	1.4	178	6	250	50	12	1.7	3.5
Ship 2	17/12–4/2/08	4	0	0	0	0	0	100	0	7	1.4	?	6	300	70	11	2	3
Ship 2	16/3–27/4/08	17	0	0	0	1	0	100	0	7	1.2	150	6	200	70	12	1	1.75
Ship 3	8/9–20/10/07	5	0	0	0	3	0	100	0	12	2.5	16	2	220	25	10	2	6
Ship 3	8/12–12/2/08	31	0	0	0	1	0	100	0	7	2.5	17	2	200	150	10	2	6
Ship 3	4/4–1/5/08	17	0	0	0	0	0	100	0	9	2.6	24	2	150	100	8	1.5	7
Ship 5	5/9–11/11/07	10	0	0	0	19	0	100	0	7	5	12	3	250	40	13	1	6.5
Ship 5	20/12–1/2/08	13	0	0	0	2	0	100	0	5.5	4	12	3	260	40	13	1.5	4
Ship 5	27/4–9/6/08	2	0	0	0	0	0	100	0	4	3.5	17	3	200	80	13	2.5	3.5
Ship 6	3/9–1/12/07	0	0	0	0	18	0	100	0	7.5	1.2	125	10	165	50	11.5	0.6	2.4

(continued)

Table 4 (continued)

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 (m)	Estimated length out of water (m)	Diameter (mm)	Minimal length (m)	Maximal length (m)
		N	D	N	D	N	D	N	D									
Division 58.5.1 (continued)																		
Ship 6	15/1, 20/3, 14/2, 31/3/08	23	0	0	0	1	0	100	0	7	1.2	130	10	165	60	12	0.8	1.5
Ship 6	12/5–2/7/08	7	0	0	0	0	0	100	0	10	2.5	77	3	220	150	5	0.2	8
Ship 7	3/9–29/10/07	14	0	3	0	7	0	100	0	8	3	8	6	150	100	12	4	8
Ship 7	14/12–31/1/08	9	0	0	0	0	0	100	0	8	24	15	6	220	70	12	6	12
Ship 7	30/3–3/5/08	26	0	0	0	4	0	100	0	7	3.5	15	6	150	60	8	3	8
Ship 11	1/9–29/9/07	1	0	0	0	7	0	100	0	7	5	10	2	100	50	6	1	4
Ship 11	3/11–6/1/08	12	0	0	0	2	0	100	0	5	3.5	15	3	100	50	6	1	4
Ship 11	16/3–10/4/08	8	0	1	0	1	0	100	0	7	4	13	4	100	55	10	0.5	6.5
		298		6		88												

Table 5: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2007/08 season (September–August). A – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); NC – not collected.

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks (thousands)			Hooks baited (%)	No. of birds observed caught						Observed seabird mortality (includes injured birds) (birds/thousand hooks)			Streamer line in use %	
			N	D	Total	%N	Obs.	Set	% observed		Dead		Injured		Uninjured						
											N	D	N	D	N	D	N	D	Total	N	D
Subarea 58.6																					
Ship 1	6/4–22/5/08	A	110	0	110	100	158.66	662.65	23.94	NC	0	0	0	0	1	0	0.0000	0	0.0000	100	0
Ship 2	12/11–24/11/07	A	38	0	38	100	57.16	238.04	24.01	NC	0	0	1	0	5	0	0.0175	0	0.0175	100	0
Ship 2	8/2–24/2/08	A	49	0	49	100	49.45	197.80	25.00	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 2	1/5–20/5/08	A	39	0	39	100	62.60	250.54	24.99	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 3	15/2–27/2/08	A	29	0	29	100	70.25	266.85	26.33	NC	15	0	0	0	0	0	0.2135	0	0.2135	100	0
Ship 3	7/5–31/5/08	A	45	0	45	100	104.95	451.50	23.24	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 5	5/2–20/2/08	A	54	0	54	100	53.73	215.75	24.90	NC	1	0	0	0	1	0	0.0186	0	0.0186	100	0
Ship 5	29/3–8/4/08	A	25	0	25	100	37.30	142.37	26.20	NC	6	0	0	0	1	0	0.1609	0	0.1609	100	0
Ship 6	22/2–17/3/08	A	67	0	67	100	135.91	530.40	25.62	NC	7	0	0	0	2	0	0.0515	0	0.0515	100	0
Ship 6	7/7–15/7/08	A	23	0	23	100	36.20	180	20.11	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 7	31/10–8/11/07	A	31	0	31	100	39.11	164.60	23.76	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 7	3/2–11/2/08	A	33	0	33	100	33.20	132.75	25.01	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 7	7/5–26/5/08	A	46	0	46	100	68.80	284.85	24.15	NC	0	0	0	0	1	0	0.0000	0	0.0000	100	0
Ship 11	25/10–1/11/07	A	13	0	13	100	18.58	72.45	25.65	NC	0	0	0	0	0	0	0.0000	0	0.0000	100	0
Ship 11	16/2, 15/4, 11/3, 17/5/08	A	152	0	152	100	187.27	733.69	25.52	NC	3	0	1	0	0	0	0.0214	0	0.0214	100	0
			754			100	1113.17	4 524.24	24.60		32		2		11		0.0305		0.0305		
Division 58.5.1																					
Ship 1	7/9–13/11/07	A	173	0	173	100	389.95	1 592.50	24.49	NC	23	0	2	0	14	0	0.0641	0	0.0641	100	0
Ship 1	13/12–13/2/08	A	133	0	133	100	344.97	1 371.45	25.15	NC	61	0	0	0	2	0	0.1768	0	0.1768	100	0
Ship 1	1/05–13/6/08	A	29	0	29	100	76.13	304.75	24.98	NC	12	0	0	0	1	0	0.1576	0	0.1576	100	0
Ship 2	18/9–9/11/07	A	134	0	134	100	74.89	299.42	25.01	NC	3	0	0	0	5	0	0.0401	0	0.0401	100	0
Ship 2	17/12–4/2/08	A	146	0	146	100	287.49	1 135.99	25.31	NC	4	0	0	0	0	0	0.0139	0	0.0139	100	0
Ship 2	16/3–27/4/08	A	114	0	114	100	228.44	923.02	24.75	NC	17	0	0	0	1	0	0.0744	0	0.0744	100	0
Ship 3	8/9–20/10/07	A	72	0	72	100	251.54	1 022.18	24.61	NC	5	0	0	0	3	0	0.0199	0	0.0199	100	0
Ship 3	8/12–12/2/08	A	121	0	121	100	431.55	1 704.57	25.32	NC	31	0	0	0	1	0	0.0718	0	0.0718	100	0
Ship 3	4/4–1/5/08	A	45	0	45	100	143.59	604.28	23.76	NC	17	0	0	0	0	0	0.1184	0	0.1184	100	0
Ship 5	5/9–11/11/07	A	147	0	147	100	398.50	1 576.78	25.27	NC	10	0	0	0	19	0	0.0251	0	0.0251	100	0

(continued)

Table 5 (continued)

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks (thousands)			Hooks baited (%)	No. of birds observed caught						Observed seabird mortality (includes injured birds) (birds/thousand hooks)			Streamer line in use %	
											Dead		Injured		Uninjured						
			N	D	Total	%N	Obs.	Set	% observed		N	D	N	D	N	D	N	D	Total	N	D
Division 58.5.1 (continued)																					
Ship 5	20/12–1/2/08	A	108	0	108	100	227.31	930.85	24.42	NC	13	0	0	0	2	0	0.0572	0	0.0572	100	0
Ship 5	27/4–9/6/08	A	96	0	96	100	205.55	816.85	25.16	NC	2	0	0	0	0	0	0.0097	0	0.0097	100	0
Ship 6	3/9–1/12/07	A	198	0	198	100	473.90	2 095.50	22.62	NC	0	0	0	0	18	0	0.0000	0	0.0000	100	0
Ship 6	15/1, 20/3, 14/2, 31/3/08	A	90	0	90	100	270.05	1 047.00	25.79	NC	23	0	0	0	1	0	0.0852	0	0.0852	100	0
Ship 6	12/5–2/7/08	A	80	0	80	100	211.75	852.38	24.84	NC	7	0	0	0	0	0	0.0331	0	0.0331	100	0
Ship 7	3/9–29/10/07	A	140	0	140	100	298.50	1 315.13	22.70	NC	14	0	3	0	7	0	0.0570	0	0.0570	100	0
Ship 7	14/12–31/01/08	A	112	0	112	100	291.60	1 165.13	25.03	NC	9	0	0	0	0	0	0.0309	0	0.0309	100	0
Ship 7	30/3–3/5/08	A	73	0	73	100	161.00	651.50	24.71	NC	26	0	0	0	4	0	0.1615	0	0.1615	100	0
Ship 11	1/9–29/9/07	A	66	0	66	100	100.92	403.47	25.01	NC	1	0	0	0	7	0	0.0099	0	0.0099	100	0
Ship 11	3/11–6/1/08	A	185	0	185	100	238.27	953.27	24.99	NC	12	0	0	0	2	0	0.0504	0	0.0504	100	0
Ship 11	16/3–10/4/08	A	89	0	89	100	94.05	368.79	25.50	NC	8	0	1	0	1	0	0.0957	0	0.0957	100	0
			2 351			100	5 199.94	21 134.79	24.60		298		6		88		0.0585		0.0585		

Table 6: 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; MAH – northern giant petrel; KPY – king penguin; PTZ – unknown petrel; DAC – Cape petrel; MAI – southern giant petrel.

Season	Area	Target species	Trips observed	Trawls			BPT	Dead								Total dead	Alive
				Set	Observed	(%)		DIC	DIM	PRO	MAH	KPY	PTZ	DAC	MAI		
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* *C. gunnari*	8	1311	1309	100	<0.11		2	2				2		6	11
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* *C. gunnari*	5	1218	1215	100	<0.10									0	13
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* *C. gunnari*	6	1303	1301	100	<0.11		5	3						8	0
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* *C. gunnari*	3	1086	1086	100	0.00									0	0
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* *C. gunnari*	3	1005	936	93	<0.01							2		2	0
2007/08	48.1/2	*E. superba*	4	2877	233	8[1]	0.00									0	0
	48.3	*C. gunnari*	6	232	206	89	0.024			3		2				5	5
	48.3	*E. superba*	4	1058	81	8[1]	0.00									0	0
	58.5.2	*D. eleginoides* *C. gunnari*	3	723	700	97	0.00									0	1

[1] These low haul numbers are a result of continuous trawls, refer to paragraph 2.21.

Table 7: Seabird mortality totals and rates (BPT: birds/trawl) and species composition, recorded by observers in the CAMLR Convention Area trawl fishery during the 2007/08 season. KPY – king penguin; PRO – white-chinned petrel; DAC – Cape petrel.

Subarea/ division	Vessel (target species)	Cruise dates	Trawls		BPT	Dead			Total dead	Alive (combined)
			Set	Observed		KPY	PRO	DAC		
48.1, 48.2	*Saga Sea* (KRI)[1]	4/12–20/1/08	774	8[2]	0.00				0	0
	Saga Sea (KRI)[1]	31/1–30/3/08	884	15[2]	0.00				0	0
	Konstruktor Koshkin (KRI)	13/3–28/4/08	565	185	0.00				0	0
	Saga Sea (KRI)[1]	7/4–2/7/08	1219	25[2]	0.00				0	0
	Total		2877	233	0.00				0	0
48.3	*Betanzos* (ANI)	16/2–1/3/08	31	31	0.10		3		3	3
	Robin M Lee (ANI)	20/1–25/1/08	5	5	0.00				0	0
	Robin M Lee (ANI)	23/4–28/5/08	76	72	0.01	2			2	2
	Sil (ANI)	20/1–26/1/08	6	6	0.00				0	0
	Sil (ANI)	30/4–24/5/08	55	48	0.00				0	0
	Insung Ho (ANI)	18/1–2/2/08	59	44	0.00				0	0
	Total		232	206	0.02	2	3		5	5
48.3	*Maksim Starostin* (KRI)[1]	6/8–31/8/08	56	11[2]	0.00				0	0
	Saga Sea (KRI)[1]	6/7–3/9/08	733	10[2]	0.00				0	0
	Juvel (KRI)	27/8–12/9/08	14	14	0.00				0	0
	Dalmor II (KRI)	5/7–28/7/08	255	46	0.00				0	0
	Total		1058	81	0.00				0	0
58.5.2	*Southern Champion* (ANI/TOP)	7/4–4/5/08	168	168	0.00				0	0
	Southern Champion (ANI/TOP)	22/1–10/2/08	113	113	0.00				0	0
	Southern Champion (ANI/TOP)	30/5–24/7/08	442	419	0.00				0	1
	Total		723	700	0.00				0	1

1 Continuous trawl method.
2 These low haul numbers are a result of continuous trawls, refer to paragraph 2.21.

Table 8: Seal mortality totals and rates (SPT: seals/trawl) and species composition, recorded by observers in the CAMLR Convention Area trawl fishery during the 2007/08 season. SXX: unidentified seal; SEA: Antarctic fur seal.

Subarea/ division	Vessel (target species)	Cruise dates	Trawls		SPT	Dead		Total dead	Alive (combined)
			Set	Observed		SXX	SEA		
48.1,48.2	*Saga Sea* (KRI)[1]	4/12–20/1/08	774	8[2]	0.00			0	0
	Saga Sea (KRI)[1]	31/1–30/3/08	884	15[2]	0.00			0	0
	Konstruktor Koshkin (KRI)	13/3–28/4/08	565	185	0.00			0	0
	Saga Sea (KRI)[1]	7/4–2/7/08	1219	25[2]	0.00			0	0
	Total		2877	233	0.00			0	0
48.3	*Betanzos* (ANI)	16/2–1/3/08	31	31	0.00			0	0
	Robin M Lee (ANI)	20/1–25/1/08	5	5	0.00			0	0
	Robin M Lee (ANI)	23/4–28/5/08	76	72	0.00			0	0
	Sil (ANI)	20/1–26/1/08	6	6	0.00			0	0
	Sil (ANI)	30/4–24/5/08	55	48	0.00			0	0
	Insing Ho (ANI)	18/1–2/2/08	59	44	0.00			0	0
	Total		232	206	0.00			0	0
48.3	*Maksim Starostin* (KRI)[1]	6/8–31/8/08	56	11[2]	0.00			0	0
	Saga Sea (KRI)[1]	6/7–3/9/08	733	10[2]	0.10		1	1	0
	Juvel (KRI)	27/8–12/9/08	14	14	0.00			0	0
	Dalmor II (KRI)	5/7–28/7/08	255	46	0.13	1	4	5	0
	Total		1058	81	0.07			6	0
58.5.2	*Southern Champion* (ANI/TOP)	7/4–4/5/08	168	168	0.00			0	0
	Southern Champion (ANI/TOP)	22/1–10/2/08	113	113	0.00			0	0
	Southern Champion (ANI/TOP)	30/5–24/7/08	442	419	0.00			0	0
	Total		723	700	0.00			0	0

1 Continuous trawl method.
2 These low haul numbers are a result of continuous trawls, refer to paragraph 2.21.

Table 9: 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; SXX – unidentified seal.

Season	Area	Target species	Trips observed	Trawls		SPT	Dead				Total dead	Alive (combined)
				Set	Observed		SLP	SEA	SES	SXX		
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*	6	904	850	0.001		1			1	0
		C. gunnari										
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*	8	1311	1309	0.003		2	2		4	2
		C. gunnari										
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*	5	1218	1215	0.002		3			3	0
		C. gunnari										
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*	6	1303	1301	0.00					0	1
		C. gunnari										
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*	3	1086	1086	0.00	1				1	0
		C. gunnari										

(continued)

Table 9 (continued)

Season	Area	Target species	Trips observed	Trawls		SPT	Dead				Total dead	Alive (combined)
				Set	Observed		SLP	SEA	SES	SXX		
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
2007/08	48.1/2	*E. superba*	4	2877	233[1]	0.00					0	0
	48.3	*C. gunnari*	6	232	206	0.00					0	0
	48.3	*E. superba*	4	1058	81[1]	0.07		5		1	6	0
	58.5.2	*D. eleginoides* *C. gunnari*	3	723	700	0.00					0	0

[1] These low haul numbers are a result of continuous trawls, refer to paragraph 2.21.

Table 10: Summary of scientific observations relating to compliance with Conservation Measure 25-02 (2007), based on data from scientific observers from the 1996/97 to the 2007/08 seasons. Values in parentheses are % of observer records that were complete. na – not applicable.

Area/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	Streamers length[7]	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)	73 (100)	100 (100)	0.001	0
2004/05	100 (100)	9.5	45	99	100 (100)	75 (100)	88 (100)	88 (100)	75 (100)	100 (100)	0.001	0
2005/06	100 (100)	10.0	40	100	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2006/07	100 (100)	9.8	39	100	100 (100)	90 (100)	100 (100)	100 (100)	90 (100)	100 (100)	0	0
2007/08	100 (100)	9.5	38.5	100	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
Subarea 48.4												
2005/06	Auto only	na	na	100	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2006/07	Auto only	na	na	100	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2007/08	Auto only	na	na	100	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
Subarea 48.6												
2003/04	100 (100)	7.0	20	41[6]	No discharge	0 (100)	100 (100)	100 (100)	0 (100)	100 (100)	0	0
2004/05	100 (100)	6.5	19.5	29[6]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	0 (100)	0	0
2005/06	Auto only	na	na	36[6]	No discharge	50 (100)	100 (100)	50 (100)	100 (100)	100 (100)	0	0
2006/07	Auto only	na	na	44[6]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	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)	100 (100)	100 (100)	0	0
2004/05	33[9] (100)	7.9	40	26[5]	No discharge	88 (100)	100 (100)	100 (100)	88 (100)	100 (100)	0	<0.001
2005/06	16[9] (100)	7.2	48	16[5]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	<0.001
2006/07	20[9] (100)	7.7	40	10[5]	4% by 1 vessel[9]	50 (100)	100 (100)	83 (100)	83 (100)	83 (100)	0	0
2007/08	71[9] (100)	8.5	40	10[5]	100 (100)	88 (100)	100 (100)	100 (100)	88 (100)	100 (100)	0	0

(continued)

Table 10 (continued)

Area/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		Streamers length[7]		Distance apart		Night	Day
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)	100	(100)	100	(100)	0	0
2004/05	Auto Only		na	na	50[8]	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2005/06	Auto Only		na	na	53[8]	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2006/07	Auto Only		na	na	54[8]	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2007/08	Auto Only		na	na	45[8]	No discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
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)	100	(100)	100	(100)	0.03	0.01
2004/05	100	(100)	6.5	20	100	100	(100)	0	(100)	100	(100)	100	(100)	100	(100)	0	(100)	0.149	0
2005/06	100	(100)	9.1	40	100	100	(100)	0	(100)	100	(100)	100	(100)	0	(100)	0	(100)	0	0
2006/07	100	(100)	10.4	40	100	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2007/08	0	(100)	11	56	100	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(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

(continued)

Table 10 (continued)

Area/season	Line weighting (Spanish system only) Compliance %		Median weight (kg)	Median spacing (m)	Night setting (% night)	Offal discharge (%) opposite haul	Streamer line compliance (%) Overall		Attached height		Total length		Streamers length[7]		Distance apart		Total catch rate (birds/thousand hooks) Night	Day
Subareas 88.1, 88.2 (continued)																		
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)	61	(81)	100	(100)	0	<0.01
2004/05	33	(100)	9.0	45	1[4]	1% by 1 vessel	64	(100)	100	(100)	100	(100)	60	(94)	94	(100)	0	0
2005/06	100	(100)	9.2	35	1[4]	No discharge	85	(92)	100	(92)	85	(92)	92	(92)	100	(92)	0	0
2006/07	100	(100)	10	36	4[4]	1% by 1 vessel	93	(100)	100	(100)	100	(100)	93	(93)	100	(100)	0	0
2007/08	67	(100)	10	37	11[4]	No discharge	92	(100)	100	(100)	100	(100)	92	(100)	100	(100)	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 216/XX and 41-09 and 41-10 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 Measures 41-05 and 41-11 permit daytime setting in Divisions 58.4.1 and 58.4.2 if the vessel complies with CM 24-02.
6 Conservation Measure 41-04 permits daytime setting if the vessel complies with CM 24-02.
7 Conservation Measure 25-02 (2003, 2007) was updated in 2003 and the requirement for a minimum of five streamers was replaced by minimum streamer lengths.
8 Conservation Measure 41-08 permits daytime setting if the vessel complies with CM 24-02.
9 The *Tronio* discharged offal on seven occasions due to a mechanical problems.

Table 11: Compliance, as reported by observers, of streamer lines with the minimum specifications set out in Conservation Measure 25-02 (2007) during the 2007/08 season. Y – yes; N – no; MP – Moon pool.

Vessel name	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	28/5–22/8/08	Spanish	Y	Y (8)	Y (150)	7	Y (5)	Y (1–7)	99.6		100
Argos Froyanes	14/5–28/8/08	Auto	Y	Y (7)	Y (166)	11	Y (4)	Y (2–7)	100		100
Argos Georgia	4/5–30/8/08	Auto	Y	Y (7)	Y (169)	8	Y (5)	Y (1–8)	100		100
Argos Helena	1/5–31/8/08	Auto	Y	Y (14)	Y (157)	13	Y (5)	Y (1–8)	100		MP
Tronio	1/5–29/8/08	Spanish	Y	Y (8)	Y (181)	11	Y (5)	Y (6.7)	100		100
Jacqueline	4/5–23/8/08	Spanish	Y	Y (7.6)	Y (158)	9	Y (5)	Y (1–7)	100		100
Koryo Maru No. 11	2/5–6/9/08	Spanish	Y	Y (8)	Y (171)	10	Y (5)	Y (4–7)	100		100
Punta Ballena	15/5–7/9/08	Auto	Y	Y (7)	Y (155)	7	Y (5)	Y (1–6.7)	100		96[1]
San Aspiring	1/5–5/6/08	Auto	Y	Y (8.2)	Y (213)	24	Y (5)	Y (9.6)	100		100
San Aspiring	18/6–12/8/08	Auto	Y	Y (8.2)	Y (205)	22	Y (4)	Y (1–9.5)	100		100
Viking Bay	1/5–28/8/08	Spanish	Y	Y (7)	Y (172)	12	Y (4)	Y (1–7.1)	100		100
Subarea 48.4											
Argos Froyanes	21/4–12/5/08	Auto	Y	Y (7)	Y (166)	11	Y (4)	Y (2–7)	100		100[2]
San Aspiring	3/4–23/4/08	Auto	Y	Y (8.2)	Y (213)	24	Y (5)	Y (9.6)	100		100[2]
Divisions 58.4.1, 58.4.2, 58.4.3a, 58.4.3b											
Tronio[3]	2/12–16/2/08	Spanish	Y	Y (7.2)	Y (160)	12	Y (5)	Y (1–6.5)	100	100	0[2]
Antillas Reefer	16/12–21/2/08	Spanish	Y	Y (7)	Y (150)	11	Y (5)	Y (6.5)	100	100	0[2]
Banzare	6/1–27/2/08	Trotline	Y	Y (8.5)	Y (155)	30	Y (5)	Y (1–8.5)	100	100	0[2]
Paloma V	21/12–17/2/08	Spanish	Y	Y (7)	Y (150)	7	Y (5)	Y (1–6.5)		100	0[2]
Janas	18/5–26/5/08	Auto	Y	Y (7)	Y (184)	29	Y (4.5)	Y (1–7.4)	100		100[2]
Insung No. 1	20/12–12/3/08	Spanish	N	Y (7)	Y (150)	10	Y (5)	N (1–4.5)		100	99[2]
Shinsei Maru No. 3	30/12–19/2/08	Trotline	Y	Y (7.5)	Y (151)	6	Y (5)	Y (4–6.8)	100	100	100[2]
Insung No. 2[3]	4/12–25/2/08	Spanish	Y	Y (7)	Y (150)	14	Y (5)	Y (1–6.5)	100	100	98[2]
Division 58.5.2											
Austral Leader II	25/5–28/6/08	Auto	Y	Y (7.2)	Y (150)	20	Y (5)	Y (2–7.2)	100	100	100
Janas	29/5–2/7/08	Auto	Y	Y (7)	Y (184)	29	Y (4.5)	Y (1–7.4)	100	100	100
Subareas 58.6, 58.7											
Koryo Maru No. 11	9/2–30/3/08	Spanish	Y	Y (8)	Y (170)	10	Y (4.6)	Y (2–9)	100		100

(continued)

Table 11 (continued)

Vessel name	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	24/12–14/2/08	Auto	Y	Y (7.2)	Y (170)	22	Y (4.5)	Y (1.5–7)		100	MP[2]
Janas	1/12–20/2/08	Auto	Y	Y (7)	Y (205)	18	Y (4)	Y (2–7)		100	0[2]
Jung Woo No. 2	5/12–17/2/08	Spanish	Y	Y (7.8)	Y (150)	10	Y (5)	Y (1–6.8)		100	0[2]
Ross Mar	1/12–1/2/08	Auto	Y	Y (7)	Y (152)	22	Y (5)	Y (1–7)		100	0[2]
Ross Star	14/1–1/3/08	Auto	Y	Y (7.7)	Y (155)	7	Y (5)	Y (1–7)	100	100	0[2]
San Aotea II	11/1–20/2/08	Auto	Y	Y (7.6)	Y (220)	19	Y (5)	Y (1–7.8)		100	0[2]
San Aspiring	2/12–16/2/08	Auto	Y	Y (7.5)	Y (205)	24	Y (4.7)	Y (1–8)		100	0[2]
Antartic III	8/12–8/12/08	Auto	N	Y (7)	Y (150)	10	Y (3)	N (1–6)		100	0[2]
Argos Georgia	1/12–15/2/08	Auto	Y	Y (7.6)	Y (155)	7	Y (5)	Y (7)	100	100	0[2]
Argos Helena	1/12–11/2/08	Auto	Y	Y (8)	Y (150)	13	Y (5)	Y (9)		100	MP[2]
Argos Froyanes	1/12–28/2/08	Auto	Y	Y (7.5)	Y (150)	10	Y (2)	Y (7.7)	100	100	0[2]
Hong Jin No. 707	3/12–19/2/08	Spanish	Y	Y (7)	Y (150)	25	Y (5)	Y (1–6.5)	100	100	0[2]
Yantar	10/1–10/3/08	Trotline	Y	Y (7)	Y (150)	7	Y (5)	Y (6.5)	100	100	0[2]

1 The *Punta Ballena* did not deploy the bird-scaring device during six hauls due to extreme weather which caused it to become unsafe to use.
2 Conservation measure not applicable in this area.
3 These vessels also conducted a small amount of fishing in Subarea 88.1 during this cruise.

Table 12: Summary of recommendations from SC-CAMLR-XXVII/10, 12 and SC-CAMLR-XXVII/BG/8, 10, 11, 12, and the Scientific Committee's recommendations last year to France (SC-CAMLR-XXVI, paragraph 5.6).

	Scientific Committee or French recommendation	Description	Status	Comments/notes
1	SC-CAMLR-XXVI, 5.6(i)	Observer data	In progress	Additional data are being recorded: details of the deployment of a haul-mitigation device, characteristics of streamer lines, and line sink rates.
2	SC-CAMLR-XXVI, 5.6(ii)	Petrel population analysis	Completed	SC-CAMLR-XXVII/BG/8 is the completed analysis; France submitted all the required documents to ad hoc WG-IMAF in 2008 and will submit an English version to WG-SAM for its 2009 meeting.
3	SC-CAMLR-XXVI, 5.6(iii)	Raw by-catch data	Completed	This year, France has submitted the full set of data from the 2007/08 fishing season.
4	SC-CAMLR-XXVI, 5.6(iv)	Analysis of vessel specific issues	Completed	See SC-CAMLR-XXVII/12 and BG/10.
5	SC-CAMLR-XXVI, 5.6(v)	Broaden set of measures used, particularly during haul	In progress	Implementation of an effective Brickle curtain (haul mitigation) on all vessels; management of offal has been modified since September 2008, offal can only be discharged between hauls; improving streamer line construction to meet CCAMLR standards.
6	SC-CAMLR-XXVI, 5.6(vi)	Further research with WG-IMAF	Ongoing	Close collaboration between TAAF and IMAF. Implementation of an independent working group with fishermen, scientists and the TAAF administration.
7	SC-CAMLR-XXVI, 5.6(vii)	Redirection of management based on data analysis	Ongoing	Improvements to streamer lines, haul mitigation devices, and offal management practices; additional data collection and analysis will inform other possible management options; weekly by-catch reports from vessel observers (daily reports during the breeding seasons of both the grey and the white-chinned petrel).
8	SC-CAMLR-XXVI, 5.6(viii)	Submit action plan	Completed	SC-CAMLR-XXVII/8 submitted and being implemented.
9	SC-CAMLR-XXVI, 5.6(ix)	Submit paper on regulatory requirements	Completed	SC-CAMLR-XXVII/BG/11

(continued)

Table 12 (continued)

	Scientific Committee or French recommendation	Description	Status	Comments/notes
10	SC-CAMLR-XXVII/12 (DeLord et al. study on environmental, spatial, temporal and operational effects 2003–2006)	Fishery closure during critical chick-rearing periods for both petrel species – 15 February to 15 March and 50 days in part of May and all of June	In progress	The one-month closure 15 February to 15 March (2003 to 2008) will be extended from 1 February to 10 March in 2009. There is no specific fishing closure during the grey petrel's chick-rearing period. There is a possibility that certain sectors might be closed during periods when mortality peaks in these areas (SC-CAMLR-XXVII/BG/11).
11	SC-CAMLR-XXVII/12	Controlled effort in seasons	In progress	Fishing closure from 1 February to 10 March 2009. Possibility exists to close the most sensitive sectors, move the fishing vessels, or reduce hook effort.
12	SC-CAMLR-XXVII/12	Minimise seabird access to baits (e.g. heavier IWL, 150 g m^{-1})	In progress	All vessels have been required to use IWL (50 g m^{-1}) since 2005, which allows a sink rate greater than 0.2 m s^{-1} (CCAMLR standard). IWL heavier than 50 g m^{-1} is not practicable or possible. Application of manual weights onto IWL during periods of highest risk is being considered. Recording the line sink rates on all vessels during the next two seasons will be done.
13	SC-CAMLR-XXVII/12	Minimum three streamer lines	Completed	Regulations are imposed to use a minimum of two streamers lines on all vessels, but in general three or more streamer lines are used.
14	SC-CAMLR-XXVII/12	Haul mitigation device	Completed	All vessels required to use a haul-mitigation device (e.g. Brickle curtain).
15	SC-CAMLR-XXVII/BG/10 (Waugh et al. cooperative study)	*Line setting*	In progress	*Recommendation*[1]*:* **Increase aerial coverage**, *increase sink rate of lines*, *add weights at high-risk times*, **reduce/eliminate fisheries waste discharge**, *underwater setting*, **batch dumping of offal**, **waste management strategies,** e.g. **storage during hauls and discharge between hauls,** mincing, mealing.
16	SC-CAMLR-XXVII/BG/10	*Haul mitigation*	In progress	*Recommendations*[1]*:* **improve Brickle curtain**, **use CCAMLR reporting procedures**, **reduce/eliminate waste discharge during hauling**, **batch offal dumping**, *active research program*, **study to tailor Brickle curtain design for vessels**.

(continued)

Table 12 (continued)

	Scientific Committee or French recommendation	Description	Status	Comments/notes
17	SC-CAMLR-XXVII/BG/10	*Hook discards*	In progress	*Recommendations*[1]*:* **increase awareness**, **outreach posters**, *improve filtering/waste treatment systems.*
18	SC-CAMLR-XXVII/BG/10	*Waste management*	In progress	*Recommendations*[1]*:* **batch dumping**, **offal retention during hauls and discharge between hauls**, *improve factory filtering system*, *test batching regimes.*
19	SC-CAMLR-XXVII/BG/10	*Haul curtains*	In progress	*Recommendations*[1]*:* **install structure needed to set up haul curtain**, **use design and custom fit for vessel which resembles the New Zealand type**, **use haul curtains at all times during hauling**.
20	SC-CAMLR-XXVII/BG/10	*Information flow*	Ongoing	*Recommendations*[1]*:* **reinforce exchange between CCAMLR and TAAF**, **establish working group to advise TAAF**, **continued exchange between TAAF and scientists**, *exchange of personnel between French vessels and New Zealand or Australian vessels.* **WG-IMAF scientists reviewed cooperative study proposal and several participated in study. TAAF has participated at annual WG-IMAF meetings since 2003**.
21	SC-CAMLR-XXVII/BG/10	*Strategic framework*	Ongoing	*Recommendations*[1]*:* **Develop a strategic action plan that includes: by-catch reduction objectives, uptake of best-practice measures**, **specialist by-catch working group, research program, penalty regime, and education and awareness raising programs**.
22	SC-CAMLR-XXVII/BG/10	*Proposed research program*	In progress	*Recommendations*[1]*:* **Develop a program to consider offal management**, **streamer line design improvements in materials and aerial extent**, **and sink rate improvements.**
23	SC-CAMLR-XXVII/BG/10	*Streamer line configuration*	In progress	*Recommendations*[1]*:* **revision of streamer materials**, **improve aerial extent**, **vessel-specific solutions,** *attach branch streamers with swivels*, *multiple streamer lines (5 or more)*, **increase attachment height to 7 m or more**, **use of outboard booms**, *consider wind direction when setting streamer line*, **carry replacement streamer lines and materials on board**.

[1] **Bold indicates item completed or under way.** *Italics indicates item is under consideration.* Regular font indicates no action has been taken.

Table 13: List and priority observer tasks for WG-IMAF.

User group	Data type	Description	Use	Optimal collection	Practical limitations
IMAF	Incidental mortality (high priority)	Record mortality of seabirds and marine mammals.	Estimate seabird and marine mammal mortalities within the Convention Area caused by fishing.	Observe all krill trawl hauls and appropriate proportions of finfish trawl hauls and longline hooks hauled as defined in Tables 14 and 15.	Time constraints Safety considerations Poor weather conditions
	Seabirds and marine mammal interactions with fishing gear (high priority)	Record entanglement and injury to seabirds and marine mammals.	Estimate seabird and marine mammal mortalities within the Convention Area caused by fishing.	Observe all krill trawl hauls and appropriate proportions of finfish trawl hauls and longline hooks hauled as defined in Tables 14 and 15.	Time constraints Safety considerations Poor weather conditions
		Trawl warp strikes.	Estimate risk of trawl warp strike interactions with seabirds within the Convention Area.	At least one warp strike observation per 24-hour period.	Time constraints Safety considerations Poor weather conditions
		Interaction of marine mammals with fishing vessels and gear.	To assess ecological impact of depredation.	Once per haul observation period (in conjunction with haul observations).	Time constraints Safety considerations Poor weather conditions Poor visibility
	Implementation of mitigation measures (medium priority but also required by SCIC)	Description and specification of mitigation measures (L2 data).	To assess the performance of the measures to review attainment of minimum requirements.	Once every seven days (in conjunction with sink rate tests).	Night setting limits ability to assess aerial extent Poor weather conditions Safety considerations
		TDR and bottle tests (L10 data).	To assess sink rates.	One test per 24-hour period and four tests on a single longline once per seven-day period (in conjunction with mitigation observations).	Poor weather conditions Night setting for bottle tests Safety considerations

Table 14: Summary of assessment of risk posed to seabirds from net entanglements in pelagic finfish trawl fisheries in the Convention Area (see also Figure 1).

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 codend 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 codend 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 15: Summary of assessment of risk to seabirds posed by longline fisheries in the Convention Area (see also Figure 1).

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 100% of sets[3]
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 100% of sets[3]
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] 100% of sets[3]
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] 100% of sets[3]
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 sets[3]

[1] Conservation Measure 25-02 with the possibility of exemption to paragraph 5 as provided by Conservation Measure 24-02.
[2] This is likely to require the presence of two observers.
[3] Observers are requested to record whether seabird mitigation is in place at least once per set and verify that no offal is being discharged.

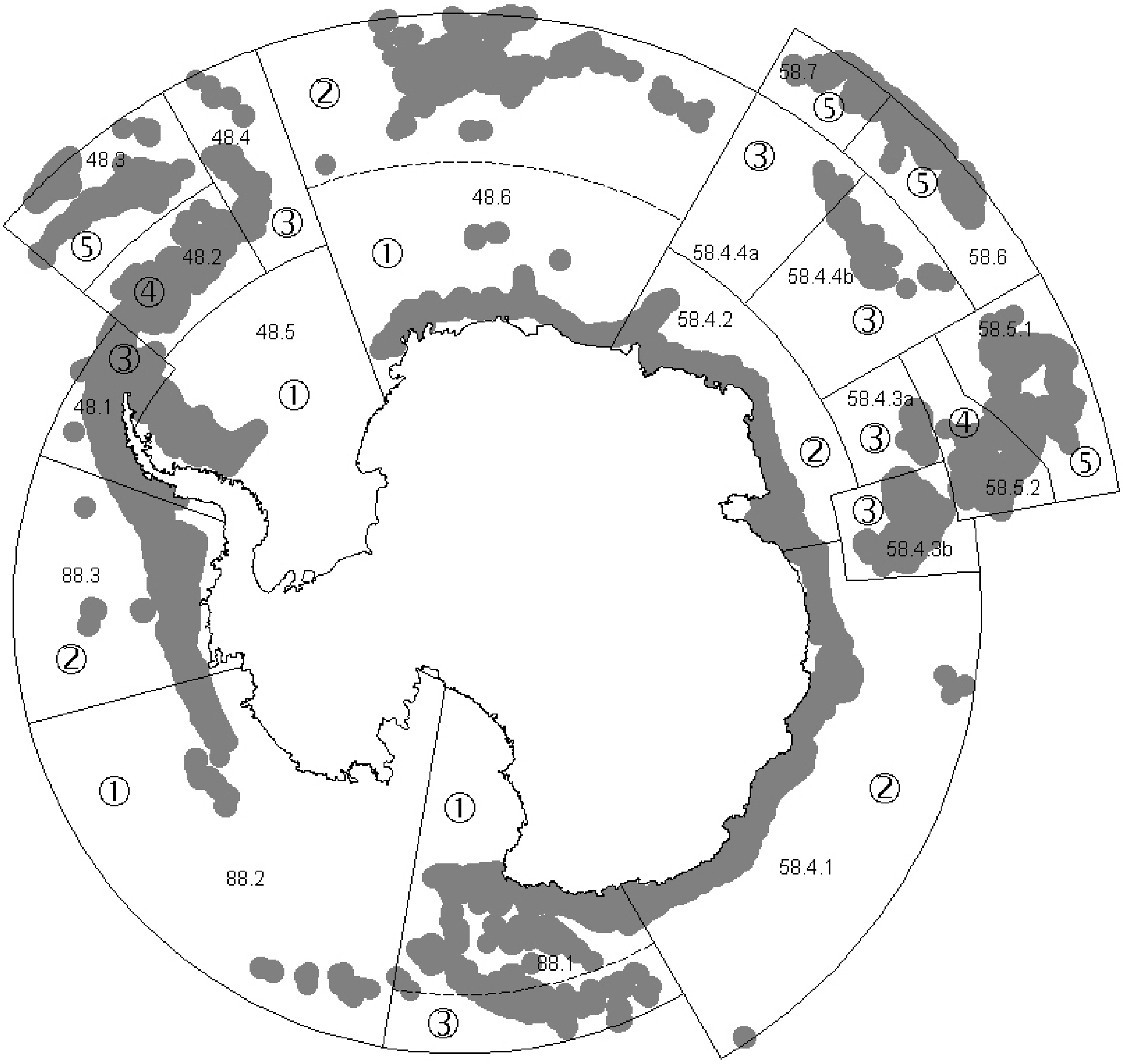

Figure 1: Assessment of the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries within the Convention Area. 1: low, 2: average to low, 3: average, 4: average to high, 5: high. Shaded patches represent seabed areas between 500 and 1 800 m.

APPENDIX A

AGENDA

Ad Hoc Working Group on Incidental Mortality Associated with Fishing
(Hobart, Australia, 13 to 17 October 2008)

1. Preliminaries and intersessional work of ad hoc WG-IMAF

2. Incidental mortality of seabirds and marine mammals in fisheries in the Convention Area
   - 2.1 Seabirds
     - 2.1.1 Longline
     - 2.1.2 Trawl
     - 2.1.3 Other
   - 2.2 Marine mammals
     - 2.2.1 Longline
     - 2.2.2 Trawl
     - 2.2.3 Other
   - 2.3 Information relating to the implementation of Conservation Measures 25-02, 25-03, 26-01 and 24-02

3. Review of action plans to eliminate seabird mortality
   - 3.1 French EEZ

4. Incidental mortality of seabirds and marine mammals in fisheries outside the Convention Area
   - 4.1 Longline
   - 4.2 Trawl
   - 4.3 Other

5. Incidental mortality of seabirds and marine mammals during IUU fishing in the Convention Area

6. Research into and experience with mitigation measures
   - 6.1 Longline
   - 6.2 Trawl
   - 6.3 Other

7. Observer reports and data collection

8. Research into the status and distribution of seabirds

9. Assessments of risk in CCAMLR subareas and divisions

10. Incidental mortality of seabirds and marine mammals in relation to new and exploratory fisheries
    - 10.1 New and exploratory fisheries operational in 2007/08
    - 10.2 New and exploratory fisheries proposed for 2008/09

11. International and national initiatives relating to incidental mortality of seabirds and marine mammals in fishing
    11.1 Coordination with ACAP
    11.2 International initiatives
    11.3 National initiatives

12. Marine debris and its impacts on marine mammals and seabirds in the Convention Area

13. Interaction with other Scientific Committee working groups

14. Fishery reports

15. Streamlining the work of the Scientific Committee

16. Other business

17. Adoption of the report and close of the meeting.

APPENDIX B

LIST OF PARTICIPANTS

Ad Hoc Working Group on Incidental Mortality Associated with Fishing
(Hobart, Australia, 13 to 17 October 2008)

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ANNEX 7

REPORT OF THE WORKING GROUP ON STATISTICS, ASSESSMENTS AND MODELLING
(St Petersburg, Russia, 14 to 22 July 2008)

CONTENTS

REPORT OF THE WORKING GROUP ON STATISTICS, ASSESSMENTS AND MODELLING
(St Petersburg, Russia, 14 to 22 July 2008)

INTRODUCTION

Opening of the meeting

1.1 The second meeting of WG-SAM was held at Giprorybflot (State Research and Design Institute for the Development and Operation of Fishing Fleet), St Petersburg, Russia, from 14 to 22 July 2008. The meeting was convened by Dr A. Constable (Australia).

1.2 Prof. V. Romanov, General Manager, Giprorybflot, welcomed the participants and provided an overview of the Institute's function. The Institute is a leading research and development centre for the fishing industry, and was directly involved with the construction and operation of the fishing fleet of the former Soviet Union. Giprorybflot's activities span more than 70 years, and include the design of fishing vessels, equipment and processing plants, the development of technical specifications and industry standards, and research in the fields of post-harvest technology, computer science and information systems.

1.3 Dr Constable thanked Prof. Romanov for his warm welcome, and Giprorybflot for hosting the meeting with the support of the State Committee for Fisheries. Dr Constable also welcomed the participants (Appendix A).

1.4 The Working Group paused in memory of Dr Edith Fanta who passed away in May 2008. Dr Fanta will be remembered for her contributions to Antarctic science, and her gentle and dedicated leadership of the Scientific Committee which she chaired from 2005 until her death, and the guidance which she provided to the working groups.

Adoption of the agenda and organisation of the meeting

1.5 The provisional agenda was discussed and adopted without change (Appendix B).

1.6 Documents submitted to the meeting, and WG-EMM documents referred by the authors for consideration by WG-SAM, are listed in Appendix C. At the request of the Convener, the papers from the WG-EMM Predator Survey Workshop (Hobart, Australia, 16 to 20 June 2008) were submitted to WG-SAM for information and consideration under Item 5.2 (Krill-based food-web models).

1.7 WG-SAM also agreed to consider the technical contents of two papers (WG-EMM-08/30 and 08/44) which had been submitted after the deadline for document submission to WG-SAM.

1.8 WG-SAM's deliberations under the krill-related Items 5.2 (Tools for population, food-web and ecosystem modelling) and 6.3 (Evaluation of management strategies) were led by Dr C. Jones (former Convener of WG-SAM) because of Dr Constable's direct contributions to the development of ecosystem-based management procedures (WG-SAM-08/15 and 08/16).

1.9 The report was prepared by Drs D. Agnew (UK) and A. Brandão (South Africa), Mr A. Dunn (New Zealand), Drs P. Gasyukov (Russia), M. Goebel (USA), S. Hanchet (New Zealand), S. Hill (UK) and R. Hillary (UK), Mr J. Hinke (USA), and Drs C. Jones (USA), S. Kasatkina (Russia), S. Kawaguchi (Australia), D. Middleton (New Zealand), É. Plagányi (South Africa), D. Ramm (Data Manager), K. Reid (Science Officer), C. Reiss (USA), G. Watters (USA) and D. Welsford (Australia).

PARAMETER ESTIMATION

Parameters used in toothfish assessment

2.1 The Working Group considered WG-SAM-08/8 and 08/14 under this agenda item. The Working Group agreed that the details of the discussion of WG-SAM-08/8 be contained under Item 3.2 (paragraphs 3.16 to 3.25) and of WG-SAM-08/14 under Item 5.1 (paragraphs 5.1 to 5.8).

Size and weight data for toothfish in East Antarctica

2.2 Dr V. Bizikov (Russia) presented WG-SAM-08/9 on behalf of the authors, describing a study conducted on *Dissostichus mawsoni* captured SSRU 5841G. The paper described the results of using factory-measured weights of processed individual toothfish, in combination with conversion factors and length–weight relationships, to derive a length frequency for the whole catch (2 000 fish). This differed in some respects, particularly in the numbers of fish between 50 and 90 cm length, with the length frequency measured by the scientific observer (300 fish).

