

SC-CAMLR-XXII

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

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

HOBART, AUSTRALIA
27–31 OCTOBER 2003

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Abstract

This document presents the adopted report of the Twenty-second Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 27 to 31 October 2003. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Ecosystem Monitoring and Management and on Fish Stock Assessment, are appended.

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REPORT OF THE TWENTY-SECOND MEETING OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 27 to 31 October 2003)

OPENING OF THE MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Dr R. Holt (USA) from 27 to 31 October 2003 at the Wrest Point Hotel, Hobart, Australia.

1.2 Representatives from the following Members attended the meeting: Argentina, Australia, Belgium, Brazil, Chile, 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 Canada, the People's Republic of China, Greece, Indonesia, Mauritius, Peru and Seychelles, along with observers from ASOC, CEP, COLTO, IUCN, IWC and SCAR, and encouraged them to participate in the meeting as appropriate.

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

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

- Dr D. Agnew (UK) – CCAMLR Scheme of International Scientific Observation;
- Drs R. Hewitt and P. Penhale (USA) – Ecosystem Monitoring and Management;
- Dr S. Nicol (Australia) – Krill Resources;
- Drs C. Jones (USA) and C. Davies (Australia) – Fish Resources excluding By-catch;
- Mr R. Williams (Australia) – Fish Resources By-catch;
- Drs S. Hanchet (New Zealand), M. Collins (UK) and Dr A. Constable (Australia) – New and Exploratory Fisheries;
- Dr K. Sullivan (New Zealand) – Crab and Squid Resources;
- Prof. J. Croxall (UK) – Incidental Mortality;
- Dr K. Reid (UK) – Additional Monitoring and Management Issues;
- Dr K.-H. Kock (Germany) – Management under Conditions of Uncertainty about Stock Size and Sustainable Yield;
- Dr C. Southwell (Australia) – Scientific Research Exemption;
- Prof. B. Fernholm (Sweden) and Mr L. López Abellán (Spain) – Cooperation with Other Organisations;
- Dr D. Ramm (Secretariat) – all other matters.

Adoption of Agenda

1.6 The Provisional Agenda had been circulated prior to the meeting (SC-CAMLR-XXII/1). The Scientific Committee agreed to move Subitem 5(ii) on 'Fish by-catch associated with longline and trawl fisheries' to Item 4, as well as to add a subitem on 'Targeted species' to Item 4. In addition, Subitem 5(iii) was renamed 'Fish by-catch'. With these changes, the Agenda was adopted (Annex 3).

Report of the Chair

Intersessional Meetings

1.7 The following meetings were held during the 2002/03 intersessional period:

- (i) The ninth meeting of WG-EMM was held from 18 to 29 August 2003 in Cambridge, UK. It was convened by Dr Hewitt and was attended by 38 participants, representing 11 Members.
- (ii) The CEMP Review Workshop was held during the first week of WG-EMM, from 18 to 22 August. Attendees at the workshop included two invited experts, Prof. E. Hofmann and Dr T. Gerrodette (USA). The workshop was co-convened by Prof. Croxall and Dr Southwell.
- (iii) The meeting of WG-FSA was held from 13 to 23 October 2003 in Hobart, Australia, prior to the Scientific Committee meeting. It was convened by Dr I. Everson (UK).

Two WG-FSA subgroups met during the intersessional period:

- the Subgroup on Assessment Methods (WG-FSA-SAM), convened by Dr Constable – 12