2.3 Given the disparity at the smaller sizes between the measured fish by observers and reconstructed fish lengths, the possibility of whether smaller fish were detected by the observers was raised. In response, it was noted that the rarity of small fish means that they may be missed by observers but are caught in the processed fish, given the higher number of measurements of processed fish.

2.4 The Working Group also considered that the observer data may demonstrate a systematic bias, for instance if scientific samples were obtained from the deeper sections of a longline or if smaller fish are preferentially selected for tagging and therefore removed from length-frequency samples. The Working Group encouraged work by Members to investigate the potential for such biases arising in observer datasets.

2.5 The Working Group further noted that previous work by WG-FSA showed that the length of fish being processed is an important factor to consider when estimating conversion factors (SC-CAMLR-XXI/BG/27), and therefore that conversion factors as a function of size would need to be considered when reconstructing size distributions from processed toothfish.

2.6 The Working Group encouraged Members to submit studies on the effect of fish length on conversion factors from *Dissostichus* spp. fisheries.

2.7 The Working Group also requested that WG-FSA consider the impacts of using reconstructed size distributions in fishery assessments as described above, and requested that TASO consider the feasibility of collecting all individual processed weights from longline vessels throughout the Convention Area.

Seabed areas in Subarea 48.3

2.8 Dr Agnew presented WG-SAM-08/10, describing the development of an updated bathymetric dataset for South Georgia and Shag Rocks, based on the use of bathymetric data arising from multi-beam swath mapping from research vessels, and single-beam echo soundings from fishing and research vessels.

2.9 The Working Group noted that this newly compiled dataset has been used to update seabed area estimates for the shelf <500 m deep, and will be used to refine biomass estimates of demersal fish species from trawl surveys, and to assist with the appropriate depth stratification of such surveys. The revised dataset indicated that point estimates of depth on previous charts were inaccurate, and the seabed areas calculated and used in previous surveys were between 0.9 and 1.33 times the values calculated from the revised dataset.

2.10 The Working Group recommended that Members consider collating bathymetric data to develop updated bathymetric grids for other areas where recent multi-beam data or single-beam echo soundings exist and trawl surveys are conducted.

STOCK AND BIOLOGICAL ASSESSMENT METHODS

Exploratory fisheries in Area 58

3.1 Dr Agnew introduced WG-SAM-08/4 which applied four different approaches to estimating stock size in Divisions 58.4.1 and 58.4.2: comparative CPUE analysis, local depletions, a constant recruitment population model and mark–recapture data. The analysis presented in WG-SAM-08/4 also contributed to understanding other issues of importance to the assessment, such as stock identity and recruitment. However, it was noted that some of the records of *D. eleginoides* in these divisions may be mis-identified *D. mawsoni*.

3.2 The least successful approach used mark–recapture data: very few tags have been returned from this fishery, despite 3 000 releases, suggesting much larger population sizes compared to the other three methods. Clearly, some of the assumptions of the method are not correct; for instance, fish could be moving rapidly away from the SSRUs where they are tagged (two of the four recaptured fish have moved between SSRUs, one travelling 150 km and one 1 690 km after 1 year at liberty), natural and tag-induced mortality rates might be higher than anticipated, fishing may still be too localised to effectively recapture tags, or there may be implementation problems causing the data to be of variable quality.

3.3 The comparative CPUE analysis utilises the fact that some vessels have fished both in the Ross Sea and Divisions 58.4.1/58.4.2. It assumes that catchability by these vessels in both areas is the same, so that standardised CPUE from SSRUs in Division 58.4.1/58.4.2 can be translated into estimated density of toothfish by comparison to the estimated density in the Ross Sea. The depletion analysis utilises local depletions of toothfish in small regions within SSRUs to estimate biomass and density in these regions. Both methods rely on calculations of fishable area within SSRUs to estimate total population biomass.

3.4 WG-SAM encouraged further development of these approaches to explore and characterise the uncertainty in the assessments that could be used by WG-FSA to consider appropriate precautionary catch levels. In particular, uncertainty in CPUE, biomass estimates, fishable area and toothfish density distribution across an SSRU should be characterised.

3.5 The characterisation of uncertainty in fishable area and density distribution will be difficult. WG-SAM-08/4 assumed that the area between 500 and 2 000 m in an SSRU is the fishable area and that the density encountered by the fleet applies evenly across the fishable area of an SSRU. However, in most cases the actual fishing pattern has been restricted to a small part of the fishable area between 800 and 1 800 m, and there is very little information from which to understand the distribution of toothfish density across the entire fishable depth range of an SSRU. It is suspected that toothfish density is not uniform across the area, and is most likely higher in the areas that have been selected by the fleet for fishing.

3.6 WG-SAM-08/5 detailed both a generic methodology of performing stock assessments in situations where data are limited (in terms of age/length structure and numbers of tags released and recaptured) that could form a bridge between the initialisation of data collection and tagging programs, and the point at which these data are usable in terms of an age/length-structured stock assessment. As an example of the potential usefulness of the approach, an initial assessment of *D. eleginoides* in Division 58.4.3a incorporating catch data (legal and IUU estimates) and the available mark and recapture data was undertaken.

3.7 While general support was given for the approach, there was a clear understanding that, when performing assessments on such limited data, care is needed to avoid the potential of errors in key data, such as fish recaptures, having a large influence on the assessment results and any potential catch limits set. With respect to the results for *D. eleginoides* from Division 58.4.3a, it was noted that, even when considering the potential for small errors in the key data, a catch limit of 250 tonnes that is currently set in this area might be too high, given the catch limits coming from the assessment (assuming a contained stock with mixed tagging data) did not exceed 120 tonnes.

3.8 The Working Group agreed that prior uncertainty in the Pella-Tomlinson shape parameter should be considered in future applications of the approach described in WG-SAM-08/5.

3.9 WG-SAM-08/6 presented a simple method by which catch limits and tagging rates (per tonne of fish landed) might be balanced to best achieve a sufficiently accurate abundance estimate from a tagging program. To test the model, the predicted variation in toothfish abundance in Subarea 48.3 was compared between this method and the variation coming from the actual stock assessment. The results were comparable, but demonstrated that the model would likely be a slight underestimator of the predicted CV in abundance. However, it was noted that information on 'additional' variance from the stock assessments could provide a suitable conversion factor with which to account for this apparent underestimation of uncertainty. As a more direct application of the model, initial stock size estimates and tagging rates for toothfish in Subarea 48.4 were used to assess whether the current catch limit (100 tonnes) would give a predicted abundance CV of around 30%, and it was found that this would be likely to achieve a CV of this level.

3.10 The Working Group agreed that an approach to managing new and exploratory fisheries, with these kinds of emerging stock assessment datasets, might be able to be developed by using all three of the approaches detailed in WG-SAM-08/4, 08/5 and 08/6. Relative CPUE analyses might be used to give approximate initial estimates of biomass from which the tagging rate and catch limit can be adjusted. This would enable fishing to proceed and would deliver tagging data that can be used in an initial stock assessment from which the catch limit can be adjusted from a more informed position. Eventually data would be obtained with which a more realistic age/length-structured assessment can be performed. Members were encouraged to submit to WG-FSA further analyses on these approaches, along with discussions on how to account for uncertainty in the orderly development of exploratory fisheries.

Ross Sea toothfish

3.11 Dr Agnew presented WG-SAM-08/7 which analysed tag data from the Ross Sea toothfish fishery. A dataset of all possible combinations of release nation, recapture nation, release year and recapture year for tags released and recaptured in the same SSRUs on the slope of Subarea 88.1 was compiled for the years 2003–2006. Recapture rate was expressed as tags captured/tags released/fish scanned (caught). The paper used regression techniques to determine the effects of release nation and recapture nation on the reported tag-recapture rates.

3.12 There was a large number of combinations of release year, recapture year, SSRU, release nation and recapture nation, with 193 recaptures available for the analysis. The paper noted that fishing had not been consistent enough between nations, locations and over time to allow the analysis to be definitive. In many cases, release or recapture nation effects were not significant. However, in the cases where significant differences existed, recapture rates were usually highest with released and recaptured fish from New Zealand vessels, and there was some evidence for suggesting that recapture rates were highest when the nation releasing and recapturing the tagged fish was the same.

3.13 The Working Group thanked the author for carrying out the analysis and noted that the results supported and extended those reported by New Zealand scientists at WG-FSA-2007 (WG-FSA-07/40). Both analyses suggested that nation effects contributed to the high variability in tag-recapture rates. Dr Hanchet suggested that it might be useful to examine the variability in tag-recapture rates at South Georgia, to determine whether the observed variability in the Ross Sea was consistent with that experienced in other parts of the Convention Area.

3.14 There were several suggestions for examining and/or improving detection rates. These included the use of PIT tags on a subset of tagged fish, using a rewards system to encourage reporting of tags, and direct experimentation to compare recapture rates from vessels fishing side by side. There was general support for these approaches but it was noted that they could affect the vessel behaviour with respect to reporting rates. The Working Group referred these points for discussion to TASO and WG-FSA.

3.15 The Working Group noted that the current assessment in the Ross Sea used tag data from New Zealand vessels only and agreed that it was important to consider data from other vessels. However, given the strong nation effects in the model, and other possible data quality issues, it was difficult to determine what additional fleets should be included in future assessment runs. It was also noted that such data quality issues were likely to be at the vessel level rather than at the nation or fleet level.

3.16 Dr Gasyukov presented WG-SAM-08/8 which described and compared some properties of the TISVPA model presented in the paper by Drs V. Vasiliev and K. Shust (Russia), and the CASAL model. The paper discussed some of the advantages of the estimation methods of the TISVPA as compared with CASAL. The authors noted that the methods of estimation used in TISVPA were designed to allow robust estimation of parameters using median absolute deviations and winsorisation. The authors noted that these methods can have some advantages over more traditional methods using likelihoods, can be more effective in cases where data are noisy or contain a large number of outliers, and results from the use of such methods may be more robust and less prone to bias. However, the authors also noted that the current implementation of TISVPA had some difficulties combining the various components of the objective function, as is currently done with CASAL.

3.17 The paper proposed to evaluate the TISVPA and CASAL models using parameters used for *D. mawsoni* in the Ross Sea. The authors noted that it would be necessary to either develop an operating model (OM) for *D. mawsoni* in the Ross Sea, or use existing simulation software to simulate datasets with errors arising from various statistical processes. These data could then be used to carry out comparisons of the performance of both models, and to assist the Working Group in understanding the reasons for different estimates of stock size and resulting catch limits from the models. The paper proposed that the Working Group consider development of a new approach that could lead to an agreed assessment method that included both robust estimation methods (TISVPA features) and statistically correct integration of data using likelihoods (CASAL features).

3.18 Dr Gasyukov noted that the CASAL model had been thoroughly tested by New Zealand scientists and WG-FSA, and has been used to assess stocks in both New Zealand and CCAMLR. The TISVPA model has been thoroughly tested by the ICES working groups on stock assessment methods and has been included in the list of available software for use by ICES working groups. Dr Gasyukov also noted that it was important to understand the reasons that the models had given different estimates of stock status when applied to data from the same region.

3.19 Dr Hillary agreed that robustness to data outliers was important in assessments. However, he considered that the concerns noted in the paper related more to normal likelihoods than to the overdispersed multinomial and binomial likelihoods used in CASAL. He also questioned the citation of Hillary and Agnew (2006) as that reference did not provide a method for calculating absolute abundance from tag data.

3.20 The Working Group noted that it was unclear whether the differences in results from the TISVPA and CASAL models arose due to model differences, differences in the input data, differences in the weights given to different datasets, or a combination of these factors.

3.21 Dr Jones noted that in 2007, WG-SAM had given general guidance on the process to be followed in the review of new methods (SC-CAMLR-XXVI, Annex 7, paragraph 6.3). Furthermore, WG-FSA had given specific guidance on the information that would have to be provided for WG-SAM to adequately review the TISVPA method (SC-CAMLR-XXVI, Annex 5, paragraph 4.27):

(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 need to be analysed using CASAL and the TISVPA 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 TISVPA 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.

3.22 The Working Group agreed that this had not been carried out and, in the absence of the authors, was therefore unable to complete an evaluation of the TISVPA method.

3.23 The Working Group agreed that it was often informative to carry out assessments using alternative models. It recalled that it had previously completed detailed comparisons of CASAL and ASPM assessments of toothfish in Subarea 48.3. In this instance, when the models were provided with identical datasets, the model outputs were very similar. The Working Group noted that it was important that the models were provided with identical data and that the subsequent treatment and fitting of those data within the models was well understood.

3.24 Dr Constable noted that in WG-SAM-08/8 the authors of the TISVPA method had indicated their commitment to the process requested by WG-SAM and should be encouraged to provide the information required for WG-SAM to review the method fully at its next meeting. He also noted that the use of simulated data from an OM was an important aspect of the validation process, and that simCASAL (Bull et al., 2008) could be used for this purpose.

3.25 The Working Group reiterated its advice from last year and recommended that the authors carry out the program of work required for evaluation of the model outlined by WG-FSA.

3.26 Dr Middleton presented WG-SAM-08/13 which developed metrics related to the quality of fishing event, catch and biological sampling data from fishing trips. Application of these metrics to data from the Ross Sea toothfish fishery illustrated the sometimes substantial variation in the quality of data from different trips. A cluster analysis of the metrics identified two groups of trips. Tag-recapture rates from trips classified into one group were consistently and substantially higher than those of the other group.

3.27 It was proposed that these measures could be used in two ways. First, individual metrics may provide useful guidance on the use of particular datasets from trips in an assessment. The Working Group noted that the quality of data required would vary depending on the nature of the analysis, and that the effects of variation in data quality would have to be considered on a case-by-case basis. Second, that a clustering analysis of the measures collectively may also provide an objective basis for the selection of the tagging dataset to be used in a particular assessment.

3.28 Dr Watters noted that the recorded catch diversity may be a useful proxy for the attention given to the scanning for tag recoveries. The Working Group encouraged the further development of the methodology, in conjunction with that of WG-SAM-08/7, to provide a basis for selecting tag datasets for assessments. The Working Group recommended that WG-FSA provide specific guidance on the metrics considered most useful for distinguishing data quality with respect to assessments.

3.29 Dr Constable suggested that rather than eliminating data, it may be possible to include both groups in an assessment as different fisheries. In the first instance, sensitivity tests, using the different datasets separately and combined, could be used to explore the degree to which the assessment might be impacted by these differences. Mr Dunn agreed that this may be feasible in the medium term. Dr Agnew supported further evaluation of the effects of retaining poorer-quality data in assessments. The Working Group agreed that this was a useful approach and recommended that further work be carried out during the intersessional period to identify alternative datasets which could be used in the next assessment of the Ross Sea toothfish fishery.

3.30 The Working Group noted that the methodology would have uses beyond the selection of data for stock assessment. These include the use of fishery data by other working groups, such as WG-EMM, and the performance management and training of observers. The Working Group also considered that a centralised system of data quality assessment by the Secretariat may provide both for rapid feedback on the quality of data from individual trips, and simplify the determination of data quality by other working groups. The Working Group recommended that ad hoc TASO consider the issues raised by the paper.

Management advice

3.31 The Working Group referred suggestions for examining and/or improving detection rates for discussion to ad hoc TASO and WG-FSA (paragraph 3.14).

3.32 The Working Group recommended that WG-FSA provide specific guidance on the metrics considered most useful for distinguishing data quality with respect to assessments (paragraph 3.28).

3.33 The Working Group recommended that ad hoc TASO consider the issues raised by WG-SAM-08/13 on data quality (paragraphs 3.26 to 3.28).

Krill

3.34 Dr Kasatkina presented WG-SAM-08/P1 which outlined proposals on krill survey data processing. The application of an Aitcheson delta distribution is proposed for estimating statistical characteristics of trawl survey catch values including the mean, standard deviation, confidence intervals and probability density function (delta distribution). This involved post-stratifying the survey area to determine strata of equal probability to detect certain values of krill biomass density. Delineation of such strata for specified krill densities should be made using PDFs from survey data. It is suggested that subsequent biomass estimation and summarising through delineated strata will improve accuracy of survey results.

3.35 Dr Kasatkina also presented WG-SAM-08/P2 which further indicated that representative sampling can only be made within areas with statistically homogeneous distributions of marine organisms. The author proposed to include stratifying a forthcoming survey area to provide strata with statistically homogeneous distributions of target species based on data from previous observations, and to allocate sample effort among these strata. This paper recommended minimising error in acoustically derived density estimates using methods of statistical averaging if a random component of error is more than twice its regular component.

3.36 Dr Agnew questioned whether some of the proposals outlined in WG-SAM-08/P1 could be used for analysis of catch data from commercial fisheries. However, the Working Group was unable to interpret the document in order to establish this possibility.

3.37 Since WG-SAM-08/P1 and 08/P2 were presented in Russian, the Working Group encouraged the author to prepare a combined manuscript in English for the next meeting of WG-SAM, with examples of analyses included to allow a comparison of proposed and traditional data processing methods. Comparing data from the traditional method and this method may be useful to try to understand what the advantages of a trawl survey might be and how that might improve on an acoustic survey.

Seals, penguins and flying seabirds

3.38 Dr Goebel reported on the Predator Survey Workshop held in Hobart, Australia, 16 to 20 June 2008. The workshop was convened by Dr C. Southwell (Australia) and was attended by 17 participants. Twelve papers were considered at the workshop covering topics relating to penguins, seals and flying seabirds. The 11 species considered at the workshop were selected based on overall abundance and krill consumption estimated in Croxall et al. (1985): penguins (4), seals (2) and flying seabirds (5). They were reviewed with respect to biology as it pertained to abundance estimates, distribution, uncertainties in estimation procedures and gaps in our current knowledge. The workshop concluded with four categories of recommendations to WG-EMM. These were: immediate (10), short-term intersessional (4), medium-term intersessional (4), and future work (4). Future work included considerations beyond estimating abundance of predators to estimating prey consumption for each species of predator. The full report was available as WG-EMM-08/8.

ADVICE ON METHODS FOR USE IN WORK OF SC-CAMLR

Research designs in exploratory fisheries

4.1 The exploratory research plan for Divisions 58.4.1 and 58.4.2 was designed to concentrate fishing in alternate SSRUs in an attempt to develop a better understanding of the distribution of toothfish in these areas and to develop mark–recapture-based assessments. The first objective has been partially met, but despite almost 3 000 tags having been released, recapture rates are much lower than would be expected and the tag data currently suggest much higher population sizes than any of the alternative methods presented in WG-SAM-08/4. Some of the assumptions in the mark–recapture experiment are clearly not being met (see paragraph 3.2).

4.2 The Working Group therefore advised WG-FSA that, given the current results, the mark–recapture data are unlikely to provide accurate assessments of local abundance or stock size in the short term. Tagging should continue, however, so that if tag mortality and movement parameters are better understood in the future, these data may be utilised in either integrated assessments (such as the CASAL assessments being undertaken in the Ross Sea) or the methods described in WG-SAM-08/5.

4.3 The Working Group advised that WG-FSA could consider providing management advice for Divisions 58.4.1 and 58.4.2 using comparative CPUE and local depletion methods (WG-SAM-08/4) as a basis for developing preliminary assessments in the short term, with the modifications noted in paragraphs 3.4 and 3.5. The Working Group requested that WG-FSA also consider methods to acquire additional information necessary to develop these methods further. This may include defining specific research plans, including set positions and consistent gear configurations for research hauls, to obtain improved information about the density distribution of toothfish across SSRUs and within likely fishing grounds.

4.4 In respect of Division 58.4.3a, WG-SAM recommended that the methods described in WG-SAM-08/5 could be used this year to provide management advice for the *Dissostichus* spp. fishery in this division.

4.5 The Working Group also discussed the value of the 10 tonne toothfish research limits as applied by commercial vessels operating in otherwise closed fisheries. The other use of these limits, to enable research trawl surveys, was not considered.

4.6 Results from WG-FSA-07 (SC-CAMLR-XXVI, Annex 5, paragraphs 5.10 to 5.23) and WG-SAM-08/6 demonstrate that 10 tonne catch levels are not high enough to provide useful mark–recapture estimates of population size, unless tagging rates are very high (more than 10 tags per tonne) and the research operation is persistent, showing commitment to fish in a single area over a number of fishing seasons.

4.7 An alternative use of the 10 tonne research operations is to explore the distribution and density of toothfish in an area. For this to be effective, the vessel's operational characteristics should be well known, it should set many short lines (5 000 hooks maximum) rather than a few long lines, and the position of lines should be determined to the extent possible in advance to conform to either a fixed position or randomised strategy with clear objectives.

4.8 Tagging at the lower rate of 3 tags tonne^{-1} is potentially useful in such research to advance understanding of toothfish movements rather than in generating estimates of stock size, but there would need to be a large number of tags before the probability of recapture of these tags would be sufficient in such studies.

4.9 Interpreting the data from 10 tonne research operations by new vessels in new areas may be difficult, but data from vessels which have a history of several years of fishing and provision of comprehensive and high-quality data in known (assessed) areas may be more readily interpreted.

Establishing precautionary catch limits in the absence of research in exploratory fisheries

4.10 The Working Group noted the difficulty encountered in using tagging data from the exploratory fisheries to develop assessments in Divisions 58.4.1 and 58.4.2 and other divisions. The Working Group proposed a procedure to be considered by WG-FSA to progress to an assessment in these and similar areas:

(i) In the absence of reliable tagging information, the methods presented in WG-SAM-08/4, utilising comparisons between assessed areas and unassessed areas and local population depletions, with the modifications to incorporate the uncertainty noted above, could be used as a proxy for an initial estimate of population density.

(ii) The method outlined in WG-SAM-08/6 could then be used to decide a suitable tagging rate.

(iii) Once tagging data are available and appropriate assumptions have been met (e.g. assumptions of mixing and overlap in the size and spatial distribution of tagged fish and those targeted routinely by the fishery), the methods presented in WG-SAM-08/5 could be used to refine the assessment until other data time series are of sufficient quality to allow the development of integrated age- or length-based assessment methods.

4.11 However, the Working Group noted that it is important that these approaches capture uncertainty adequately, as, for example, previous attempts to use seabed areas and population densities from Subarea 48.3 had resulted in a higher estimate of yield in the Ross Sea (SC-CAMLR-XIX, Annex 5, Table 32) than that obtained with the subsequent integrated assessment using tag data with the homogenous mixing assumption (SC-CAMLR-XXVI, Annex 5, Appendix I).

Approaches to minimising the effects on assessments
of changing fishing practices

4.12 The Working Group recognised that there were two situations in which fishing practices may change:

(i) In the case where change is gradual, this should be monitored and controlled, so that there is sufficient overlap between new and old gear for good estimates to be made of the relative impacts on assessments of the gear change, for instance the relative catchability or selectivity of the gear. In toothfish assessments, this overlap period should be at least five years. More rapid change-over could be achieved if some experimental trials were organised which controlled for different gear effects and increasing capability as vessels learn to use new gear types, rather than having to separate them statistically.

(ii) In the case where change needs to be rapid, such as with the introduction of a new mitigation method, this introduction will usually follow some experimental development of the mitigation method. These experiments should also be used to investigate the effect of the new method on catchability and selectivity, again controlling for as many other gear effects as possible.

Use of BRTs in bioregionalisation

4.13 Dr Hanchet provided an overview of WG-SAM-08/12, which applied a multivariate statistical technique called BRTs as a method of predicting spatial distributions from discontinuous biological data. The method allows fitting complex and scale-dependent relationships between species abundance and environmental data, and is applied to measurements of an abundant zooplankton species (*Oithona similis*) from CPR deployments, taken primarily in East Antarctica, and 13 environmental data layers. The fitted model was then used to predict zooplankton abundance and presence/absence in locations where CPR data were not available.

4.14 The authors concluded that this method was able to successfully detect and define a relationship between long-term broad-scale environmental conditions and observed patterns of biological presence and abundance for *O. similis*. They noted factors that affect the correlation between environmental data and biological distributions, and suggested that larger and longer-lived species, or species with the ability to seek preferred habitat niches, and in environments that exhibit less short- and small-scale spatio–temporal dynamics, are likely to exhibit stronger correlations with environmental data.

4.15 The Working Group generally agreed that the BRT approach is a useful method that can be applied toward bioregionalisation and biogeography, and for ecosystem modelling. However, a number of issues and concerns regarding the utility of this technique, as well as the uncertainty surrounding the extrapolation from local datasets to larger scales, were raised.

4.16 Most Working Group participants agreed that the cross-validation approach used by the authors was appropriate, and some noted that this type of cross-validation approach should be used whenever possible when this type of analysis is attempted, whether or not BRTs alone are used.

4.17 There was some concern regarding the presentation of the uncertainty when extrapolating to larger scales. The Working Group noted the box and whisker plots were useful in this regard, and it was suggested that spatial maps of the residuals might be useful to examine the patterns of bias and uncertainty in the BRT predictions. Further, it was suggested that the variability in the more global datasets that form the layers, which themselves have uncertainty, should also be included in the modelling.

4.18 The Working Group also discussed the efficacy of the environmental overlap statistic, and some members believed that a formal test of the sensitivity of these overlap curves could be useful. Others thought that this information could be inverted and used to predict what the environmental overlap might be. This could then form the basis of a formal statistical test and prediction of the BRT mapping.

4.19 The Working Group encouraged the authors of WG-SAM-08/12 to continue developing this approach and suggested that this could best be pursued through a correspondence group involving statistical experts familiar with BRTs.

Response of white-chinned and grey petrel populations to fisheries and environmental factors

4.20 Ad hoc WG-IMAF had asked for a detailed analysis of petrel population responses to fisheries and environmental factors (SC-CAMLR-XXVI, Annex 6, paragraph I.8(ii)). No papers were submitted on this specific topic; however, WG-SAM-08/P3 introduced a seabird population dynamics model as a potential tool for use by WG-IMAF.

4.21 Mr Dunn gave a presentation of WG-SAM-08/P3, a draft user manual for SeaBird, a generalised age- and/or stage-structured seabird population dynamics modelling package. While the model is still undergoing development, it has been used for the assessment of a Buller’s albatross (*Thalassarche bulleri*) population in New Zealand. The software is designed to model seabird populations and assess the effects of fishing on their variability. It was developed to integrate a wide variety of data to generate outputs that could be used to inform management decisions. The model specification is designed for flexibility, allowing a population to be structured on age, life stage, sex or behaviour (e.g. breeder or non-breeder). Interactions with fisheries can be modelled and the user can choose the sequence of events in the model years. Estimation can either be by maximum likelihood or Bayesian.

4.22 SeaBird shares many features with CASAL, in that the model is partitioned into three sections (population, estimation and output), it shares the concept of partitioning within a year (i.e. time steps less than a year), and the command-block format used for input files. Differences between SeaBird and CASAL include: concepts relating to model parameters which are fundamental and explicit in SeaBird but either limited (and implicit) or missing from CASAL; the way SeaBird treats mark–recapture observations, where the sample is not considered random and the main aim is to estimate survival and transition probabilities and not abundance; and finally, the concept of catchability in CASAL is equivalent to visibility in SeaBird.

4.23 Mr Dunn noted that, as SeaBird allowed for a great deal of flexibility in specifying population dynamics, observations and initialisation, modellers would need to exercise caution to ensure that model structure and data inputs were correctly specified. Mr Dunn also noted that the package, manual and source code were available on request and that the authors had offered their assistance if others wished to develop models using SeaBird.

4.24 The Working Group thanked the authors of WG-SAM-08/P3 for this valuable contribution.

Joint CCAMLR-IWC Workshop

4.25 Dr Constable gave a brief summary of the terms of reference and goals for the upcoming Joint CCAMLR-IWC Workshop to be held in Hobart, Australia, from 11 to 15 August 2008 referring to papers submitted for consideration by WG-EMM (WG-SAM-08/14 and 08/15). He emphasised that CCAMLR-IWC welcomed any additional attendees and was open to remote involvement, through correspondence, during the meeting. He stressed the view that the workshop is part of an ongoing process to help the development of models and provide metadata. It is envisaged that one output will be metadata that will be available on the CCAMLR website and available for all CCAMLR modellers.

4.26 Dr R. Holt (USA) expressed a concern that CCAMLR and IWC had different rules of data access and that this would have to be addressed at the workshop.

TOOLS FOR POPULATION, FOOD-WEB AND ECOSYSTEM MODELLING

Dissostichus spp. population models

5.1 Mr Dunn presented WG-SAM-08/14, the development of a spatially explicit, age-structured, statistical, catch-at-age population dynamics model for modelling movement – Spatial Population Model (SPM). SPM is an aggregate movement model suitable for use with large numbers of areas, and is implemented as a discrete time-step state-space model that represents a cohort-based population age structure in a spatially explicit manner. The model is parameterised by both population processes (i.e. ageing, recruitment and mortality), as well as movement processes defined as the product of a set of preference functions that are based on known attributes of spatial location. SPM was designed to be flexible, allow for the estimation of both population and movement parameters based on local or aggregated spatially explicit observations, and optimised for speed of computation.

5.2 A preliminary spatial movement model for *D. mawsoni* in the Ross Sea implemented in SPM was presented. The model was a single-sex model that categorised fish as immature, mature or spawning. Observations included within the model were spatially explicit commercial catch proportions-at-age and CPUE indices. The authors noted that the model results were preliminary, but that the initial outputs were encouraging. The preliminary model captured key aspects of the current understanding of *D. mawsoni* distribution, suggesting immature fish were located in the southern Ross Sea on the continental shelf, mature fish were located on the continental slope, and spawning fish were located on the northern banks of the Ross Sea. The results also suggested that parameterising of movement based on latitude, depth and distance provided a significantly better fit to the observations than a model where depth was ignored.

5.3 Mr Dunn noted that SPM is an estimation model, and allows the use of AIC/BIC or other statistics to compare between models, and that this had the potential to assist in defining plausible movement OMs for evaluating assessment models.

5.4 The Working Group noted that some aspects of the preliminary model should be developed, including the inclusion of spatially explicit tag and maturation-state data, as well as considering the impact of different levels of spatial aggregation. Some consideration could also be given to how regional variability in recruitment, catchability coefficients (q), and other processes may be included within the model. Further, that methods to derive spatially explicit sampling error values and methods to include additional process error will need to be developed.

5.5 The Working Group encouraged further development of SPM, including processes and observation classes to incorporate year-class variability, stock-recruitment relationships, as well as tag–release/recapture and maturation-state observations. The Working Group noted that the implementation of the MCMC algorithm in SPM is only partially complete, and there is some further work on parallelisation algorithms for MCMC that could be investigated. Also, in order to address the assessment model adequacy, SPM needs to be modified to allow simulation of observations from underlying movement parameters.

5.6 Finally, once adequate models for *D. mawsoni* in the Ross Sea have been developed using SPM, the current assessment model (SC-CAMLR-XXVI, Annex 5, Appendix I) should be evaluated within a simulation experiment in order to address current assessment model uncertainties.

5.7 Mr Dunn also described the methods and results from model validation, including implementation checking, development-driven unit tests and comparative software evaluation. Comparative software validation suggested that the processes within SPM replicated results derived from other population models and movement processes implemented in S+/R code.

5.8 The Working Group noted that the use of the unit-testing procedure was a useful development in the context of code development for software developed for use by the scientific working groups, and was an approach that Members could use to allow the Working Group to have some confidence that future developments will maintain the integrity of the underlying software code.

Krill-based food-web models

5.9 Three approaches have been developed for krill-based food-web modelling (EPOC, FOOSA and SMOM[1]). The Working Group considered the advances in these models, particularly with respect to their use in evaluating the subdivision of the Area 48 krill catch limit amongst SSMUs, hereafter termed 'SSMU allocation'. The following sections discuss these advances.

1 EPOC (Ecosystem, Productivity, Ocean, Climate modelling framework) Constable (2005, 2006, 2007, WG-SAM-08/15); FOOSA – formerly KPFM (Krill–Predator–Fishery Model) – Watters et al. (2005, 2006, WG-EMM-08/13); SMOM (Spatial Multi-species Operating Model) Plagányi and Butterworth (2006, 2007, WG-SAM-08/17).

Tuning models to the calendar of events

5.10 During its 2007 meeting WG-SAM proposed that, in evaluating models, it would be useful to have a calendar of reference points for Area 48. A calendar of events, also endorsed by WG-EMM (SC-CAMLR-XXVI, Annex 4, paragraph 6.45), was developed to provide a set of expectations to be met in models to be used to address the SSMU allocation, particularly regarding recent trends, based on population growth rates and timing of changes, in predator and krill population dynamics for 1970–2007 (SC-CAMLR-XXVI, Annex 7, paragraph 5.24).

5.11 Dr Hill introduced WG-EMM-08/10, which provided a quantitative translation of the calendar into numerical terms suitable for use in the models. This process had two steps. First, for the penguin, seal and whale predator populations, year- and SSMU-specific abundances were estimated from literature sources. Second, the abundance estimates were then back-calculated to 1970 and projected to 2007 using an exponential growth model based on the rates of change reported in the calendar. In the case of whales, growth rates specified in the calendar were updated with recent estimates from the published literature.

5.12 The Working Group noted that the numerical calendar provided in WG-EMM-08/10 gives a common starting point for FOOSA and SMOM, from which comparisons with the expectations of the calendar could proceed. The Working Group agreed that having a common set of starting conditions is useful for model comparison. It acknowledged that only the point estimates provided in WG-EMM-08/10 were used for conditioning FOOSA and SMOM. However, a distinction should be made between using the calendar to provide a common starting point for comparisons of historical trajectories versus using the calendar to provide a set of parameterisations on which future results will be derived.

5.13 The Working Group questioned whether aggregating predators into generic groups was appropriate and how parameters based on generic predators could be interpreted. While the Working Group recognised the need to balance model complexity with the requirement to make progress, it remains unclear whether maintaining generic predator groupings or re-parameterising a disaggregated food web presents a lesser degree of uncertainty in model results. Generally, it was suggested that disaggregating the generic predator groups could increase model complexity (hence uncertainty) due to the larger number of ecological interactions requiring parameterisation. The Working Group noted that the generic group parameters presented in Hill et al. (2007) and used in WG-EMM-08/13 and WG-SAM-08/17 are SSMU specific, i.e. that the composition of the generic predator groups is not the same across all SSMUs. As an alternative to generic predators, Dr Plagányi suggested that OMs with alternative taxonomic resolutions could be constructed. In particular, single indicator species could be represented in the parameterisations. Such OMs could also be included in the reference set for management strategy evaluations.

5.14 The Working Group recalled that the WG-SAM calendar provides no guidance on how fish stocks in the model arena have changed over time (SC-CAMLR-XXVI, Annex 7, paragraph 5.25). Existing data, however, may be useful for updating the calendar to include the general expectations for fish dynamics. The Working Group identified multiple sources of data potentially suitable for inclusion in the calendar, including, *inter alia*, annual AMLR survey acoustic data, CCAMLR-2000 Survey acoustic data and groundfish time-series data from South Georgia.

5.15 With respect to updates to the calendar, the Working Group noted that the forthcoming Joint IWC-CCAMLR Workshop, through the review of available data for input into ecosystem models, may suggest a need for adjusting the calendar generally. The Working Group agreed that such adjustments of the calendar would be welcome, although the need to periodically suspend adjustments to the calendar for the purpose of model development and testing would be essential for progress towards the provisioning of advice on the SSMU allocation.

5.16 Two general concerns on the conditioning of all models to the calendar were noted. First, a question over the degree to which the specified trend in krill biomass is realistic was raised. Dr Constable cautioned that the available data on krill abundance may not support the conclusion for a decline in abundance in Area 48 given the CVs (which are often not reported) surrounding the historical estimates of krill abundance. The Working Group suggested, therefore, that WG-EMM review the evidence for this hypothesised trend. Second, Dr Hillary suggested an alternative method for assessing the degree of correspondence between the calendar and the model outputs. Rather than condition the model to the numerical translation of the calendar reported in WG-EMM-08/10, it might be possible to condition models on the growth rates reported in the calendar starting from the empirical abundance estimates of predators provided in the latter paper.

Updates to FOOSA

5.17 Dr Watters presented the updated version of FOOSA (WG-EMM-08/13). In particular, Dr Watters discussed how the authors have dealt with issues previously noted by WG-SAM-07 regarding model conditioning and validation. New functionality included the potential to link recruitment success of predators to foraging conditions during the winter. To allow for this possibility in the model, a term was included to impose a penalty on recruitment based on the foraging success of predators during the first winter of life, for example, as suggested by the results in Hinke et al. (2007). This formulation is consistent with the requirement in the calendar that the breeding success of penguins not necessarily be related to summer foraging success (SC-CAMLR-XXVI, Annex 7, paragraph 5.24(i)(b)).

5.18 Further, Dr Watters reviewed the base set of four parameterisations used in this version of FOOSA to develop risk-assessment scenarios. These realisations include contrasting movement (*m*) or no-movement (*n*) of krill through the SSMUs, and an assumption of either a stable (*s*) or a linear (*l*) relationship between adult foraging success and the ratio of effective numbers of breeders to the total pool of adults for each population. In all scenarios, a trend (*t*) in krill abundance was used to drive the model.

5.19 The base set of parameters derived from the calendar in WG-EMM-08/10 was developed by tuning the stock-recruitment parameters of predators. The authors discussed how they parameterised the considerable uncertainty surrounding these parameters. Dr Watters also noted that krill and fish parameters were not estimated. Rather, krill recruitment was assumed to be independent of stock size over most of the range of population size and was modelled with no process error. Krill mortality was modelled as a function of predation alone. The calendar also specified that krill abundance exhibited a step-change, and the model conditioning was conducted by assuming a 50% step-change in krill recruitment.

5.20 Following discussion of the model, Dr Watters discussed how to weight the various scenarios in terms of their plausibility. He noted that a method for weighting the scenarios could be based on statistical (e.g. do tuned parameters capture expectations of the calendar) and ecological (e.g. do the tuned parameters result in plausible estimates of predator productivity) criteria. However, they would likely be arbitrary at present. The Working Group agreed that methods for weighting scenarios deserved consideration in the future.

5.21 Ultimately, the Working Group agreed that FOOSA is capable of capturing the expectations of predator populations as specified in the calendar, given krill as a driver of the system. A question arose, however, regarding the ability to predict both the krill and predator dynamics simultaneously. Dr Watters noted that some important future work is under way (see WG-EMM-08/51) to more reliably represent krill dynamics in the model.

5.22 The Working Group further noted that long-term simulations are useful to assess whether model parameters result in viable populations over the long term in the model. Such simulations are useful to provide an internal check of model consistency.

Update of SMOM

5.23 Dr Plagányi presented aspects of work from WG-SAM-08/17 and WG-EMM-08/44. The former paper described an updated version of the Spatial Multi-species Operating Model (SMOM) of krill–predator–fishery dynamics, and the latter paper describes how SMOM was conditioned on the calendar. The presentation focused on efforts to model krill dynamics and fish removals in SMOM and how work to condition SMOM contrasted with similar work to condition FOOSA. A reference set of parameterisations for SMOM was specified from plausible bounds on survival rates for predators. These parameterisations were conditioned to the calendar by tuning a steepness parameter that characterises the sensitivity of predator breeding success to krill abundance (for each combination of survival rates, one steepness parameter was estimated for each of whales, seals, penguins and fish) and by estimating initial (1970) abundances of fish in each SSMU.

5.24 Two models of krill dynamics were considered in applications of SMOM. In the first model, a krill biomass series was specified on the basis of the calendar (i.e. a series that explicitly describes a step-change) and used to drive predator dynamics from the bottom up. This model was relatively easy to condition on the calendar by simply inputting krill biomass as a driving variable. This approach was also used to condition FOOSA on the calendar. In the second model, two sea-surface temperature time series were used to model temporal variations in the intrinsic population growth rates of krill from a group of southern SSMUs (in Subareas 48.1 and 48.2) and a group of northern SSMUs (in Subarea 48.3). This model was also able to be conditioned on the calendar, but a step-change in krill recruitment was nonetheless required. The Working Group agreed that SMOM was capable of reproducing the direction and timing of observed changes in predator abundance in the calendar.

5.25 Historical removals of finfish were explicitly considered in SMOM. This contrasts with the application of FOOSA, which does not currently attempt to account for historical removals of finfish. Historical SSMU-specific catches for generic fish (generic fish are used in the modelling framework to represent a mixture of species, but the implied species composition is assumed to vary among SSMUs) were compiled from information in the *CCAMLR Statistical Bulletins* and are reported in WG-SAM-08/17.

5.26 The Working Group noted two concerns with the methods used to condition SMOM. First, the attempts to model krill growth rates as a function of environmental conditions like temperature were regarded as an important step, but that the current approach was a simplistic implementation and further development was recommended. Second, the Working Group noted that attempts to generate fish dynamics based on fishery catches could be difficult given the generic nature of the fish group currently represented in the models. With respect to the aggregation of the fish group, a question was raised as to whether disaggregation of the fish group would be beneficial.

Implementation of FOOSA in EPOC

5.27 Dr Constable provided an overview of his implementation of FOOSA in EPOC, noting that the result is FOOSA-like rather than a direct implementation (WG-SAM-08/15). He described how a number of the functions were generalised to allow greater flexibility for specifying scenarios that could be explored in evaluating management strategies for krill. This object-oriented implementation provides opportunities for more predators and prey to be included in the food web and to provide flexibility in the number of stages of a predator consuming krill. Some critical differences in model structure include a more general predator recruitment function, to ensure the abundance of predators at which maximum recruitment occurs is able to change with carrying capacity of the predators, and a consumption model for predators, that specifically accounts for potential differences amongst SSMUs in the predator consumption rates within a season. Dr Constable also showed the general implementation of EPOC in its current form.

5.28 The Working Group commented that the FOOSA-like implementation in EPOC includes features that are more complex than those implemented in FOOSA and this complexity may add another layer of uncertainty. Dr Constable noted that, as an operating modelling framework, the features add to the diversity of scenarios that can be explored in management strategy evaluation. As such, it provides the user with the ability to explicitly vary the model parameterisation based on mathematical or ecological considerations or to limit the model to restricted scenarios. It also means that greater transparency in decisions on model structures can be achieved for a broader range of modellers and ecologists because the equations are explicit and provide a template for a wider range of hypotheses to be tested. A useful strategy of incrementally adding features to model simulations was suggested to allow an assessment of the utility of increasing model complexity and to help convey model results. This process also provides ample opportunity to scrutinise whether the modelling framework would require reconditioning based on recent parameter sets. Given the differences between FOOSA and its implementation in EPOC, the Working Group agreed that presentation of a case study developed from the FOOSA-like implementation in EPOC would help to compare it with the other two modelling approaches (FOOSA and SMOM).

Other considerations for SSMU allocation work

5.29 Other specific issues discussed by the Working Group centred on how whale populations could be represented in the models, how parameterisations of fish recruitment might result in stabilising influences that could allow populations to rebound when fishing was stopped in the model, and whether it was important to have the potential of predator groups to recolonise areas where their populations have been reduced to zero. Additionally, the role of krill flux from and into areas outside the SSMUs, the potential for predators to forage outside the SSMUs, and whether environmental forcing was applied to those components of the model were also discussed.

5.30 The Working Group agreed that there was an important difference between modelling frameworks, such as EPOC, and purpose-built models, such as FOOSA and SMOM. It suggested that the FOOSA-like implementation in EPOC was sufficiently different from FOOSA that it should be given a unique name.

5.31 The Working Group noted that the ongoing development of models may result in multiple versions of models that are considered by the working groups of the Scientific Committee at various times during model development. To better manage model development and distribution, it was generally agreed that some formal mechanism be provided to 'version' and archive models as they are updated. Both software and datasets that include parameter formulations should be included in the versioning, and it was thought that the parameter sets, at least, should be provided to the Secretariat.

An empirical ecosystem assessment model

5.32 Dr Constable introduced an empirical ecosystem assessment model described in WG-SAM-08/16 (other aspects of this paper were discussed under Item 6.3). The model is intended to characterise the food web from a statistical perspective and requires fewer assumptions than most other ecosystem models. The model describes krill biomass as a function of fishing mortality and a hierarchical set of error terms that describe different sources of process variation (e.g. independent SSMU and year effects). Fishing mortality can be made to affect the future biomass of krill using an autoregressive term, and density dependence in the krill population can be modelled using a term that compares the current level of abundance to the long-term mean abundance. The model does not explicitly characterise the impacts that predators have on krill, but it is explicit about the impacts that krill availability has on predators. Such impacts are modelled to affect one or more indices of predator performance (e.g. individual CEMP indices or CSIs) using a function that is sufficiently flexible to produce patterns resembling the well-known Holling Types II and III functional feeding responses. Although the model was applied as a simulation model in WG-SAM-08/16, Dr Constable noted that it is intended to be developed as an estimation model.

5.33 The Working Group recognised the novelty of the modelling approach described in WG-SAM-08/16. Usually, ecosystem models have been considered to be most useful as OMs in management strategy evaluation, not as assessment models (e.g. FAO, 2008). Thus, the model described in WG-SAM-08/16 is both unconventional and promising in the sense that it is proposed for use as an assessment model. The Working Group encouraged the authors of the paper to continue pursuing their work in this regard.

5.34 Following its endorsement for continued work with the model described in WG-SAM-08/16, the Working Group suggested that, during this process, the authors consider three additional points. First, the Working Group noted that it was difficult to fully evaluate the model at this meeting because of the breadth of the work presented in the paper and the time available. As such, it was requested that the authors keep the Working Group informed of progress with the modelling approach and provide a completely worked example to the group in the future. Second, the Working Group suggested that the authors consider approaches to re-parameterise and possibly simplify the model. For example, it was suggested that the authors consider a re-parameterisation approach known as hierarchical centering (Gelfand et al., 1995, 1996) and alternative models for density dependence and/or future fishing impacts that are structured as random walks. Finally, the Working Group suggested that it would be useful to generate data (with error) from the model and then try an estimation to see whether the true model parameters can be estimated.

Fish-based food-web models

5.35 No papers were submitted to WG-SAM on fish-based food-web models. However, Dr Hanchet noted that a paper describing an updated carbon-budget trophic ecosystem model of the Ross Sea had been submitted to WG-EMM (WG-EMM-08/42). The authors regard the model as a first step towards investigating ecosystem effects of the fishery for *D. mawsoni*. The paper noted that a future aim of this work is to develop a plausible minimum-realistic model with which to investigate and manage the effects of the *D. mawsoni* fishery on the Ross Sea ecosystem.

Ecosystem models

5.36 There were no additional ecosystem-based modelling approaches presented for consideration by the Working Group. WG-SAM encouraged Members to develop or advance models that may potentially be used toward understanding ecosystem dynamics and consequences of management approaches for Antarctic resources.

Other models

5.37 Mr Dunn gave a presentation of WG-SAM-08/P3, a draft user manual for SeaBird, a package for modelling seabird populations. It was discussed in more detail under Item 4.5. No other papers were presented to the Working Group under this agenda item.

EVALUATION OF MANAGEMENT STRATEGIES

Dissostichus spp.

6.1 Dr Brandão presented WG-SAM-08/11, which described a reference set of four OMs that reflect an 'Optimistic', 'Intermediate', 'Less Pessimistic' and 'Pessimistic' current status for the toothfish resource in the Prince Edward Islands region (Subareas 58.6/58.7). These models are used to investigate the performance of a candidate MP that uses two data sources, the trend in CPUE indices and the mean length of fish in the longline catches, to provide future catch limits, with the primary objective of generating a reasonable probability of securing a catch rate increase, whatever the current resource status. The proposed MP performance is shown to be reasonably robust across a range of sensitivity tests, although it deteriorates in conservation terms if the steepness assumed in the reference set is appreciably lower. The sensitivity tests also indicate that monitoring of future catch-at-length information is necessary to guard against a change in selectivity towards greater catches of older fish.

6.2 The Working Group noted that it would be of interest to compare the performance of the MP with the CCAMLR decision rules. It further suggested that a statistic based on the probability of the final CPUE value being lower than the most recent levels would be very informative.

6.3 The Working Group noted that there is more uncertainty in CPUE projections for the Less Pessimistic scenario than for all other scenarios, and that this needs to be further investigated. One possibility is that the estimated variance for the CPUE indices is much larger for the Less Pessimistic OM than for the other OMs and that this variance is used in generating future CPUE values.

Champsocephalus gunnari

6.4 No papers were received or available to WG-SAM for evaluation of management strategies for *C. gunnari*, and the Working Group did not further consider this topic.

Euphausia superba

Framework for Stage 1 evaluations

6.5 The Working Group recalled that it had previously advised WG-EMM and the Scientific Committee on a staged development of the krill fishery in Area 48 (SC-CAMLR-XXVI, Annex 7, paragraphs 5.7 to 5.51). That advice was subsequently endorsed, including the expectation that further advice on a Stage 1 subdivision of the precautionary catch limit among SSMUs could be delivered, in the form of a risk assessment, this year (SC-CAMLR-XXVI, paragraph 3.36).

6.6 Dr Watters introduced WG-EMM-08/30 which provided a risk assessment purposefully designed to provide advice on strategies for subdividing the precautionary krill catch limit among SSMUs during Stage 1. The risk assessment was conducted with FOOSA, using the reference set of four parameterisations that were conditioned on the calendar

(WG-EMM-08/13). The risk assessment followed the technical guidelines specified by WG-SAM-07 almost exactly with minor additions that include:

(i) the introduction of implementation error by including random errors in the quantities used to compute SSMU-specific catch limits (i.e. the initial estimates of krill biomass and predator demand);

(ii) performance measures for krill that are based on the existing decision rules and are referenced both to pre-exploitation abundance (as stated in the existing decision rules) and to results from comparable no-fishing trials;

(iii) a vector of plausibility weights that are used for model averaging.

6.7 The presentation of work described in WG-EMM-08/30 focused on methodological and technical details and how such details influence the interpretation of results. The results *per se* were not discussed.

6.8 Initially, questions from the Working Group focused on understanding the initial conditions used to set up simulations in the risk assessment. Dr Watters informed the Working Group that the initial conditions were the same throughout the simulations for a given model, i.e. the starting point for risk assessment from each parameter set was fixed. Nevertheless, the tuning process used to develop the set of four reference parameterisations used in the risk assessment, did result in differences in starting points between parameterisations. These four starting points can be considered to come from a distribution of initial conditions, although the between-parameterisation variance in these starting points likely under-represents the true uncertainty in initial conditions. The same set of process errors was used to simulate random variations in krill recruitment and abundance across all four parameterisations in the reference set.

6.9 Dr Agnew noted that predictions from the FOOSA parameterisations with no krill movement indicated that the depletion part of the krill decision rule could be violated (i.e. that, during the fishing period, the krill spawning stock would fall below 20% of the median pre-exploitation spawning stock more than 10% of the time) because those parameter sets implied ongoing downward trends in krill abundance. However, if the risks of violating the krill decision rules are assessed relative to predictions from comparable no-fishing trials, the risk was substantially reduced. The Working Group noted that the Scientific Committee has not recommended whether performance metrics for krill should be referenced to no-fishing trials. Nevertheless, the Working Group agreed that such metrics could be useful for helping evaluate the impacts of fishing when other factors cause trends in the system (paragraph 6.16).

6.10 The discussion summarised in the preceding paragraph prompted further consideration of the assumptions used to derive levels of γ from the krill yield model. The Working Group agreed that WG-EMM, the Scientific Committee and the Commission should be advised that the level of γ (0.093), which is currently agreed and applies to krill in Area 48, was derived under the assumption that, in the future, krill biomass will continue to vary interannually but not trend in response to external factors such as climate change.

6.11 Dr Constable reported on WG-SAM-08/16 in which an ecosystem-based precautionary management procedure for krill fisheries is developed, based on the extensive past experience in CCAMLR. The procedure is based on an empirical ecosystem assessment model, a decision rule for determining local-scale catch limits based on a harvest strategy and a single-species assessment of yield, and a method for implementing the procedure. The decision rule for setting catch limits for a given harvest strategy expresses the target conditions to be achieved and the uncertainties that need to be managed. It is a natural extension of the current precautionary approach of CCAMLR for krill and can utilise existing datasets, including B_0 surveys, local-scale monitoring of krill densities, local-scale monitoring of predator performance, monitoring of predator foraging locations and time series of catches from the fishery.

6.12 Dr Constable noted that this procedure provides a common framework for inserting data, assessment methods and candidate modelling approaches for assessing yield. Consequently, its formalism means that advice on krill harvest strategies can be updated as improvements are made in any component of the procedure, including the provision of data, implementation of new assessment or projection models, or a revision of the decision rule. This framework formalises the decisions that need to be made in dealing with an ensemble of food-web models for providing suitably precautionary advice on how to spatially structure krill fisheries to account for the needs of predators. It provides the primary expectation for managing uncertainty, either by obtaining better estimates of parameters for the projection models and/or by altering the harvest strategy.

6.13 Dr Constable further noted that a preferred harvest strategy, which is initially untenable because of the uncertainties associated with its ecosystem impacts, could become a suitable option if its related uncertainties are reduced. Conceivably, the procedure outlined in WG-SAM-08/16 could be used in a spatially structured feedback management system that can ensure CCAMLR is able to respond to trends in the ecosystem, including those arising from fishing and/or climate change.

6.14 The Working Group noted the breadth of work presented in WG-SAM-08/16 and considered the work in a wide-ranging discussion that included issues relating to:

(i) the definition of terms used by the Working Group. Specifically, the Working Group recommended that the terminology should, as far as possible, be consistent with that of other international fora (e.g. Rademeyer et al., 2007, Appendix 1). Additionally, the report of the Working Group could contain a glossary of the terms once developed;

(ii) the implementation and interpretation of CSIs within the proposed framework of WG-SAM-08/16 (paragraphs 6.26 to 6.30);

(iii) the clarification of how the ecosystem-based management procedure proposed in WG-SAM-08/16 could be used to provide advice on the spatial allocation of krill catch this year by using output from FOOSA and SMOM to construct CSIs (paragraphs 6.26 to 6.30);

(iv) whether decision rules and their associated control parameters should be considered fixed or should evolve over time. The Working Group agreed that an evolution would be necessary, particularly if the Commission requested changes. The Working Group noted that it would be difficult to determine what the values of such control parameters should be in the future (paragraph 6.24);

(v) whether the framework is intended to apply to all predators or just predators whose foraging distributions are limited during particular times in their life histories (e.g. during breeding). The Working Group agreed that the former interpretation was more consistent with Article II of the Convention.

6.15 The foregoing commentary prompted further discussion centred on three specific questions.

6.16 First, the Working Group considered whether the decision rules should be referenced to pre-exploitation states or states predicted from comparable no-fishing trials. In principle, the Working Group agreed that predator performance could be assessed relative to both states, but no agreement was reached on a preference for one or the other. WG-SAM-08/16 proposed a decision rule that is referenced to pre-exploitation states to determine departures from baseline conditions. The alternative is to reference decision rules to a time series of predictions from no-fishing trials (paragraph 6.9) because it is potentially useful to remove trends, transient effects of model parameterisations, climate effects and effects from other dynamical properties not caused by the management strategy being evaluated.

6.17 The Working Group recalled previous work by the Subgroup on Statistics to define VOGONs (values outside the generally observed norm) (SC-CAMLR-XV, Annex 4, Appendix H; SC-CAMLR-XVI, Annex 4, Appendix D, paragraph 2.9) and discussed whether this concept would also be useful for defining reference points in decision rules. The Working Group suggested that the concept of VOGONs and their derivation is useful for defining such reference points. The Working Group agreed that establishing baseline norms should include consideration of variation over a range of time scales.

6.18 Second, the Working Group considered whether a decision rule should explicitly address fishery performance (i.e. not be limited to predator performance). WG-SAM-08/16 proposed a decision rule that does not explicitly address fishery performance. However, Dr Constable indicated that WG-SAM-08/16 showed how fishery performance could be used to help choose between different harvest strategies if the resulting options for harvest strategies, including spatial catch limits, have the same level of precaution. For example, fishery performance, along with other commercial, implementation or compliance issues, could result in a lower catch limit being preferred. Thus, metrics of fishery performance are important to accompany the results of calculations used to determine the outcome of a decision rule. The Working Group agreed that it would be possible to explicitly include measures of fishery performance in ecosystem-level decision rules. The Working Group also agreed that these types of decision rules should be investigated. The Working Group noted that the IWC has previously addressed this issue, and it might be worthwhile to review its approach.

6.19 Third, the Working Group considered the manner in which the precautionary approach should be incorporated during various stages of an ecosystem-level decision framework. WG-SAM-08/16 proposed a decision rule wherein the precautionary approach is addressed at the final stage of summarising across models or evaluations (e.g. by taking the 20th percentile of the distribution of harvest rates suggested by an ensemble of results). The Working Group noted that it is difficult to accommodate the precautionary approach in other parts of the decision rule because of the potential biases in projection and assessment models. It also noted that:

(i) models will inevitably have bias, unforeseen or otherwise, that could be in favour of the fishery or the ecosystem;

(ii) precaution needs to be applied in order to achieve the objectives in Article II;

(iii) it would be desirable to have a decision rule that is robust to biases in both directions and satisfies the precautionary approach.

6.20 Dr Plagányi provided an overview of WG-EMM-08/44 that provided a framework for using SMOM and its output to develop appropriate risk metrics from which to develop performance measures. Dr Plagányi presented the following list of factors that should be included in a framework for evaluating MPs:

(i) agreement on broad objectives for the management of the populations in the region under consideration;

(ii) agreement on the data (observations) available which are pertinent to the dynamics of these populations (e.g. WG-EMM-08/10);

(iii) development of a wide range of OMs (e.g. FOOSA, SMOM and EPOC);

(iv) fitting (condition) each of these models to the agreed data;

(v) weighting plausible OMs based on *a priori* considerations and their fit to data;

(vi) specifying statistics in terms of the performances of alternative candidate MPs that are to be assessed and compared;

(vii) agreement on guidelines and/or thresholds that candidate MPs need to meet or achieve to be acceptable in terms of the agreed objectives for management;

(viii) development of candidate MPs;

(ix) testing of candidate MPs based on forward projections over a number of years, of each OM under the management actions output annually by the MP;

(x) comparison of the performance statistics for each candidate MP across all OMs given weighting structure, and selection from amongst the candidates, the MP which best achieves the broad objectives.

6.21 The Working Group agreed it is worthwhile to pursue work that might allow all modelling frameworks to be considered in the provision of management advice. It agreed that the framework introduced by Dr Plagányi could be adapted to suit the purposes of SC-CAMLR to guide future work in subsequent stages and suggested this be considered at a future meeting. In doing so, the Working Group should also compile a table of the progress made with respect to each step.

6.22 The Working Group agreed that if different models suggest different advice it would be important to take additional precaution in setting levels of catch for each SSMU.

6.23 The Working Group agreed that while WG-EMM-08/30 and the outcomes of its deliberations this year could be used to provide advice on a Stage 1 SSMU allocation, WG-EMM should discuss the relative plausibility of each parameterisation in the reference set. WG-EMM-08/30 provided some guidance on plausibility weights that might be assigned to each reference set.

6.24 In considering subsequent work on the SSMU allocation (Stage 2 and beyond), the Working Group noted the following:

(i) the current models and reference sets considered by WG-SAM have a number of assumptions, parameterisations and structures that will need to be updated and/or revised in future work as better scientific evidence becomes available;

(ii) the development of decision rules needs to include consideration of the interpretation of 'the maintenance of ecological relationships' in Article II;

(iii) when decision rules are agreed, judgements will need to be made on the magnitude of control parameters, for example the probability of departure from baseline variation, in order to achieve the appropriate level of precaution.

6.25 The Working Group agreed to inform WG-EMM and the Scientific Committee of the issues that need to be considered in formulating ecosystem-level decision rules. The Working Group further agreed that the framework proposed in WG-SAM-08/16 had covered such issues extensively and should be considered by WG-EMM.

Performance measures

6.26 The Working Group noted that most of the model scenarios result in trends in ecosystem dynamics after the tuning period. It might therefore be appropriate to construct performance measures for biological ecosystem components that make comparisons with norms indicated by no-fishing trials (paragraph 6.16). The Working Group cautioned that comparison to expected future norms increases reliance on model predictions.

6.27 Fish have an important influence on the overall dynamics in current realisations of FOOSA and SMOM, but there has been no conditioning of models on observed fish dynamics due to a paucity of data. There are a number of structural differences in the parameterisation of fish in FOOSA and SMOM which is useful in representing some of the uncertainty associated with this group. Nonetheless, the role of fish in the ecosystem remains an important area of uncertainty. For example, the dynamics of myctophids may be very important in some SSMUs as predators of krill and as prey to higher predators.

6.28 The Working Group noted that, when interpreting results from the models in providing Stage 1 advice, WG-EMM should be aware of the paucity of data on mesopelagic fish in developing generic fish abundances in the calendar.

6.29 The Working Group noted that several questions regarding the development of aggregate performance measures (including CSIs) are worthy of further consideration:

(i) Is there potential to smooth over important detail when aggregating across areas, time periods and populations?

(ii) How can time lags (e.g. between when the effects of fishing occur and when the performance metrics are realised) be dealt with in the development of the aggregate measures?

(iii) Should component measures included in the aggregate measure be weighted?

(iv) How can aggregate measures avoid being confounded by factors not related to the effects of fishing on krill?

6.30 The Working Group agreed to use output from FOOSA for developing an example of CSIs to enable clarification of these questions, based on the output of an ecosystem model (paragraph 6.37).

Risk summaries

6.31 The Working Group reviewed the use of the risk-assessment metrics derived from FOOSA with respect to the scenarios listed in section 5.2 of this report. The discussion focused on the graphical output and, with respect to Article II of the Convention, the decision rules for the allocation of krill. Given that these summaries follow exactly from the specifications made by WG-SAM in 2007, the Working Group endorsed their use.

6.32 Dr Plagányi provided an overview of the modelling work in SMOM to produce risk scenarios that could be compared directly with output from the FOOSA model, as presented in WG-EMM-08/30. Using simulation data, Dr Plagányi examined the probability that predator abundance declines to less than 75% of abundance under a comparable no-fishing scenario across a range of harvest rates for Fishing Options 2, 3 and 4. This scenario was considered most similar to the 'nst' scenario presented in Figure 6 of WG-EMM-08/30.

6.33 In comparing the risk assessment plots between the two modelling frameworks, the Working Group was satisfied that there were considerable similarities between the modelling frameworks and , given the scenarios presented.

6.34 Some differences were observed however, and members of the Working Group requested clarification as to whether: (i) such differences were related to structural differences between the modelling approaches, or (ii) the differing results were related to starting parameters and initial conditions. Dr Plagányi noted that some of the difference was related to the implementation of generic fish in the models (paragraph 5.25). Additionally, adult and juvenile survival are handled differently in each model. Technical questions to further clarify the extent of similarities and differences between the models related to the weights given to the relative plausibility of models in the reference set, how implementation error was accounted for, how the subdivision of catch for each of the fishing options was implemented, the relative competitive abilities of predator groups, and the krill movement scenarios. It was acknowledged by the authors of both models and a number of Working Group participants that krill movement is an important component of uncertainty that has been discussed by WG-EMM in past years (SC-CAMLR-XXV, Annex 4). Those discussions specified the contrast of no-movement and movement scenarios presented in WG-EMM-08/30.

6.35 Dr Watters indicated that while it is appropriate to consider the differences between models, the modelling approaches do encompass different structural uncertainties and that such differences can indicate robust results. For example, both models predicted fairly small risks around the trigger level for Fishing Options 2 and 3.

6.36 The Working Group next discussed the types and limits of advice that could be provided to WG-EMM. It agreed that FOOSA and SMOM are valid and that most differences in model output could be adequately understood. On that basis, the Working Group agreed that both modelling approaches could be used to provide an indication of risk for WG-EMM to consider. The Working Group also suggested that resolving the differences in model results might be facilitated if experts in WG-EMM provide an indication of which parameters may need modification in order to align parameter inputs for each model. The Working Group also suggested that ranking the plausibility of models could be a task for WG-EMM.

6.37 Dr Constable provided an overview of his work to use model output from FOOSA to develop CSIs to examine ecosystem performance and to provide indices of risk for various MPs (such as those represented by Fishing Options 2, 3 and 4). Dr Constable suggested that the CSI was an appropriate measure of risk because of a high degree of uncertainty when using the available ecosystem models to assess the effect of fisheries on individual predator populations at the SSMU level. However, the CSI should detect fishery effects by integrating responses of predators across all areas. As indicated in WG-SAM-08/16, the goal of the CSI is to provide a measure of the variation of the ecosystem and how fishing might cause a departure of food-web dynamics from the normal range. The CSI presented to the Working Group thus used the variability in predator dynamics under no-fishing scenarios to define baseline variability. Referencing to a no-fishing scenario helps to remove bias that may be present in the model.

6.38 The results for the CSI presented to the Working Group were based on the recruitment of predators. The recruitment series for each predator was standardised for the age of recruitment so that the recruitment could be directly related to the krill abundance affecting recruitment. It was noted that such an index, like other performance measures, will be sensitive to several factors, including: (i) the degree to which the krill-based system is an open system maintaining a supply of krill over time as represented by the bathtubs in the model; (ii) the degree to which predators forage widely in the system; and (iii) the dependence of predators on krill for reproductive success.

6.39 In his presentation, Dr Constable addressed the issues raised by the Working Group (paragraph 6.29), including:

(i) smoothing-over important detail when aggregating into CSIs – the inclusion of predators that are largely unresponsive to krill abundance will dilute the index. This is important to consider when aggregating across species and/or areas. It is important that the index primarily comprises predators in locations where they respond to krill abundance (see also de la Mare and Constable, 2000);

(ii) lags between the effects of fishing on krill populations and response of predators – WG-SAM-08/16 indicated the need to standardise the time series of predator responses, such as recruitment, so they can be directly related to changes in krill;

(iii) weighting component measures within CSIs – it is difficult to weight individual predator responses using marginal weights. It is easier to adjust the use of CSIs by using binary weights (inclusion or exclusion) to determine what predators should be included and from which areas. Similarly, the degree to which a predator response is summed amongst SSMUs before inclusion in the CSI is a decision that will potentially reduce or enhance the contribution of the predator to the CSI;

(iv) influence of confounding factors – these are less important if predator responses directly relate to krill abundance. Detecting trends in the system would require comparison to baselines in the first part of a time series. However, detection of the effects of fishing may require comparisons of the fishing scenarios to a baseline over the same projection period but with no fishing. Density-dependent effects are unlikely to impact the CSI if the time series of predator response is a summed population response, as recommended in WG-SAM-08/16.

6.40 Dr Constable showed that by calculating the difference in the cumulative distribution functions of CSI values between fished and non-fished trials at the end of the fishing period, the relative difference could provide information about the effect of harvest strategies. He illustrated how the effects of fishing could be observed if setting a critical CSI level at, say, the lower 10th percentile for the CSI in the no-fishing scenario in the last year of the designated fishing period in the fishing scenarios. The probability of being below that critical value at the end of the fishing period could be used as an indicator of the expected effects of fishing in that scenario (WG-SAM-08/16). Plots showing the relationship between the harvest rate (γ) and this probability were shown. These plots provide an indication of the risk of departing from natural variation under each level of fishing for a given fishing and model scenario.

6.41 The Working Group agreed that this is an interesting approach and that the relative risk levels could be considered in more detail at WG-EMM.

6.42 There was discussion among Working Group members about how and whether to disaggregate the regional CSI values to the SSMU level, or into predator/prey group levels. Dr Plagányi noted that it will be important to check the predictions of the CSI by working an example of the CSI in reverse to demonstrate that, given a CSI, the Working Group could correctly interpret the underlying ecosystem dynamics on the level of the SSMUs. Dr Constable indicated that initial work in this regard was presented (e.g. de la Mare and Constable, 2000).

6.43 A number of questions were thought to fall under the purview of WG-EMM, including, *inter alia*:

(i) To what degree do the dynamics of generic predators reflect the dynamics of component species, and how can the regional scale of the CSI and the SSMU-scale of management be reconciled?

(ii) To what extent does consideration of an open or closed population of krill influence the outputs of the models providing advice and does the approach to uncertainty adequately address this issue?

6.44 WG-SAM reviewed a number of tools that might be used by WG-EMM to provide guidance regarding the SSMU allocation. These tools include new developments (e.g. CSIs) and implementation of risk methods as outlined by WG-SAM in 2007. WG-SAM recommended that these methods be considered by WG-EMM in formulating advice.

Future work

6.45 The Working Group noted that much of the work in FOOSA, SMOM and EPOC provides a foundation for evaluation of management procedures for krill in subsequent stages of the SSMU allocation work. It encouraged Members to continue this work and present results to WG-SAM and WG-EMM.

OTHER BUSINESS

Revision control

7.1 Mr Dunn described how revision (version) control systems allow the management of multiple revisions of information within a central database. He noted that two modern implementations include CVS (Concurrent Version System) and Subversion, and he gave a demonstration of the revision control system CVS.

7.2 Revision control systems allow organisations and individuals to manage digital documents like software source code, manuals, spreadsheet data or other forms of electronic information in a controlled and future-recoverable manner. Mr Dunn noted that CASAL, SPM and other important software developed in New Zealand for use at SC-CAMLR working groups was maintained within a revision control system.

7.3 The Working Group noted that the use of such systems allowed for a greater degree of transparency in comparing between-code revisions, allowed easy recovery of historical code where issues may arise, and allowed easy checking of who made changes and when those changes were made (see paragraph 5.31).

7.4 The Working Group recommended that WG-FSA and WG-EMM consider how they may use such systems to document and archive their work.

CCAMLR Science

7.5 As the new Editor-in-Chief of *CCAMLR Science*, Dr Reid reiterated that the aim of the journal is to communicate the science being done in CCAMLR to the scientific community, and to be a vehicle to advertise CCAMLR and encourage scientists to become involved in the work of CCAMLR.

7.6 The Working Group recognised that there should be a clear distinction between working group papers and peer-reviewed papers in *CCAMLR Science*. The latter must be made accessible to a broader readership – with greater emphasis on ensuring that the context for the work is clearly described and the consequences/conclusions beyond CCAMLR are provided.

7.7 Dr Reid reminded potential authors to ensure that they have permission to use any data released under the Rules for Access and Use of CCAMLR Data for publication in the public domain. In order to ensure that this is done, there will be a new tick-box on the *CCAMLR Science* manuscript submission form to declare that permission to publish (and to cite working group papers) has been granted.

7.8 Dr Reid invited comments from all working groups on manuscript submission and editorial process of *CCAMLR Science* in order to prepare a paper for this year's meeting of the Scientific Committee.

Paper submission to working group meetings

7.9 The Working Group considered the issue of deadlines for meeting documents and agreed that papers could be accepted after the deadline in exceptional circumstances. Such circumstances include those where the paper(s) contains information of importance to the working group for delivering advice to the Scientific Committee in that year, noting that where Members anticipate the late submission of the paper they should correspond with the convener of the working group to assess the suitability of the paper for the working group.

7.10 In agreeing that flexibility is required with respect to paper submission deadlines, the Working Group noted that such flexibility should not compromise the ability of its members to assess papers prior to the meeting.

7.11 The Working Group noted that there is duplication of information on the document submission forms and the synopsis proformas that are required for papers submitted to working groups. The Secretariat agreed to consider a potential revision to the submission forms prior to the meeting of the Scientific Committee this year.

FUTURE WORK

8.1 The Working Group thanked participants for their innovative contributions, including, *inter alia*:

(i) methodology for data quality assessment (paragraph 3.26);

(ii) assessment approaches for exploratory fisheries in Subarea 58.4 (paragraphs 3.1 to 3.10);

(iii) spatially explicit population dynamics model (paragraph 5.1);

(iv) evaluation of the application of TISVPA (paragraph 3.16);

(v) potential use of BRTs in bioregionalisation, biogeography and modelling (paragraph 4.13);

(vi) a generalised age- and/or stage-structured seabird population dynamics model (paragraph 4.21);

(vii) FOOSA, SMOM and EPOC (paragraph 5.9);

(viii) development of ecosystem-based management procedures (section 5);

(ix) evaluation of management strategies (section 6).

8.2 The Working Group encouraged participants and Members to consider future work relevant to the working groups and the Scientific Committee, noting that items of future work could be submitted to other working groups directly for consideration, including, *inter alia*:

(i) Relevant to WG-FSA –

(a) investigation of the potential for systematic biases arising in observer datasets (paragraph 2.4);

(b) study of the effect of fish length on conversion factors from *Dissostichus* spp. fisheries (paragraph 2.6);

(c) development of updated bathymetric grids for areas other than Subarea 48.3 where recent multi-beam data or single-beam echo soundings exist and trawl surveys are conducted (paragraph 2.10);

(d) development of approaches to estimating stock size and advice on precautionary catch limits in Divisions 58.4.1 and 58.4.2 (paragraphs 3.4 and 3.10);

(e) identify alternative tagging datasets which could be used in the next assessment of the Ross Sea toothfish fishery (paragraph 3.29);

(f) further development of SPM, including processes and observation classes to incorporate year-class variability, stock-recruitment relationships, as well as tag–release/recapture and maturation-state observations (paragraph 5.5);

(g) refine the MP for the Prince Edward Islands region, and compare the performance of the procedure with the CCAMLR decision rules (paragraph 6.2).

(ii) Relevant to WG-EMM –

(a) consider methods for weighting scenarios, based on statistical and ecological criteria (paragraph 5.20);

(b) presentation of a case study developed from the FOOSA-like implementation in EPOC to help compare its performance and outputs with FOOSA and SMOM (paragraph 5.28);

(c) continue the development of FOOSA, SMOM and EPOC (paragraph 6.45);

(d) archive versions of FOOSA, SMOM and EPOC, together with datasets that include parameter formulations, with the Secretariat (paragraphs 5.31 and 7.4).

(iii) General:

(a) consider using the unit-testing procedure in future software developments to assist in checking that the integrity of functions in software code is maintained in future versions (paragraph 5.8).

8.3 The Working Group also:

(i) urged the authors of the TISVPA method (WG-SAM-08/8) to carry out the program of work required for evaluation of the model outlined by WG-FSA (paragraph 3.25);

(ii) encouraged the author of WG-SAM-08/P1 and 08/P2 to prepare a combined manuscript in English for the next meeting of WG-SAM, with examples of analyses (paragraph 3.37);

(iii) encouraged the authors of WG-SAM-08/12 to continue developing the BRT approach and suggested that this could best be pursued through a correspondence group involving statistical experts familiar with BRTs (paragraph 4.19);

(iv) encouraged the development of the novel modelling approach that is intended to characterise the food web from a statistical perspective and that requires fewer assumptions than most other ecosystem models (WG-SAM-08/16) (paragraphs 5.33 and 5.34).

8.4 Dr Gasyukov noted that the implementations of models need to be validated and verified in order to determine that the implementation reflects the mathematical and procedural descriptions provided in submitted papers. This is important for models on which advice is based. He also noted that the models for use in the SSMU allocation have not yet been validated in this way and requested that WG-SAM undertake the validation work required.

8.5 Dr Constable will undertake to assemble a group of interested members of the Working Group during the intersessional period to establish a process for validation based on SC-CAMLR-XXVI, Annex 7, paragraph 8.19, and review progress to date on such a process for existing models. A report will be provided to WG-SAM next year for it to consider how validation work might proceed.

8.6 The Working Group agreed that the work and advice developed during the meeting now requires consideration by the other working groups. The Working Group confirmed the need for flexibility and the maintenance of 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 (SC-CAMLR-XXVI, Annex 7, paragraph 6.6). It noted, however, that there are many aspects in Item 9 that will require further development of methods in statistics, assessments and modelling, and encouraged Members to submit this work for consideration next year.

ADVICE TO THE SCIENTIFIC COMMITTEE

9.1 Advice of the Working Group for the Scientific Committee and other working groups is summarised below. Generally, the main points are highlighted with reference to appropriate paragraphs with the detail of that advice. Advice on future work arising from the deliberations of the Working Group is also provided under Item 8.

Advice to WG-FSA

9.2 Consider the impacts of using reconstructed size distributions from factory/processing data as described in fishery assessments (paragraph 2.7).

9.3 Stock and biological assessment methods:

(i) develop approaches to assessing new and exploratory fisheries, including consideration of how to account for uncertainty to achieve an orderly development of exploratory fisheries (paragraph 3.10);

(ii) consider ways of examining and/or improving detection rates of tags (including the methods identified in paragraph 3.14);

(iii) provide specific guidance on the metrics considered most useful for distinguishing data quality with respect to assessments (paragraphs 3.28 and 3.30);

(iv) explore the degree to which the assessment of *Dissostichus* spp. in the Ross Sea might be impacted by the use of different sets of tag–recapture data (paragraph 3.29).

9.4 Research design in exploratory fisheries:

(i) tagging should continue in Divisions 58.4.1 and 58.4.2, although mark–recapture data are unlikely to provide accurate assessments of local abundance or stock size in the short term (paragraphs 4.1 and 4.2);

(ii) use comparative CPUE and local depletion as a basis for developing preliminary assessments in Divisions 58.4.1 and 58.4.2, and consider how to further develop these methods (paragraph 4.3);

(iii) use the framework for performing preliminary assessments for exploratory fisheries (WG-SAM-08/5) to provide management advice for the *Dissostichus* spp. fishery in Division 58.4.3a (paragraph 4.4);

(iv) consider the value and requirements for research fishing by longline vessels when fishing within a 10 tonne catch limit (paragraphs 4.6 to 4.9);

(v) consider using the procedure outlined in paragraph 4.10 to develop assessments in exploratory fisheries where difficulty is encountered in using tagging data (paragraph 4.11);

(vi) consider experimental approaches to understand the effects of changing fishing practices on CPUE (paragraph 4.12).

Advice to ac hoc WG-IMAF

9.5 Consider the application of SeaBird for use in modelling populations (WG-SAM-08/P3) (paragraphs 4.20 to 4.24).

Advice to WG-EMM

9.6 FOOSA, SMOM and EPOC:

(i) use of the WG-SAM calendar and numerical calendar of events for tuning krill-based food-web models and a discussion on their further development (paragraphs 5.12 to 5.16);

(ii) FOOSA and SMOM are capable of capturing the trends in predator populations as specified in the calendar, given krill as a driver of the system (paragraphs 5.21 and 5.24);

(iii) the FOOSA-like implementation in EPOC could provide a useful comparison with the modelling approaches used in FOOSA and SMOM (paragraphs 5.28 and 5.30);

(iv) WG-EMM should review the evidence and attendant uncertainty in support of the krill trend represented in the calendar (paragraph 5.16).

9.7 Advice on SSMU allocation:

(i) general advice is provided in paragraphs 6.5 to 6.45;

(ii) FOOSA and SMOM can be used to provide advice on SSMU allocation; however, WG-EMM should discuss the relative plausibility of each scenario (paragraphs 6.5 to 6.45).

Request to TASO

9.8 (i) Consider the feasibility of collecting all individual processed weights from longline vessels throughout the Convention Area (paragraph 2.7).

(ii) Consider ways to improve detection and reporting of tag recaptures (paragraph 3.14).

General advice

9.9 (i) Further develop methodologies to assess data quality (paragraphs 3.28 and 3.30).

(ii) Develop or advance models that may be used towards understanding ecosystem dynamics and consequences of management approaches for Antarctic resources (paragraph 5.36).

(iii) Consider the implementation of revision (version) control systems which allow the management of multiple revisions of programming code, documents and data files within a central database (paragraphs 7.3 and 7.4; see also paragraph 5.31).

(iv) Recommend adoption of a common set of terminology consistent with that of other international fora with respect to the evaluation of management procedures (paragraph 6.14).

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

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

10.2 Dr Constable thanked all participants for making this such an interesting, challenging and exciting meeting that was characterised by a wide diversity of ideas and contributions that had put the modelling and assessment work on a good footing.

10.3 Dr Constable also thanked all rapporteurs, noting that by working in teams almost all participants had an input into the process which had produced a very concise and accurate report. He also thanked Mrs L. Zaslavskaya for facilitating the meeting and noting especially her flexibility and efficiency in arranging transport. Dr Constable recorded his appreciation of the accommodation made by the Convener of WG-EMM to allow WG-SAM two extra days for its meeting this year, noting that this had allowed substantial progress in the advice that WG-SAM was able to provide to WG-EMM. He also thanked Dr Jones for chairing some particularly complex discussions as well as the Secretariat for its advice, guidance and support.

10.4 Dr Constable noted that while WG-SAM was yet to ‘find its feet’ as a working group, and especially its working relationship with the other working groups, it had made substantial progress this year and that this had been substantially assisted by the effective participation of quantitative experts from all working groups in all areas of the agenda.

10.5 Dr Holt, on behalf of the participants, expressed his appreciation to the Convener and congratulated him on his preparation and leadership, noting particularly his long history of involvement in the development of the Working Group. In response to Dr Constable’s comments about WG-SAM 'finding its feet', Dr Holt noted that he considered that the Working Group had indeed found its feet, but that the challenge now was to determine how big its shoes are.

10.6 The meeting was closed.

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APPENDIX A

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APPENDIX B

AGENDA

Working Group on Statistics, Assessments and Modelling
(St Petersburg, Russia, 14 to 22 July 2008)

1. Introduction
   1.1 Opening of the meeting
   1.2 Adoption of the agenda and organisation of the meeting

2. Parameter estimation

3. Stock and biological assessment methods

4. Advice on methods for use in work of SC-CAMLR
   4.1 Research designs in exploratory fisheries
   4.2 Establishing precautionary catch limits in the absence of research in exploratory fisheries
   4.3 Approaches to minimise effects on assessments of changing fishing practices
   4.4 Use of boosted regression trees in bioregionalisation
   4.5 Response of white-chinned and grey petrel populations to fisheries and environmental factors

5. Tools for population, food web and ecosystem modelling
   5.1 *Dissostichus* spp. population models
   5.2 Krill-based food-web models
   5.3 Fish-based food-web models
   5.4 Ecosystem models

6. Evaluation of management strategies
   6.1 *Dissostichus* spp.
   6.2 *Champsocephalus gunnari*
   6.3 *Euphausia superba*
      6.3.1 MSE framework for Stage 1 evaluation
      6.3.2 Performance measures
      6.3.3 Risk summaries
      6.3.4 Future work

7. Other business
   7.1 Procedural steps for multi-year assessments of *Dissostichus* spp.
   7.2 Fisheries and Ecosystem Models in the Antarctic (FEMA)
   7.3 Bottom fisheries and vulnerable marine ecosystems
   7.4 Reporting and archiving validation, verification and assessment work
   7.5 *CCAMLR Science*

8. Future work
    8.1 Long-term work plan
    8.2 Other issues

9. Advice to the Scientific Committee
    9.1 WG-EMM
    9.2 WG-FSA
    9.3 Ad hoc WG-IMAF
    9.4 General

10. Adoption of report and close of meeting.

APPENDIX C

LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling
(St Petersburg, Russia, 14 to 22 July 2008)

WG-SAM-08/1	Preliminary Agenda and Annotated Preliminary Agenda for the 2008 Meeting of the Subgroup on Assessment Methods
WG-SAM-08/2	List of participants
WG-SAM-08/3	List of documents
WG-SAM-08/4	Analysis of the potential for an assessment of toothfish stocks in Divisions 58.4.1, 58.4.2 D.J. Agnew, C. Edwards, R. Hillary, R. Mitchell (UK) and L.J. López Abellán (Spain)
WG-SAM-08/5	Exploratory assessment methods for exploratory fisheries: an example case using catch, IUU catch and tagging data for Subarea 58.4.3a R.M Hillary (UK) (*CCAMLR Science*, submitted)
WG-SAM-08/6	Defining tag rates and TACs to obtain suitably precise abundance estimates for new and exploratory fisheries in the CCAMLR Convention Area R.M. Hillary (UK) (*CCAMLR Science*, submitted)
WG-SAM-08/7	Analysis of Ross Sea tagging and recapture rates D.J. Agnew (UK)
WG-SAM-08/8	Towards the balanced stock assessment of Antarctic toothfish in the Ross Sea D. Vasilyev and K. Shust (Russia)
WG-SAM-08/9	Reconstruction of size and weight composition of Antarctic toothfish (*Dissostichus mawsoni*) from the data on processed commercial catches of longliners using conversion factor I. Istomin, K. Shust and V. Tatarnikov (Russia)
WG-SAM-08/10	Revised estimates of the area of the South Georgia and Shag Rocks shelf (CCAMLR Subarea 48.3) M. Belchier and P. Fretwell (UK) (*CCAMLR Science*, submitted)

WG-SAM-08/11	A proposed management procedure for the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity A. Brandão and D.S. Butterworth (South Africa) (*CCAMLR Science*, submitted)
WG-SAM-08/12	Extrapolating continuous plankton recorder data through the Southern Ocean using boosted regression trees M.H. Pinkerton, A.N.H. Smith (New Zealand), B. Raymond, G. Hosie (Australia) and B. Sharp (New Zealand)
WG-SAM-08/13	Development of a methodology for data quality assessment D.A.J. Middleton and A. Dunn (New Zealand)
WG-SAM-08/14	Development of a spatially explicit age-structured statistical catch-at-age population dynamics model for modelling movement of Antarctic toothfish in the Ross Sea A. Dunn and S. Rasmussen (New Zealand) (*CCAMLR Science*, submitted)
WG-SAM-08/15	Implementation of FOOSA (KPFM) in the EPOC modelling framework to facilitate validation and possible extension of models used in evaluating krill fishery harvest strategies that will minimise risk of localised impacts on krill predators A. Constable (Australia)
WG-SAM-08/16	An ecosystem-based management procedure for krill fisheries: a method for determining spatially-structured catch limits to manage risk of significant localised fisheries impacts on predators A. Constable and S. Candy (Australia) (*CCAMLR Science*, submitted)
WG-SAM-08/17	An updated description and parameterisation of the spatial multi-species operating model (SMOM) É.E. Plagányi and D.S. Butterworth (South Africa)

Other Documents

WG-SAM-08/P1	Resources evaluation of Antarctic krill *Euphausia superba* Dana using areal trawling and hydro-acooustic data L.A. Kovalchuk (Ukraine) (*Ukrainian Antarctic Journal*, 2 (2004): 170–178.)
WG-SAM-08/P2	Methodology of evaluating the aquatic life resources L.A. Kovalchuk (Ukraine) (*Reports of the National Academy of Science of Ukraine*, 12 (2006): 150–157)

WG-SAM-08/P3	SeaBird: Draft User Manual V1.00-2008/06/18 D. Fu and R.I.C.C. Francis (New Zealand) (*Final Fisheries Report to the New Zealand Ministry of Fisheries*)
WG-EMM-PSW-08/4	A population estimate of macaroni penguins (*Eudyptes chrysolophus*) at South Georgia P.N. Trathan (United Kingdom)
WG-EMM-PSW-08/5	The white-chinned petrel (*Procellaria aequinoctialis*) on South Georgia: population size, distribution and global significance A.R. Martin, S. Poncet, C. Barbraud, P. Fretwell and E. Foster (United Kingdom)
WG-EMM-PSW-08/6	Abundance estimates for crabeater, Weddell and leopard seals at the Antarctic Peninsula and in the western Weddell Sea (90°–30°W, 60°–80°S) J. Forcada and P.N. Trathan (United Kingdom)
WG-EMM-PSW-08/7	Spatial and temporal variation in attributes of Adélie penguin breeding populations: implications for uncertainty in estimation of the abundance of breeding penguins from one-off counts C. Southwell, J. McKinlay, R. Pike, D. Wilson, K. Newbery and L. Emmerson (Australia)
WG-EMM-PSW-08/8	Estimating the number of pre- and intermittent breeders associated with the Béchervaise Island Adélie penguin population L. Emmerson and C. Southwell (Australia)
WG-EMM-PSW-08/9	Aspects of population structure, dynamics and demography of relevance to abundance estimation: Adélie penguins L. Emmerson and C. Southwell (Australia)
WG-EMM-PSW-08/10	Flying seabirds in Area 48: a review of population estimates, coverage and potential gaps in survey extent and methods D. Wilson (Australia)
WG-EMM-PSW-08/11	Seasonal estimation of abundance by bootstrapping inexact research data (seabird): a method for assessing abundance and uncertainty from historical count data using Adélie penguins as a case study J.P. McKinlay and C.J. Southwell (Australia)
WG-EMM-PSW-08/12	A brief summary of Adélie penguin count data from east Antarctica C. Southwell and J. McKinlay (Australia)

WG-EMM-PSW-08/13	Incomplete search effort as a potential source of bias in broad-scale estimates of penguin abundance derived from published count data: a case study for Adélie penguins in east Antarctica C. Southwell, D. Smith and A. Bender (Australia)
WG-EMM-PSW-08/14	Antarctic fur seal pup production and population trends in the South Shetland Islands with special reference to sources of error in pup production estimates M.E. Goebel (USA), D.E. Torres C. (Chile), A. Miller, J. Santora, D. Costa (USA) and P. Diaz (Chile)
WG-EMM-PSW-08/15	Timing of clutch initiation in *Pygoscelis* penguins on the Antarctic Peninsula: towards an improved understanding of off-peak census correction factors H.J. Lynch, W.F. Fagan, R. Naveen, S.G. Trivelpiece and W.Z. Trivelpiece (USA)
WG-EMM-08/8	Report of the Predator Survey Workshop (Hobart, Australia, 16 to 20 June 2008)
WG-EMM-08/9	Report from Invited Expert to WG-EMM-PSW-08 R. Fewster
WG-EMM-08/10	Reference observations for validating and tuning operating models for krill fishery management in Area 48 S. Hill (United Kingdom), J. Hinke (USA), É. Plagányi (South Africa) and G. Watters (USA)
WG-EMM-08/11	Proposed small-scale management units for the krill fishery in Subarea 48.4 and around the South Sandwich Islands P.N. Trathan, A.P.R. Cooper and M. Biszczuk (United Kingdom)
WG-EMM-08/12	Allocating the precautionary catch limit for krill amongst the small-scale management units in Area 48: the implications of data uncertainties P.N. Trathan and S.L. Hill (United Kingdom)
WG-EMM-08/13	Developing four plausible parameterisations of FOOSA (a so-called reference set of parameterisations) by conditioning the model on a calendar of events that describes changes in the abundances of krill and their predators in the Scotia Sea G. Watters, J. Hinke (USA) and S. Hill (United Kingdom)
WG-EMM-08/14	Developing models of Antarctic marine ecosystems in support of CCAMLR and IWC A. Constable (Australia)

WG-EMM-08/15	CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models: update on progress 2008 A. Constable and N. Gales (Co-conveners)
WG-EMM-08/40	Krill fishery behaviour in the 1999/2000 season S. Kawaguchi (Australia)
WG-EMM-08/44	Conditioning SMOM using the agreed calendar of observed changes in predator and krill abundance: a further step in the development of a management procedure for krill fisheries in Area 48 É.E. Plagányi and D.S. Butterworth (South Africa)

TERMS OF REFERENCE
Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)

TERMS OF REFERENCE

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)

(to be held close to the time and location of the 2009 WGFAST meeting
which will be in Ancona, Italy, from 18 to 22 May 2009)

The Scientific Committee recommended the following terms of reference for the meeting of SG-ASAM in 2009.

The following are general tasks for the subgroup:

(i) to develop, review and update as necessary, protocols on:

(a) the design of acoustic surveys to estimate the abundance index of nominated species, including surveys and data collection using commercial krill trawlers;

(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;

The following specific tasks have also been identified by the Scientific Committee. Points (ii), (iii) and (iv) are considered to be of highest priority:

(ii) to provide advice that will assist in quantifying uncertainties in krill B_0 estimates, including:

- evaluate developments in target strength modelling and other new observations on krill (SC-CAMLR-XXVI, Annex 8, paragraph 84);

- validate acoustic identification techniques – by collating a set of net-validated acoustic data and evaluating whether acoustic target identification methods are biased;

- evaluate and consider available information and current methods for the measurement of krill orientation and material properties, and using analyses of tilt angle from recent research cruises;

- develop a probability density function of the estimate of B_0 based on the current understanding of uncertainties in various parameter values.

(iii) to document the current agreed protocols for krill B_0 assessment;

(iv) to investigate the use of ancillary acoustic data (e.g. from finfish surveys, exploratory fisheries data and commercial fisheries echo sounders) and the required analytical methods with a view to:

- documenting protocols for and analysing data from exploratory fisheries acoustic data processing and interpretation;

- providing krill biomass estimates from areas that are not regularly surveyed.

(v) to evaluate acoustic results from IPY surveys in 2008, supported by a summary of all IPY acoustic data and related metadata submitted to CCAMLR to be prepared by the Secretariat (SC-CAMLR-XXVI, Annex 8, paragraph 84; SC-CAMLR-XXVI/BG/3, paragraph 22) and to provide specific advice to the Scientific Committee on the value of IPY acoustic data, and their analysis, for krill biomass estimation (SC-CAMLR-XXVI/BG/3, paragraph 22);

(vi) to evaluate developments in target strength modelling and other new observations Antarctic fish species, including icefish and myctophids (SC-CAMLR-XXVI, Annex 8, paragraph 84);

(vii) to resolve difficulties identified with the swept-area estimation of icefish abundance, including the application of the adjustment factor for trawl headline height used in surveys for *Champsocephalus gunnari* (Annex 5, paragraphs 3.26 and 13.20).

ANNEX 9

DEBATE ON OBSERVER COVERAGE IN THE KRILL FISHERY BY THE SCIENTIFIC COMMITTEE

(taken from Scientific Committee reports)

DEBATE ON OBSERVER COVERAGE IN THE KRILL FISHERY BY THE SCIENTIFIC COMMITTEE

(taken from Scientific Committee reports)

From SC-CAMLR-XXIII (2004)

2.5 WG-EMM recommended that international scientific observers continue to be placed on as many krill vessels as possible. Some participants considered that a high level of observation would be required to acquire the information necessary to determine sampling protocols, and that this ought to apply equally to all krill fisheries (Annex 4, paragraphs 3.29 and 3.30).

From SC-CAMLR-XXIV (2005)

2.7 The Scientific Committee considered the issue of compulsory deployment of CCAMLR scientific observers on all krill fishing vessels in the Convention Area, which was raised by WG-EMM and WG-FSA (Annex 4, paragraphs 3.45 and 3.55; Annex 5, paragraph 11.3(iii)).

2.8 The Scientific Committee noted that WG-EMM agreed, in principle, that there is an urgent need for CCAMLR scientific observers on all krill fishing vessels (Annex 4, paragraph 3.45) to maximise spatial and seasonal observer coverage of the fishery and to adequately understand current developments in the krill fishery, especially given the recent changes in catching and processing technology (Annex 4, paragraphs 3.45 and 3.46). However, consensus on this issue has not been reached (Annex 4, paragraphs 3.46 and 3.55).

2.9 The Scientific Committee also noted the recommendation by WG-FSA that CCAMLR scientific observers be deployed on all krill fishing vessels (Annex 5, paragraph 11.3(iii)).

2.10 The Scientific Committee noted that data from observers on board fishing vessels in the Convention Area are used:

(i) to provide accurate catch rates used in standardising CPUE, the effect of this is most evident in the improved data following the introduction of 100% coverage of observers in the *D. eleginoides* fishery in Subarea 48.3;

(ii) to provide length frequencies for use in determining the interaction of the fishery with the caught species, the utility of this is demonstrated in the implementation of integrated assessments for *Dissostichus* spp. in Subareas 48.3 and 88.1 that help understand the changes in the stock structure during the development of the fishery;

(iii) to provide information on the differences between vessels which need to be estimated for use in standardising time series of CPUE as well as for inclusion of different integrated assessments;

(iv) to provide catch and length information as above to help determine the overlap between fisheries and predators at small scales.

The Scientific Committee agreed that these purposes are important in the assessment work being undertaken to provide advice to the Commission.

2.11 Dr Shin indicated that, while seeing the scientific merits of the observer-collected data, he does not share the same view on the magnitude of improvements the observer-collected data will bring to the assessment of the krill fishery as in other fisheries. He further noted that the krill fishery is a commercial venture and there may be constraints in having the fishery provide scientific data.

2.12 Dr Holt suggested that, from the scientific point of view, there were no doubts as to the appropriateness of deploying international scientific observers on all krill fishing vessels. However, it has not been possible to resolve this question for some years due to reasons which have little to do with scientific aspects of the matter. For example, the question of protecting the confidentiality of fishery information represents an obstacle for some countries. Dr Holt suggested that this issue be referred to the Commission for consideration since it would be difficult for the Scientific Committee to eliminate these obstacles.

2.13 Dr M. Naganobu (Japan) expressed his disagreement with compulsory deployment of international scientific observers on all krill fishing vessels, for the following reasons:

(i) Japan has signed a number of international agreements, in accordance with which foreign scientific observers already collect scientific data on Japanese vessels, and these agreements are sufficiently effective;

(ii) compliance with the requirement of compulsory 100% international scientific observer coverage of all krill fishing vessels may have significant financial implications;

(iii) there are problems arising from the need to respect the fishing companies' rights to protect the confidentiality of fishing information;

(iv) currently, the total catch of krill is at a stable level. It is significantly lower than the precautionary catch and there is therefore no urgent need to increase the amount of data being collected.

2.14 Profs J. Beddington (UK) and Croxall expressed surprise at the nature and content of some of the contributions to this discussion, and noted that:

(i) the WG-EMM report indicated that apparently all Members, except Japan, had agreed in principle that the deployment of scientific observers should be required on all krill vessels (Annex 4, paragraph 3.46); the reservation by Japan appeared solely to relate to commercial confidentiality, a matter which should be referred to the Commission for discussion;

(ii) the WG-FSA report indicated consensus amongst all Members that observer coverage should be required on all vessels participating in the Convention Area krill fishery (Annex 5, paragraph 11.3 and Appendix S, paragraph 31);

(iii) reservations now being expressed by Members, including by the same individuals who were present at the working group meetings, involve a combination of new objections, most of which relate to matters outside the competence of the Scientific Committee and old objections, which have been extensively debated in previous years.

2.15 However, Profs Beddington and Croxall did recognise that while there appeared to be consensus on the scientific merits of increased levels of observation on vessels fishing for krill in the Convention Area, there may be valid concerns about how this should be implemented in order best to achieve the desired scientific objectives.

2.16 To address any such concerns, the UK proposed a scientific study whereby, in the first year feasible, each vessel participating in the krill fishery in the Convention Area should have a scientific observer on board to carry out the tasks already requested or required by the Scientific Committee. For this single-year pilot study, protocols should be developed and the results analysed and evaluated by an appropriate group established by the relevant working groups of the Scientific Committee. This group would then recommend to the Scientific Committee, levels of observer coverage appropriate for each specified task and for the observer program for the krill fishery overall.

2.17 Dr V. Siegel (European Community) supported the UK proposal which could prove to be an acceptable option to speed up the process of improving scientific data collection in the krill fishery. He noted that CCAMLR should not be complacent just because the catch of krill has stabilised in recent years, as the fishery enters a new stage associated with the adoption of a new fishing technology. The Scientific Committee will therefore need to have sufficient information available to it to be able to provide appropriate management advice. He also noted that the majority of objections to the 100% coverage by CCAMLR scientific observers of the krill fishery (issues of confidentiality, finance etc.) do not fall within the Scientific Committee’s terms of reference and should be considered by the Commission.

2.18 Mr L. Pshenichnov (Ukraine) noted that an acceptable option would be a requirement of conservation measures to deploy at least national scientific observers on all krill fishing vessels, provided that they would collect data in accordance with the CCAMLR Scheme of International Scientific Observation.

2.19 Dr Shin observed that a unanimous recommendation of 100% observer coverage on all krill fishing vessels was not likely, and did not see the utility of attempting to forward such a recommendation under the current circumstance. He further observed that krill catch varied little from year to year over a decade at a low level, while the catch limit has risen by four times in the major fishing ground. With regard to seal by-catch, solutions are being found, and the problem is far more tractable now. To his delegation’s view, it is more pressing to ensure observer-collected data are analysed and the results are delivered in time, and it will be more useful to articulate where the more critical data needs are and to discuss the means to improve the situation. He further noted that krill fishing occurs over protracted periods and across large distances, and hence placing observers on such fishing platforms would incur a much greater challenge in logistics and cost.

2.20 Dr A. Constable (Australia) noted that it would be useful to introduce a process which would allow the CCAMLR Secretariat to accredit and coordinate scientific observers’ activities on all krill fishing vessels.

2.21 The Scientific Committee agreed that deployment of international observers on all krill fishing vessels would allow collection of useful scientific information required to develop management advice for the krill fishery, based on the ecosystem approach.

2.22 At the same time, the Scientific Committee was unable to reach consensus as to the urgency of including this requirement in the CCAMLR Scheme of International Scientific Observation, as its appropriateness in terms of balance between scientific usefulness and costs was not clear to some participants.

2.23 The Scientific Committee has also found that the majority of problems which could become an obstacle to the introduction of compulsory scientific observer coverage of all fishing vessels (issues of costs, and confidentiality of data collected on board fishing vessels) do not fall within the Scientific Committee's responsibility and should be decided by the Commission.

2.24 The majority of Members of the Scientific Committee agreed to support the proposal put forward by the UK and to conduct an experiment during the first year feasible in organising the work of scientific observers on all krill fishing vessels during this season (paragraph 2.16).

Advice for the Commission

2.32 The Scientific Committee recommended that:

(iii) the deployment of international scientific observers on krill fishing vessels would allow collection of useful scientific information required to develop management advice for the krill fishery, based on the ecosystem approach, be noted (paragraph 2.21);

(iv) the remaining problems hindering the introduction of the system of compulsory deployment of scientific observers on all krill fishing vessels cannot be resolved by the Scientific Committee as they are included in the Commission's responsibilities (paragraph 2.23).

2.33 The Scientific Committee noted that most Members supported a proposal to conduct, in the first appropriate season, an experiment in the organisation of the work of CCAMLR scientific observers on all krill fishing vessels during this fishing season, in order to assess the scientific usefulness and effectiveness of the introduction of a system of compulsory deployment of scientific observers on all krill fishing vessels (paragraph 2.24).

From SC-CAMLR-XXV (2006)

2.14 The Scientific Committee noted that both WG-EMM (Annex 4, paragraph 3.80) and WG-FSA (Annex 5, paragraph 10.3) recommended increased observer coverage across the krill fleet. It also recalled its discussion last year on the deployment of observers on krill vessels (SC-CAMLR-XXIV, paragraphs 2.7 to 2.24), including specific comments indicating the points of disagreement on compulsory deployment of observers on krill fishing vessels.

2.15 The Scientific Committee noted that three main issues are of high priority in the krill fishery at present:

(i) understanding the differences in selectivity between the various krill fishing gear configurations (paragraph 2.9);

(ii) determining the level of by-catch of fish larvae in the krill fishery (paragraph 2.12);

(iii) determining the level of warp strikes by seabirds and incidental mortality of seals (paragraphs 5.31 and 5.32).

2.16 In considering these three issues, the Scientific Committee agreed that there may be differences in by-catch of fish larvae and incidental mortality of seabirds and seals between different trawl methods and gear configurations in this fishery. It therefore agreed that observations from all Members were important for addressing these issues.

2.17 Some Members, however, were of the view that the issues of by-catch of larval fish and the incidental mortality of seabirds and mammals do not outweigh the importance of more direct krill-related observations. They also noted that, at present, the effect of by-catch of larval fish on the dynamics of those stocks has not been assessed and that it would be desirable for the working groups to make this assessment using existing data before focussing on further monitoring of by-catch of larval fish in the krill fishery. Dr M. Naganobu (Japan) noted that Japan has provided information from the scientific observation on krill vessels including the by-catch of larval fish for over 10 years. He further noted that the interaction with seabirds and mammals in the krill fishery is only modest or coming under control.

2.18 Most Members agreed that, as proposed last year (SC-CAMLR-XXIV, paragraph 2.16), a scientific study should be undertaken such that each vessel in the krill fishery should carry an observer at the same time in the same areas to enable a valid comparison of the different methods and that this study could be used to help determine the level of observer coverage that would be required in the future. It was noted from Table 1 that such a study might be undertaken in Subarea 48.2 during March–May when most Members fished in that area.

2.19 Some Members indicated that such an experiment is still unlikely to result in sufficient coverage of the features intended to be monitored, as the level of krill fishery is currently very low. Hence the justification of the cost that will incur is not sufficiently strong. They also noted that, should such a study proceed, the manner in which the study would be funded would need to be considered (for example, see the comments in CCAMLR-XXIV, paragraph 9.7).

Advice to the Commission

2.22 The Scientific Committee recommended that:

(ii) the deployment of scientific observers on krill fishing vessels should be a high priority to investigate the by-catch of larval fish in the krill fishery (paragraphs 4.7 to 4.10);

From SC-CAMLR-XXVI (2007)

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.

Table 1: Recommendations from the Scientific Committee on scientific observer coverage in the krill fishery.

Recommendations from the Scientific Committee		Implementation by the Commission	
Year	Detail	Year	Detail
	Scientific observations		
2000	Recommended the placement of national and, or, international scientific observers, following the protocols outlined in the *Scientific Observers Manual* (SC-CAMLR-XIX, paragraph 3.14)		
2001	Re-iterated need for detailed data (SC-CAMLR-XX, paragraphs 3.7 to 3.9)	2001	Endorsed the approach (CCAMLR-XX, paragraph 4.14)
2002	Noted the inconsistency in the data requirements for krill fisheries (SC-CAMLR-XXI, paragraphs 4.19 and 4.23)	2002	Noted the inconsistency and the compelling needs for detailed data (CCAMLR-XXI, paragraphs 4.27 and 4.28)
2002	Recognised the importance of data collected regularly by scientific observers (SC-CAMLR-XXI, paragraphs 4.19 and 4.22)		
2003	Implement standard electronic logbooks on krill vessels (SC-CAMLR-XXII, paragraph 2.1)		
2004	Re-iterated need for placement of scientific observers on board krill fishing vessels (SC-CAMLR-XXIII, paragraph 2.5)	2004	Noted the need (CCAMLR-XXIII, paragraph 4.5)
2005	Re-iterated need for placement of scientific observers on board krill fishing vessels (SC-CAMLR-XXIV, paragraphs 2.7 to 2.10)		
2005	Advised the Commission that the majority of the obstacles to the placement of scientific observers on board krill fishing vessels did not fall within the Scientific Committee's responsibilities (SC-CAMLR-XXIV, paragraphs 2.21 to 2.24)	2005	Noted the advice (CCAMLR-XXIV, paragraphs 9.3 and 9.8)
2005	Advised on new requirements for detailed data and coverage by scientific observers (SC-CAMLR-XXIV, paragraph 4.11)	2005	Noted the need (CCAMLR-XXIV, paragraphs 4.24 and 4.32)
2006	Re-iterated need for scientific observations, with focus on gear selectivity, by-catch of larval fish and IMAF (SC-CAMLR-XXV, paragraphs 2.15, 2.22 and 4.20)	2006	Noted the need (CCAMLR-XXV, paragraphs 4.27 to 4.30 and 10.1 to 10.11)
2007	Re-iterated need for the systematic observer coverage in krill fisheries (SC-CAMLR-XXVI, paragraphs 3.13 to 3.16)	2007	Endorsed the approach (CCAMLR-XXVI, paragraph 4.35). Implemented requirement for observers in the fishery in Division 58.4.2 (note: fishery is inactive) (CCAMLR-XXVI, paragraph 4.49; Conservation Measure 51-03)

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2008/09 INTERSESSIONAL PERIOD

SCIENTIFIC COMMITTEE TASKS FOR THE 2008/09 INTERSESSIONAL PERIOD

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
1.	**WG-SAM**				
1.1	Methodologies to assess data quality should be further developed and implemented.	2.4(i)	Jun 09	Implement	Implement (New Zealand)
1.2	Models that may be used towards understanding ecosystem dynamics and consequences of management approaches for Antarctic resources should continue to be developed and advanced.	2.4(ii)	Ongoing	Assist	Implement
1.3	Revision (version) control systems which allow the management of multiple revisions of programming code, documents and data files within a central database should be implemented in the work of SC-CAMLR.	2.4(iii)	Ongoing	Assist	Implement
1.4	A common set of terminology consistent with that of other international fora with respect to the evaluation of management procedures should be adopted for use of the work of SC-CAMLR.	2.4(iv)	Ongoing	Assist	Implement
2.	**SG-ASAM**				
2.1	Recommendations for issues to be addressed at the fourth meeting of WG-ASAM including priorities and terms of reference.	2.5–2.9	Apr 09	Implement	Implement
3	**Joint CCAMLR-IWC Workshop**				
3.1	Joint Steering Group to consider future work.	2.20	Ongoing	Assist	Implement
4.	**Ecosystem monitoring and management**				
	SSMU allocation				
4.1	Prepare risk assessment of option 1 similar to those for options 2 and 3.	3.18	Jun 09		Implement
4.2	Provide details to WG-SAM and WG-EMM on modelling issues.	3.21	Jun 09	Note	Implement (Japan and Republic of Korea)
	WG-STAPP				
4.3	Implement future work program.	3.39	Jun 09	Assist	WG-EMM

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
	Revised Agenda for WG-EMM				
4.4	Implement new agenda for 2009 meeting of WG-EMM.	3.48	Jun 09	Implement	WG-EMM Convener
	Marine Protected Areas				
4.5	Continue development of representative systems of MPAs including the priority areas identified by WG-EMM.	3.55(iv)	Jun 09	Assist	Implement
	Interactions between WG-EMM and WG-FSA				
4.6	Note terms of reference, timing and venue for FEMA2 focus topic at WG-EMM.	3.60–3.62	Jun 09	Assist	WG-EMM and WG-FSA Conveners
5.	**Harvested species**				
	Krill resources				
	Gear types				
5.1	Note modification to krill fishery gear types in notification.	4.11–4.12	Feb 09	Implement	Note
	Estimation of krill catch				
5.2	Members to report on issues arising from direct measurement of green weight of krill to TASO 2009.	4.17	Jun 09	Assist	Members engaged in krill fishery
	By-catch of larval and juvenile fish				
5.3	Translate Russian fish guide into English.	4.20	Ongoing	Implement	Note
	Fish resources				
	Tagging studies				
5.4	Continue tag verification and databasing.	4.41–4.42	Ongoing	Implement	Assist
	General biology and ecology				
5.5	Complete and publish the species profiles for *D. mawsoni*, *D. eleginoides* and *C. gunnari* on website in 2010.	4.45	Ongoing	Assist	New Zealand, Germany, UK
	Progress towards assessments of new and exploratory toothfish fisheries				
5.6	Provide random station positions for vessels participating in exploratory fisheries for toothfish in Subareas 48.6 and 58.4.	4.112–4.114	Dec 08	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
	Bottom fishing activities and VMEs				
5.7	Hold workshop on VMEs according to TORs including development of template for VME 'fishery report'.	4.217, 4.243	Aug 09	Implement	Conveners
	Undertake simulations of VME encounters given different management approaches and provide results to WG-SAM and WG-FSA.	4.251	Ongoing	Assist	Implement
6.	**Incidental mortality**				
	Review of action plan to eliminate seabird mortality				
6.1	Submit an English translation of SC-CAMLR-XXVII/BG/8 and, if possible, to send appropriate experts to WG-SAM.	5.8	Jun 09	Assist	France
6.2	Provide a detailed progress report on action plan implementation in 2009 to WG-IMAF and the Scientific Committee including figures to show the overlap between weekly fishing effort by sector and seabird incidental mortality rates.	5.8	Sep 09	Assist	France
	Observer data collection				
6.3	Implement recommendations for update to *Scientific Observers Manual*.	5.28	Feb 09	Implement	Assist
6.4	Prepare analysis of warp strike protocol implementation in Division 58.5.2.	5.29	Sep 09	Implement	Assist
	International and national initiatives relating to incidental mortality of seabirds in relation to longline fishing				
6.5	The Secretariat to explore the possibility of obtaining incidental mortality and effort data, and other details, from the IOTC Secretariat about gillnetting regulated by the IOTC.	5.36(iii)	Sep 09	Implement	
6.6	The CCAMLR Executive Secretary to write to the Executive Secretaries of the RFMOs listed in Appendix 1 of Resolution 22/XXV, again reiterating the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area.	5.36(v)(a)	Sep 09	Implement	
6.7	The CCAMLR Executive Secretary to seek the inclusion of an agenda item, reflecting the Commission's interests in reducing the incidental mortality of Convention Area seabirds outside the Convention Area, on the agenda of the meeting of RFB secretariats to be held in March 2009.	5.36(v)(b)	Mar 09	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
6.8	Prepare and submit a paper to the RFB meeting illustrating the overlap of foraging ranges of seabirds that breed in the Convention Area with CCSBT fishing.	5.37	Mar 09	Implement	
	Marine debris and its impacts on marine mammals and seabirds in the Convention Area				
6.9	Implement revised definitions of debris associated with seabird colonies, and the age and sex of Antarctic fur seals for reporting of marine debris.	5.40(i)	Mar 09	Implement	Implement
6.10	Develop a photo library of debris found, including photos of fishing gear, taken by observers.	5.40(ii)	Jun 09	Assist	TASO
6.11	Include advice on marine debris when CCAMLR makes contact with other international organisations, including RFMOs.	5.40(iii)	Ongoing	Implement	
6.12	Produce a A3 Perspex-backed poster to emphasise the importance of managing garbage in accordance with conservation measures, and the consequences to marine life of not managing garbage effectively.	5.4(iv)	Sep 09	Implement	
6.13	Members to provide data on marine debris to the Secretariat.	5.40(vi)	Ongoing	Assist	Implement
7.	**Scheme of International Scientific Observation**				
	Ad hoc TASO				
7.1	Compile list of issues from other working groups remitted to TASO and develop agenda for two-day meeting in 2009.	6.12	Jun 09	Assist	TASO Co-conveners
8.	**Fisheries management and conservation under conditions of uncertainty**				
	Climate change				
	Working groups to consider the following issues at their meetings in 2009:				
8.1	Examination of the robustness of the scientific advice provided by the Scientific Committee and the stock assessments prepared by its working groups in the face of increasing uncertainty accompanying climate change, particularly in relation to predictions of future population responses and recruitment levels.	7.14(i)	Ongoing	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
8.2	Examination of the need for, and implement as appropriate, improvements to current monitoring programs of harvested species and dependent and related species so as to provide robust and timely indicators of climate change impacts.	7.14(ii)	Ongoing	Assist	Implement
8.3	Determination of whether CCAMLR's management objectives and performance indicators require modification to remain appropriate in the face of climate change uncertainty.	7.14(iii)	Ongoing	Assist	Implement
9.	**Cooperation with other organisations**				
	Cooperation with the Antarctic Treaty System				
9.1	Joint SC-CAMLR–CEP Workshop Steering Committee to deliver agreed work plan for workshop in April 2009.	9.10–9.18	Apr 09	Assist	
10.	**Report of the CCAMLR Performance Review Panel**				
	Review Panel recommendations relative to the Scientific Committee				
10.1	Provide direction to the various Scientific Committee working groups on how the three highest-priority recommendations can be addressed and how the remainder might be addressed in the future.	10.11	Sep 09	Assist	SC Chair
11.	**Secretariat supported activities**				
	STATLANT data				
11.1	Develop an example of the type of table proposed to summarise the STATLANT IMAF data.	13.4	Intersessional	Implement	
	Metadata				
11.2	Create GCMD portal and identify metadata classifications.	13.7		Implement	
	D4Science Project				
11.3	Report on potential application of the D4Science Project to the work of CCAMLR to WG-SAM and WG-EMM in 2009.	13.10	Jun 09	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXVII	Deadline	Action required	
				Secretariat	Members
12.	**Scientific Committee activities**				
	Intersessional activities during 2008/09				
12.1	Note schedule of meetings for 2008/09.	14.4	Ongoing	Note	Note
12.2	Investigate means of involving additional scientists.	14.5	Ongoing	Assist	Implement
13.	**Other business**				
	CCAMLR website password rationalisation				
13.1	Undertake password rationalisation process.	16.4	Ongoing	Implement	
	Capacity building				
13.2	Consider ways of capacity building, including augmenting participation in the work of WG-FSA and other working groups.	16.8	Ongoing	Assist	Implement

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN SC-CAMLR REPORTS

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AAD	Australian Government Antarctic Division
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ACAP BSWG	ACAP Breeding Sites Working Group (BSWG)
ACC	Antarctic Circumpolar Current
ACW	Antarctic Circumpolar Wave
ADCP	Acoustic Doppler Current Profiler (mounted on the hull)
ADL	Aerobic Dive Limit
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AKES	Antarctic Krill and Ecosystem Studies
ALK	Age–length Key
AMD	Antarctic Master Directory
AMES	Antarctic Marine Ecosystem Studies
AMLR	Antarctic Marine Living Resources
AMSR-E	Advanced Microwave Scanning Radiometer – Earth Observing System
ANDEEP	Antarctic Benthic Deep-sea Biodiversity
APBSW	Bransfield Strait West (SSMU)
APDPE	Drake Passage East (SSMU)
APDPW	Drake Passage West (SSMU)
APE	Antarctic Peninsula East (SSMU)
APEC	Asia-Pacific Economic Cooperation
APEI	Elephant Island (SSMU)
APEME Steering Committee	Steering Committee on Antarctic Plausible Ecosystem Modelling Efforts
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)

APW	Antarctic Peninsula West (SSMU)
ASE	Assessment Strategy Evaluation
ASI	Antarctic Site Inventory
ASIP	Antarctic Site Inventory Project
ASMA	Antarctic Specially Managed Area
ASOC	Antarctic and Southern Ocean Coalition
ASPA	Antarctic Specially Protected Area
ASPM	Age-Structured Production Model
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
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
CVS	Concurrent Version System
CWP	Coordinating Working Party on Fishery Statistics (FAO)
DCD	*Dissostichus* Catch Document
DMSP	Defense Meteorological Satellite Program
DPM	Dynamic Production Model
DPOI	Drake Passage Oscillation Index
DVM	Diel vertical migration
DWBA	Distorted wave Born approximation model
EAF	Ecosystem Approaches to Fishing
EASIZ	Ecology of the Antarctic Sea-Ice Zone
E-CDS	Electronic Web-based Catch Documentation Scheme for *Dissostichus* spp.
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
ECOSIM	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
EEZ	Exclusive Economic Zone
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 modelling framework
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
FEMA2	Second Workshop on Fisheries and Ecosystem Models in the Antarctic
FFA	Forum Fisheries Agency
FFO	Foraging–Fishery Overlap
FIBEX	First International BIOMASS Experiment
FIGIS	Fisheries Global Information System (FAO)
FIRMS	Fishery Resources Monitoring System (FAO)
FMP	Fishery Management Plan
FOOSA	Krill–Predator–Fishery Model (previously KPFM2)
FPI	Fishing-to-Predation Index
FRAM	Fine Resolution Antarctic Model
FV	Fishing Vessel
GAM	Generalised Additive Model
GATT	General Agreement on Tariffs and Trade
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
OM	Operating Model
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
PRP	CCAMLR Performance Review Panel
PS	Paired Streamer Line
PTT	Platform Terminal Transmitter
RES	Relative Environmental Suitability
RFB	Regional Fishery Body
RFMO	Regional Fishery Management Organisation
RMT	Research Midwater Trawl
ROV	Remotely-Operated Vehicle
RPO	Realised Potential Overlap
RTMP	Real-Time Monitoring Program
RV	Research Vessel
RVA	Register of Vulnerable Areas
SACCB	Southern Antarctic Circumpolar Current Boundary
SACCF	Southern Antarctic Circumpolar Current Front
SAER	State of the Antarctic Environment Report
SAF	Sub-Antarctic Front

SBDY	Southern Boundary of the ACC
SBWG	Seabird Bycatch Working Group (ACAP)
SCAF	Standing Committee on Administration and Finance (CCAMLR)
SCAR	Scientific Committee on Antarctic Research
SCAR-ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (SCAR Program)
SCAR-BBS	SCAR Bird Biology Subcommittee
SCAR-CPRAG	Action Group on Continuous Plankton Recorder Research
SCAR-EASIZ	Ecology of the Antarctic Sea-Ice Zone (SCAR Program)
SCAR-EBA	Evolution and Biodiversity in Antarctica (SCAR Program)
SCAR-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
SONE	South Orkney North East (SSMU)
SOOS	Southern Ocean Observing System
SOPA	South Orkney Pelagic Area (SSMU)
SOW	South Orkney West (SSMU)
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Specially Protected Area
SPC	Secretariat of the Pacific Community
SPGANT	Ocean Colour Chlorophyll-*a* algorithm for the Southern Ocean
SPM	Spatial Population Model
SSB	Spawning Stock Biomass
SSG-LS	The Standing Scientific Group on Life Sciences (SCAR)
SSM/I	Special Sensor Microwave Imager
SSMU	Small-scale Management Unit

SSMU Workshop	Workshop on Small-scale Management Units, such as Predator Units
SSRU	Small-scale Research Unit
SSSI	Site of Special Scientific Interest
SST	Sea-Surface Temperature
STC	Subtropical Convergence
SWIOFC	Southwest Indian Ocean Fisheries Commission
TASO	ad hoc Technical Group for At-Sea Operations (CCAMLR)
TDR	Time Depth Recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TISVPA	Triple Instantaneous Separable VPA
ToR	Term of Reference
TrawlCI	Estimation of Abundance from Trawl Surveys
TS	Target Strength
TVG	Time Varied Gain
UBC	University of British Columbia (Canada)
UCDW	Upper Circumpolar Deep Water
UN	United Nations
UNCED	UN Conference on Environment and Development
UNEP	UN Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNCLOS	UN Convention on the Law of the Sea
UNFSA	the United Nations Fish Stock Agreement is the 1995 United Nations Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
UNGA	United Nations General Assembly
UPGMA	Unweighted Pair Group Method with Arithmetic Mean

US AMLR	United States Antarctic Marine Living Resources Program
US LTER	United States Long-term Ecological Research
UV	Ultra-Violet
UW	Unweighted
UWL	Unweighted Longline
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
VOGON	Value Outside the Generally Observed Norm
VPA	Virtual Population Analysis
WAMI	Workshop on Assessment Methods for Icefish (CCAMLR)
WCO	World Customs Organization
WFC	World Fisheries Congress
WCPFC	Western and Central Pacific Fisheries Convention
WG-CEMP	Working Group for the CCAMLR Ecosystem Monitoring Program (CCAMLR)
WG-EMM	Working Group on Ecosystem Monitoring and Management (CCAMLR)
WG-EMM-STAPP	Subgroup on Status and Trend Assessment of Predator Populations
WG-FSA	Working Group on Fish Stock Assessment (CCAMLR)
WG-FSA-SAM	Subgroup on Assessment Methods
WG-FSA-SFA	Subgroup on Fisheries Acoustics
WG-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

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE TWENTY-SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
27–31 OCTOBER 2008

Part II

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Chair of the Scientific Committee
November 2008

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ANNEX 12

REPORT OF THE JOINT CCAMLR-IWC WORKSHOP
(Hobart, Australia, 11 to 15 August 2008)

CONTENTS

REPORT OF THE JOINT CCAMLR-IWC WORKSHOP

(Hobart, Australia, 11 to 15 August 2008)

INTRODUCTION

Opening of the meeting

1.1 The Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models was held at the CCAMLR Headquarters in Hobart, Australia, from 11 to 15 August 2008. The workshop was co-convened by Drs A. Constable and N. Gales from the Scientific Committees of CCAMLR and the IWC respectively.

1.2 The CCAMLR Executive Secretary, Dr D. Miller, welcomed the workshop participants. He noted that Article XXIII(3) of the CAMLR Convention expressly referred to cooperation with the IWC to further CCAMLR's work. Discussions between the two organisations as long ago as 1987 had highlighted the importance of baleen whales in particular as krill predators and as an important component in CCAMLR's needs to account for ecosystem interactions in its management approach. Further cooperation between the two organisations during the CCAMLR-2000 Survey in particular, had planted the seeds for the current workshop. It had also highlighted the importance of advancing Antarctic ecosystem models, particularly on predator–prey relationships, in developing robust management, as well as conservation, advice relevant to both CCAMLR and the IWC. The Executive Secretary wished the workshop well and emphasised that its outcomes were likely to be of great interest to both organisations.

1.3 The Co-conveners welcomed all participants[1], including representatives from SC-CAMLR and the IWC SC, invited experts and experts from the expert groups.

1.4 Special thanks were extended to the CCAMLR Secretariat for hosting the workshop and assisting with its organisation.

Organisation of the meeting

1.5 The workshop terms of reference were (SC-CAMLR, 2007a, paragraph 13.40; SC-CAMLR, 2007b, paragraph 7.25; IWC, 2008a):

(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.

[1] The affiliations of attendees cited in this report may be found in Appendix B.

(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 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.

1.6 The workshop thanked the expert group coordinators, nominated by the Joint Steering Group, for coordinating contributions from the expert groups to the workshop:

- toothed whales – Mr R. Leaper
- baleen whales – Dr A. Zerbini
- pack-ice seals – Dr C. Southwell
- fur seals – Dr K. Reid
- penguins – Dr P. Trathan
- flying birds – Drs B. Weinecke, M. Double and B. Sullivan
- fish – Dr K.-H. Kock
- squid – Prof. P. Rodhouse
- krill – Dr S. Nicol
- protists – Dr P. Strutton
- zooplankton – Dr A. Atkinson
- Sea-ice – Dr R. Massom
- Ocean processes – Prof. E. Hofmann
- Exploitation – Dr S. Kawaguchi.

1.7 The workshop agreed that the discussion would be in three parts. Firstly, the submissions by the expert groups would be reviewed and feedback provided on how the expert groups could complete the expectations of the terms of reference. These discussions were to be addressed by three small groups: pelagic species, seals and birds, and whales. Each small group comprised experts with experience in research on the respective taxa along with experts with backgrounds in oceanography, sea-ice dynamics, primary production, statistics and/or modelling. Each group addressed the following topics:

(i) abundance
(ii) habitat
(iii) life histories
(iv) food-web linkages
(v) future analytical and research priorities.

1.8 Each small group was to organise its discussion appropriate to the natural divisions of the taxa and topics being considered. Therefore, the format of the report would vary amongst the small groups. The reports of the small groups were then to be considered in Plenary to help the subsequent general discussions. While these reports are included in the workshop report, it was recognised that the degree of Plenary discussion on each report would be only short and not necessarily covering the complete detail of each report.

1.9 Secondly, the workshop considered the general issues on metadata for the CCAMLR and IWC modelling efforts, and finally it considered the outputs from this process and the requirements for future work.

1.10 The adopted agenda is in Appendix A. The workshop participants are listed in Appendix B. The documents submitted to the workshop are listed in Appendix C. Acronyms used in this report are listed at the end of the document.

1.11 The report of the meeting was prepared by workshop participants, with primary contributions by the coordinators and rapporteurs of the small groups:

- pelagic species – Drs S. Nicol (coordinator) and A. Punt (rapporteur)
- seals and seabirds – Prof. D. Costa (coordinator) and Dr C. Southwell (rapporteur)
- whales – Dr J. Bannister (coordinator) and Mr R. Leaper (rapporteur).

Workshop background

1.12 Background to the workshop was provided by the Co-conveners in CCAMLR-IWC-WS-08/2.

1.13 SC-CAMLR and the IWC SC agreed to hold a joint workshop to review input data required for ecosystem models being developed to provide management and conservation advice on krill and krill predators in the Antarctic marine ecosystem (SC-CAMLR, 2005, paragraphs 13.44 to 13.53; IWC, 2006).

1.14 A Joint Steering Group was established for the CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models' incorporating steering committees from both organisations:

SC-CAMLR
Drs A. Constable (Co-convener), M. Goebel, J. Pierre, D. Ramm, K. Reid, C. Southwell, P. Trathan

IWC SC
Drs N. Gales (Co-convener) and A. Bjorge, Prof. D. Butterworth, Dr D. DeMaster, Mr G. Donovan, Drs N. Grandy, S. Hedley, K-H. Kock, R. Leaper and M. Mori, Mr H. Murase and Dr T. Polacheck.

1.15 Models developed to support discussions in SC-CAMLR and the IWC SC include those of Mangel and Switzer (1998), Thomson et al. (2000), Watters et al. (2005, 2006), Plagányi and Butterworth (2005, 2006a, 2006b), Mori and Butterworth (2003, 2006a, 2006b) and Constable (2005, 2006). An important difference in the current modelling for SC-CAMLR and the IWC SC is the spatial scale and taxa of interest. Models on the dynamics of cetacean populations will necessarily operate at larger scales commensurate with the ability of whales to move widely in Antarctic waters. Modelling of krill availability to all predators is an important issue being addressed by SC-CAMLR and at this stage is focused on krill availability and predator foraging at the scale of land-based predator colonies and of CCAMLR's SSMUs; however, given the potential for appreciable increase in the krill fishery in the longer term, models at a wider spatial scale are also of interest to SC-CAMLR. An important issue for these models is how to ensure that they provide results that are consistent with each other.

1.16 Baleen whales are clearly important krill consumers in the Southern Ocean, and their improved parameterisation in CCAMLR models, facilitated in part by this workshop, should add value to models informing sustainable krill fishery practice.

1.17 Similarly, as the IWC considers the ecological aspects of the recovery of the great whales in the Southern Ocean, this collaboration with CCAMLR will importantly link IWC knowledge of whales with that of other krill consumers.

1.18 From the perspectives of both Commissions, a consistent approach to modelling by CCAMLR and the IWC should improve the provision of sound conservation and management advice in the Southern Ocean.

1.19 Models discussed at CCAMLR and the IWC are developed from a variety of data types and reflect different spatial and temporal scales with different degrees of ecological detail. These data types may be drawn from the following, *inter alia*:

(i) Population –

(a) biomass/numbers in different regions of the Southern Ocean in absolute terms;

(b) trends in relative abundance;

(c) population structure, including age/size/spatial structure.

(ii) Habitat utilisation –

(a) movement;

(b) key habitats and environmental variables (drivers of key population processes);

(c) foraging areas.

(iii) Population growth rates –

(a) growth of individuals
(b) reproductive output
(c) recruitment
(d) mortality rates
(e) carrying capacity.

(iv) Foraging activities –

(a) diet
(b) foraging success
(c) consumption rate
(d) competition
(e) spatial utilisation.

(v) Catch –

(a) biomass/numbers taken
(b) size structure in different regions over time.

1.20 The degree of detail in taxonomic information required for each of the above data types is difficult to determine *a priori* given that a number of physical and ecological parameters can impact on krill availability and food-web dynamics (Murphy et al., 2007).

1.21 Expert groups compiled ecological and environmental data for the following main categories:

(i) exploitation of seals, whales, finfish and krill
(ii) cetaceans – toothed whales, baleen whales
(iii) seals – pack-ice seals, fur seals
(iv) seabirds – penguins, flying seabirds
(v) mesopelagic and epipelagic predators – fish and squid
(vi) krill
(vii) other biological components – primary production and protists, zooplankton
(viii) environmental components – sea-ice, sea-surface temperature and atmospheric and ocean processes.

1.22 The most important data were considered to be abundance data and particularly the associated information on likely bias, variance and comparability of any time series. These data are available from the literature, a number of general sources, including the IWC, CCAMLR and SCAR-MarBIN, and from works in progress. Depending on the model, these data will need to be subdivided or aggregated in space. In the first instance, abundance data need to be collated by either CCAMLR or IWC statistical/management unit (Figure 1), converting these into densities and providing a description about the spatial extent to which the densities can be applied. The latter can then be used to determine whether the data collected at one scale, say IWC management units, can be used to provide information at another scale, say a CCAMLR statistical division. Statistical divisions that extend from the Antarctic continent to the CCAMLR boundary (Subarea 48.6, Division 58.4.1) should be further divided into north and south at 60°S. Further subdivision of data into CCAMLR SSMUs in the south Atlantic will be useful (Figure 2). The degree to which input data can be re-analysed to fit alternative subdivisions to the original analysis is important to be reviewed.

1.23 Analyses of data on habitat utilisation endeavour to specify the potential spatial overlap between taxa and the spatial variation in productivity that might occur. Two types of data may be needed, the spatial attributes of habitats and the temporal partitioning of habitat and movement between areas.

1.24 Typically, population growth is dependent on reproduction, mortality and growth of individuals. Intraspecific competition may result in changes to one or all of these processes. They can be modelled in part or together as functions.

1.25 Models of the foraging dynamics of a taxon utilise diet data and functions for foraging, e.g. Holling Type II and III functions or other dynamic approaches. Although difficult to measure, assumptions are usually made about the nature and extent of inter-/intra-specific competition in these models.

1.26 Catch data will have been reported at taxon-specific spatial and temporal scales with much catch data being of variable quality, particularly for finfish. It may also be important to consider species for which there is substantial by-catch, such as seabirds. All these data will need to be subdivided into common statistical units across the taxa as appropriate.

1.27 Preparation for the workshop involved expert groups compiling and providing a commentary on metadata. A database was developed and is currently hosted at the AADC with the expectation that the database will be deposited with both the CCAMLR and IWC Secretariats.

1.28 With the exception of the flying seabirds group, reviews were available from expert groups. An additional expert group was added early in 2008 under the coordination of Dr Kawaguchi to review the state of the datasets on the exploitation of Southern Ocean species, including seals, whales, finfish and krill. The compilation of this paper will occur after the workshop, pending the outcomes of work by the individual expert groups.

1.29 The establishment of a metadatabase of data for use in models by CCAMLR and the IWC was considered to be an important outcome of the workshop. Such a database along with a web-based GUI was established by the AADC and made available to the expert groups for use. It is currently being hosted on a secure site by the AADC. This is only temporary in preparation for the workshop. The database will be provided to both the CCAMLR and IWC Secretariats for archiving and further development as needed. Information on how to access the database and how to use the GUI is available in CCAMLR-IWC-WS-08/16.

1.30 The workshop was open to members of SC-CAMLR and the IWC SC and their working groups. Furthermore, participants in the expert groups were invited to attend. A number of additional general experts, including those with expertise in statistics and modelling, were also invited to attend.

CCAMLR and IWC modelling requirements

1.31 CCAMLR-IWC-WS-08/3 provided a general overview and background to models of Antarctic marine ecosystems being discussed at CCAMLR and the IWC, in particular, summarising the following:

(i) ecosystem models could be developed in CCAMLR and the IWC for the purposes of either –

  (a) evaluating management procedures; or
  (b) in CCAMLR, estimating the status of the ecosystem or components thereof;

(ii) ecosystem modelling in CCAMLR –

  (a) the development of food-web and ecosystem models in CCAMLR since 1995 and the concerted effort to develop ecosystem models for assisting in evaluating krill management procedures since a workshop in 2004;

(b) details of the outcomes of the 2004 WG-EMM workshop (SC-CAMLR, 2004) on ecosystem models, including conceptual representation of the ecosystem;

(c) spatial characterisation of the Southern Ocean, in terms of CCAMLR and IWC statistical units, CCAMLR SSMUs, and the CCAMLR bioregionalisation;

(iii) ecosystem modelling in the IWC;

(iv) a discussion on model structure, data inputs and where uncertainties in the modelling process arise, including:

(a) food-web model structure;

(b) model use and handling uncertainty;

(c) natural variation and parameter uncertainty;

(d) model uncertainty arising from how the following are specified –

- taxonomic specification – guilds and functional groups
- prey mortality and predator consumption
- relative timing of consumption and biomass accumulation
- maintaining appropriate covariation between parameters and model behaviours.

1.32 Prof. Butterworth presented a summary of the development of food-web models in the IWC:

(i) Issues that have been raised include:

(a) To what extent might consumption of forage species by top predators impact fisheries?

(b) To what extent might competition occur between top predators for forage species?

(c) To what extent might fisheries impact top predators and/or the ecosystem as a whole?

(ii) Management advice taking account of species interactions has included:

(a) a strategy for setting minke whale catches in the early 1980s based on the 'krill surplus' hypothesis;

(b) evaluation of the RMP using variation in MSYR and K as surrogates for species interaction effects.

(iii) The manner in which uncertainty can be dealt with has been considered, noting the difficulty that different models can give very different results; the conclusion of the FAO Expert Workshop on Modelling (FAO, in press) was that ecosystem models could be used as operating models, but have not evolved sufficiently for use as tactical models on which to base quantitative advice.

(iv) Examples of food-web modelling have included:

(a) models in northeast Atlantic, northwest Pacific, and northwest Africa, using Ecopath with Ecosim and Multspec, which is an example of a Minimally Realistic Model (MRM);

(b) a model for Antarctica considering competition (Mori and Butterworth, 2005).

1.33 Prof. Butterworth concluded by indicating that improved data are essential for further development of the models and for providing sufficient power to test their predictive reliability, which is one of the core motivations for this workshop.

1.34 Dr Constable presented further clarification of his views of the use of data in CCAMLR and IWC models to assist the discussions on what data are needed for these purposes. In particular, he drew attention to the need to use models to provide a minimal representation required to capture the dynamics of importance (minimal realistic models), i.e. what is essential to be represented in terms of spatial scales, temporal scales and timing of events, biotic detail (species, functional groups, environmental covariates) and population/individual processes? He provided a number of figures to illustrate where he believed data and knowledge can be used to build plausible scenarios (models) of ecosystems (Figures 3 to 6).

General questions for CCAMLR and IWC ecosystem modelling

1.35 The workshop considered the following as useful general questions guiding the examination of ecosystem effects in conservation and management in the Antarctic:

(i) How might fishing on a species, in particular krill, impact predators of that species?

(ii) How might changes in abundances of predators, for example those recovering from prior exploitation, influence other components of the ecosystem?

(iii) How might the environment and environmental change impact the abundances of fished species and their predators, and conservation objectives?

The workshop noted the different data types and scales relevant to each question. Issues of timelines for required outcomes were also highlighted with respect to risking unreliable model predictions if timelines are overly constrained. Attempts to model climate related change in particular were noted to require long timelines.

1.36 The workshop noted that these questions were to be considered primarily in relation to krill and krill predators. It noted that each question would naturally be addressed at different scales, ranging from Antarctic-wide, through CCAMLR or IWC management units, to CCAMLR SSMUs.

METADATA SUMMARIES

2.1 The workshop recognised that the tasks originally assigned to all expert groups were very substantial, and that it was a very difficult task for the expert groups to address all the issues prior to the workshop.

Physical environment and primary production

Oceanography

Summary from expert group

2.2 CCAMLR-IWC-WS-08/15 discussed how analyses of the dynamics of Southern Ocean ecosystems have highlighted the importance of understanding physical and biological interactions because these are fundamental to predicting the impacts of climate and harvesting in the Southern Ocean and in improving sustainable management strategies. Modelling provides one approach for combining environmental and biological data in a quantitative framework to develop scenarios for system responses to a range of perturbations. However, models typically consider a limited range of space and time scales that are dictated by the questions of interest. Information on processes at smaller scales is included through parameterisations; information at larger scales is included via boundary conditions. These requirements place important emphasis on availability of datasets that are adequate to meet these modelling needs. Data are also integral to model evaluation and calibration and must encompass the space and time resolution needed to do this. Model-data fusion via data assimilation provides another important use for data in modelling studies.

2.3 Numerical ocean circulation models are now relatively mature. Community-based models, such as the Regional Ocean Modelling System (ROMS) (Haidvogel et al., 2008) and the Princeton Ocean Model (POM) (Mellor, 1996), are available and these have extensive user communities. These models are supported and continually updated as new understanding, numerical procedures and research foci evolve. Biological models are not yet as mature as some numerical ocean circulation models and reliable simulations of an ecosystem state are not considered feasible beyond the level of bulk quantities, such as macronutrients or chlorophyll. The limitation of these models comes from insufficient data to parameterise processes, provide initial and boundary conditions, and undertake rigorous model evaluation. An equally important limitation is basic understanding of the coupling between trophic levels, food-web structure and coupling of food webs to environmental conditions and to models of biogeochemical processes. Coupling these models to those developed for marine resource management remains to be done.

2.4 Environmental datasets exist in a variety of forms that include large-scale climatologies, numerous regional programs, Lagrangian measurements (e.g. floats), Eulerian measurements (e.g. moored current meter arrays), and satellite-based observations (e.g. sea-ice, surface winds). The challenge is to combine these data sources to develop characterisations of environmental structure and variability.

2.5 Approaches for quantitative evaluation of model output are key to improving model structure and ultimately the ability to predict and evaluate scenarios for altered system states. Simulated distributions should, at a minimum, reproduce observed means and variances with little bias, capture the dynamic range of the observations, match phasing of events, and capture regional differences. How well models meet these criteria is often determined by model-data comparisons, which in many cases are qualitative evaluations. More rigorous quantitative evaluations through statistical comparisons, such as Taylor diagrams (Taylor, 2001) and target diagrams (Joliff et al., 2007), provide estimates of uncertainty in model predictions and highlight areas where model improvements are needed. A diversity of approaches for assessing model skill is needed to identify where model improvements are needed.

2.6 Data assimilation is an approach that allows the combining of models and data in a quantitative manner that yields estimates of associated error and uncertainty. Several of the ocean circulation models that are now available are data assimilative models. Assimilation of data into ecological models has been shown to be feasible. For ecological models, approaches, such as variational adjoint methods, have been used to estimate parameter sets, improve model structure and investigate model complexity.

2.7 A cautionary note is that reduction of uncertainty is not necessarily a desirable goal. It is important to characterise and understand uncertainty in data, models and model predictions. This may actually lead to an increase in uncertainty in estimates. If reduction of uncertainty is a desired goal, it is important to establish the metrics by which progress towards this goal will be assessed.

Future research priorities

2.8 The workshop noted the advances in ocean modelling and the assistance that they can provide in understanding the physical dynamics of key habitats. The workshop also noted a number of questions that could be useful to address in determining habitat variability and change (see paragraphs 3.3 and 3.4).

2.9 The workshop also noted the general advances in modelling that integrate food-web and physical system models providing opportunities to better understand the effects of habitat variability and change on food-web dynamics, including:

(i) Multi-species models are being developed for large oceanic pelagic species that are coupled to circulation, biogeochemical and harvesting models. These models represent the integration of ocean and ecosystem processes in a framework that can be used to understand physical and biological controls on important commercial species. An example of such a model is the Apex Predators ECOSystem Model (APECOSM), which represents the spatial dynamics of open ocean pelagic ecosystems in the global ocean (Maury et al., 2007a, 2007b). Physical forcing (winds, temperature and currents from a circulation model), biogeochemical forcing (primary production and oxygen from a biogeochemical model) as well as the effects of fishing are explicitly taken into account in the model. This type of modelling structure allows investigation of the relative effects of environment (bottom-up), species interaction (top-down), and fishing effects on important commercial species. This approach may be useful to CCAMLR and the IWC for some applications.

(ii) Individual-based modelling is an approach that makes good use of many types of data, such a feeding rates or foraging behaviour, which are usually collected at the level of an individual. These models allow detailed investigation of animal responses to environmental, biological and physiological processes. The results of individual-based models can be scaled to population level using approaches based on statistical distributions that describe the range of variability in key biological or physiological processes. This allows the observed range of variability for a population (e.g. a proxy for genetic variability) to be included, thereby providing a range of possible outcomes for a population in response to particular forcings. Individual-based models may be an approach for inclusion in CCAMLR and IWC modelling activities.

2.10 The workshop also noted two emerging research programs that may have relevant inputs to CCAMLR and IWC modelling activities:

(i) ICED – Integrating Climate and Ecosystem Dynamics in the Southern Ocean

ICED is a decade-long international multi-disciplinary program that has been established primarily to facilitate the scientific coordination and communication required to produce models of Southern Ocean ecosystems that allow the prediction of future scenarios. ICED is a regional program under GLOBEC and the Integrated Marine Biogeochemistry and Ecosystem Research Programs of the International Geosphere-Biosphere Program.

The long-term goal of ICED is to develop a coordinated circumpolar approach to understand climate interactions in the Southern Ocean, the implications for ecosystem dynamics, the impacts on biogeochemical cycles, and the development of management procedures for the sustainable exploitation of living resources.

ICED has three major scientific objectives:

(a) to understand how climate processes affect the structure and dynamics of ecosystems in the Southern Ocean;

(b) to understand how ecosystem structure and dynamics affect biogeochemical cycles in the Southern Ocean;

(c) to determine how ecosystem structure and dynamics should be incorporated into management approaches to sustainable exploitation of living resources in the Southern Ocean.

Many of the ICED activities, such as analyses of historical datasets, could be relevant to CCAMLR and the IWC. In particular, the emphasis on circumpolar models that combine circulation, food webs and biogeochemistry are intended to be directly linked to many of the modelling efforts relevant to CCAMLR and the IWC. The regional observational programs that are planned as part of ICED will provide integrated datasets that are potentially of interest to CCAMLR and the IWC.

(ii) SOOS – Southern Ocean Observing System

The Southern Ocean is vast, remote and logistically difficult to access and as a result is one of the least sampled regions on Earth. SOOS is an attempt to design and implement an observing system that encompasses physical, biogeochemical and ecological processes. SOOS is now in the development stages and should have an implementation plan developed this year. It would be useful if CCAMLR and the IWC could provide inputs on needed measurements and regions for measurements.

2.11 The workshop noted that these models will not be used directly in decision-making in the short term. They may prove helpful to inform the development of models for evaluating management procedures in the IWC and CCAMLR, but there was insufficient time to discuss them in detail.

Sea-ice

Summary from expert group

2.12 CCAMLR-IWC-WS-08/14 provided a synthesis of data on sea-ice, its dynamics and its role in Southern Ocean marine ecosystems. Sea-ice plays a dominant yet highly variable role in structuring marine ecosystems of the high-latitude Southern Ocean. It forms a nutrient-rich substrate for concentrating microbial communities; a critical food source for pelagic herbivores, which in turn form a key food source for larger predators; and a resting, breeding and protection platform for seals and penguins. Moreover, it strongly impacts pelagic production during ice melt. Different ice types have different ecosystem functions, (e.g. pack-ice versus fast-ice). While sea-ice habitat is highly heterogeneous over small spatial scales, the circumpolar sea-ice cover is characterised by large-scale (seasonal) patterns in its distribution, dynamics and characteristics – driven by climatological temperature, wind and ocean current fields. Sea-ice responds to, and modulates, changes/trends in these forcing fields, and as such is highly sensitive to climate change/variability – with ramifications for organisms associated with/dependent on it.

2.13 Major large-scale components of the sea-ice habitat include the SSIZ (including the marginal ice zone), the inner pack, regions of perennial sea-ice that persist through summer, and coastal fast-ice, flaw leads and polynyas. A key characteristic of the latter is their annual recurrence and persistence in certain locations, while leads within the pack are essentially short-lived, although biologically significant, features. The extraordinary annual growth-decay cycle of the ice (from a minimum extent of ~3–4 million km^2 in February to ~19 million km^2 in September–October) moves the sea-ice zone across important physical and biological boundaries/zones in the ocean, e.g. the ACC, shelf break, Antarctic Divergence and the SBACC.

2.14 Icebergs play a major role in the coastal zone, both when grounded and drifting. They form anchor points for fast-ice formation and boundaries for polynya and localised open-water formation, and are a source of meltwater and iron on melting. On the other hand, they can be a 'wildcard' element that can diminish polynya size (and regional primary production) and deleteriously affect penguin breeding success.

2.15 Modelling of sea-ice primary production is very important, yet only one model is currently available (although two more are under development). This is specific to Weddell Sea conditions, and not applicable to circumpolar studies. A major current deficiency in terms of model validation is the lack of *in situ* observations quantifying temporal evolution of sea-ice physical habitat and communities, with no measurements of the annual cycle. In fact, current knowledge of the ecological roles of sea-ice based on short and widely-spaced *in situ* 'snapshots'. A particular challenge is to adequately sample and investigate the heterogeneous and multiple ecological niches of sea-ice within the spatio-temporal domain. New technologies such as autonomous underwater vehicles (AUVs) may help acquire large-scale datasets of combined physical-biological parameters, and experiments are planned.

2.16 Current needs have been identified for:

(i) more dedicated multi-disciplinary campaigns to measure physical and biochemical ice processes and properties plus associated biological communities, and their temporal evolution;

(ii) information on complete annual cycles in the offshore pack;

(iii) sustained long-term datasets, e.g. Palmer LTER, to enable detection of trends versus interannual variability, short- to long-term cycles and decadal-scale regime shifts;

(iv) development of a better understanding of the impact on, and sensitivity of, sea-ice 'habitat' to variability in modes of climate variability, e.g. Southern Oscillation, ENSO and SAM, and possible teleconnections;

(v) more thorough seasonal understanding of linked sea-ice and water column ecosystem (a campaign is planned off the Adélie Land coast);

(vi) establishment of a mechanistic understanding of the linkages between sea-ice, biogeochemical processes, lower to upper trophic levels and climate.

2.17 Although an emphasis is placed in the literature on sea-ice extent, ice extent alone is only a partial descriptor of sea-ice habitat. Other key factors include ice concentration, the mode of ice formation, wind-driven ice dynamics as they determine ice transport and the degree of divergence (lead formation) versus convergence (ice compaction and deformation), snowfall/accumulation, wave-ice interaction processes, the timing of annual ice growth and decay (and length of the annual growth season) and ice-surface flooding. An over-riding factor is the strong coupling between ice and snow cover, ocean and atmosphere. Satellites alone can measure/monitor the vast and remote sea-ice zone at a variety of spatial and temporal scales, and in a systematic fashion. *In situ* observations remain essential, however, to both provide information not attainable from satellites and to validate key satellite-derived products. Snow cover plays a key role in sea-ice 'habitat' considerations in terms of its impact on (i) the thermal and optical properties of the sea-ice substrate, and (ii) the spatio-temporal distribution of ice-surface flooding and surface biological communities.

2.18 Alternative sources of information are available on large-scale Antarctic sea-ice distribution and its evolution within the ocean–ice–atmosphere system. Coupled models are the key to better understanding factors determining this distribution, and its predicted response to changing and variable climatic conditions. Recent comparison of the output of the 16 coupled models for the fourth assessment report of the IPCC for 1981 to 2000 versus the satellite record of ice extent reveals wide variability in performance, which has been attributed to the performance of their individual atmospheric and ocean components. General recommendations have been made for better expressions of snow cover, ice rheology and ice–ocean interactions. Regarding predictions for the 21st Century, an average extent decrease of ~25% occurs across 15 of the models. Proxy records enable reconstruction of sea-ice extent in the pre-satellite era (effectively pre-1978). Particularly remarkable is the high-resolution reconstruction back over the past 170 years based on the MSA (methanesulphonic acid)[2] record at Law Dome on the continent in eastern Antarctica. Moreover, diatom records from ocean-floor sediment cores indicate a sea-ice cover at the last glacial maximum that was double its current maximum extent, and research is continuing to both supplement and extend these data. The current status of atmospheric observation and modelling is also a key consideration, given that sea-ice habitat is determined by numerous external forces and conditions, including wind speed and direction, air temperature and precipitation.

2.19 In terms of ecosystem response, robust prediction rests on an understanding of the various mechanisms and relationships underlying correlations with measures of the environment and environmental change together with an awareness of the non-linearity of ecosystem responses to environmental change. The latter has strongly emerged from Palmer LTER work on the changing Adélie penguin populations in the West Antarctic Peninsula region, for example. Regional sea-ice conditions over the past 30 years in this case have changed to the extent that given locations are no longer experiencing the same frequency of ‘optimal’ ice conditions (from a penguin perspective) and major ecological change is resulting. This again underlines the key importance of long time-series data not only covering biological but also key environmental parameters (sea-ice, ocean, atmosphere) (i.e. a committed long-term multi-disciplinary approach).

2.20 Regarding marine mammals and birds, little information is currently available on species-specific ‘optimal’ sea-ice conditions. This baseline information is essential if the impacts of environmental change are to be predicted in a realistic fashion. Of particular importance in this regard is the instrumentation and tracking of seals, birds and whales. Initial comparison of data of southern elephant seal tracks from Macquarie Island, for example, suggests that certain polynyas may be preferred habitat. Similarly, king penguins (*Aptenodytes patagonicus*) appear to show a preference for feeding at and within the marginal ice zone. In all cases, a great deal of information can be gained by comparing and combining the locational and environmental data with satellite-derived information on sea-ice distribution and characteristics. New information is also emerging on the key importance of changeable fast-ice conditions on the breeding success of emperor penguins (*A. forsteri*) at Dumont d’Urville. A major question is: where are seal/whale seabird ‘hot spots’ within the sea-ice zone, and when and why?

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[2] Methanesulphonic acid (MSA) is released by phytoplankton living in and around sea-ice and is correlated with sea-ice extent (Curran et al., 2003).

Future research priorities

2.21 The workshop agreed that, rather than treating sea-ice as a single amorphous 'habitat', which is not the case in reality, a standardised approach across CCAMLR and the IWC to classifying ice habitats is needed. This would aid cross-disciplinary comparisons and provide a framework for drawing together the biological and physical (environmental) realms. A possible scheme for such a standardised approach could be the following broad-scale zonal elements:

(i) SSIZ;

(ii) the marginal ice zone (the outer zone of the SSIZ affected by wave–ice interaction processes);

(iii) the inner pack-ice zone;

(iv) regions of perennial sea-ice that persist through summer;

(v) coastal and near-coastal fast-ice;

(vi) flaw leads and polynyas (persistent and recurrent open water areas).

Primary production

Summary from expert group

2.22 CCAMLR-IWC-WS-08/13 summarised the satellite ocean colour (chlorophyll *a*: Chl-*a*) data that are currently available, from missions beginning with the Coastal Zone Colour Scanner in the late 1970s through to the SeaWiFS and MODIS sensors that have collectively been providing data for the last 10 years. The characteristics of these data and limitations such as cloud cover and high solar zenith angle are discussed with regard to their use in the Southern Ocean. A brief history of algorithms linking ocean colour to primary productivity is presented, focusing on the vertically generalised production model (VGPM) and more recent regional carbon-based approaches. Using monthly climatologies of SeaWiFS Chl-*a*, a phenology of phytoplankton blooms was presented for the major provinces surrounding Antarctica. Some of the published information regarding phytoplankton species composition and succession is summarised. Finally, a review of ecosystem and biogeochemical models for the Southern Ocean was presented, with a focus on those models that have been validated using satellite ocean-colour data.

Future research priorities

2.23 The workshop noted the following with respect to using satellite ocean-colour data in representing primary productivity and algal biomass:

(i) such data provide good spatial coverage at time scales of one month or greater and can be used to discern interannual trends from chlorophyll climatologies;

(ii) the data provide only surface (10–20 m) chlorophyll with an accuracy of around 40%;

(iii) any chlorophyll maxima are likely to be at depths deeper than the measurements and therefore the surface measurements may not properly reflect the density of chlorophyll in the water column. Work is needed to identify whether the relative densities of surface chlorophyll reflect the true climatologies of chlorophyll in the Southern Ocean;

(iv) estimates of Chl-*a* from ocean-colour data may not reflect the relative densities of algal biomass. An important issue to address is the degree to which changes in species composition over the Southern Ocean and over time would impact on the calculations of algal biomass and productivity both spatially and temporally;

(v) biogeochemical models are good for characterising regional processes but their outputs do not match satellite data at present;

(vi) ocean-colour sensors cannot measure Chl-*a* concentrations in sea-ice. Thus, the question remains whether hot spots of primary production might occur within the sea-ice zone.

Pelagic species

General

2.24 The workshop considered the spatial resolution at which data for pelagic species would be needed given the types of questions likely to be addressed using ecosystem models for the Antarctic ecosystem. Although the Antarctic pelagic species interact at a variety of spatial scales, the workshop agreed that most ecosystem models would be based on CCAMLR statistical areas or larger areas. As a result, the data summaries for pelagic species are based on CCAMLR statistical subareas/divisions (see Figure 1).

2.25 In considering species other than krill, the workshop recognised that a desirable feature of CCAMLR and IWC ecosystem models is to provide alternative pathways to the well recognised (and modelled) phytoplankton–krill–top-predators pathway. Several Antarctic studies have now shown that secondary production by copepods exceeds that by krill, thus forming a potentially important link between the microbial system and vertebrate predators (CCAMLR-IWC-WS-08/12). Apart from Antarctic krill (*Euphausia superba*), which is a keystone species in the Antarctic ecosystem, it is not straightforward to select the fish, cephalopod and zooplankton species to be included in an ecosystem model, in part because these species may fill various ecological niches during their lives. In addition, considerable uncertainties exist associated with the abundance and dynamics of almost all species.

2.26 The workshop agreed that one way to identify the species (or functional groups) to be included in an ecosystem model designed to evaluate the implications of alternative pathways in the ecosystem was to start with the main top predators of krill and identify the prey species that constitute a large proportion of their diets when krill is not abundant, and then identify the prey species of those prey species, continuing this process until phytoplankton as primary prey is reached.

2.27 The workshop agreed that zooplankton and squid should be represented as functional groups given data limitations (see paragraphs 2.45 to 2.58 (zooplankton) and 2.59 to 2.69 (squid)), while it might be possible to model individual fish species (e.g. mackerel icefish (*Champsocephalus gunnari*)) if this was deemed necessary or appropriate. It also noted that smaller life stages within functional groups may be vulnerable to predation by larger individuals of the same functional group.

2.28 The Southern Ocean ecosystems provide a valuable opportunity for the development of understanding of the importance of trophic interactions in the operation of food webs. Southern Ocean ecosystems are vulnerable to change from climate (bottom-up) and harvesting (top-down) driven process. The workshop agreed that some ecosystem models are needed that have a sufficient degree of complexity to allow adjustments in food-web pathways due to these effects to be an emergent property of the models. This will require a new generation of models that include realistic representations of biological processes operating in ecosystems, where these representations encompass the complex physical and biological interaction processes.

2.29 The workshop noted that distribution was likely to be related to a large number of factors (see for example, paragraph 2.30(ii)). In principle, if relationships between presence (and perhaps density) and such factors could be developed, these relationships could be used to infer presence (or density) in unsampled areas. Although analyses to determine the environmental factors that determine distribution (and abundance) should be undertaken, a first, and key step towards understanding habitat requirements for the pelagic species is to produce presence-absence maps (such as those in the *Squid Atlas* – www.nerc-bas.ac.uk/public/mlsd/squid-atlas/) and to overlay these with maps of key environmental factors.

2.30 The workshop constructed tables for each species/functional group which summarise information on:

(i) abundance (in absolute and relative terms), generation time, catches (where appropriate), and environmental factors determining abundance;

(ii) distribution by season (summer and winter) in terms of northern and southern boundaries and whether the following relate to presence: distance from the shelf break and the PFZ, the presence of sea-ice, sea-surface temperature, depth, chlorophyll concentration, water mass and location around Antarctica. The distribution tables should ideally be constructed by life-history stage;

(iii) diet composition in quantitative term and feeding rates (e.g. daily consumption rations).

2.31 Appendix D provides summaries of life-history information for the four pelagic groups.

2.32 The section of the report on pelagic species does not follow the format for the other small group sections of this report because many discussions covered aspects related to abundance, habitat, diet and life history at the same time.

Future research priorities

2.33 Assess alternative model structures to determine the minimum number of functional groups such that alternative pathways arise as emergent behaviour.

Krill

Summary from expert groups

2.34 The krill expert group focused on methods for obtaining information on krill distribution and abundance. Life-history and process data for the krill species are included in CCAMLR-IWC-WS-08/11. Four basic sources of information were identified: net surveys, acoustic surveys, fisheries data and information from krill predators. Each data source leads to biases and has its methodological problems. Overall, there is a lack of long-term systematically collected data on krill distribution and abundance and the time-series data that do exist are from restricted areas of the Southwest Atlantic. Large-scale synoptic surveys have covered areas of the Southwest Atlantic and the Indian Ocean and the most recent acoustic surveys (BROKE, CCAMLR-2000 and BROKE-West; see Table 1) have provided the largely comparable datasets that have been used by CCAMLR to set precautionary catch limits. These datasets also contain a wealth of ancillary information that are of use in examining ecosystem structure and function in key areas of the Antarctic. Future research needs to concentrate on understanding the errors and biases in the data collection methods.

Species/functional groups

2.35 The data for krill are summarised for Antarctic krill, ice krill (*Euphausia crystallorophias*) and bigeye krill (*Thysanoessa macrura*) because these species are caught in krill fisheries and/or they constitute an important component of the diet of Antarctic predators.

Issues arising from metadata summaries

2.36 There remains considerable uncertainty associated with estimates of abundance from acoustic surveys as they pertain to absolute abundance (e.g. in terms of the area of occurrence and the various estimates of abundance from the CCAMLR-2000 Survey). These latter uncertainties relate primarily to target strength but also to analysis methods.

2.37 Spatial and temporal variations in the krill population have been linked to a number of features of the physical environment: (i) the position of major frontal systems (Tynan, 1998; Nicol et al., 2000), (ii) the extent of sea-ice both temporally (Loeb et al., 1997; Atkinson et al., 2004, 2008) and spatially (Nicol et al., 2000), (iii) the duration of winter sea-ice (Quetin and Ross, 2003; Quetin et al., 2007), (iv) water mass movements (Priddle et al., 1988), (v) current flows (Hofmann and Murphy, 2004), and (vi) bathymetric features (e.g. shelf break) (Nicol et al., 2006; Atkinson et al., 2008). Several of these relationships have been established for quite restricted regions and may not apply throughout the Antarctic region. For example, the direct effect of sea-ice on production is not likely to be a major driver in the South Georgia region where sea-ice rarely forms in winter. Given the diversity of environments around Antarctica, it is unlikely that universal rules can be developed that will describe the distribution of habitats throughout the Southern Ocean (but see the CCAMLR bioregionalisation, SC-CAMLR-XXVI, Annex 9, and spatial modelling procedures being developed there, e.g. Pinkerton et al., 2008). The large-scale survey datasets collected for CCAMLR could be used to examine these relationships further. Additionally, sectoral analysis of the major physical features, such as using the CCAMLR bioregionalisation, could be used to investigate which of these features might be expected to dominate geographically (Nicol et al., 2007; Atkinson et al., 2008).

2.38 Table 2 summarises the information on abundance, distribution for the three krill species and Table 3(c) summarises information on diet for these species. Data on Antarctic krill are available from both net and acoustic surveys. Large-scale acoustic surveys have been conducted specifically to determine biomass in several CCAMLR statistical areas. Additionally, net and acoustic surveys have been conducted regularly in several areas to examine interannual variability in krill demographics and biomass. Data on the other two species of krill have been collected in a less systematic fashion and no efforts have been made to survey the entire habitat of these species with the aim to determine their biomass in an area.

2.39 Ice krill is a species of krill which forms large aggregations and is found in coastal waters. Its aggregating behaviour and size makes it a suitable candidate for acoustic surveys. However, there are no agreed target strength estimates for this species and its ice-covered habitat poses extreme challenges for acoustic surveys.

2.40 Bigeye krill is a smaller species and information on distribution and abundance of this species is available from net surveys. It should be possible to obtain estimates of relative biomass of bigeye krill from the large CCAMLR-related surveys.

Feedback for expert group

2.41 The report of the expert group on krill should be expanded to include ice and bigeye krill. Data on krill abundance in the Ross Sea are available from Italian surveys and JARPA, and the report should be extended to discuss these sources of data. The estimates of abundance should be annotated by CVs (or CIs) where these are available. There is a need to update the report of the expert group with information on habitat, life history and diet (some of this information is available in CCAMLR-IWC-WS-08/12). The report should be expanded to include trends in relative abundance from AMLR, LTER and South Georgia time series.

Future research priorities

Key gaps

2.42 The major knowledge gap for krill remains the lack of accurate estimates of absolute abundance, and the lack of information on krill distribution and abundance in large regions of the Southern Ocean. The lack of time series of estimates of krill abundance is a major limitation for the conditioning of ecosystem models, and stock structure uncertainty is also a major limitation. In addition, it is still unclear how krill abundance and life history vary among regions within basins (e.g. West Antarctic and South Georgia within the South Atlantic) (but see paragraph 2.41).

Further analyses

2.43 (i) Collate and summarise studies which have been undertaken or are currently under way to develop conceptual models of the relationship between krill and environmental covariates.

(ii) Conduct a quantitative analysis which compares krill abundance with phytoplankton distribution, sea-surface temperature, chlorophyll concentration, and other covariates, based on broad-scale studies.

(iii) Estimate time series of relative abundances using data from the AMLR, LTER and South Georgia surveys in light of identified correlations, after correcting the data to ensure that like is being compared with like.

Research programs

2.44 (i) Continue to refine methods for analysing data from acoustic surveys so that these surveys are capable of providing reliable estimates of absolute abundance, with known statistical properties.

(ii) Develop approaches for scaling information (e.g. on feeding functional relationships) from the individual level to the population level.

(iii) Develop conceptual models and then investigate the effect of food quality/ quantity on egg quality and reproductive output.

(iv) Conduct further studies to examine the relationship between the winter behaviour of krill and local environmental conditions.

(v) Conduct studies to determine the residence time of krill populations, in relation to physical and geographic features; these results, in addition to those from other (e.g. genetics) studies should also assist in determining krill stock structure.

Zooplankton

Summary from expert groups

2.45 CCAMLR-IWC-WS-08/12 provided a critical evaluation of the strengths and weaknesses of zooplankton data that may be used in Southern Ocean food-web models. There is a plethora of data on Southern Ocean zooplankton, but most is on abundance and biomass, with very little on feeding responses. Most of the data are not in any central database, and CCAMLR-IWC-WS-08/12 provided pointers to where some of the data can be found.

2.46 CCAMLR-IWC-WS-08/12 emphasised the dominant role of copepods, with the relative importance of other zooplankton groups varying regionally. A recurring theme in CCAMLR-IWC-WS-08/12 is that straightforward-sounding issues can make compilations of data at best confusing and at worst totally misleading if appropriate allowances are not made. Some of these issues are general to any assimilation of zooplankton datasets, such as the sensitivity of abundance estimates to the variable identification of larval stages. Likewise the time of year, depth of sampling and mesh size of net used have great influence on recorded abundance, since the populations can make seasonal vertical migrations and their pulsed reproduction causes great seasonal changes in size structure and abundance. Other issues are specific to the polar environments. For example, lipid storage leads to appreciably different relationships between vital rates and body mass than are found elsewhere. Likewise stenothermy (narrow temperature tolerance) means that more general literature compilations of metabolic rates with temperature and Q_{10}-type relationships must be applied with great caution in Antarctica. CCAMLR-IWC-WS-08/12 identified datasets and approaches to combat these issues, and suggested four simple functional groups based on biomass and ecology (mesozooplankton, salps, Antarctic krill and remaining macrozooplankton).

2.47 CCAMLR-IWC-WS-08/12 also highlighted some of the strengths and weaknesses in methodology and data coverage in feeding studies. The zooplankton show a wide range of feeding behaviour from omnivory to carnivory – there are no true herbivores. The range of food chain types is examined with the conclusion that protozoans/micrometazoa (<200 µm) must indeed be the main grazers in the Southern Ocean, since larger zooplankton typically remove <30% of primary production. This emphasises the dominant role of microbial food chains relative to the classical diatom–krill–top-predator type food chains. Overall, the great diversity in zooplankton size and ecology, combined with their specific adaptations to Antarctica, requires care both in assembling comparable datasets and in modelling their rate processes.

Species/functional group resolution

2.48 The workshop noted that zooplankton would need to be treated as a set of functional groups rather than individual species in any ecosystem model. It agreed that best choice of zooplankton functional groups would depend on the question to be addressed by the ecosystem model, but that the following functional groups might be appropriate given the data available: salps, large (>2 mm) copepods, small (<2 mm) copepods, and amphipods (specifically *Themisto gaudichaudii*), and the discussion at the workshop focused around these groups. Life-cycle models are available for several key species (e.g. *Calanoides acutus* and *Rhincalanus gigas*) and possibly these could be used as generic models to represent the respective groups (in this case the large copepods).

2.49 Microzooplankton are important grazers of primary production (consuming 60–70%) as well as prey for larger zooplankton (Appendix D), but there were no microzooplankton specialists at the workshop. It was noted that some information on the microbial loop was available from studies that had concentrated on biogeochemistry and efforts should be made to access this information. Grouping species into functional groups is an approach when constructing ecosystem models, but the workshop cautioned that productivity will vary among the species within each functional group, although there is a general relationship between size and generation time (and hence productivity).

Issues arising from metadata summaries

2.50 Mesozooplankton biomass was identified as one quantity for which there are substantial amounts of data available that have been collected in a consistent manner at circumpolar scales. General data compilation for model input is a much more tractable proposition for mesozooplankton biomass than that for the abundance of individual taxa. Information on life history/diet is obviously more limited, but mesozooplankton impact on primary production is well quantified. Mesozooplankton could be a functional group represented as a forcing function in ecosystem models.

2.51 Estimates of zooplankton and krill abundance, numbers and biomass, have been collected in all CCAMLR/IWC statistical areas on a number of scales over the last 80 years. However, these have been gathered by various methods with great variation in sampling intensity and these must to be taken into account. Standardisation is required before spatial and temporal comparisons can be made (CCAMLR-IWC-WS-08/12). The CPR is the one system that has provided a consistent sampling method in the region, being most intensive in eastern Antarctica. The Southern Ocean CPR Survey has been in operation since 1991 and can provide surface distribution maps by species in the southern Indian Ocean to supplement net data using standardised abundance estimates (CCAMLR-IWC-WS-08/12).

2.52 While there is substantial information on copepod life cycles and factors affecting distribution, oceanic time-series data are still scarce (CCAMLR-IWC-WS-08/12). Long-term monitoring (>10 years) is being conducted in Subarea 48.1 by LTER and AMLR programs, and in Subarea 58.4 from the CPR data and the JARE annual NORPAC net sampling. These can provide trend data, although many of the JARE samples are still being processed. Trend data are available for copepods for Subarea 48.3 from BAS studies. Correlations between abundance and distribution and environmental data exist in Subareas 48.1, 48.2 and 48.3 for copepods and salps. Correlations could be examined for other areas using the CPR data. There is much less information on trends, life history and information on correlations for *T. gaudichaudii* by area.

2.53 The workshop also noted that studies used different sampling techniques and that this could make between-study comparisons, and hence evaluation of trends, difficult

(CCAMLR-IWC-WS-08/12). This is further complicated by a general inability to distinguish changes in availability to the sampling gear from those in abundance as well as the high seasonal variation of many zooplankton species.

2.54 Table 3 summarises the information on abundance, distribution and diet for salps, large and small copepods and amphipods.

Feedback for expert groups

2.55 The report of the expert group should highlight the various long-term datasets more clearly and identify what would be needed to develop time series of indices of abundance for key functional groups. A table should be added to the paper that lists the major sources of data which, if analysed, could be used for model parameterisation.

Priorities for future work

Key gaps

2.56 There is a large amount of information at the species level. However, this information has yet to be assembled into a format that could be used in ecosystem models. There needs to be a more comprehensive effort to evaluate existing published information.

Further analyses

2.57 (i) More comprehensive effort in compiling existing data, including past and current datasets, and deposition of the resultant data in an appropriate database (e.g. SCAR-MarBIN and/or databases arising from this workshop).

(ii) Synthesise the relationships between key species and environmental features based on data from multiple surveys (e.g. CCAMLR-2000, BROKE and BROKE-West).

(iii) There needs to be a more comprehensive effort to evaluate existing published information for its suitability to identify feeding functional relationships and to parameterise them.

Future research programs

2.58 (i) Examine, analyse and synthesise existing microzooplankton data to develop parameterisations for the incorporation of these parameters into food-web models and to assess the relative importance of the linkage between microzooplankton and food webs to biogeochemical cycles.

(ii) Collect and analyse additional information on diet and feeding rates for key species and functional groups, and use these to estimate functional responses.

(iii) Evaluate whether data which are relatively easy to collect (e.g. from satellites) could be used as proxies for the abundance of some of the zooplankton groups.

(iv) Use inverse models to obtain first-order estimates of biological rates and interactions.

Squid

Summary from expert groups

2.59 CCAMLR-IWC-WS-08/10 provided information about populations, habitat utilisation, population growth rates, foraging activities and catch of squid. Squid are notoriously difficult to sample because they possess excellent eyesight and sound and vibration sensors which, coupled to a jet-propelled escape mechanism, enable all but small specimens to easily avoid scientific sampling gear. Commercial fisheries catch adults, but provide unrepresentative data and there have only been limited exploratory fisheries in Antarctic waters. Most population data that exist have been derived from remains, especially beaks, in the gut contents of higher predators. Total consumption of squid in the Antarctic by seabirds, seals and whales has been estimated from these data to be some 34.2 million tonnes per year, and in the Scotia Sea it is estimated to be some 3.7 million tonnes. Some 15 to 20 species of squid occur in the diet of predators. These range in size from a mantle length of a few millimetres to >2 m. Consumption of one species of commercial interest, seven star flying squid (*Martialia hyadesi*), in the Scotia Sea is conservatively estimated to be 0.25 million tonnes per year and possibly up to 0.55 million tonnes.

2.60 There are sufficient data from net-caught specimens to enable the distribution of most species to be characterised in relation to oceanic frontal systems, bathymetry and sea-ice extent as well as their general vertical distribution, which is related to time of day. Concentrations of seven star flying squid, and probably other species, are related to the presence of mesoscale oceanographic features in the vicinity of the Antarctic PFZ.

2.61 There are no data on population growth rates of squid in the Antarctic, but it is likely that they are slower growing than temperate species, relatively short-lived and semelparous, have relatively low fecundity and large eggs, pelagic eggs and paralarvae, and slow development. Pelagic squid are all predators and opportunistic foragers, usually feeding on crustaceans in early life and shifting to fish, mostly mesopelagics such as myctophids, as they grow larger. It is unlikely that any pelagic squid are specialist krill feeders, but some, or all, can be expected to feed on krill opportunistically when available. Catch data are limited to experimental fisheries for seven star flying squid that took place on five occasions between 1989 and 2001. Catch rates were at the low end of commercial viability. The so-called colossal squid (*Mesonychoteuthis hamiltoni)* is taken as an occasional by-catch in the longline fisheries for Patagonian toothfish (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*).

Species/functional groups

2.62 The workshop discussed information on squid species for which data are available, but recognised that squid would likely have to be a single functional group in any Antarctic ecosystem model.

Issues arising from metadata summaries

2.63 The most reliable source of data on abundance for squid species in the Antarctic are analyses of stomach content data, although estimates of squid consumption may be biased owing to squid beaks potentially being retained in predator stomachs longer than other prey items, as well as being subject to uncertainty due to the imprecision and bias associated with predator numbers and diet.

2.64 Consideration could be given to modelling squid as a constant mortality rate on their prey species in ecosystem models given (i) the lack of data on abundance of squid and the inability in the short- to medium-term to develop methods to index the abundance of squid, and (ii) the fact that squid populations are likely to respond quickly to changes in prey abundance.

2.65 The workshop noted that the *Squid Atlas* (www.nerc-bas.ac.uk/public/mlsd/squid-atlas/) provided a useful way for modellers to assess likely overlap in species distributions and also indicate relationships between squid abundance and some environmental covariates (ice extent, bathymetry and fronts; see for example, Figure 7), but noted that the lack of observations of squid species in the atlas did not imply absence, but could reflect a lack of sampling. Annotating the atlas by locations where sampling was conducted but squid had not been found would help address this issue.

2.66 Table 4 summarises the information on distribution and diet for squid. No information on abundance is provided in Table 4 owing to lack of data on abundance for squid.

Feedback for expert group(s)

2.67 The report of the expert panel should be extended to reflect information of life-history strategy.

Priorities for future work

Key gaps

2.68 The lack of information on absolute and relative abundance for squid severely limits the ability to include this component in ecosystem models.

Future research programs

2.69 (i) Future distribution maps for squid should include locations where sampling was conducted but squid had not been found.

(ii) Continued examination of potential methods to assess absolute and relative abundance for squid species.

Fish

Summary from expert groups

2.70 CCAMLR-IWC-WS-08/9 noted that the first attempts to estimate the krill and pelagic food consumption by Antarctic demersal fish were made in the early 1980s based on a few biomass estimates, and mostly qualitative and a few quantitative food studies. These estimates were extended to the mesopelagic realm and the high-Antarctic zone in the late 1980s and early 1990s when these areas were exploited commercially and a larger number of feeding studies were conducted concomitant with the fishery. Currently, the best estimates of krill consumption by fish are 23–29 · 10^6 tonnes of krill and other pelagic prey taken annually by demersal fish and 7–44 · 10^6 tonnes taken by mesopelagic fish in the Atlantic Ocean sector only. No estimates of consumption by mesopelagic fish can yet be provided for the Indian and Pacific Ocean sectors. Due to the commercial fishery substantially reducing abundant krill predators such as marbled rockcod (*Notothenia rossii*) and mackerel icefish, the importance of demersal fish as predators of krill has been substantially reduced in the last three decades.

2.71 Estimates of pelagic prey consumption still have wide confidence limits. Major shortcomings of the consumption estimates for mesopelagic fish are the validity of hydroacoustic biomass estimates conducted in the late 1980s and the scarcity of quantitative food consumption data for some abundant myctophid species. Major shortcomings of the consumption estimates of demersal fish are the inaccuracy of biomass estimates for most abundant fish species, the shortness of most food studies which do not adequately reflect the opportunistic feeding habits of many demersal fish, and the scarcity of quantitative feeding studies during winter. There is evidence from CCAMLR-IWC-WS-08/9 that the importance of krill in fish diets varies substantially with time and location on various scales, and with the suite of prey types available in the different regions in the Southern Ocean.

2.72 The imprecise nature of abundance estimates, coupled with a wide range of estimates for daily food consumption in summer and a scarcity of such data for the winter season, means that it is unlikely that fish will be an important component in ecosystem and food-web models in the Southern Ocean in the near future. As a first step in a modelling approach which includes fish, mackerel icefish might be included in modelling approaches currently being undertaken in CCAMLR. Mackerel icefish plays an important role as a predator of krill and as prey for seals and birds for which, at least at South Georgia, sufficiently precise parameter estimates could be developed to serve as input for models. Furthermore, the effects of large changes in abundance and community structure of fish brought about by industrial fishing needs to be considered.

2.73 Table 5 summarises the information on abundance, distribution and diet for fish.

Species/functional groups

2.74 The workshop discussed data availability for myctophids and considered them as a single group (owing primarily to the lack of quantitative information and stomach evacuation rates in some of the important krill predators). The workshop noted that ecosystem models might need to represent fish species using size-, age- or stage-structured models.

Issues arising from metadata summaries

2.75 CCAMLR-IWC-WS-08/9 contained information on the abundance of fish in sections 4.1.1 for mesopelagic fish and sections 4.4.1.1, 4.4.2.1, 4.5., 4.6, 4.7.2 and 4.8.2 for demersal fish. Estimates of abundance of mesopelagic species (myctophids) in the South Atlantic are available from Russian acoustic surveys from 1987 to 1989. However, these estimates should not be used as the basis for ecosystem models owing to uncertainty associated with their calculation and the changes and improvements in both methodology and target strength estimation since the surveys were conducted. The workshop agreed that more was known about the distribution of mesopelagic fish than their abundance, at least for some of the myctophid species.

2.76 In contrast to the situation for mesopelagic fish, survey estimates of abundance are available for demersal fish in some CCAMLR statistical areas (see Table 5). These surveys are unlikely to provide absolute estimates of abundance owing to catchability differing from unity for most species. Rather, these data should be included in ecosystem models as a source of information on trends in relative abundance.

Feedback for expert group(s)

2.77 The report of the expert group needs to be extended to include information on habitat and a brief outline of the major biological characteristics of mesopelagic and demersal fish.

Priorities for future work

Key gaps

2.78 The paucity of data for a group of key fish predators (mesopelagic fish) is a major uncertainty for parameterising ecosystem models for the Antarctic region. Data on diet, abundance and habitat are more complete for demersal fish, but the inability to express abundance in absolute terms restricts the use of abundance data in ecosystem models.

Further analyses

2.79 (i) Examine whether it is possible to re-analyse past myctophid surveys to develop estimates of abundance.

(ii) Compare net-based and acoustics-based indices of relative abundance for mesopelagic fish.

(iii) Produce maps for each fish species (e.g. using the fish distribution maps in Gon and Heemstra, 1990) which show where they are found and where sampling has been conducted but the species was not found, and overlay these with maps of key environmental covariates.

Future research programs

2.80 (i) Research on mesopelagic fish should focus on:

(a) reliable estimation of the target strength of myctophids and other mesopelagic fish;

(b) reliable estimation of biomass and its changes over time (month, year);

(c) estimation of daily food intake for the most abundant myctophid species;

(d) estimation of daily food consumption by abundant mesopelagic fish other than myctophids (e.g. Antarctic Jonas fish (*Notolepis coatsi*) and slender escolar (*Paradiplospinus gracilis*)).

(ii) Studies on demersal and mesopelagic fish in the future need to focus on:

(a) use of an ROV (in combination with trawling to allow the question of how trawls integrate over multiple mesoscale habitats to be addressed);

(b) use of properly designed surveys to estimate biomass and its trends;

(c) estimation of prey availability;

(d) winter feeding studies;

(e) estimation of daily food intake and food requirements of fish.

Seals and seabirds

Summary of expert group reports

Pack-ice seals

2.81 CCAMLR-IWC-WS-08/6 reviewed population surveys and abundance estimates for the four seal species that breed in the sea-ice – crabeater seal (*Lobodon carcinophagus*), leopard seal (*Hydrurga leptonyx*), Ross seal (*Ommatophoca rossii*) and Weddell seal (*Leptonychotes weddellii*). The spatial scope covers the circumpolar extent of pack-ice, and the temporal scope spans a period of more than 50 years from when pack-ice seal surveys were first undertaken and reported in the 1950s to the present day. The review was presented chronologically, and in doing so tried to provide a sense of the evolution and development of methodologies over a 50-year period of application. The methodologies employed in individual survey efforts were described, and likely biases and uncertainties in resulting abundance estimates discussed. It was concluded that estimating trends in abundance was difficult because there have been few repeat surveys in the same regions, methodologies have evolved over time, and uncertainty around abundance estimates is substantial.

Antarctic fur seals

2.82 CCAMLR-IWC-WS-08/7 reviewed data on abundance, habitat utilisation, population growth and foraging for the Antarctic fur seal (*Arctocephalus gazella*). Abundance data are available for the major known breeding localities, although recent surveys of the largest part of the population breeding at South Georgia are relatively old (1991) and a recent survey is still in progress. Data on habitat utilisation are available from several sites from remote tracking. Diet and foraging behaviour are well described during the lactation period. Catch was not considered.

Penguins

2.83 CCAMLR-IWC-WS-08/8 reviewed the availability of data for deriving breeding abundance estimates for the four krill-consuming penguins – macaroni (*Eudyptes chrysolophus*), Adélie (*Pygoscelis adeliae*), chinstrap (*P. antarctica*), gentoo (*P. papua*) – in the CAMLR Convention Area and the uncertainties in deriving regional abundance estimates from these counts. The available count data comes from a variety of sources and survey efforts, and when combined, was thought to be reasonably comprehensive for some regions but less complete for others. Key problems identified in the paper were variety and variability in the demographic units counted, and the variable age of count data across sites. It was recommended that modelling approaches may be useful in addressing biases and uncertainties when deriving abundance estimates from these count data.

Flying birds

2.84 CCAMLR-IWC-WS-08/18 reviewed information relevant to estimation of food consumption for 34 species of flying seabirds in the Southern Ocean. The paper collated information on population size, diet and energetic requirements for each of the species and derived estimates of overall consumption.

Species/functional groups

2.85 The workshop reviewed the species that were included in the expert group reports.

2.86 It was recognised that the southern elephant seal (*Mirounga leonina*), which breeds in areas both inside and outside the CAMLR Convention Area, but spends a considerable amount of time, particularly outside the breeding season, foraging in the CAMLR Convention Area where it acquires a significant component of its annual energy budget, should be considered in future work.

2.87 It was agreed that the four penguin species reviewed in CCAMLR-IWC-WS-08/8 were relevant to the workshop, but that considering only krill consumers may be restrictive for the purposes of the workshop. It was therefore recommended that two additional species, the emperor penguin and king penguin, be considered in future work.

2.88 It was noted that the flying seabird species considered in CCAMLR-IWC-WS-08/18 included all species whose distribution overlapped the CAMLR Convention Area, and recommended that a reduced list of species be prepared that included only those breeding in the CAMLR Convention Area, and visitors to the CCAMLR area that were considered to be present in appreciable numbers. A reduced list based on these criteria is provided in Table 6. It was suggested that the flying birds could be grouped into functional categories such as large albatrosses, small albatrosses and giant petrels, large procellariformes, small procellariformes (Pterodromas etc.), diving and storm petrels, and coastal species. The workshop also recognised this was still a substantial number of species, and recommended the expert group consider whether further prioritising of species is appropriate in future work.

2.89 The workshop recommended that, given the commonality in issues related to habitat utilisation, life history and foraging, that future work may be efficiently considered within two broad groups: seals and seabirds.

Spatial stratification

2.90 The workshop agreed that the following broad spatial stratification for summarising parameter data for all seals and seabirds would be useful.

Ross Sea	Subareas 88.1 and 88.2
Amundsen Sea	Subarea 88.3
Antarctic Peninsula/Scotia Sea	Subareas 48.1, 48.2, 48.3 and 48.4
Weddell Sea	Subarea 48.5 and 48.6
East Antarctica	Divisions 58.4.1 and 58.4.2
Indian Ocean sub-Antarctic islands	Subareas 58.5, 58.6, 58.7.

2.91 Having considered these general issues, the workshop then reflected on the current work of the expert groups and recommended priorities and directions for future work. These recommendations are addressed below by parameter, and by broad species groups (seals and seabirds) within parameters.

Issues related to metadata summaries and feedback for the expert groups

Abundance

Seals

2.92 Considerable progress has been made in summarising information on abundance and trends in abundance for pack-ice seals and the Antarctic fur seal. As neither of the seal expert groups was originally tasked with summarising abundance information on the southern elephant seal, but the workshop recommended this species now be considered, this species is recommended to be considered in future work. The workshop recognised that substantially different methods are required for estimating abundance for pack-ice seals, which are widely dispersed over large areas, compared to Antarctic fur seals and the southern elephant seal, which are surveyed when aggregated into dense colonies at their breeding sites. This fundamental difference in life history also means that different components of the population are available to surveys for the ice-breeding and land-breeding species, and that methods for estimating abundance need to account for these differences. For example, surveys of pack-ice seals are thought to include most or all population components (adults, juveniles, breeders, non-breeders) if conducted at an appropriate time, but surveys of Antarctic fur seals and southern elephant seals at breeding sites only include breeding adults and/or pups. Therefore, colony-based population counts must incorporate some method to incorporate non-breeding individuals in the population assessment.

2.93 With regard to pack-ice seals, the subgroup welcomed the recent completion of analyses of APIS surveys, and indicated that completion of analysis of APIS data from the eastern Weddell Sea would be valuable for the development ecosystem models. It was noted that trends are of similar importance to status in ecosystem modelling, and indicated that the expert group's conclusion that trend estimation from APIS and earlier surveys is difficult has important implications for ecosystem modelling efforts. It was recommended that, wherever possible, new surveys employing new methodologies ensure that some linkage to past surveys is possible by including essential comparable elements of methodology.

2.94 Pack-ice seal abundance estimates are summarised in CCAMLR-IWC-WS-08/6 for the scale at which surveys were conducted, which varied substantially between surveys. Development of abundance estimates for areas of specific interest to CCAMLR or the IWC may require re-analysis, splitting or merging of data from different survey efforts. Alternatively, as abundance estimates for the most recent APIS surveys were derived from spatial predictive models, the models might be used to predict abundance over different areas to those from which they were developed.

2.95 In addition to a summary of abundance estimates and a discussion of the potential biases in abundance estimates for Antarctic fur seals, CCAMLR-IWC-WS-08/7 included a list of publications pertaining to abundance estimation for the Antarctic fur seal that can form the basis of a metadata summary. The subgroup noted that a survey currently in progress at the major fur seal colony at South Georgia, if completed in 2008/09, will substantially improve knowledge of fur seal abundance. The workshop also noted that estimation of the non-breeding population is not addressed by the survey efforts and would need to be addressed through demographic modelling. A survey of Antarctic fur seal abundance at the South Shetland Islands has recently been completed and results should be available in the near future. As for pack-ice seals, knowledge of trends in Antarctic fur seals will facilitate ecosystem modelling efforts, and in this regard it was felt that further consideration of long-term trends in Antarctic fur seal abundance is important.

2.96 Known breeding colonies of Antarctic fur seals are restricted to a few localities (primarily South Georgia and the South Shetland Islands), so scaling-up estimates is simply a matter of merging estimates across localities.

2.97 The workshop recommended that an overview summary of availability of abundance and trend information be compiled for all seal and seabird species in a single table structure. This table was populated for the four pack-ice species during the workshop (Tables 7 to 10).

Birds

2.98 The workshop recognised that knowledge of abundance for penguins and flying seabirds could, in principle, be derived from surveys of breeding populations at breeding sites, and at-sea surveys. As with land-breeding seals, abundance estimates derived from colony counts must include corrections and or assessments of non-breeding individuals that are not observed on the colony. At-sea surveys, in contrast, include both breeding and non-breeding birds.

2.99 CCAMLR-IWC-WS-08/8 reviewed issues involved in estimating penguin breeding population abundance from land-based survey methods. The report included a very useful discussion of the general issues involved in estimating the abundance and its uncertainty. It was recommended that future work include, where possible, specific information on abundance data and estimates, even if preliminary and not yet accounting for known biases and uncertainties but that the attendant potential uncertainties and biases be described. It was noted that extending the estimates of breeding abundance to total abundance to enable total prey consumption may also be necessary for ecosystem modelling. The workshop recommended that future work on abundance by the expert group could focus on both these issues.

2.100 Penguin count data have been collected at the scale of the breeding colony. Given this scale of data collection, the workshop recognised it would be possible to combine data across colonies to any desired level for regional abundance estimation, and recommended that future work in abundance estimation should build in flexibility in the scale of estimation to estimation procedures in order to satisfy any scale requirements of future ecosystem models.

2.101 CCAMLR-IWC-WS-08/18 indicated that the knowledge of flying seabird abundance was poor and errors were impossible to estimate from cited sources, which were not the original reports. The workshop recommended that it would be desirable for future work on flying seabird abundance, if feasible; to review the original sources of abundance data in order to better understand the biases and uncertainties inherent in abundance estimates. This would require a substantial effort, and a larger expert group, to complete.

Habitat

General considerations

2.102 Apex predators occur in areas where oceanographic features such as currents, sea-ice, frontal systems, thermal layers, sea mounts and continental shelf breaks increase the availability or predictability of prey. All these oceanographic features and processes are thought to impact marine predator distributions by physically forcing prey aggregations and, thus, creating areas where foraging efficiency can be increased. Indeed, for many marine predators, regions of highly localised productivity may be essential for reproduction and survival. In the Antarctic there is also the role of sea-ice in directly affecting the foraging ability of seals and birds.

2.103 Many of these studies use ship or aerial surveys to assess abundance and then correlated the observed distribution with oceanography. Although these studies have been and continue to be quite informative, they do not provide insights into the strategies employed by individual animals to locate prime habitats (or is this food), nor can they provide insights into the spatial or temporal course of these interactions. Advances in satellite telemetry, electronic tags and remote-sensing methods provide tools that allow us to follow the movements and behaviour of individual animals. These approaches are making it possible to extend our understanding beyond simple linkages of prey and predator distributions with environmental features to the identification of specific behaviours with specific environmental conditions. A comparison of the advantages and disadvantages of the two approaches of studying top marine predators can be seen in Table 11.

2.104 The workshop recommended that future work on habitat utilisation could include consideration of both tagging and at-sea survey data in order to provide the most complete assessment of habitat utilisation.

2.105 The workshop considered that a consistent format for developing habitat metadata summaries across seal and bird groups would facilitate a coherent approach to this issue, and designed a template for summarising habitat utilisation data (Table 12). The recommended approach identifies a temporal and spatial (horizontal and vertical) stratification.

Seals

2.106 The expert group on pack-ice seals has not yet been able to review the state of knowledge on seal habitat utilisation. The template (Table 12) developed by the workshop is recommended to structure and standardise future work by the expert groups.

Birds

2.107 As for seals, the penguin and flying seabird expert groups have not yet been able to review information on habitat utilisation. The workshop recommended that future work on habitat by the penguin expert group should include the development of metadata using the habitat table template provided in Table 12.

Diet, foraging and life history

General considerations

2.108 Many of the issues relating to the trophic linkages/diet are common to seabirds and seals as data are generally restricted to the period when adults are provisioning offspring and this causes a limitation to both the spatial and temporal coverage. The restriction in the availability of diet data outside the period of offspring provisioning was recognised as a substantial limitation in characterising the trophic linkages.

2.109 A common suite of techniques is available for determining the diet for seals and seabirds, including direct regurgitates (from birds), stomach lavage (seals), scats (seals, especially fur seals) and serological methods and fatty acid profile analysis, stable isotope analysis and prey DNA identification. All these methods provide different data on the diet of individual species and have limitations and advantages with respect to other methods. The most productive approach to understanding diet will come from the use of an ensemble of techniques. This will be especially important where there are known biases in one of the methods (e.g. over-representation of squid beaks in stomachs due to retention of beaks). The workshop recommended that a standardised approach to summarising diet information would facilitate a coherent approach across species groups in future work. A template for summarising diet information is provided in Table 13.

2.110 Diet data for seabirds and seals are recognised to exist in summary databases, including CEMP and other compilations. The workshop recognised that where diet data are presented it is important to present the range of data in order to represent uncertainty/variability rather than to decide on a representative/best study. The compilation of such a summary metadata table is a priority.

2.111 The workshop recognised that there was a paucity of data on what seabirds and seals eat outside the period when diet have been sampled; both as a function of where they go and what they eat when they are in the regions they inhabit outside the breeding season.

2.112 There are generally very few data that provide information on the concurrent measurement of prey consumption and independent measures of prey availability at comparable scales of the predator foraging event. If obtained across the foraging area of the population as a whole, these measurements are essential for constructing the functional relationships required for modelling. The workshop considered this further under general issues.

2.113 Estimation of feeding rates from diet requires knowledge of the energy requirements of the predator, the energy content of the diet and the efficiency by which prey are converted to energy. With respect to seals and seabirds there is considerable information on the Field Metabolic Rate (FMR) of many species during the breeding season. There is substantial information on the overall energetic costs associated with rearing the young. For example, data exists on rates of prey delivery to some species of penguins and albatross chicks and to reproduction in Weddell, elephant and fur seals. However, there is minimal data on the energetic costs associated with reproduction in Ross, crabeater and leopard seals. For species where direct data are not available, rates of prey intake can be derived from the information currently available for the other species of birds and seals.

2.114 Marine environments are quite dynamic with resource availability varying dramatically in both space and time. Reliably finding resources in such a variable environment is limited to a range of foraging patterns where temporal and spatial variation match. Consequently, some marine vertebrates are thought to have evolved a suite of life history traits that allow species to match the spatio-temporal variability in resource acquisition (i.e. foraging) with the demands of reproduction and self-maintenance. For land-breeding bird and seal species, reproduction is further constrained by the need to breed on land but feed at sea. The separation between breeding and feeding habitats can be characterised by two general life-history patterns: (i) income breeders (most seabirds and fur seals), where the young are provisioned from resources that are acquired as they are needed; and (ii) capital breeders (true seals and baleen whales) where resources are acquired and stored over a long period of time prior to the reproductive event. As capital breeders obtain all of the resources necessary to provision their offspring after one very long trip to sea prior to parturition, they are able to forage over spatial scales exceeding 1 000s km from their breeding site. In contrast, most income breeders return to provision their offspring frequently and are therefore limited to trips lasting a few hours to a few days. Income breeders are thus limited to foraging at distances of 10s to 100s km from the colony. Albatrosses represent an extreme form of income breeder and can forage over large spatial scales, often covering 1 000s km in a matter of days.

2.115 The workshop considered the attributes of life history that may be important in developing ecosystem models. Important attributes included age at first breeding, frequency of breeding, adult and juvenile survival, maximum clutch size, the duration and timing of the breeding season, and whether moult is continuous or distinct. A template for summarising this information is provided in Table 14.

Seals

2.116 The workshop noted that the pack-ice seal expert group has not yet been able to review information on diet, foraging and life history. CCAMLR-IWC-WS-08/7 indicated that diet data for Antarctic fur seals are available from breeding sites (some year-round, some during the breeding season only), and provided a list of papers relating to diet and foraging. Information on life history has not yet been reviewed. It was recommended that future work should include the development of metadata using the templates described above.

Seabirds

2.117 The workshop noted that the penguin expert group had not yet been able to review diet, foraging and life history information for penguins. The flying seabird report included information on diet, but the group has not yet been able to review life-history parameters.

Future work

2.118 The workshop considered future work for seals and birds under this item and this is reported in paragraphs 4.12 to 4.18.

Whales

Summary from expert groups

2.119 CCAMLR-IWC-WS-08/4 addressed the abundance, trends, exploitation history, and foraging parameters of six baleen whales; humpback (*Megaptera novaeangliae*), blue (*Balaenoptera musculus*), fin (*B. physalus*), sei (*B. borealis*), Antarctic minke (*B. bonaerensis*), and southern right whales (*Eubalaena australis*) in the southern hemisphere. The majority of survey data have come from the area of open-ocean south of 60°S to the ice edge. The review focused on (i) population abundance, trend and stock structure; (ii) habitat utilisation including migration, spatial structure at peak concentrations and foraging areas; (iii) foraging activities including diet and consumption; and (iv) catch as annual summaries by species and broad-scale areas or breeding populations. Consideration has also been given to possible biases and uncertainty in the data. In the review, emphasis has been given to information obtained in the high latitudes (feeding grounds), but in some cases data from low latitudes (winter/breeding) grounds have been included to complement or contrast what is known from feeding grounds and to include information on whales throughout their range. In some instances, parameters are either estimated across IWC management units or as parts of management units and are scaled accordingly. Data have been sourced from international research programs such as those conducted by the IWC and CCAMLR (e.g. IDCR SOWER, CCAMLR-2000 Survey) and national programs (SOCEP, BROKE, JARPA).

2.120 For the six species considered here, data range from comprehensive to extremely sparse, differ greatly in quality, in terms of spatial and temporal resolution, where these differences are dependent on both the species and area concerned. Information on diet and large-scale spatial distribution are relatively good, but understanding the complex spatial structuring of baleen whales in relation to their prey and environment at scales relevant to the individual or regions is only in its infancy; there is considerable uncertainty in estimates for consumption. Finally, there is a fairly comprehensive understanding of biases for certain data types (mainly abundance and trend), although these involve often complex issues to do with survey design, and changing statistical analytical methodologies. This means that bias can be very specific to whale datasets and should be addressed in each case.

2.121 There is generally less information on the odontocetes of the Southern Ocean than the baleen whales. Abundance estimation is often complicated by long dive times and inconspicuous surface behaviour or by responsive movement towards or away from survey vessels. In a systematic review of odontocetes of the Southern Ocean, Van Waerebeek et al. (2004) identified 28 species as occurring with 22 species showing a regular, apparently year-round, presence. Based on this review and the frequencies of sightings, a list of species that appear potentially ecologically important south of the CCAMLR boundary (between 45°S and 60°S depending on longitude) was identified as sperm whale (*Physeter macrocephalus*), killer whale (*Orcinus orca*), southern long-finned pilot whale (*Globicephala melas edwardii*), hourglass dolphin (*Lagenorhynchus cruciger*), southern bottlenose whale (*Hyperoodon planifrons*), Arnoux's beaked whale (*Berardius arnuxii*), strap-toothed beaked whale (*Mesoplodon layardii*) and Gray's beaked whale (*Mesoplodon grayi*). Of these species, biomass is dominated by sperm whales and southern bottlenose whales; other species may be locally important but have had few sightings due to being difficult to see and more northerly distribution. CCAMLR-IWC-WS-08/5 reviewed data on abundance, distribution, feeding ecology, exploitation and life-history parameters for these species, noting that in many cases data are extremely limited or non-existent. The diet of sperm whales and beaked whales appears dominated by squid whereas three ecotypes have been described for killer whales with different diets that are either dominated by marine mammals or fish.

Species/functional groups

2.122 In addressing the terms of reference of the workshop, baleen whales were given the highest priority because of the dominance of krill in the diet. Of the baleen whale species, sei whales were considered of lower priority because of their generally more northerly distribution. The IWC SC is preparing for an in-depth assessment of North Pacific sei whales (IWC, 2008b) which includes reviewing available data on the species, including the Southern Ocean.

2.123 Toothed whales, which have a more varied diet, dominated by squid for some species, were given lower priority. However, the most abundant toothed whales were also considered important because of the interactions between their prey species and krill. In terms of biomass, sperm whales and southern bottlenose whales are the most important odontocete consumers, but killer whales also have important interactions as predators of marine mammals.

Abundance

State of metadata summaries

2.124 Table 15 shows the workshop summary of relevant abundance estimates by known populations. Where population sub-structure is not known, abundance estimates are given by species. The table attempts to distinguish between estimates made on the breeding grounds, estimates on the feeding grounds that are believed to include the whole population, and regional estimates that do not cover the whole range of the population range. If the combined regional snapshots are believed to encompass the complete (or nearly complete) range of a single population then these can be taken as estimates of the population. If the snapshots are believed to include more than one population, then estimates need to be partitioned according to what is known about spatial population structure and uncertainty. For some species such as fin whales, abundance estimates cover only the southern portion of the known range and thus cannot be considered as reliable estimates of the total population.

Issues arising from metadata summaries

2.125 Most estimates of whale abundance are snapshot surveys of numbers of individuals within a specified region at a particular time. The IWC SC has devoted large amounts of time to trying to obtain the best possible snapshots and associated variances from design-based surveys. It also has an agreed methodology for combining different snapshots from different times to generate a combined abundance estimate and variance. Although in some instances there are unresolved issues (e.g. related to the proportion of animals directly on the trackline that are detected and to group size), these have been discussed in detail by the IWC SC and were not considered further at the workshop.

2.126 Abundance estimates and time series may include (i) estimates that are believed to be unbiased, (ii) biased estimates where the likely direction of bias has been identified, or (iii) estimates that represent a relative index of abundance. In general, abundance estimates need to be interpreted with other data. For example, abundance estimates need to be reconciled with historic catch series and any observed trends. Combining such data will need a population model which will likely incorporate life-history and/or habitat parameters. Whale populations typically show some degree of segregation of population components, both on winter breeding grounds and in summer feeding grounds. The main population components are mothers with calves (or who have recently weaned a calf), pregnant females, resting females, males, and juvenile animals. These components are typically represented to differing extents in different areas at different times of year. In interpreting abundance data, it is important to determine which components are included, and to take account of the 'missing' components. For example, of southern right whales surveyed in their Southwest Atlantic breeding area, about 30% of the observed population are mothers with calves (Rowntree et al., 2001), but demographic analyses reveal that this group makes up only 8% of the total population (Cooke et al., 2001). Segregation of adult and juvenile animals into different feeding areas appears to be the norm rather than the exception at least for *Balaenoptera* spp. (Leaper et al., 2000).

2.127 Table 15 indicates where data are available but some indication of data quality (e.g. whether estimates have been accepted by the IWC SC as suitable for particular purposes) is also required. The expert groups were recommended to develop categories to indicate the status of the abundance estimates listed in the table. An example of the type of categories that have been developed for general classification of data quality is given in (Kucera et al., 2005).

Scaling issues

2.128 The need for information on population structure within ecosystem models will depend on the nature of the model and the spatial scale in particular. Estimates of prey consumption do not rely on information on population structure except for killer whales where diet differs between ecotypes. However, it may be important to understand population structure at spatial scales for which localised changes in prey abundance might occur (e.g. such as might occur as a result of a krill fishery). Stock structure and feeding locations for the populations of humpback whales are the best understood of all the baleen whales and have been the subject of considerable discussion within the IWC SC (IWC, 2008c). Minke whale stock structure has been studied intensively in some regions of the Southern Ocean (from JARPA in Areas III–VI), but there are almost no data elsewhere. There are very few data on stock structure for blue, fin, and sei whales or odontocetes.

Recommendations for further work

2.129 It was noted that resolving issues with abundance and trends of minke whales was important, and that this is being addressed by the IWC SC. Addressing the lack of abundance data for fin whales is a key priority due to the high historic abundance of this species and the current lack of data. Surveys for these species on the breeding grounds (which are largely unknown) are unlikely to be feasible.

2.130 Data from the Southern Ocean, north of 60°S are limited and could be addressed by surveys between 60°S and CCAMLR boundary which could also help generate estimates for other species (particularly sei and right whales). However, weather conditions frequently make surveys in this area very difficult. Complete new circumpolar surveys are unlikely in the future, so there is a need for a regional focus to detect trends at smaller spatial scales. Surveys to identify regional trends may also help identify variables driving these trends.

2.131 Examining recovery of small well-studied populations may be informative in an ecosystem modelling context. For example, there are considerable data on population dynamics of southern right whales in the Southwest Atlantic (Cooke et al., 2001) which are believed to feed around South Georgia (Rowntree et al., 2008). This is a well-studied area for other species and data such as estimates of whale density from these feeding grounds would be valuable. The longitudinal sector south of South Africa was also identified as an area where estimates of fin whale abundance could be particularly important (in combination with detailed feeding studies; paragraph 2.154). IDCR SOWER cruises in this area have also noted high densities of minke, blue and humpback whales (Ensor et al., 2007).

Habitat

2.132 For the purposes of the workshop, habitat was considered in terms of the physical and biological covariates that determine whale distribution patterns. It was noted that there was a need for models that relate whale density to spatial and temporal covariates to support ecosystem models.

2.133 The majority of data on habitat use and whale distribution patterns in the Southern Ocean have come from visual surveys with some data from passive acoustics and a very small amount of data from telemetry studies. Most observations relate to whales at the surface and there is very little information on use of the water column in terms of depth. Multi-disciplinary large-scale surveys with the specific objective of collecting whale data concurrently with habitat data include the CCAMLR-2000, SO-GLOBEC and BROKE surveys. It was noted that there were data from these surveys (including data that could be used for abundance estimation) that could be analysed further and it was recommended that these analyses should be undertaken as soon as possible. Habitat-related data have also been collected during the JARPA and JARPAII surveys.

State of metadata summaries

2.134 The expert group papers described patterns of habitat use in general qualitative terms. Table 16 develops on the qualitative descriptions by identifying parameters that have been related to whale distribution.

Issues arising from metadata summaries

2.135 In addition to the parameters that have been used in previous studies (Table 16), the workshop identified additional spatial and temporal covariates that could be considered in trying to estimate whale abundances from density data (Table 17).

2.136 Changes in sea-ice dynamics and concentration have been identified as particularly important in understanding differences in minke whale abundance estimates. Sea-ice dynamics were also identified as important predictors of habitat, including formation of polynyas and primary productivity associated with ice. Changes in grounded iceberg, fast-ice distribution and coastal configuration are likely to impact on whale habitat by modification of coastal polynyas. In many cases there will be time lags between changes in sea-ice and resulting changes that are likely to affect whales. Several interactions between sea-ice and other permanent features such as the shelf break or grounded icebergs have been identified.

2.137 In discussion of primary productivity, it was noted that two types of data are available from satellites which measure the amount of light absorbed by chlorophyll which is a function of chlorophyll concentration. Algorithms have been developed to derive the rate of primary production from remotely sensed chlorophyll concentration and other environmental variables. Both chlorophyll concentration and primary production rate are readily available from providers of remotely sensed data. However, satellite-derived measures of these data should be used with caution because there is often a subsurface chlorophyll maximum layer that is too deep in the water column to be sensed remotely and this may impact on the value of these data as covariates.

Scaling issues

2.138 It was noted that choice of spatial scale is particularly important when relating whale density to habitat covariates. For example, although krill distribution will inevitably be a major factor determining the distribution of baleen whales, there is not always a clear correlation between krill concentration and whale density. It was noted, however, that this lack of correlation may be solely a function of analytical resolution and that a simple correlation might not necessarily be expected.

2.139 Data on the movements of individual whales on their feeding grounds is limited to some *Discovery* mark data and more recently, a few brief satellite-tracking studies. Satellite telemetry has advanced to the point where more widespread application of tags to cetaceans in the Southern Ocean is now possible. Such studies are likely to inform our understanding of the scale and heterogeneity of their foraging patterns. The workshop encouraged such studies, particularly where they might coincide with studies that provide data on other aspects of the marine environment.

Further research

2.140 In addition to habitat covariate data collected on multi-disciplinary surveys, remote sensing can provide data including SST, sea-ice and primary productivity. In many cases there are time sequences of these data over several years which could be used in further analyses of whale surveys.

2.141 Considerable data on habitat use by other predators have been gained from telemetry studies and the workshop discussed the importance of such data for whales. In particular, telemetry devices that include data loggers can provide three-dimensional information on the use and characteristics of the water column.

2.142 Studies of habitat use by individual animals may also use photo-identification or genetic mark–recapture. For example, the ongoing analysis of re-sightings of individually identified blue whales using IDCR SOWER data (Olson, 2008) has provided valuable insights on the residency and fidelity within and between seasons of blue whales near the pack-ice south of South Africa; the continued collection of such data and comparison with other Antarctic areas, will yield more information on these patterns.

2.143 Long-term passive acoustic monitoring, such as bottom-mounted Acoustic Recording Package (ARP) devices which can record continuously for over a year, have the potential for monitoring seasonal variation in vocalisations at a particular location. These can be used to generate a relative index of density based on assumptions about variations in calling rates.

Life histories and food-web linkages

2.144 The expert review for baleen whales did not consider life-history parameters because the group determined that reviewing data on abundance, trends, distribution and foraging were of primary importance in the context of current CCAMLR and IWC models. However, based on discussions at the workshop, it was recommended that the group should review these. The parameters of interest are pregnancy rates, calf production, age-at-first reproduction and survival. In some cases these data are available for specific populations, in other cases these are just available for the species within Antarctic waters as a whole, and in other cases there are data for the species in the northern hemisphere. These parameters cannot be considered as static values and the time period over which estimates were made needs to be specified.

2.145 Life-history parameters have proven difficult to measure but estimates have been made from lethal sampling on the feeding grounds and photo-identification studies (mainly on the breeding grounds). Estimates derived from lethal sampling for minke whales were discussed extensively in the JARPA review conducted by the IWC in 2006 (IWC, 2007b).

2.146 The workshop discussed food-web linkages in the context of:

(i) diet by species (noting that for baleen whale diet is limited to krill species within the area of interest), population or ecotype, including the ability to switch diet in response to changes in prey availability;

(ii) where prey are consumed;

(iii) when are prey consumed;

(iv) how much prey is consumed.

State of metadata summaries

2.147 Basic data on diet composition were reviewed by the expert groups. Key uncertainties relate to the length of the feeding period within Antarctic waters and the spatial patterns of prey consumption. In addition, there is considerable uncertainty in estimating energy requirements of large whales and the relationship between energy requirements and body mass (Leaper and Lavigne, 2007).

Issues arising from metadata summaries

2.148 Much of the data on diet in the metadata summaries had been derived from analyses of stomach contents. Recently developed techniques include genetic analyses of faeces and fatty acids/isotopes to identify prey species. These techniques have the potential to provide estimates of prey consumption integrated over longer time periods. The advantages and disadvantages of the different methods have been discussed in detail by the IWC SC (IWC, 2003).

2.149 Ecosystem models require functional relationships between predators and prey. These relationships will depend on an interaction between the availability of the prey to the predator and the selectivity of the prey by the predator. The workshop noted previous discussions on functional response in relation to whales including the 2002 IWC SC workshop in La Jolla, USA, on whales and fisheries (IWC, 2004a) and the JARPA review (IWC, 2007b). The La Jolla workshop had identified functional response as one of the key uncertainties in ecosystem models. Empirical measurements of both sets of parameters are difficult, and perhaps impossible to acquire, especially in a manner that can be applied over varying temporal scales and at the level of the population. Nonetheless, researchers have used a variety of data to inform estimates of functional responses (e.g. in a study of minke whales in the northeast Atlantic based on stomach content data, Smout and Lindstrom (2007)). As these estimates are likely to be influential in model function and output, the workshop recommended that where such estimates are used, the basis for that estimate and the uncertainties, including biases, are provided.

2.150 In addition, recent studies of southern right whales based on isotope analysis have shown different feeding patterns between individuals apparently passed on by mothers to their calves.

Scaling issues

2.151 In discussion of scaling issues within the IWC SC, one suggestion for three categories of scale that describe feeding ecology and the spatial-temporal distribution of cetaceans are (i) cetaceans migrate seasonally between feeding and breeding grounds; (ii) cetaceans move over days and weeks in search of preferred local abundance of food; and (iii) whales dive and search for food within localised areas.

2.152 These issues of spatial scale are relevant to methods used to estimate consumption rates due to the considerable uncertainty in the period for which whales feed within the area of interest. New analytical techniques based on isotope analysis may be able to identify whether feeding occurred outside the Southern Ocean.

Further research

2.153 The relationship between distribution patterns of Antarctic minke whales and krill was investigated in the Ross Sea using a multi-disciplinary dataset collected by the *Kaiyo Maru*-JARPA joint survey (Murase et al., 2007). Two species of krill, Antarctic and ice krill, were distributed in the Ross Sea. The scale of interactions between Antarctic minke whales and the environmental factors were investigated at a segment length of 5 n miles using GAM. The results indicated that the abundance of Antarctic minke whales could relate to the biomass of Antarctic krill.

2.154 The workshop also received details of a recent study (pers. comm. G. Santora) from the western Antarctic Peninsula which combined biological and physical sampling of the water column including qualification of the length-frequency distribution of krill, with observations of feeding whales. It was noted that this type of study helped to elucidate niche separation and localised prey utilisation. Further similar studies in other areas should be encouraged. Other areas identified with particular potential for feeding ecology studies include the Kerguelen plateau and the longitudinal sector south of South Africa. The Kerguelen plateau (from Kerguelen Islands to Prydz Bay) area has been studied during multi-disciplinary and multiple predator studies by France and Australia, and strong linkages along the plateau have been demonstrated. Recent IDCR SOWER cruises have operated in the area south of South Africa where observations included large feeding aggregations of fin whales around Bouvet Island and made observations of blue whales (including successful photo-identification). It was noted that in this longitudinal sector, minke and humpback whales were abundant and blue whales were also frequently encountered. The three ecotypes of killer whales also occur in this area.

2.155 These types of small-scale studies need to be considered along with synoptic surveys and large-scale tracking in order to provide the necessary range of data likely required for ecosystem models.

2.156 An increased understanding of changes in life-history parameters related to environmental effects and density dependent responses is also important. Such studies will require long-term datasets. For example, a study of southern right whale breeding success for the population in the Southwest Atlantic (Leaper et al., 2006) used a 30-year time series of photo-identification data to investigate relationships between calf production and environmental variables. In this study, calving success appeared to be affected by environmental variables even though the population was still at a low level.

2.157 It was noted that further review of historical whaling data and resulting literature may be informative on a number of relevant issues. It was recommended that the expert group review these sources for information on life-history parameters, including for example, age-at-first reproduction. Whaling data may also be informative on spatial and temporal patterns of habitat utilisation, particularly in areas that have not been covered by recent surveys.

Exploitation

Cetaceans

2.158 Catch data have and do play an important part in the assessment work of the IWC SC. The IWC Secretariat maintains the definitive series of catch data for the 'modern whaling' period: some two million records. Considerable effort has been expended to code and verify the catch data, including documentation of uncertainties in the record. For some operations in the early years of the 20th century, only total catch data are available (this represents about 20% of the total catch record for modern whaling). For the remaining 80% of the catch, individual catch records are available; in the 'best instance', for each whale the following information is available: species, date of catch, position of catch (latitude and longitude to the nearest minute), length (to the nearest foot or 0.1 m), sex, reproductive status, stomach contents and fishery operation (nation, vessel). The resolution of the reported data varies by operation and time period (e.g. position may vary from exact position of the catch, through noon position of the factory ship or position of the land station); the reliability of the various types of reported information by nation, operation and time period (including the major falsification of data reported by the USSR) has been extensively discussed within the IWC SC and in a number of published papers.

2.159 For open-boat whaling (pre-modern whaling period), the catch history has been reconstructed using various methods including examination of logbooks and records of whale products; this applies particularly to southern right whales (IWC, 2001).

2.160 Appropriate ways to incorporate satisfactorily the various levels of uncertainty in the catch records (ranging from uncertainty in the records themselves to methods of allocating catches from breeding stocks to Antarctic feeding areas) for modelling purposes has been thoroughly considered by the IWC SC, and is often based on alternative plausible hypotheses. Such an approach should also be applicable to any ecosystem modelling work.

2.161 In addition to the catch data, effort data are available. The resolution and reliability of these data vary with operation and time period. The IWC SC has reviewed the utility or otherwise of the use of CPUE data for assessments and modelling and has recognised the limitations of using such information in anything but a crude manner (IWC, 1989).

2.162 The catch records (and to some extent the effort data) are relevant to ecosystem modelling at a number of different levels, from simple catch series to population dynamics modelling, including spatial and temporal distribution, to estimation and interpretation of life-history parameters and even making inferences on ice-edge data (e.g. de la Mare, 2002).

2.163 Although there are some published summaries of catch data, it is most appropriate to obtain the most recent validated catch series from the IWC catch database which is available from the IWC Secretariat.

Seals

2.164 The workshop noted that the UK is the depository for the Convention on the Conservation of Antarctic Seals (CCAS) and, as part of this role, the UK receives data on catches of seals. The workshop agreed to investigate possibilities of gaining access to historical sealing records from the Convention and from other published and unpublished sources.

Penguins

2.165 In the 19th century and early 20th century, king (and probably other species) penguins were exploited by sealing gangs on sub-Antarctic islands. The birds were used for several purposes, such as fuelling the boilers used in the processing of seals, and fuelling lamps and cooking stoves. Penguin skins were turned into clothing, and flesh and eggs were consumed by sealers. Accurate records of the number of birds killed were not kept and available information is largely anecdotal. King penguin populations were drastically reduced in size on most islands and completely disappeared from some for several decades. In recent decades, king penguin populations have made a remarkable recovery throughout their range. Most of the recoveries have been documented (e.g. Macquarie Island: Rounsevell and Copson, 1982; Heard Island: Gales and Pemberton, 1988; Kerguelen Archipelago: Weimerskirch et al., 1989).

Albatross

2.166 Historic records indicate that albatross eggs were extensively harvested for food during the whaling era (Cott, 1953).

Fish

2.167 The CCAMLR Secretariat holds various databases related to fish exploitation. Catch statistics cover the complete history of fish exploitation. Detailed data such as catch and effort by species, area and CCAMLR seasons are incomplete for the first years of the fishery. Available statistical data can be accessed in the public domain. Other data are subject to the ‘Rules for Access and Use of CCAMLR Data’, and include haul-by-haul data from longline and trawl fisheries, detailed biological data collected as part of CCAMLR’s Scheme for International Scientific Observation, and fishery research and acoustic data collected during research surveys.

2.168 The workshop acknowledged that there were some uncertainties associated with early catch records reported to CCAMLR, and that the extent of these uncertainties has not been resolved. In particular, the accuracy of the catch data from the early years of the fishing history (e.g. for the first 7–10 years in the 1970s) is under question, and therefore usage of data from this period should be dealt with caution. The workshop agreed that the analysis of such uncertainty would be a matter of priority.

Squid

2.169 The workshop noted that experimental squid fisheries have taken place in Subarea 48.3 between 1989 and 2001 when a total of five jigging vessels fished for seven star flying squid at the PFZ to the north of South Georgia. The catch rate was about 8 to 10 tonnes per night per vessel.

2.170 This species is caught by the jigging fleet targeting Argentine shortfin squid (*Illex argentinus*) on the Patagonian shelf and is also caught south of New Zealand. A mass stranding has been reported at Macquarie Island. This species is also taken as by-catch in the slender tuna (*Allothunnus fallai*) fishery in the Southern Pacific. No interest for fishing on this species in Subarea 48.3 has been expressed over the past 7 to 8 years.

2.171 The workshop also noted that Argentine shortfin squid is taken on the Patagonian shelf, and annual catches were highly variable (10 000–300 000 tonnes). Interest in a targeted fishery for seven star flying squid has been highest when Argentine shortfin squid catches have been at their lowest levels.

Krill

2.172 Four types of data submissions are required from krill fishing countries fishing within the CAMLR Convention Area:

(i) monthly summaries of catch and effort (STATLANT) data aggregated into FAO statistical areas;

(ii) in-season catch and effort reports;

(iii) fine-scale, haul-by-haul data;

(iv) scientific observer data and reports, including biological data and technical information on the fishery.

2.173 STATLANT data are in the public domain (*CCAMLR Statistical Bulletin*). Haul-by-haul data and observer data include details of time, date, positions of fishing, and general information of the vessel and conversion factors of the products. With the exception of STATLANT data, the data are subject to the, Rules for Access and Use of CCAMLR Data, and originators/owners of data retain control over the use of their unpublished data outside CCAMLR.

2.174 The STATLANT database contains all reported krill catches at FAO statistical area/subarea resolution. Fine-scale catch and effort data consist of data which are finer than

STATLANT statistics. Most of the fine-scale data are reported on a haul-by-haul basis with accurate positional information; this is the current requirement in krill fisheries. Some historic data are reported as catch and effort aggregated by approximately 10 n miles x 10 n miles rectangle and 10-day period, and some data were aggregated by approximately 30 n miles x 30 n miles (0.5° latitude by 1° longitude) rectangle and monthly period. Also, fine-scale data coverage of the krill fisheries is incomplete, especially in the period prior to the mid-1980s.

2.175 Various sources of uncertainties were highlighted for the commercial krill catch records. Firstly, the accuracy itself of catch and effort data and position data, especially before the mid-1980s. Secondly, large uncertainties surround the conversion factors used to estimate the landed catch from the final products. Thirdly, uncertainties surrounding the total amount of krill removed from the system by the fishing activities, which result from krill that are killed by the fishing gear but are not retained in the codend when it is landed on the vessel.

Fishery by-catch

Fish by-catch

2.176 Although information on records of fish by-catch taken in krill fisheries are held in the CCAMLR databases, no quantitative data are available due to lack of systematic coverage by the scientific observers in the krill fishery. It was stressed that 100% systematic coverage is the only way to obtain quantitative data on fish by-catch.

2.177 Information on the distribution of larval fish in relation to krill aggregation is unknown. This is important information which is currently lacking when interpreting the by-catch data from the krill fishery.

Incidental mortality of marine mammals and seabirds associated with fishing in the CAMLR Convention Area

2.178 Over the period 1997–2007, the number of observed seabird mortalities decreased from 6 589 (1997) to 2 (2006) and to 0 in 2007 (not including the French EEZ around Kerguelen and Crozet Islands). Over the same period, the estimated median total potential seabird by-catch in unregulated longline fishing was 193 927 (157 917–565 245).

2.179 Incidental mortality of Antarctic fur seals in the krill fishery in Area 48 was first reported to CCAMLR in 2002/03 when 27 seals were recorded dead. This increased to 142 seals in 2003/04 and, following the introduction of by-catch mitigation measures including seal excluder devices, the incidental mortality was reduced to 16 seals in 2004/05, one in the following season and 2006/07.

2.180 Incidental mortality of marine mammals and seabirds associated with fishing in the CAMLR Convention Area is reviewed annually by the ad hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF) and reported to SC-CAMLR (e.g. SC-CAMLR, 2007c).

Future work

2.181 The workshop agreed that it would be useful for CCAMLR to undertake work to quantify the uncertainties in catch records for krill and finfish.

GENERAL ISSUES AND PRIORITIES

3.1 The workshop generally discussed the issues, questions and priorities for collating and acquiring data for use in the development of multi-species/ecosystem models relevant to CCAMLR and the IWC. It noted that the questions of importance could be grouped into those pertaining to predators, prey and habitat variability and change. There were also some general modelling-based questions that would be useful to address.

3.2 The workshop noted that the general questions surrounding predators and prey were well articulated from the work of each subgroup.

3.3 The workshop noted that there had not been an opportunity for a similar depth of discussion on the physical environment and primary production that might give rise to environmental and habitat variability and change. The workshop agreed that habitat variability and change are important drivers of food-web dynamics in the Southern Ocean. It noted that the analyses listed below, which use existing environmental datasets and circulation models, could contribute to understanding the relationships between biota and habitats, how habitats may vary in space and time, and to what extent climate change could impact on habitats:

(i) Establish baselines that could be used to evaluate change in habitats: combine and analyse historical hydrographic, sea-ice, atmospheric and satellite datasets to develop a characterisation of environmental structure and its variability at circumpolar and regional scales with a focus on:

   (a) determine variability associated with locations of ACC fronts, such as latitudinal range, sea-ice distribution and characteristics, and responses to large-scale climate forcing (e.g. ENSO, SAM), and changes in ACC transport;

   (b) determine basic circulation patterns and sea-ice dynamics for regions (e.g. Ross Sea, WAP, Weddell Sea) including seasonal changes (e.g. from buoyancy forcing) and extent of coupling to large-scale circumpolar circulation;

   (c) correlating biological distributions with habitat structure.

(ii) Estimate potential biotic linkages between different regions using simulated circulation distributions to:

   (a) evaluate large-scale and regional transport of krill and zooplankton, including residence times;

   (b) estimate exchange rates;

(c) provide insights into potential areas with distinct stocks;

(d) identify potential metapopulation structure, including source and sink local populations.

(iii) Improve the predictability of frontal locations, characteristics of the sea-ice zone, the ability to identify processes that lead to changes in habitat, as well as evaluate the effect of frontal variability on the transport of biota through the continued development of circulation models (circumpolar and regional scale) so that they capture patterns and variability seen in large-scale and regional data analyses.

3.4 The workshop developed a set of key integrated questions that emerged from the various discussions of the three subgroups along with the discussion above on habitats and the physical environment. These questions attempted to specify the overarching issues that characterise the data and methodologies that would be needed to support a variety of ecosystem models relevant to CCAMLR and the IWC. The questions considered predators, prey, habitat variability and change, which would be correlates of the physical and biological environment of the key taxa, and general food-web modelling issues. It was once again noted that the relevance of the different questions about data will vary with the particular model being developed or the objective that a model may be attempting to address. Discussions were framed around the three agreed ecosystem issues identified earlier (paragraph 1.35). The questions are as follows:

Predators:

(i) Spatial overlap: How well can we define the foraging space by taxa/population?

(a) What are the priority taxa?
(b) What are the defining features of feeding habitats?
(c) What are the priority methodologies?

(ii) Temporal overlap: How well can we define the foraging season by taxa/population?

(a) What are the taxa with influential seasonal dynamics?
(b) What are the priority methodologies?

(iii) Resulting consumption: How well can we define the diet (foraging success) by taxa/population?

(a) What are the influential consumers and their food requirements?

(b) What is the species composition in the diet of the influential consumers?

(c) What are the key population dynamics (e.g. reproductive rate, stage-specific predation) that influence the strength of the predator–prey relationship?

(d) When would predators be expected to feed in the Southern Ocean?

(e) What are the priority methodologies?

Prey:

(iv) Spatial issues: How well can we define the spatial extent and variability by taxa/population?

(a) What are the priority taxa?
(b) What are the priority methodologies?

(v) Temporal overlap: How well can we define the availability of prey to predators by season?

(a) What are the priority taxa?
(b) What are the priority methodologies?

(vi) Productivity: How well can we characterise the forcing functions that reflect bottom up influences?

(a) What are the priority taxa?
(b) What are the priority methodologies?

(vii) Non-predation effects on dynamics: How well can we characterise the forcing functions that reflect general mortality?

(a) What are the priority taxa?
(b) What are the priority methodologies?

Habitat variability and change:

(viii) How can we quantify the three dimensional habitat of predator and prey populations based on oceanographic, sea-ice, atmospheric and productivity data?

(ix) How can variability in habitats be quantified in spatial and temporal scales relevant to the key taxa and ecological processes?

(x) How can we establish the effect of environmental variability and change on the productivity and dynamics of food webs?

3.5 Workshop participants were reminded of the conclusions of an IWC workshop on modelling interactions between cetaceans and fisheries (IWC, 2004a). At that meeting the participants concluded the following: 'The reality is that for no system at present are we in a position, in terms of data availability and model development, to be able to provide quantitatively predictive management advice on the impacts of cetaceans on fisheries or fisheries on cetaceans'. At a more recent ecosystem modelling workshop run by the FAO in July 2007, a similar conclusion was reached.

3.6 In order to distil a shared view of the relative priority that each or all of the integrated questions should be given in relation to particular ecosystem models, 11 of the workshop participants, many of whom are modellers or who work closely with modellers, were asked to provide a brief summary of their view of research priorities and needs, based on the relevant ecosystem questions (paragraph 1.35) and the categories above (predators, prey, habitat variability and change, general model-based questions). These summaries attributed to their authors are in Appendix E.

3.7 The range of views presented to the workshop reflected the substantial challenge that building informative ecosystem models represents for CCAMLR and the IWC. These challenges were characterised as the difficulty of developing sufficiently refined model inputs, as well as in the development of appropriate model structure and in the manner in which uncertainty is bounded. Importantly, in relation to defining data needs and approaches, some strong common threads emerged. These are expanded upon below (paragraph 3.9) and form the basis for recommendations from this workshop.

3.8 The differences in views of approaches to the model environment itself, and the timeline for which these models will become relevant to management are perhaps not surprising and reflect both the relatively embryonic phase of this discipline as well as the diversity of questions the models are designed to address, the timelines in which they strive to provide outputs and the scales at which they are designed to operate. In general terms, two approaches to ecosystem models were presented:

(i) parsimonious models being built from a relatively well understood core (perhaps a central species), branching out into the ecosystem (in components and scale) only as far as the data would reasonably allow inference; or

(ii) inherent complexity and dynamics of ecosystems would be a focus of the models being developed, starting from a broader, more complex structure, applying parsimony during the course of development by trimming the model down to a more practical core that aimed to retain the influential components and dynamics of the system.

Both approaches include inherent advantages and challenges. The workshop noted that there are broader modelling issues, such as model and data validation, that are important, but that these lay beyond the scope of this workshop.

3.9 The primary aim of this workshop was to attempt to review data availability and develop some prioritisation of data needs for ecosystem models which focus on krill and krill-based predators. Notwithstanding the need for different types of data for different models and questions, the common views expressed in an approach to data collection, integration and analysis provide a cogent guide for future work relevant to CCAMLR and the IWC. In essence, these approaches fell into three broad categories:

(i) Characterisation, linkages and influences of environmental and seasonal features on the distribution and density of predators and their prey.

A strong emphasis was given to improved characterisation of the physical and biological environment in which animals move. In particular, identification of relevant sampling and analytical scales, quantification of environmental variability, and identification of the persistent or ephemeral nature of major features were highlighted. The elucidation of linkages within food webs, including alternate pathways, was also highlighted a priority. It was noted that such data are increasingly being generated from remote-sensed data series, as well as animal-borne sensors and transmitters. Improvements in the prioritised collection and integrated analysis of these data would likely enhance modelling efforts.

(ii) The value of further, integrated analyses of existing datasets and series to explore the relationships of predators, prey and environmental correlates.

The particular value of large-scale, integrated studies that collect synoptic assessments of the distribution of predators, their prey and key aspects of the environment was highlighted. The relevance and utility of historical data series, such as 20th century whaling data and the *Discovery Reports*, were also highlighted as providing possible 'baseline' measures of seasonal and spatial distribution of predators and prey.

(iii) The importance of appropriate, coordinated, long-term data series of key features of the environment (e.g. remote-sensed data) and the predators and their prey (e.g. time series of relative abundance).

All three core ecosystem modelling issues (paragraph 3.4) considered by the workshop require time-series data. Questions relevant to climate change perhaps needing the most extensive trophic level range. The maintenance of such time series are expensive and consistent funding is a perennial challenge. The development of new, and the maintenance of existing data series for modelling should focus on core and influential components of the physical and biological environment in which predators and prey exist.

3.10 The workshop endorsed the general data and research prioritisation detailed in paragraph 3.9.

3.11 Throughout the discussions in Plenary and within the subgroups, two general modelling-based questions arose:

(i) How well, and with what methods, can we define functional feeding relationships?

(ii) How much abundance data (by taxon, location, and temporal resolution) do we need?

3.12 There was insufficient time for a focused discussion on these issues at the workshop, but a few general conclusions and recommendations can be noted. Firstly, in relation to functional feeding relationships in ecosystem models, it was stressed that these can only be estimated through inference. The difficulty of scaling measurements and resultant inferences made at fine temporal and spatial scales was noted to be problematic (IWC, 2004a).

3.13 In relation to data on abundance, the workshop agreed that such data are core to ecosystem models, but their relative importance differs for different types of models.

3.14 The workshop agreed that a more comprehensive discussion on these modelling issues, and their relative importance and influence for different models would be valuable.

PRODUCTS AND FUTURE WORK

Metadatabase and other tools

4.1 CCAMLR-IWC-08/16 provided an overview of the CCAMLR-IWC metadatabase and web-based GUI developed by the AADC and instructions on its use. The workshop was supportive of the aims of the development of the metadatabase and GUI and agreed that it was an important component of the work program identified in preparation for the workshop. To date, the expert groups have primarily been responsible for managing content for the tool.

4.2 The workshop noted that the metadatabase and GUI are still in an early stage of development and to date, the database has not been well populated with data. The workshop agreed that this is a very useful development and encouraged users to provide content and to identify issues in capturing the metadata in order to improve the tool. Members of the expert groups were invited to provide comments on the metadatabase and GUI and their experience with its use.

4.3 Dr Southwell (coordinator of the pack-ice seals group) and Dr Leaper (member of the baleen whales group) noted that standardising metadata in tabular form as a first step prior to working directly with the metadatabase increased the efficiency of metadata entry for these groups. Other methodologies in building content, particularly for more complex taxonomic groups (e.g. zooplankton), should be explored with the developers to improve the metadatabase and GUI.

4.4 The workshop noted that a number of steps could be taken to ensure that the metadatabase and GUI becomes a useful and well-utilised repository of metadata. It was noted that currently all Antarctic metadata records are already, or soon will be, online at the Global Change Master Directory (GCMD). Dr Ramm noted that CCAMLR is currently in the process of developing GCMD metadata records and considers the CCAMLR-IWC metadatabase and GUI as a contribution to this process. Using the GCMD keywords within the metadatabase would provide a consistent approach to discovery of data and metadata records.

4.5 Providing direct links from the metadatabase to relevant datasets at SCAR-MarBIN was proposed. The workshop encouraged data to be made available via SCAR-MarBIN, either by direct hosting by SCAR-MarBIN or publication through other data providers such as AADC, CCAMLR and the IWC. Direct delivery of data should be considered as a next step, using SCAR-MarBIN as the first example.

4.6 The workshop also noted that SCAR-MarBIN has a funding cycle only to 2009. CCAMLR and the IWC could act as key drivers, both in terms of end-users of data and in recommending data portal developments of SCAR-MarBIN, with the aim of improving the long-term sustainability of SCAR-MarBIN. Similar considerations could be given to other common data repositories that are required for the metadata tool.

4.7 The workshop noted that further content development of the CCAMLR-IWC metadatabase and GUI would require substantial resources and the process would benefit from achieving a higher profile within CCAMLR and the IWC.

4.8 The workshop agreed that the metadatabase and GUI should continue to be available after the workshop to support further work by the expert groups. The manner in which the metadatabase and the metadata tool will be developed and managed will need to be considered by the Joint Steering Group, in particular when and how this work will be migrated from the AADC to the CCAMLR and IWC Secretariats.

Publications

4.9 CCAMLR-IWC-WS-08/2 discussed the publication of the results from the work of the expert groups. There was insufficient time to consider this in detail and was referred to future work by the Joint Steering Group (paragraph 4.30 below).

Future work

Physical environment and primary production

4.10 Future work on oceanography, sea-ice and primary production was considered in the following paragraphs:

(i) oceanography (paragraphs 2.8 to 2.11)
(ii) sea-ice (paragraph 2.21)
(iii) primary production (paragraph 2.23).

Pelagic species

4.11 The workshop noted the future work identified by the pelagic species group in the following paragraphs:

(i) defining functional groups of pelagic species (paragraph 2.33);

(ii) krill –

(a) feedback to the expert group (paragraph 2.41)
(b) key gaps (paragraph 2.42)
(c) further analyses (paragraph 2.43)
(d) research programs (paragraph 2.44);

(iii) zooplankton –

(a) feedback to the expert group (paragraph 2.55)
(b) key gaps (paragraph 2.56)
(c) further analyses (paragraph 2.57)
(d) future research programs (paragraph 2.58);

(iv) squid –

  (a) feedback to the expert group (paragraph 2.67)
  (b) key gaps (paragraph 2.68)
  (c) future research programs (paragraph 2.69);

(v) fish –

  (a) feedback to the expert group (paragraph 2.77)
  (b) key gaps (paragraph 2.78)
  (c) further analyses (paragraph 2.79)
  (d) future research programs (paragraph 2.80).

Seals and birds

4.12 The workshop considered the question of future work in two categories: the first concerned the work required to complete the 'inventory' work of the expert groups; the second concerned necessary field and analytical work required to fill 'key' information gaps. Clearly, there is an interaction between these two categories (completing the inventory work is required to identify the key gaps).

Completion of the expert group reports

4.13 The workshop noted that the expert groups within this category could be reformed either taxonomically (perhaps seals and birds) or issue-based (e.g. abundance, diet, habitat etc.) that would cut across taxa. It was also noted that, whichever approach is adopted, a convener and steering committee for these groups needs to be finalised as soon as possible to ensure that the necessary expertise is available and that the workload for individuals is manageable; the *modus operandi* for the expert groups will be discussed by the Joint Steering Group. Templates for the information to be covered by the expert groups are provided in the text and tables (paragraph 2.97, Tables 7 to 10; paragraph 2.105, Table 12; paragraph 2.109, Table 13; paragraph 2.115, Table 14).

4.14 The workshop noted that the critical evaluation of existing analyses/datasets is important for the reports to be of value for conservation and management. The initial examination of the available information for seals and birds revealed that there are considerable gaps in information for some species/spatial scales/temporal scales/parameters. In some cases, obtaining and analysing such data may be feasible in the short-to-medium term, but that this may take some time and resourcing. In other cases the difficulty of the task may make this unfeasible, at least using present methods; it is important that expert groups identify clearly which is the case for identified 'key gaps' because this is valuable information for modellers as it will prevent the development of models for which necessary information may never become available (at least at the level of resolution required to make them useful).

4.15 Given this, the workshop recommended that the expert groups provide, at the end of their reports, an indication of what they believe is the timeframe, methods, resource level and feasibility to compile the available data for what they consider to be 'key gaps' taking into account the discussions under Item 3.

4.16 Completion of expert group reports will require a considerable amount of work. The workshop noted that timely completion of this work is important both in terms of valuable publications and in the development of a coordinated integrated set of research recommendations that will greatly assist conservation and management. The manner in which this work will be completed will need to be considered by the Joint Steering Group and the expert groups that are formed. It was suggested that resources be made available to assist collation of the available published and unpublished information and that short (3–4 day) workshops may be necessary to complete the reports.

An initial consideration of issues related to field/analytical work to fill key information gaps

4.17 The workshop noted that determination of 'key gaps' cannot be seen in isolation from modelling exercises themselves and their objectives; in a number of cases, for example, the need to refine (or even perhaps do more than best-guess a range for) parameter estimates will depend on initial modelling exercises to determine sensitivity to those parameters. It may be necessary to develop mechanisms to facilitate this collaboration after the completion of the expert group reports.

4.18 The following priorities were identified by the workshop:

(i) to undertake analyses of information (available from many sources) relating animal distribution and density with environmental variables;

(ii) to extend the collection of distribution, abundance and diet data to the whole year as they are at present almost exclusively limited to the breeding season;

(iii) to carefully investigate existing data to determine whether reliable qualitative or quantitative information on trends in demography can be identified (e.g. abundance of penguins, flying seabirds, crabeater and fur seals);

(iv) to develop a common set of tools for addressing these issues including the identification/development of a central data archive.

Whales

Further work requested from expert groups

4.19 It was recommended that the expert group for baleen whales should review life-history parameters including information from historical whaling data and resulting literature. Whaling data may also be informative on spatial and temporal patterns of habitat utilisation, particularly in areas that have not been covered by recent surveys (paragraph 2.157).

4.20 The expert groups were recommended to develop categories to indicate the status of the abundance estimates listed in Table 15 (paragraph 2.127).

Further analyses of existing data

4.21 It was noted that resolving issues with abundance and trends of minke whales was important, and that this is being addressed by the IWC SC (paragraph 2.129).

4.22 It was noted that multi-disciplinary large-scale surveys with the specific objective of collecting whale data concurrently with habitat data (including data that could be used for abundance estimation) could be analysed further, and it was recommended that these analyses should be undertaken as soon as possible (paragraph 2.133).

Further long-term research projects

4.23 Addressing the lack of abundance data for fin whales is a key priority due to the high historic abundance of this species and the current lack of data. Data from the Southern Ocean, north of 60°S, are limited and could be addressed by surveys between 60°S and the CCAMLR boundary. Complete new circumpolar surveys are unlikely in the future and, in the absence of such surveys, the workshop recommended a regional focus to detect trends at smaller spatial scales (paragraph 2.130). The workshop also noted that examining recovery of small well-studied populations may be informative in an ecosystem modelling context (paragraph 2.131).

4.24 In addition to habitat covariate data collected on multi-disciplinary surveys, remote sensing can provide data including SST, sea-ice and ocean colour. The workshop recommended investigating historical sources of such data which could be used in further analyses of existing whale survey data (paragraph 2.140).

4.25 Considerable data on habitat use by other predators have been gained from telemetry studies and the workshop recognised the importance of such data for whales (paragraph 2.141). Studies of habitat use by individual animals may also use photo-identification or genetic mark recapture (paragraph 2.142). The workshop noted the value of studies which combined biological and physical sampling of the water column, including qualification of the length-frequency distribution of krill with observations of feeding whales, and encouraged further such studies (paragraph 2.154).

4.26 To address the question of seasonal abundance of whales in the Southern Ocean, long-term passive acoustic data can be used for monitoring seasonal variations in vocalisations at a particular location. These can be used to generate a relative index of density based on assumptions about variations in calling rates (paragraph 2.143).

Exploitation

4.27 Future work recommended for the exploitation expert group is in paragraph 2.181.

General

4.28 The workshop agreed that the Joint Steering Group should continue its work beyond the workshop in order to help coordinate the future work. It also agreed that others, who are able to assist the Joint Steering Group to achieve its work, should be encouraged to be involved in the Joint Steering Group as ad hoc members, and that the Joint Steering Group should seek to have its membership endorsed by the relevant Scientific Committee.

4.29 The workshop noted that it would be useful to retain the existing expert groups for collating the metadata on the different taxa. It also noted that some issues could be usefully considered across all taxa because of the similarities of the estimation issues, biases and uncertainties. In that sense, the workshop encouraged the Joint Steering Group to consider whether three additional small groups could be assembled to help expert groups consider some of the general issues in estimating parameters and collating data, and to provide a synthesis of advice on the general issues, where appropriate. The suggested additional groups are:

(i) habitats
(ii) life-history characteristics
(iii) food-web linkages.

4.30 The workshop agreed that the Joint Steering Group should be asked to progress the work under the terms of reference according to the following tasks and timeline:

(i) Submit the report of the workshop to the respective Scientific Committees, noting that:

    (a) an executive summary will be prepared by the workshop co-conveners for submission to SC-CAMLR for translation in order that the key points of the report are highlighted to all Members of SC-CAMLR, as there is insufficient time to have the report translated in full in time for its meeting in October 2008;

    (b) the CCAMLR and IWC Secretariats would correspond to determine the publication timetable of the report.

(ii) Consult with workshop participants and expert groups to determine the manner in which the work could be concluded and how the expert groups might progress this, in line with the discussion above. Where needed, the Joint Steering Group will need to find conveners and membership of expert groups to facilitate this work. The Joint Steering Group should consider the following when developing a work plan:

    (a) resources required to complete the tasks;

    (b) the possibility of workshops to help progress the collation and synthesis of data and to complete the papers.

(iii) Develop a proposal for publishing the consolidated reports from the expert groups and associated syntheses, including consideration of publication as a book, special volume or a sequence of papers as the work is completed.

(iv) Continue supervising the development of the metadatabase.

(v) Provide a proposal advancing all of these actions by September 2008 in time for consideration by SC-CAMLR in 2008 and the IWC SC in 2009.

4.31 The workshop agreed that it remained desirable to complete this work program within 12 months in order to maintain the momentum and to achieve a coherent whole.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

5.1 The Report of the Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models was adopted. It was noted that the report would be formatted separately by the two organisations in accordance with their house styles.

5.2 In closing the meeting, Drs Constable and Gales noted the substantial progress made by the expert groups and the workshop towards providing a standardised approach to the use of data from Southern Ocean ecosystems in modelling by CCAMLR and the IWC. They thanked the participants of the workshop for their active contributions and desire for progressing this work. They also noted and thanked the many contributors to this success, including SC-CAMLR and the IWC SC, the CCAMLR and IWC Secretariats, the Joint Steering Group, the expert groups and their coordinators, the workshop small group coordinators and rapporteurs along with other rapporteurs, the support of the CCAMLR Secretariat in hosting the meeting and helping with preparation of the report, and Dr S. Doust for providing administrative support to the workshop.

5.3 The participants joined Mr Donovan in thanking Drs Constable and Gales for their work with the Joint Steering Group in preparing for and convening the workshop.

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Table 1: Selected biomass and time series acoustic studies for krill. References are listed at the end of the report text.

Survey type		Survey area	Survey period	Reference
Biomass	CCAMLR-2000	Area 48 (South Atlantic)	Jan–Feb 2000	Hewitt et al., 2004
	BROKE 1996	Division 58.4.1		Nicol et al., 2000
	BROKE-West 2006	Division 58.4.2		Nicol et al., 2008
	AKES	Subarea 48.6	Jan–Feb 2008	Iversen et al., 2008
	FIBEX	South Atlantic Subarea 48.3	Jan–Mar 1981	El-Sayed, 1994
Time-series surveys	LAKRIS	Subarea 48.6	2005–2008	Siegel et al., 2008
	US AMLR	Subarea 48.1	1988–present	Lipsky et al., 2007
	US SO-GLOBEC	Subarea 48.1	2001–2006	Hofmann et al., 2004
	US LTER	Subarea 48.1	1991–2007	
	BAS	Subarea 48.3	1981–present	
	US AMLR	Subarea 48.2	1999, 2008, 2009*	Reiss and Cossio, 2008

* Proposed survey in 2009

Table 2: Summary of available information on krill.

(a) Distribution. Y – information available; N – no information available.

CCAMLR subarea/ division	Total abundance	Trends in abundance	Relative abundance	Catch history	Environmental correlates	Life history
E. superba						
48.1	N	Y	Y	Y	Y	Y
48.2	N	Y	Y	Y	Y	Y
48.3	N	Y	Y	Y	Y	Y
48.4	N	N	Y	N	Y	Y
48.6**	N	Y	Y	N	Y	Y
58.4.1	N	N	Y	Y+	Y	Y
58.4.2	N	N	Y	Y+	Y	Y
88.1	N	N	N*	Y+	Y	Y
E. crystallorophias						
48.1	N	Y	N	N	Y	Y
48.2	N	N	N	N	Y	Y
48.3	N	N	N	N	Y	Y
48.4	N	N	N	N	Y	Y
48.6	N	N	N	N	Y	Y
58.4.1	N	N	N	N	Y	Y
58.4.2	N	N	N	N	Y	Y
88.1	N	N	Y?	N	N	N
T. macrura						
48.1	N	N	N	N	Y	Y
48.2	N	N	N	N	Y	Y
48.3	N	N	N	N	Y	Y
48.4	N	N	N	N	Y	Y
48.6	N	N	Y	N	Y	Y
58.4.1	N	N	N	N	Y	Y
58.4.2	N	N	N	N	Y	Y
88.1	N	N	Y	N	N	N

* Non-standard acoustic and net survey results available.
** Only net data available.
\+ Data available pre-1990s.

(b) Habitat considerations for the three major species of krill. Y – some relationships have been reported; N – a relationship has not been established; ? – variable relationships have been indicated.

Species	Shelf break	PFZ	Other frontal zones (SBACC, SACCF, slope current)	Water temper-ature	Depth zone	Chl-*a*	Geography (embayments, island groups)	Water-mass structure	Sea-ice
E. superba	Y	Y	Y	Y	Y	?	Y	Y	Y
E. crystallorophias	Y	N	Y	Y	Y	N	Y	Y	Y
T. macrura	Y	Y	N	N	N	N	N	N	N

Table 3: Summary of available data for zooplankton.

(a) Abundance and abundance-environmental correlations. C – Can be calculated from CPR data for individual species, some work at community level, ? – possibly.

CCAMLR subarea/ division	Abun-dance	Trends	Life history	Corre-lations	>10 years monitoring data	Abun-dance	Trends	Life history	Corre-lations	>10 years monitoring data
Large copepods (>2 mm)						Small copepods (<2 mm)				
48.1	Y	Y		Y	Y	Y	Y		Y	Y
48.2	Y		Y	Y		Y		Y	Y	
48.3	Y	Y	Y	Y		Y	Y	Y	Y	
48.4	Y					Y				
48.5	Y					Y				
48.6	Y			C		Y			C	
58.4	Y	Y	?	C	Y	Y	Y		C	Y
58.5	Y			C		Y			C	
58.6	Y					Y				
58.7	Y					Y				
88.1	Y			C		Y			C	
88.2	Y					Y				
88.3	Y			C		Y			C	
Salps						*T. gaudichaudii*				
48.1	Y	Y	Y	Y	Y	Y	Y			Y
48.2	Y			Y		Y				
48.3	Y			Y		Y				
48.4	Y					Y				
48.5	Y					Y				
48.6	Y					-		Y		
58.4	Y	Y	Y			Y				
58.5	Y					Y				
58.6	Y					Y	Y	Y		
58.7	Y					Y				
88.1	Y					Y				
88.2	Y					?				
88.3	Y					?				
Mesozooplankton biomass										
48.1	Y	Y								
48.2	Y									
48.3	Y									
48.4	Y									
48.5	Y									
48.6	Y									
58.4	Y									
58.5	Y									
58.6	Y									
58.7	Y									
88.1	Y									
88.2	Y									
88.3	Y									

(continued)

Table 3 (continued)

(b) Environmental factors that affect the distribution of salps and the amphipod *Themisto gaudichaudii*. Large copes comprise five species, most with fairly well known habitats (i.e. factors affecting distribution). - – no major affect; ? – insufficient data to determine whether there is an effect.

Taxon	Distance from shelf break	Water depth	Sea-ice	Fronts	Temperature	Chl-*a*	Sector
Salps	Yes	Yes	Yes	-	Yes	Yes (prefers moderate Chl-*a*)	-
T. gaudichaudii	?	?	?	-	Yes	-	-
Large copepods	-	-	?	-	Yes	Yes	?
Small copepods	-	-	?	-	Yes	?	?

(c) Diet and feeding rates (source: section 5 and Tables 6 and 7 of CCAMLR-IWC-SC-08/12).

Taxon	Diet (and variability)	Feeding rate (and variability)
E. superba	Yes	Yes, no info on variation
T. macrura	Yes, but poor info on variation	-
E. crystallorophias	Yes, but poor info on variation	-
Salps	Yes	Limited, variation data only in relation to size
T. gaudichaudii	Yes, but poor info on variation	Limited, no info on variation
Large copepods	Yes	Limited, no info on variation
Small copepods	Yes	Limited, no info on variation

Table 4: Summary of available data for squid. References are listed at the end of the report text.

(a) Relationship between squid species and various covariates.

Family	Species	Geographic distribution	Sources
Onychoteuthidae	*Kondakovia longimana* (Filippova, 1972)	Circumpolar Antarctic	Filippova, 1972; Lu and Williams, 1994; Vacchi et al., 1994; Lynnes and Rodhouse, 2002
	Moroteuthis ingens (Smith, 1881)	Circumpolar Sub-Antarctic	Massy, 1916; Filippova, 1972; Filippova and Yukhov, 1979; Alexeyev, 1994
	Moroteuthis knipovitchi (Filippova, 1972)	Circumpolar Antarctic	Fillipova, 1972; Filippova and Yukhov, 1979; Rodhouse, 1989; Rodhouse et al., 1996; Piatkowski et al., 1998
	Moroteuthis robsoni (Adam, 1962)	Occasional Sub-Antarctic	Rodhouse, 1990
	Notonykia atricanae (Nesis et al., 1998)	Sub-Antarctic	Nesis et al., 1998b
Gonatidae	*Gonatus antarcticus* (Lönnberg, 1898)	Circumpolar Sub-Antarctic	Kubodera and Okutani, 1986; Rodhouse et al., 1996; Nesis, 1999; Anderson and Rodhouse, 2002
Histioteuthidae	*Histioteuthis atlantica* (Hoyle, 1885)	Sub-Antarctic	Kubodera, 1989; Alexeyev, 1994
	Histioteuthis eltaninae (Voss, 1969)	Circumpolar Sub-Antarctic	Lu and Mangold, 1978; Alexeyev, 1994; Piatkowski et al., 1994; Rodhouse et al., 1996
Batoteuthidae	*Batoteuthis skolops* (Young and Roper, 1968)	Circumpolar Antarctic	Young, 1968; Filippova and Yukhov, 1979; Rodhouse et al., 1992b; Rodhouse et al., 1996; Anderson and Rodhouse, 2002; Collins et al., 2004
Psychroteuthidae	*Psychroteuthis glacialis* (Thiele, 1920)	Circumpolar Antarctic	Filippova, 1972; Filippova and Yukhov, 1979; Kubodera, 1989; Rodhouse, 1989; Piatkowski et al., 1990, 1994, 1998; Lu and Williams, 1994; Anderson and Rodhouse, 2002; Collins et al., 2004
Neoteuthidae	*Alluroteuthis antarcticus* (Odhner, 1923)	Circumpolar Antarctic	Odhner, 1923; Dell, 1959; Filippova and Yukhov, 1979; Filippova and Yukhov, 1982; Kubodera, 1989; Rodhouse, 1988; Anderson and Rodhouse, 2002
Bathyteuthidae	*Bathyteuthis abyssicola* (Hoyle, 1885)	Circumpolar Antarctic	Hoyle, 1886, 1912; Odhner, 1923; Roper, 1969; Lu and Mangold, 1978; Lu and Williams, 1994; Rodhouse et al., 1996
Brachioteuthidae	*Slosarczykovia circumantarctica* (Lipinski, 2001)	Circumpolar Antarctic	Kubodera, 1989; Lipinski, 2001; Rodhouse, 1989; Rodhouse et al., 1996; Piatkowski et al., 1994; Anderson and Rodhouse, 2002; Collins et al., 2004
	Brachioteuthis linkovski (Lipinski, 2001)	Occasional Sub-Antarctic	Lipinski, 2001; Cherel et al., 2004

(continued)

Table 4(a) (continued)

Family	Species	Geographic distribution	Sources
Ommastrephidae	*Martialia hyadesi* (Rochebrune and Mabille, 1887)	Circumpolar Sub-Antarctic	O'Sullivan et al., 1983; Rodhouse and Yeatman, 1990; Rodhouse, 1991; Piatkowski et al., 1991; Uozomi et al., 1991; Alexeyev, 1994; Rodhouse et al., 1996; Gonzalez and Rodhouse; 1998; Anderson and Rodhouse, 2001
	Todarodes filippovae (Adam, 1975)	Circumpolar Sub-Antarctic	Piatkowski et al., 1991; Dunning, 1993; Alexeyev, 1994
Chiroteuthidae	*Chiroteuthis veranyi* (Ferussac, 1825)	Occasional Sub-Antarctic	Alexeyev, 1994; Rodhouse and Lu, 1998
Mastigoteuthidae	*Mastigoteuthis psychrophila* (Nesis, 1977)	Circumpolar Antarctic	Jackson and Lu, 1994; Lu and Williams, 1994; Piatkowski et al., 1994; Rodhouse et al., 1996; Cherel et al., 2004
Cranchiidae	*Galiteuthis glacialis* (Chun, 1906)	Circumpolar Antarctic	Chun, 1910; Dell, 1959; Filippova, 1972; Lu and Mangold, 1978; McSweeney, 1978; Kubodera and Okutani, 1986; Rodhouse and Clarke, 1986; Rodhouse, 1989; Lu and Williams, 1994; Piatkowski and Hagen, 1994; Rodhouse et al., 1996; Nesis et al., 1998a; Piatkowski et al., 1998; Anderson and Rodhouse, 2002
	Taonius sp. (cf. *pavo*)	Occasional Sub-Antarctic	Rodhouse, 1990b
	Mesonychoteuthis hamiltoni (Robson, 1925)	Circumpolar Antarctic	McSweeney, 1970; Filippova and Yukhov, 1979; Rodhouse and Clarke, 1985
Lepidoteuthidae	*Pholidoteuthis boschmai* (Adam, 1950)	Scotia Sea	Nemoto et al., 1985; Offredo et al., 1985

(b) Diet information

Species/location	Size range (mm)	Prey types	Main prey species	Source	Data collection methods
Martialia hyadesi					
South Georgia	278–370	Myctophids, crustacea, cephalopods	*Krefftichthys anderssoni, Protomyctophum choriodon, P. bolini, Gymnoscopelus nicholsi, Euphausia superba, Gonatus antarcticus*	Gonzalez and Rodhouse, 1998	Visual/gut contents
South Georgia	190–310 ($n = 61$)	Myctophids, euphausids, amphipods	*K. andersoni, Electrona carlsbergi, E. superba*	Rodhouse et al., 1992a	Visual/gut contents
Patagonian Shelf	190–350 ($n = 336$)	Myctophids, euphausids, amphipods, cephalopods	*K. anderssoni, G. nicholsi, Themisto gaudichaudii, Martialia hyadesi*	Gonzalez et al., 1997	Visual/gut contents
Patagonian Shelf	220–370	Myctophids, euphausids, amphipods, cephalopods	*Protomyctophum tensioni, G. nicholsi, M. hyadesi*	Ivanovic et al., 1998	Visual/gut contents

(continued)

Table 4(b) (continued)

Species/location	Size range (mm)	Prey types	Main prey species	Source	Data collection methods
Scotia Sea	216–260 (n = 25)	Fish, cephalopods	*K. anderssoni, G. nicholsi, Electrona antarctica*	Kear, 1992	Serology +Visual/gut contents
South Georgia	225–312 (n = 40)	Amphipods, myctophid fish and cephalopods	*T. gaudichaudii, K. anderssoni, P. choriodon*	Dickson et al., 2004	Visual/gut contents
Moroteuthis ingens					
New Zealand	264–445 (n = 37)	Principally fish >90%; 9% squid	*Stomias boa/Chauliodus sloani, Lampanyctodes hectoris*	Jackson et al., 1998	Visual/gut contents
Macquarie and Heard	150–432 (n = 54)	96% fish myctophids Bathylagus	*Electrona* spp., *Gymnoscopelus* spp., *P. bolini, K. anderssoni*	Phillips et al., 2001	Visual/gut contents
New Zealand, Macquarie, Patagonian Shelf	200–500 (n = 316)	Primarily myctophid fish	*L. hectoris, E. carlsbergi*	Phillips et al., 2003a	Visual/gut contents
Patagonian Shelf	75–375 (n = 100)	Crustacea, myctophids, cephalopods	*G. nicholsi, Loligo gahi, Moroteutis ingens*	Phillips et al., 2003b	Visual/gut contents
South Shetlands	(n = 1)	Krill	*E. superba*	Nemoto et al., 1988	Visual/gut contents
Kerguelen	112–286 (n = 72)	Principally fish, with squid and crustacea	*Arctozenus risso, Paradiplospinosus gracilis, M. ingens*	Cherel and Duhamel, 2003	Visual/gut contents
Kondakovia longimana					
South Shetlands	60–360 (n = 121)	Macroplankton	*E. superba, T. gaudichaudii, T. macrura,* amphipods, chaetognaths, fish, squid	Nemoto et al., 1985, 1988	Visual/gut contents
Moroteuthis knipovitchi					
South Shetlands	140–360 (n = 23)	Krill, fish	Myctophids, *E. superba*	Nemoto et al., 1985, 1988	Visual/gut contents
South Georgia	212–321 (n = 8)	Krill, fish	*E. superba, G. nicholsi*	Collins et al., 2004	Visual/gut contents
Moroteuthis robsoni					
South Shetlands	60–100 (n = 5)	Euphausids	*E. superba*	Nemoto et al., 1988	Visual/gut contents
Alluroteuthis antarcticus					
South Shetlands	40–140 (n = 7)	Macroplankton	*E. superba, T. gaudichaudii*, fish, squid	Nemoto et al., 1985, 1988	Visual/gut contents
Scotia Sea	221 (n = 1)	Euphausids, fish	*E. superba*	Kear, 1992	Visual/gut content

(continued)

Table 4(b) (continued)

Species/location	Size range (mm)	Prey types	Main prey species	Source	Data collection methods
Prydz Bay	(*n* = 2)	Squid, fish	*Psychroteuthis glacialis, Pleuragramma*	Lu and Williams, 1994	Visual/gut contents
Galiteuthis glacialis					
South Shetlands	100–240 (*n* = 19)	Macroplankton	*E. superba, T. gaudichaudii,* chaetognaths	Nemoto et al., 1985, 1988	Visual/gut contents
		Macroplankton	Euphausids, amphipods, copepods and chaetognaths	McSweeney, 1978	Visual/gut contents
Prydz Bay	74–493 (*n* = 3)	Crustacea, fish	*E. superba*	Lu and Williams, 1994	Visual/gut contents
Slosarczykovia circumantarctica					
South Shetlands	40–160 (*n* = 75)	Krill	*E. superba*	Nemoto et al., 1985, 1988	Visual/gut contents
Scotia Sea	67–113 (*n* = 3)	Crustacea		Kear, 1992	Visual/gut contents
Gonatus antarcticus					
South Shetlands	40–160 (*n* = 48)	Krill	*E. superba*	Nemoto et al., 1988	Visual/gut contents
Scotia Sea	57–375 (*n* = 2)	Unidentified fish		Kear, 1992	Visual/gut contents
Psychroteuthis glacialis					
Scotia Sea	114–360 (*n* = 13)	Euphausids, fish	*E. superba, Chionodraco, Chaenodraco*	Kear, 1992	Visual/gut contents
Prydz Bay	121–201 (*n* = 53)	Krill and fish	*Pleuragramma, E. superba*	Lu and Williams, 1994	Visual/gut contents
South Georgia	(*n* = 4)	Krill	*E. superba*	Collins et al., 2004	Visual/gut contents

Table 5: Summary of available data for fish. Rows are only included in this table if the species concerned is found in the subarea/division. Y – data are available; L – little data available; N – no data available.

CCAMLR subarea/ division	Relative abundance	Trends in relative abundance	Catch history	Habitat	Life history	Quantity food composition	Daily food consumption	Environment
Notothenia rossii								
48.3	Y	Y	Y	L	Y	Y	Y	L
48.2	N	L	Y	N	N	N	N	N
48.1	Y	Y	Y	L	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
58.5.1	Y	N	Y	N	Y	N	N	N
58.5.2	Y	N	N	N	N	N	N	N
58.4.4	N	N	N	N	N	N	N	N
Champsocephalus gunnari								
48.3	Y	Y	Y	L	Y	Y	Y	Y
48.2	Y	N	Y	N	Y	N	N	N
48.1	Y	Y	Y	L	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
58.5.1	Y	N	Y	N	Y	N	N	L
58.5.2	Y	Y	Y	N	Y	N	N	L
Gobionotothen gibberifrons								
48.3	Y	Y	Y	N	Y	Y	Y	N
48.2	Y	Y	Y	N	Y	N	N	N
48.1	Y	Y	Y	N	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
Chaenocephalus aceratus								
48.3	Y	Y	Y	N	Y	Y	Y	L
48.2	Y	Y	Y	N	Y	N	N	N
48.1	Y	Y	Y	N	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
Pseudochaenichthys georgianus								
48.3	Y	Y	Y	N	Y	Y	Y	L
48.2	Y	Y	Y	N	N	N	N	N
48.1	Y	Y	Y	N	N	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N

(continued)

Table 5 (continued)

CCAMLR subarea/ division	Relative abundance	Trends in relative abundance	Catch history	Habitat	Life history	Quantity food composition	Daily food consumption	Environment
Lepidonotothen larseni								
48.3	Y	Y	N	L	Y	Y	Y	L
48.2	Y	N	N	N	Y	N	N	N
48.1	Y	Y	N	L	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
58.6 and 58.7	Y	N	N	N	N	N	N	N
58.5.1	N	N	N	N	N	N	N	N
58.5.2	N	N	N	N	N	N	N	N
58.4.4	N	N	N	N	N	Y	Y	N
Lepidonotothen squamifrons								
48.3	Y	Y	Y	N	Y	Y	Y	N
48.2	N	N	N	N	N	N	N	N
48.1	Y	Y	N	N	Y	Y	Y	L
48.4 and 48.6	N	N	N	N	N	N	N	N
58.6 and 58.7	N	N	N	N	N	N	N	N
58.5.1	Y	Y	Y	N	Y	N	N	N
58.5.2	Y	N	N	N	Y	N	N	N
58.4.4	N	N	Y	N	Y	N	N	N
88.1 and 88.2	N	N	N	N	N	N	N	N
Dissostichus eleginoides								
48.3	Y	Y	Y	N	Y	Y	Y	N
48.2	N	N	N	N	N	N	N	N
48.1	N	N	N	N	N	N	N	N
48.4 and 48.6	N	N	Y	N	Y	N	N	N
58.6 and 58.7	Y	Y	Y	N	Y	N	N	N
58.5.1	Y	Y	Y	N	Y	N	N	N
58.5.2	Y	Y	Y	N	Y	N	N	N
58.4.4	N	N	Y	N	N	N	N	N
58.4.3	N	N	Y	N	N	N	N	N
58.4.2	N	N	Y	N	N	N	N	N
58.4.1	N	N	Y	N	N	N	N	N

(continued)

Table 5 (continued)

CCAMLR subarea/ division	Relative abundance	Trends in relative abundance	Catch history	Habitat	Life history	Quantity food composition	Daily food consumption	Environment
Dissostichus mawsoni								
48.2	Y	N	N	N	N	N	N	N
48.1	Y	N	N	N	N	Y	Y	N
48.4 and 48.6 southern part	N	N	Y	N	N	N	N	N
58.4.3	N	Y	Y	N	N	N	N	N
58.4.2	N	Y	Y	N	N	N	N	N
58.4.1	N	N	Y	N	N	N	N	N
88.1 and 88.2	Y	Y	Y	N	Y	N	N	Y

Table 6: Revised list of penguin and flying seabird species for consideration in future work. Future consideration of visitors needs to take into account the difficulty of determining the timing and distribution of visitation. Vagrants are not included.

Breeding	
Aptenodytes forsteri	Emperor penguin
Aptenodytes patagonicus	King penguin
Pygoscelis papua	Gentoo penguin
Pygoscelis adeliae	Adélie penguin
Pygoscelis antarctica	Chinstrap penguin
Eudyptes chrysolophus	Macaroni penguin
Diomedea exulans	Wandering albatross
Thalassarche melanophrys	Black-browed albatross
Thalassarche chrysostoma	Grey-headed albatross
Phoebetria palpebrata	Light-mantled sooty albatross
Macronectes giganteus	Southern giant petrel
Macronectes halli	Northern giant petrel
Catharacta lonnbergi	Brown skua
Catharacta maccormicki	South polar skua
Larus dominicanus	Kelp gull
Fulmarus glacialoides	Southern fulmar
Thalassoica antarctica	Antarctic petrel
Daption capense	Cape petrel
Pagodroma nivea	Snow petrel
Procellaria aequinoctialis	White-chinned petrel
Sterna vittata	Antarctic tern
Halobaena caerulea	Blue petrel
Pachyptila desolata	Antarctic prion
Pachyptila crasirostris	Fairy prion
Oceanites oceanicus	Wilson’s storm-petrel
Fregetta tropica	Black-bellied storm-petrel
Pelecanoides georgicus	South Georgia diving petrel
Pelecanoides urinatrix	Common diving petrel
Phalacrocorax atriceps	Imperial shag
Visitor	
Diomedea sanfordi	Northern royal albatross
Diomedea epomophora	Southern royal albatross
Thalassarche impavida	Campbell albatross
Pterodroma brevirostris	Kerguelen petrel
Pterodroma inexpectata	Mottled petrel
Pterodroma lessonii	White-headed petrel
Pterodroma mollis	Soft-plumaged petrel
Pachyptila belcheri	Slender-billed prion
Puffinus griseus	Sooty shearwater
Puffinus tenuirostris	Short-tailed shearwater

Table 7: Overview summary of availability of abundance and trends data for the crabeater seal. AP – Antarctic Peninsula; Y – yes; N – no; - – not applicable; 1999/2000 – austral summer; B – breeding; NB – non-breeding.

Crabeater seal	Ross Sea	Amundsen Sea	AP Scotia Sea	Weddell Sea	East Antarctica	Sub-Antarctic Islands
Is there a population estimate?	Y	Y	Y	N	Y	-
Confidence/uncertainty in estimate	Y	Y	Y	N	Y	-
Is there trend data (population or other parameter)?	N	N	N	N	N	-
Confidence/uncertainty in trend	N	N	N	N	N	-
Number of sites (spatial cover of count effort)	-	-	-	-	-	-
Year of most recent count	1999/ 2000	1999/ 2000	1999/ 2000	-	1999/ 2000	-
Component of population estimated? (B, NB, All)	All	All	All	-	All	-

Table 8: Overview summary of availability of abundance and trends data for the Ross seal. AP – Antarctic Peninsula; Y – yes; N – no; - – not applicable; 1999/2000 – austral summer; B – breeding; NB – non-breeding.

Ross seal	Ross Sea	Amundsen Sea	AP Scotia Sea	Weddell Sea	East Antarctica	Sub-Antarctic Islands
Is there a population estimate?	Y	Y	N	N	Y	-
Confidence/uncertainty in estimate	Y	Y	N	N	Y	-
Is there trend data (population or other parameter)?	N	N	N	N	N	-
Confidence/uncertainty in trend	N	N	N	N	N	-
Number of sites (spatial cover of count effort)	-	-	-	-	-	-
Year of most recent count	1999/ 2000	1999/ 2000	1999/ 2000	-	1999/ 2000	-
Component of population estimated? (B, NB, All)	All	All	All	-	All	-

Table 9: Overview summary of availability of abundance and trends data for the leopard seal. - not applicable. AP – Antarctic Peninsula; Y – yes; N – no; - – not applicable; 1999/2000 – austral summer; B – breeding; NB – non-breeding.

Leopard seal	Ross Sea	Amundsen Sea	AP Scotia Sea	Weddell Sea	East Antarctica	Sub-Antarctic Islands
Is there a population estimate?	Y	Y	Y	N	Y	-
Confidence/uncertainty in estimate	Y	Y	Y	N	Y	-
Is there trend data (population or other parameter)?	N	N	N	N	N	-
Confidence/uncertainty in trend	N	N	N	N	N	-
Number of sites (spatial cover of count effort)	-	-	-	-	-	-
Year of most recent count	1999/ 2000	1999/ 2000	1999/ 2000	-	1999/ 2000	-
Component of population estimated? (B, NB, All)	All	All	All	-	All	-

Table 10: Overview summary of availability of abundance and trends data for the Weddell seal. AP – Antarctic Peninsula; Y – yes; N – no; - – not applicable; 1999/2000 – austral summer; B – breeding; NB – non-breeding.

Weddell seal	Ross Sea	Amundsen Sea	AP Scotia Sea	Weddell Sea	East Antarctica	Sub-Antarctic Islands
Is there a population estimate?	Y	Y	Y	N	N	-
Confidence/uncertainty in estimate	Y	Y	Y	N	N	-
Is there trend data (population or other parameter)?	N	N	N	N	N	-
Confidence/uncertainty in trend	N	N	N	N	N	-
Number of sites (spatial cover of count effort)	-	-	-	-	-	-
Year of most recent count	1999/ 2000	1999/ 2000	1999/ 2000	-	-	-
Component of population estimated? (B, NB, All)	All	All	All	-	-	-

Table 11: Comparison of survey and tagging methods to determine the distribution of marine animals.

Measure of animal distribution and abundance	
Survey	Electronic tags
Advantages Can sample hard to study species Environmental Data Physical Environment CTD, chlorophyll	Advantages Long time series Animal behaviour Dive pattern Animal movements Home range Habitat utilisation Environnemental data Physical environnent CTD, chlorophyll
Disadvantages Snapshot Only know about area surveyed Biased measure of range Sample bias Animal behaviour	Disadvantages Must be able to tag animal. No direct measure of abundance. Environmental and habitat data primarily relate to where the animals have been. Other data is needed to identify environmental attributes of where the animals did not spend sufficient time to estimate those attributes.

Table 12: Template for habitat utilisation summary.

		Summer	Autumn	Winter	Spring
Species 1	Horizontal distribution				
	Vertical distribution				
Species 2	Horizontal distribution				
	Vertical distribution				

Temporal categories:
Summer (21 Dec–20 Mar)
Autumn (21 Mar–20 June)
Winter (21 June–20 Sep)
Spring (21 Sep–20 Dec)

Vertical distribution categories:
Surface (S)
Lunge diver (L)
Epipelagic diver (E)
Mesopelagic diver (M)
Benthic-demersal diver (BD)

Horizontal distribution categories:
Polar Frontal Zone (PFZ)
Marginal ice zone (MIZ)
Interior annual pack-ice (IAPI)
Interior perennial pack-ice (IPPI)
Fast-ice (FI)
Coastal polynya (CP)
Continental shelf break (CSB)
Continental shelf CS)

Table 13: Template for diet summary.

Species/species group	Data (**Y**es/**N**o)	Technique [**R**egurgitate, **L**avage, **S**cat, **F**asa, **I**sotope, **DNA**]	Region [Ross Sea/Amundsen Sea/Antarctic Peninsula-Scotia Sea/Weddell Sea/East Antarctica/Indian Ocean sub-Antarctic Islands]	Season [1 – spring, 2 – summer, 3 – autumn, 4 – winter (use actual dates)]
Crabeater seals	Y	R, S	-/y/-/-/y/-	-/1,3/-/-/2,3,4/-
Antarctic prion	Y	R	-/-/y/-/-/y	-/-/2/-/-/2

Table 14: Template for life-history summary. Where appropriate information on confidence intervals around point estimates, potential biases and interannual variability are highly desirable.

By species	Parameter estimate or description
Age-at-first breeding	
Breeding frequency	
Juvenile survival	
Adult survival	
Maximum clutch size	
Breeding season: timing	
Breeding season: duration	
Moult (continuous or distinct)	

Table 15: Matrix for conditioning whale population dynamics component of models. Annotated fields data are available (and presented in the expert review) for which any model should be consistent with – these data might either be used to develop the model or to validate it. N – no data are currently available. References are listed at the end of the report text.

Species/species population	Estimates for breeding population		Regional snapshots of abundance in Antarctic waters	Trend from regional estimates of abundance	Some data on stock boundaries within surveyed region in Antarctic	Long-term history of substantial catches
	Total abundance	Trend in total abundance				
Humpback whale (A)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Humpback whale (B)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables, 4, 5[2]
Humpback whale (C)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Humpback whale (D)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Humpback whale (E)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Humpback whale (F)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Humpback whale (G)[1]	Table 2[2]	Table 3[2]	Table 2[2]	Table 3[2]	Table 1[2]	Tables 4, 5[2]
Blue whale	Table 6[2]	Branch et al., 2004	Table 6[2]	Matsuoka et al., 2006	N	Table 7[2]
Fin whale	N	N	Table 8[2]	Table 8[2]	N	Tables 9, 10[2]
Sei whale	N	N	N	N	N	Tables 11, 12[2]
Antarctic minke whale	Tables 13, 14[2, 3]	N	N	N	Pastene et al., 2006; and see IWC, 2008b, p. 422	Tables 15, 16[2]
Southern right whale (Eastern South America)	Cooke et al., 2001	Cooke et al., 2001	Hedley et al., 2001	N	N	Section 4.6.1.3[2]
Southern right whale (Australia/NZ)	Bannister, 2008	Bannister, 2008	N	N	N	Section 4.6.3.3[2]
Southern right whale (South Africa)	Best et al., 2006	Best et al., 2006	N	N	N	Section 4.6.2.3[2]
Southern right whale (Western South America)	IUCN, 2008	N	N	N	N	Section 4.6.4.3[2]
Sperm whale	N	N	Table 1[4]	N	N	Smith et al., 2005
Southern bottlenose whale	N	N	Table 1[4]	N	N	N
Killer whale	Table 1[4]	N	Table 1[4]	N	N	N
Hourglass dolphin	N	N	Table 1[4]	N	N	N

[1] See CCAMLR-IWC-WS-08/4, Table 1
[2] See CCAMLR-IWC-WS-08/4
[3] The status of Antarctic minke whales is still currently under review within the IWC, although the IWC is nearing the end of a comprehensive review of their status. There are currently no agreed estimates.
[4] See CCAMLR-IWC-WS-08/5

Table 16: Suggested format for the expert group to summarise studies where spatial/temporal covariates have been used in models of whale density.

Species abundance estimate	Covariates included in model	Reference
Humpback whale		
Blue whale		
Fin whale		
Sei whale		
Antarctic minke whale		
Southern right whale		
Sperm whale		
Southern bottlenose whale		
Killer whale		
Hourglass dolphin		

Table 17: Potential covariates discussed in relation to developing models of whale density.

Temporal covariates
Timing within a season
Variability and time lags in relation to physical or biological processes
Fixed physical covariates
Lat/Long
Depth
Distance from shelf break
Shelf slope
Dynamic physical covariates
SST
Upwelling intensity and mixed layer depth
Frontal systems
Seasonal sea-ice dynamics
Short term (days/weeks) changes in ice concentration
Biological covariates
Primary productivity (rate and quantity)
Krill concentration (spatial scale)
Krill swarm type and vertical distribution
Interspecific interactions between whales
Intraspecific factors including segregation by age, sex, reproductive status

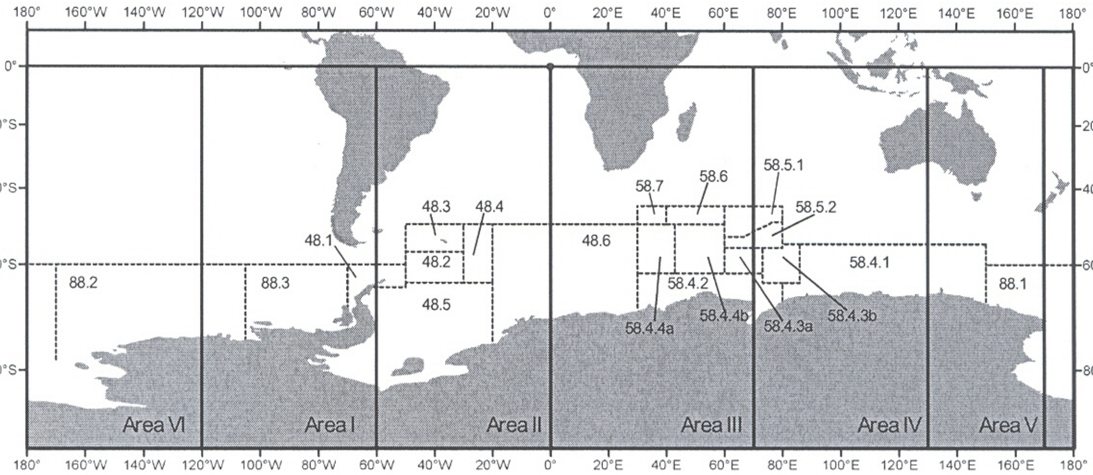

Figure 1: Map showing the area managed by CCAMLR and the CCAMLR statistical areas/subareas/divisions along with the IWC management units.

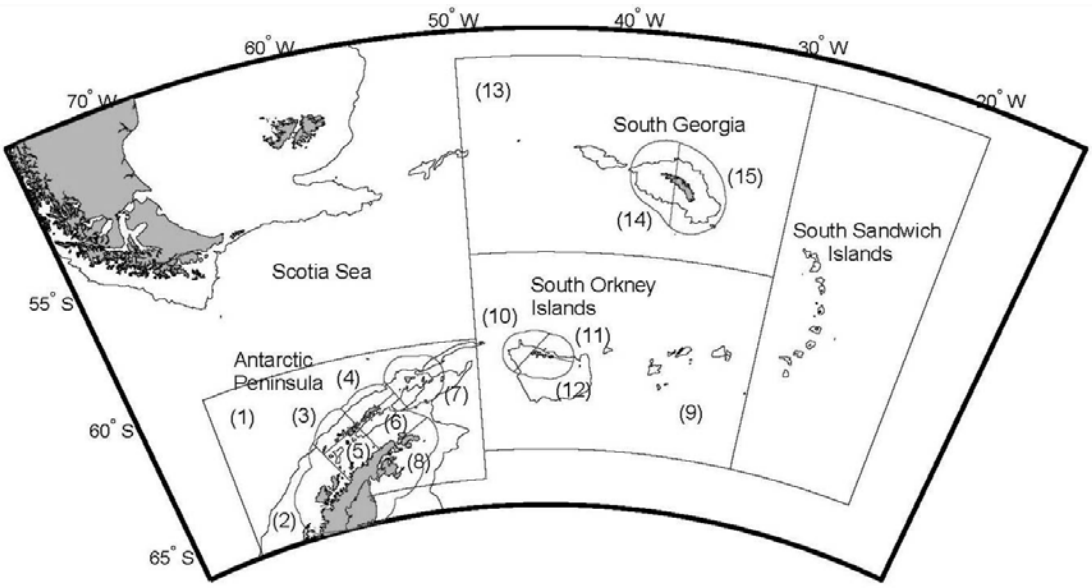

Figure 2: Small-scale management units adopted by CCAMLR for Area 48.

NB: The following figures are available in colour on the CCAMLR website.

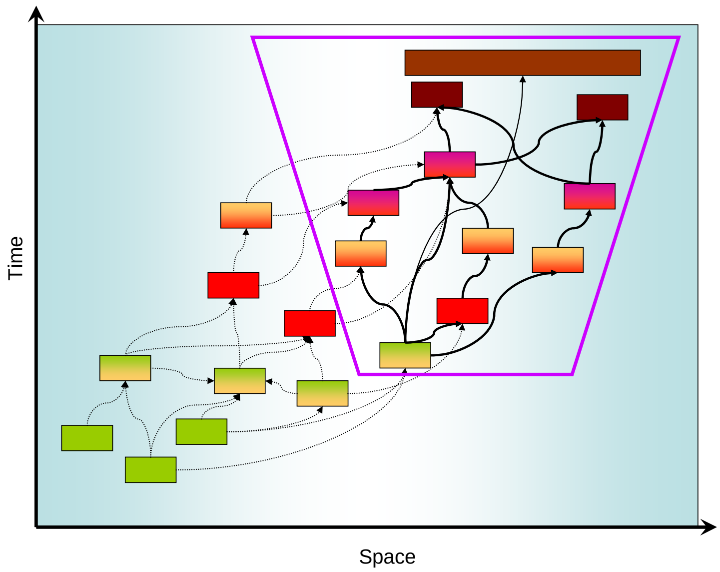

Figure 3: Schematic representation of different taxa and their relationships, within the physical ocean and sea-ice, arranged according to the spatial and temporal scales within which individuals of the different taxa typically function. The trapezoid shows a typical subset of a minimal realistic model that might be considered by CCAMLR and the IWC with krill at the bottom of the food web operating at smaller scales than larger predators. In this case, some species of whales cover broad spatial scales and are shown at the top of this food web.

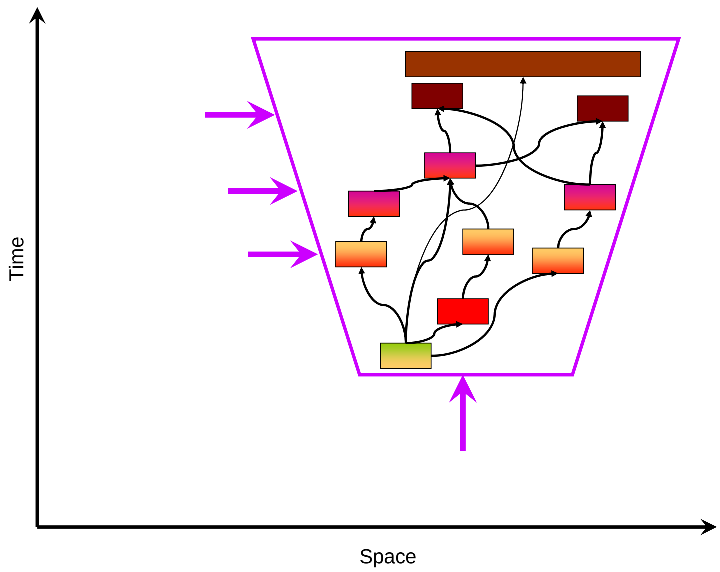

Figure 4: For simplicity, the food web and physical environment outside the trapezoid is then collapsed into a series of forcing functions indicated by the arrows.

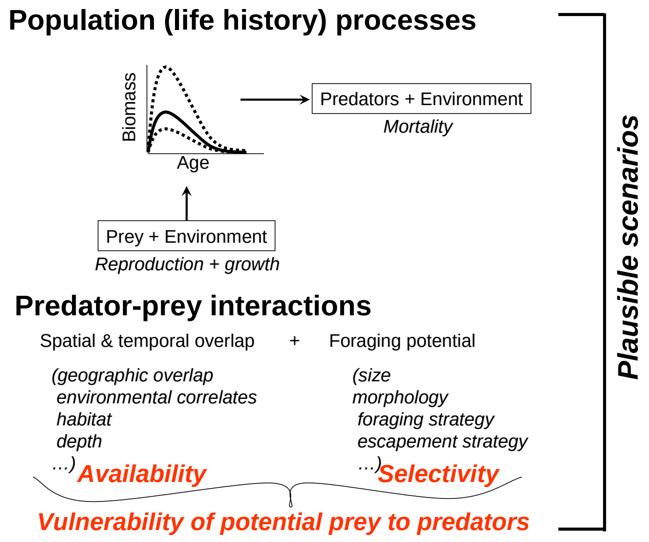

Figure 5: Plausible scenarios are first built into models by representing population and predator–prey processes at a level of detail appropriate to the purpose of the model. For populations, these processes will influence reproduction, growth and mortality. For predator–prey interactions, the functions will represent the vulnerability of prey to predators given the degree of spatial and temporal overlap (prey availability to predators) combined with the ability for predators to capture prey when they are encountered (selectivity).

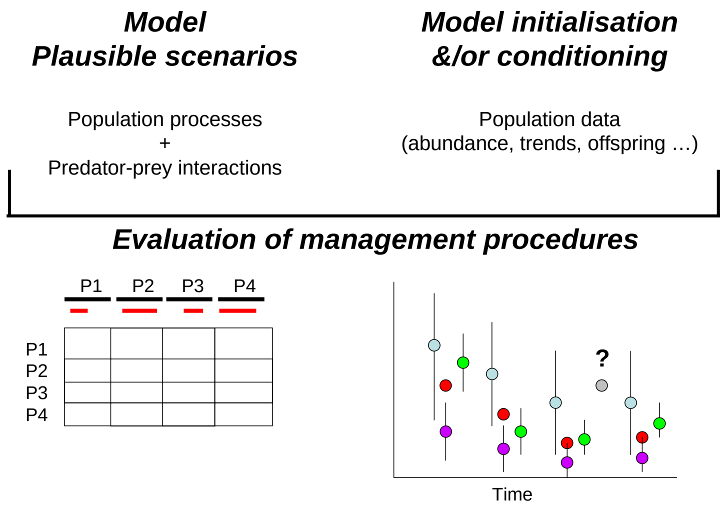

Figure 6: Plausibility can be improved by the inclusion of population data either for initialising the models or for conditioning the models to a time series. In this case, some parameters in the model structure can be estimated and, individually, represent many ecological processes. Data will have differing relationships to the true state of the population, which is indicated by the red circles. Precision of estimates is indicated by the magnitude of the error bars while biases may be of a consistent relative magnitude (useful as a relative time series) or could be offset by fixed amounts, which could cause problems if those offsets are unknown and the models need to remove fixed quantities.

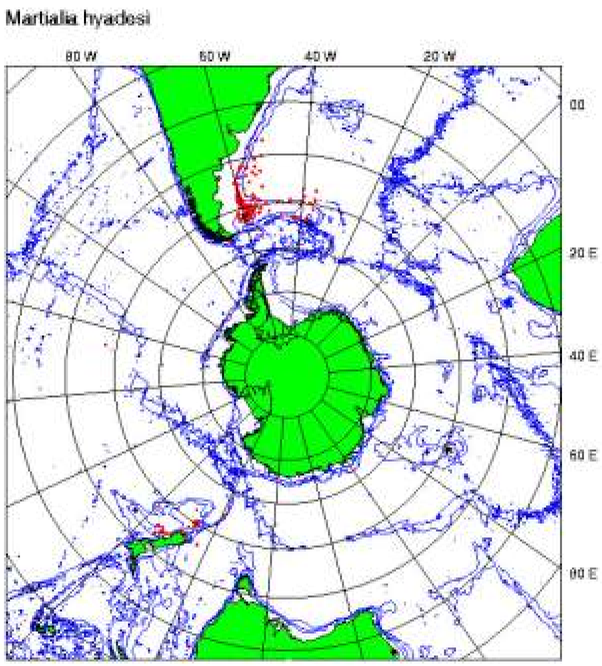

Figure 7: Example of relationship between abundance of *Martiala hyadesi* (red dots) and bathmetry (data from the *Squid Atlas*; www.nerc-bas.ac.uk/public/mlsd/squid-atlas/).

APPENDIX A

AGENDA

Joint CCAMLR-IWC Workshop
(Hobart, Australia, 11 to 15 August 2008)

1. Introduction
    - 1.1 Terms of reference
    - 1.2 Agenda and organisation of the meeting
    - 1.3 Background

2. Metadata summaries
    - 2.1 Physical environment and primary production
        - 2.1.1 Oceanography
        - 2.1.2 Sea-ice
        - 2.1.3 Primary production
    - 2.2 Pelagic species
    - 2.3 Seals and seabirds
    - 2.4 Whales
    - 2.5 Exploitation

3. General issues surrounding metadata and priorities for future research

4. Products and future work
    - 4.1 Metadatabase and other tools
    - 4.2 Publications
    - 4.3 Future work

5. Report adoption

6. Close of the meeting.

APPENDIX B

LIST OF PARTICIPANTS

Joint CCAMLR-IWC Workshop
(Hobart, Australia, 11 to 15 August 2008)

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APPENDIX C

LIST OF DOCUMENTS

Joint CCAMLR-IWC Workshop
(Hobart, Australia, 11 to 15 August 2008)

CCAMLR-IWC-WS-08/1	Draft Agenda Co-Conveners – A. Constable and N. Gales
CCAMLR-IWC-WS-08/2	CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models Co-Conveners – A. Constable and N. Gales
CCAMLR-IWC-WS-08/3	Models of Antarctic marine ecosystems in support of CCAMLR and IWC: background Co-Conveners – A. Constable
CCAMLR-IWC-WS-08/4	A review of abundance, trends and foraging parameters of baleen whales in the southern hemisphere Coordinator – A. Zerbini
CCAMLR-IWC-WS-08/5	Report of review group of data sources on odontocetes in the Southern Ocean in preparation for IWC/CCAMLR workshop in August 2008 Coordinator – R. Leaper
CCAMLR-IWC-WS-08/6	A review of bias and uncertainty in Antarctic pack-ice seal abundance estimates Coordinator – C. Southwell
CCAMLR-IWC-WS-08/7	Report of the review group on sources of data on Antarctic fur seals *Arctocephalus gazella* in the Southern Ocean in preparation for the CCAMLR-IWC workshop, August 2008 Coordinator – K. Reid
CCAMLR-IWC-WS-08/8	A review of the uncertainties associated with penguin population and abundance estimates for the CCAMLR region Coordinator – P. Trathan
CCAMLR-IWC-WS-08/9	The role of fish as predators of krill (*Euphausia superba*) and other pelagic resources in the Southern Ocean Coordinator – K.-H. Kock

CCAMLR-IWC-WS-08/10	Review of input data for Antarctic ecosystem models: pelagic cephalopods Coordinator – P. Rodhouse
CCAMLR-IWC-WS-08/11	Krill population trends Coordinator – S. Nicol
CCAMLR-IWC-WS-08/12	Zooplankton in Southern Ocean food web models: a critique of available data Coordinator – A. Atkinson
CCAMLR-IWC-WS-08/13	CCAMLR-IWC Export Group Report: Primary Productivity and Phytoplankton Coordinator – P. Strutton
CCAMLR-IWC-WS-08/14	Observing and modelling Antarctic sea ice habitats – Sea Ice Expert Group Report to the CCAMLR-IWC Workshop to Review Input Data for Marine Ecosystem Models Coordinator – R. Masson
CCAMLR-IWC-WS-08/15	An overview of data and models for Southern Ocean studies Coordinator – E. Hofmann
CCAMLR-IWC-WS-08/16	CCAMLR-IWC Workshop metadatabase Coordinator – S. Doust
CCAMLR-IWC-WS-08/17	Conveners’ guide to generating a synopsis of papers from expert groups to assist with general discussions Co-Conveners – A. Constable and N. Gales
CCAMLR-IWC-WS-08/18	Food consumption by flying seabirds in the Southern Ocean Coordinator – B. Wienecke

APPENDIX D

SUMMARIES OF LIFE HISTORY FOR KRILL, ZOOPLANKTON AND SQUID

Krill

1. CCAMLR-IWC-WS-08/11 concentrated on studies that examined distribution and abundance. There is a wealth of studies into krill life history from both field and laboratory studies (most recent review by Siegel, 2005). These have resulted in the development of conceptual models at the individual level (Nicol et al., 2006) and at the population level (Atkinson, 2008) which aim to describe the observed patterns of distribution. Most of the background information relating to population dynamics of krill is summarised in Siegel and Nicol (2000) and Siegel (2005). These papers provide reviews of estimates of growth, mortality, fecundity, recruitment and longevity. Probably the key bottleneck in the life history of krill is the survival of larvae from the point of hatching through the first winter. At this point in their life cycle the animals have little ability to resist food shortage and the survival of the larvae through to their first spring is probably key to subsequent recruitment (Quetin et al., 2007).

2. There is little information on the effect of quality of food on krill growth and reproduction. Growth has been linked to food availability (see below) and there is field information on the effects of food quality on the growth of young krill. Growth rates of krill, including larvae, during the austral spring and early summer (November to mid-January) is a function of the abundance and composition of the phytoplankton community in the water column (Ross et al., 2000). Sea-ice microbial communities are also thought to be a better nutritional source in the under-ice habitat for larvae than open-water source. Krill rely on springtime primary production (ice-associated and open-water primary production) to fuel ovarian development and the timing of the spring bloom is thought to be critical (Kawaguchi et al., 2007, Ross and Quetin, 2000; Hagen et al., 1996; Quetin and Ross, 2001).

3. Krill have a number of overwintering strategies: (i) reduced metabolism, (ii) increased carnivory or detritivory, (iii) starvation and shrinkage, (iv) migration inshore or to deep water, and (v) feeding under the ice. The circumstances under which each of these strategies is employed are not well defined and populations of krill may utilise all of these strategies (Siegel, 2005).

4. The various life-history stages (and seasonally the reproductive stages) of krill can show distinct spatial separation, both vertically and horizontally. Krill are broadcast spawners and they lay their eggs in deep water where they can sink to 1 000 m. The developing larvae swim upwards and return to the surface to feed in autumn. Eggs spawned by krill in one area may therefore recruit as juveniles to another area, thus the population structure of a krill population may reflect both endogenous as well as exogenous effects. The extent to which krill exist as populations in an area and their capacity to self-recruit is a subject of active modelling and research.

5. Several models of krill growth have been produced. The most recent are Atkinson et al. (2006), Candy and Kawaguchi (2006), Hofmann and Lascara (2000), Kawaguchi et al. (2006), Rosenberg et al. (1986) and Tarling et al. (2006).

Zooplankton

Copepods

6. Life-cycles information is available in CCAMLR-IWC-WS-08/12, in particular sections 2 and 4. In brief, three species are known to have two-year life spans, *Rhincalanus gigas*, *Calanus propinquus* and *C. acutus*. They exhibit deep-water seasonal migration (~1 000 m) to diapause over winter before returning to the surface waters in spring to mature or reproduce. Most of the other copepod species are assumed to live one year with generally pulse spawning. The small cyclopoid copepod *Oithona similis* lives a few months and breeds continuously.

7. All major species are now considered omnivore, feeding on phytoplankton, microzooplankton and particulate matter such as marine snow and possibly faecal matter. Genuine carnivorous copepods are low in number. Very little is known on food quality, recruitment and mortality for copepods.

Salps

8. Basic information is available on their unusual life cycle of alternating sexual/asexual generations, including their seasonal vertical distribution. Growth rates are available but fundamental questions remain over mortality rates, factors affecting ‘recruitment’ (i.e. causes of salp blooms) and metapopulation structure.

Themisto gaudchaudii

9. Only very basic information is available on the life cycle, with absence of detailed data on reproduction, recruitment, separation of age classes and mortality rates etc.

10. All species have circumpolar distributions and pronounced latitudinal zonation. The distribution of abundance is highly variable, and can be transient. Sub-Antarctic islands, gyres and polynyas may have more persistent localised high abundances.

Squid

11. Pelagic squid, in common with most other cephalopods, are fast-growing, short-lived and semelparous. Although there is no reason to suppose that Antarctic squid are not semelparous, low temperature is a major factor controlling growth in polar organisms and the few Antarctic cephalopods in which growth has been examined have slower growth rates than species from warmers waters. Rates of growth as well as fecundity, egg size and development

in Antarctic cephalopods are reviewed by Collins and Rodhouse (2006). The Antarctic octopuses have very large eggs compared with lower latitude species. The pelagic squids also have larger eggs than lower latitude species, but the difference is less marked than in the octopuses. As expected, larger egg size does appear to be related to lower fecundity although there are few data. Egg development time has not been measured, but on the basis of their size and prevailing temperatures it has been suggested to be about 30 months for the Antarctic pelagic cranchiid squid *Galiteuthis glacialis*. There are no estimates for recruitment, mortality rates or carrying capacity for Antarctic pelagic squid. On the basis of comparisons with lower latitude species it is probably safe to assume that: (i) recruitment of most species is annual following an extended egg and paralarval phase; (ii) recruitment is probably variable and driven by environmental variability; (iii) mortality is relatively low; and (iv) carrying capacity will vary with availability of prey. Populations of ecologically opportunistic squid will increase and that when prey is abundant, but over time they will be variable. This is supported by evidence of variability of interannual variability in species of squid in the diet of seabird predators.

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APPENDIX E

UNEDITED VIEWS OF SOME PARTICIPANTS ON RELATIVE PRIORITIES FOR ECOSYSTEM MODELLING RELATED TO CCAMLR AND IWC

Dr Mark Bravington

The range of possible structures for an ecosystem model is too big to allow a purely empirical approach to building them (e.g. based purely on cross-correlations in time-series). It is necessary to develop some basic physical and biological understanding of the system in order to constrain the space of *a priori* plausible models; otherwise, the task is statistically hopeless. But it also seems hopeless to try to deduce the population dynamics responses of major predators from first principle, so some notion of time series data and model fitting seems unavoidable. The comments below relate to what the priorities might be for further data on large spatial-scale krill-centric models in the Antarctic.

Species-level information

In deciding whether the model should specifically incorporate a particular taxon, and what, if any, priority there should be for further work on the species (in an ecosystem-model-building context), I would ask three questions:

- does the species eat enough to matter—is it a 'player'? This can be very rough: some idea of abundance, and some idea of consumption rates, e.g. from allometry.

- if yes to 1, then: is our current or medium-term future information on the species good enough that explicitly including the species in the model would substantially improve our certainty about overall predictions?

- if yes to 1 and 2, then: what is the population structure / site fidelity (e.g. do individuals range the whole Antarctic, across ocean basins, or across smaller scales such as gyres? are they there all year or..?). Knowing this is crucial to building sensible models, given that management and conservation decisions are typically linked to particular spatial scales.

In the Antarctic, examples of species that would likely 'fail' question 1 are a number of seabird species. Examples of taxa that would likely 'fail' question 2 are fish, squid and non-krill zooplankton. With respect to question 3, a best guess may be necessary to begin with; but there are big uncertainties with respect to krill and many baleen whales, and this is surely a priority for future work. At least for krill, this is linked to a decent level of understanding of basic physics and primary production; how much is 'decent' is a whole other story.

Even if a taxon 'fails' question 2 and therefore does not warrant explicit inclusion, we cannot ignore its existence if we know it has a big impact on krill. The corollary is that the model would need to have black-box components reflecting unknown predation on krill, which we cannot expect to be bridged by process studies in the medium term. And the corollary of *that* is: in order to estimate how the black-box works, surely we will need time-series data on the explicitly included species.

Historical data

Fitting statistical models to data, ecosystem models or otherwise, requires more than just *quantity* of data; it also requires *contrast* in the data. For example, if abundance of species X varies very little over the time series, then we have no direct data on what the implications of *changes* in species X might mean. For species which have been heavily exploited, the historical record is the obvious place to look (e.g. for how life-history parameters of whales changed over exploitation).

Should we build models?

Ecosystem models are much trickier than single-species models, in part because there are more dimensions to our ignorance about how the system works, not just parameter values, but also in terms of alternative model structures. It is healthier to think about developing a *suite* of models that try to capture parametric and structural uncertainty (subject to all the models being consistent with the data, not just in terms of time series but also in terms of plausibility of mechanism). If the model-suite is too narrow and leads to spuriously precise predictions, it will be worse than useless for management. So we need to be able to move beyond 'best guesses' at phenomena, to figuring out plausible ranges. Although the Antarctic is easier than many other parts of the globe in terms of simplicity of food webs and clarity about physical drivers, the job of building and fitting a model-suite is immense.

Ecosystem management *necessarily* requires some level of qualitative and quantitative understanding of the ecosystem, but it does not *necessarily* require an underlying quantitative ecosystem model. Building a decent ecosystem model-suite, i.e. one that honestly captures our ignorance about structure and parameters, is a huge amount of work. The question to ask *before* starting, is this: is it obvious in advance that the model's predictions will provide more certainty than we can already get from our fundamental understanding? I do not know enough to answer that for the Antarctic, but hopefully others can. And if the answer is 'no, the predictions will be no more precise', then the time and effort required to build models would better be spent doing something else.

Prof. Doug Butterworth

Note: The use of the word 'progressing' in the title is particularly deliberate; what follows is not intended to describe a comprehensive long-term approach, but rather necessary initial steps in a long-term process.

Questions 1 and 2

- The spatial scale pertinent to the points below is the scale at which the question is directed: Management Unit or SSMU; the temporal scale is annual, or biannual where relevant to encompass important seasonal differences (e.g. in production or presence within the spatial unit).

- Conduct an approximate accounting of estimates of consumption of krill by the top predator/predator groups in the spatial unit to provide an order of relative importance ('importance index').

- Institute (where not already available) approaches to provide comparable indices over time of the relative abundance of krill and top predators/predator groups in the spatial unit. The priorities for the latter are to be determined by joint consideration of the 'important index' and practical considerations. The frequency of index determination (annual or longer intervals) is to be based on typical species life spans (e.g. inverse natural mortality rates) (i.e. less frequent for species with slower dynamics) and practical considerations.

- To the extent possible, convert indices of relative to estimates of absolute abundance.

- Sample the diet of the top predators/predator groups on an annual basis if possible, with priority guided by the 'importance index', and with a view towards estimating the parameters of a range of plausible feeding functional relationships.

- Estimate the period of the year that each predator/predator group spends feeding within the spatial unit.

- For SSMUs (in particular), develop approaches to estimate the transport of krill into and out of the spatial unit.

- Develop a range of MRMs (minimally realistic models), incorporating predator–prey interaction terms, to serve as operating models for testing catch limit algorithms, conditioning these models on the available abundance, life history and diet data.

- Select a catch(es) (or efforts) limit algorithm to provide scientific management recommendations, based on performance in simulation testing under the operating models developed. The algorithm's computations would most likely give particular weight to recent trends in indices of abundance to incorporate the robustness provided by feedback control into the overall management approach.

Question 3

The following points are added to those above:

- Request biologists and oceanographers with knowledge of the potential major environmental drivers of the ecosystem at the spatial level under consideration to select a maximum of three annual environmental indices (e.g. extent of sea-ice cover) hypothesised to be those most likely to impact the dynamics. There need to be time series of these indices available for some past years, and the capability of monitoring them into the future.

- Incorporate such indices as external inputs to the dynamics of the operating models being used to simulation test alternative catch limit algorithms; this would be to the extent that plausible relationships can be determined by conditioning against past data (even if only on a more qualitative than quantitative basis).

Dr Justin Cooke

Of the three main management questions (paragraph 1.35) questions of type 1 – how does fishing on a prey species impact predators of that species – might well be answerable (and in several cases have been answered) using models of the local system, incorporating just a few components and little in the way of environmental factors, that do not need to explicitly include a model of the large-scale and multi-year dynamics of the prey.

Addressing questions of type 2 and 3 requires an understanding of the system at larger scales and longer time scales, and potentially consideration of the full system, from the physical environment, through primary production, through to prey species and finally to predators.

While some of the interaction between predators (questions of type 2) can be quite local and immediate, and addressable using relatively simple modelling approaches as for questions of type 1, it may be wrong to ignore the wider-scale interactions (e.g. depletion of common prey populations, even where predators do not overlap in time or space). Addressing these wider-scale interactions will tend to lead into consideration of models of the more comprehensive kind required to address questions of type 3.

For example, in the case of krill, the apparent absence of genetic differentiation between areas may be suggestive that instead of there being permanent, self-sustaining populations in each area, populations may tend to be regenerated from a common source, at more or less frequent intervals.

To understand the multi-year dynamics of the ecosystem, it is important to be able to identify those persistent source populations of krill and other prey species, which are primarily responsible for the (periodic or aperiodic) regeneration of prey populations throughout the Southern Ocean, following environmental perturbations.

Conservation of these core populations will likely be important for long-term management of the system, in particular if a management goal is the prevention of 'tipping' of the system semi-permanently into qualitatively different and less desirable states.

The more ephemeral prey populations, that are liable to disappear or reappear following major environmental fluctuations, may be very important in many areas as food for the predators that exploit them, but depletion of these populations may not have the same effects on prey production in subsequent years as depletion of the core populations would have.

Most of the components of an ecosystem model are subject to great uncertainty. Because the sum of all the uncertainties tends to be dominated by the few largest individual uncertainties (expressed simply: CVs add as squares, not linearly), improving understanding of the currently most poorly known components of the system is probably the highest priority. The development of models which qualitatively capture the system well, even if their predictions are subject to large quantitative uncertainty, may be of the greatest value for developing long-term management approaches of the most appropriate qualitative form.

Such management approaches might involve, for example, complete protection of core populations, with exploitation confined to the remainder, rather than having exploitation of all populations subject to quantitative regulation.

Prof. Daniel Costa

There is a need to develop approaches to derive an understanding of the functional response of top predators from the considerable behavioural data that can and is being collected from them. For example, can we infer something about patch quality from the dive behaviour and or pattern? One approach that has been developed in IPQ (individual patch quality?) and transit time between patches versus patch residence time. The ability to eventually test these models against studies where prey abundance is actually measured while a predator or predators are foraging in that area would be outstanding interaction between models and empirical data collection.

Develop individual-based models (IBMs) or other approaches to allow prediction and or description of movement and foraging behaviour of top predators. Such models are critical to link the demography (at the population level, as populations are made up of individuals) to biophysical processes at the scale appropriate to the predator. This would allow integration of top predators in bottom up nutrient, phytoplankton, zooplankton (NPZ) type models. It could also incorporate models of predation risk (avoidance behaviour) and or competition between other predators or organisms.

Develop a model to assess alternative trophic pathways. For example, what happens to top predators if they derive most of their energy from fish rather than krill. There is evidence that these different food webs have different patterns and can support different predator populations. How is energy flow altered? Is one most stable, is one low energy or better able to sequester energy or carbon?

What are the fundamental measurements that would be most desirable if we had a SOOS? Assuming such a system would be offshore or near your predator study site.

Dr Megan Ferguson

The integrated questions that the Workshop proposed cover the scope of the ecosystem modelling question well. The overarching question is, How do we collect and analyse data to address these questions? I think there are three themes that could help guide future research efforts with the goal of informing ecosystem models. First, the Southern Ocean is so vast that we need to think about **nested field sampling designs** that could be incorporated into **hierarchical models** to integrate information across spatial and temporal scales, and from the individual to the population. Second, in order to determine the appropriate sampling scales for the field and analytical scales and scaling functions for the models, we need to understand the **patch structure and temporal variability** of the biological and physical environment. Third, modellers need to talk to biologists and physical oceanographers to try to understand how the **physical environment** affects the relevant species. This level of understanding is critical for identifying the appropriate sampling scale and for developing models that will have predictive power in a dynamic environment.

Dr Toshihide Kitakado

There are several key items at population level for modelling purposes as follows:

(i) Information on prey availability and its dynamics in a certain scale of space and time, which is of course linked to the distribution and abundance of the prey species (perhaps by life stage).

(ii) Information on pattern of habitat utilisation by predators (as well as their abundance and population dynamics), which may depend on their life stages, sex segregation, environment and so on.

(iii) Information on feeding rates or functional responses for predators.

(iv) Information on prey selection.

The bottom lines to resolve these key issues are availability of information on abundance of prey and predators and stomach contents or diet composition against prey availability at population level. Also, monitoring the diet composition is informative to capture the impact of environmental change on the ecosystem. In this sense, work for transforming knowledge on the individual-based behaviour to population-based one is important. Furthermore, the scale of space and time that needs to consider surely depends on research and management objectives of either CCAMLR and IWC or both. These should be clearly described. Handling uncertainties is another key issue. Statistical uncertainties will be handled well by the statistical methods, but it is necessary to develop a management procedure which is robust to ecosystem model uncertainty.

Mr Russell Leaper

Many ecosystem models have placed an emphasis on parameter estimates rather than model structure. One option in developing a model is to start with a model of the most simple pathway (e.g. diatoms→krill→higher predators) and continue adding additional pathways as needed to generate a MRM. One problem with this is that the basic model structure may effectively determine the model results, and although the sensitivity of results to parameter estimates can be tested, the sensitivity of the results to model structure is not possible to test. An alternative approach is to start with a more complex, multiple pathway model and to try to simplify this by removing pathways on the basis of sensitivity tests. For this type of approach it is more critical to put broad bounds on all the pathways rather than refine parameter estimates for a few.

Dr Andre Punt

The key information needs for ecosystem (or multi-species) models depend critically on the objectives for which they were designed, and whether they are to be used for tactical (e.g. the updating of catch limits) or strategic (e.g. testing of management rules) purposes. The nature and information needs for ecosystem models also depend on the how quickly results are needed (in some cases, and from a management perspective, obtaining an approximate answer quickly may be much more useful than obtaining the right answer long into the future). Ideally, an ecosystem model should be built around a 'core' species or set of 'core' species. 'Core' species are species that can be assessed using conventional single-species approaches and hence for which data on (minimally) indices of relative abundance are available. In principle, ecosystem models constrain species behaviour through the constraints implied by feeding functional relationships. However, this benefit will not be available, and the model will be of limited use (at least for tactical purposes), without a 'core' species, models for which can be reliably parameterised. There is minimally a need for daily ration and diet composition data for the 'core' species and preferably a time series for both. Sampling which is random with respect to predator and prey distribution, and based on consistent methodology, is preferable to detailed high-intensity sampling at limited temporal and spatial scales. The information needs for an ecosystem model designed to evaluate the implications of environmental forcing, including environmental change, will be different from those for ecosystem models designed for other purposes. Specifically, ecosystem models designed to evaluate the implications of environmental forcing are ideally developed based on process-based hypotheses and involve nested sub-models operating at different temporal and spatial scales.

Dr Keith Reid

I preface these comments with the acknowledgement that I am not a modeller.

I see the role of ecosystem models as a component of the ecosystem approach as they provide a means of developing a simulation environment to test assessment models in order to evaluate the likelihood of achieving management objectives. An important consideration of this approach to management strategy evaluation is that potential scenarios should not be ruled out because they do not fit with our observations. The risk that an observation gains a greater weight through repeated reporting, rather than repeated observation, creates the risk of a disproportionate weighting for some scenarios. In the development of ecosystem models the acquisition of large-scale, long time-scale data is obviously a goal (grail), however, there is a recognition that acquiring these data is very difficult if not impractical/impossible. In considering predator–prey interactions, I feel that it is important to provide an understanding of those interactions at the scales that influence the life histories of the species involved. The highly seasonal nature of the Antarctic means that predators and prey respond at sub-annual scales and therefore understanding the short time-scale changes in the krill abundance in the regions where predators feed (especially at times when they are constrained by the need to provision offspring) is especially important as even small changes in distribution and/or timing of periods of krill abundance may have a large impact of reproductive performance. Viewed at an annual time scale, these small changes will be subsumed, however, they may actually have a very large impact of predator populations. The short time-scale data on krill, as collected by moored acoustic arrays, as well as the monitoring of predator performance (including diet and reproductive output) are key data collection priorities for assessing the potential impact of fisheries on predators of krill in the Antarctic.

Dr Andrew Constable

The structure and data requirements of ecosystem models is dependent on whether they are to be used as assessment tools or in providing scenarios for testing management procedures (i.e. testing the assessment tools and the decision rules in a management procedure). There is a lesser requirement for time series of population and food-web data in scenario-type models. Importantly, the models should focus on a central species or group of species (e.g. krill and krill predators) and concentrate on primary and secondary interactions and factors that will influence those (species and processes that could directly impact or have a substantial indirect impact on krill and krill predators). Species and interactions further out in the food web can be considered peripheral and likely not to be relevant, at least in the first instance. Scenario-type models are very useful for identifying how we can best learn about the important processes in the ecosystem and the degree to which we can make good management decisions for achieving management and conservation objectives.

The building of an ecosystem model will need to account for all the issues identified in paragraph 3.4. Even though the model may summarise many processes in a single process or parameter, the author of a model needs to ensure that such simplification of the model does not inadvertently and inappropriately bias the outcomes with respect to the management questions being addressed. A key issue is whether the spatial, temporal and biological partitioning in reality is correctly reflected in the model, i.e. that a predator–prey overlap in the model takes appropriate account of the factors that could cause the overlap to occur or not; presence in the Southern Ocean at the same time of year does not mean that a predator will necessarily have access to potential prey. Similarly, the opportunities for alternative energy pathways to give rise to an alternative suite of ecological dynamics in the predator–prey system of interest, e.g. the krill-based food web, needs to be preserved in the model structure, even if those pathways are not represented in full.

As there are many model structures that could give rise to a suite of time series of abundances, most of which are of poor quality in the Southern Ocean, then the focus in the short term for developing ecosystem models for the Southern Ocean needs to be on characterising the processes and interactions that influence the dynamics of the key populations of interest.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

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AAD	Australian Government Antarctic Division
AADC	Australian Antarctic Data Centre
ACC	Antarctic Circumpolar Current
AKES	Antarctic Krill and Ecosystem Survey (Norway)
AMLR	Antarctic Marine Living Resources (USA)
APECOSM	Apex Predators Ecosystem Model
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
ARP	Acoustic Recording Package
BAS	British Antarctic Survey
BROKE	Baseline Research on Oceanography, Krill and the Environment (Australia); CCAMLR Division 58.4.1
BROKE-West	as above; CCAMLR Division 58.4.2
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-2000 Survey	CCAMLR 2000 Krill Synoptic Survey of Area 48
CCAS	Convention on the Conservation of Seals
CPR	Continuous Plankton Recorder (international) 1991 onwards
CPUE	Catch-per-unit-effort
CI	Confidence Interval
CV	Coefficient of Variation
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)
ENSO	El Niño Southern Oscillation

FIBEX	First International BIOMASS Experiment (Krill survey under auspices of SCAR)
FMR	Field Metabolic Rate
GAM	Generalised Additive Model
GCMD	Global Change Master Directory
GLOBEC	Global Ocean Ecosystems Dynamics Research (USA)
GUI	Graphical User Interface
ICED	Integrating Climate and Ecosystem Dynamics in the Southern Ocean
IDCR SOWER	International Decade of Cetacean Research – Southern Ocean Whale and Ecosystem Research
IPCC	Intergovernmental Panel on Climate Change
IWC	International Whaling Commission
IWC SC	IWC Scientific Committee
JARE	Japanese Antarctic Research Expedition
JARPA	Japanese Whale Research Program under special permit in the Antarctic
K	Carrying Capacity
LAKRIS	Lazarev Krill Study (the German contribution to CCAMLR-IPY 2008)
LTER	Long-term Ecological Research (US National Science Foundation)
MODIS	Moderate Resolution Imaging Spectroradiometer
MRM	Minimally Realistic Models
MSA	Methanesulphonic Acid
MSYR	Maximum Sustainable Yield Rate
Multspec	Multi-species Model for fish and marine mammals
NORPAC	North Pacific
PFZ	Polar Frontal Zone
POM	Princeton Ocean Model
RMP	Revised Management Procedure
ROM	Regional Ocean Modelling Systems

ROV	Remotely-Operated Vehicle
SACCF	Southern Antarctic Circumpolar Front
SAM	Southern Annular Mode
SBACC	Southern Boundary of the Antarctic Circumpolar Current
SC-CAMLR	Scientific Committee of CCAMLR
SCAR	Scientific Committee on Antarctic Research
SCAR-Marbin	SCAR Marine Biodiversity Information Network
SeaWiFS	Sea-viewing Wide field-of-view Sensor
SOCEP	Southern Ocean Cetacean Environment Program (Australia)
SO-GLOBEC	Southern Ocean GLOBEC
SOOS	Southern Ocean Observing System
SSIZ	Seasonal Sea-ice Zone
SSMU	Small-scale Management Unit (CCAMLR)
VGPM	Vertically Generalised Production Model
WAP	Western Antarctic Peninsula
WG-EMM	SC-CAMLR Working Group on Ecosystem Monitoring and Management
WG-IMAF	(ad hoc) Working Group on Incidental Mortality Associated with Fishing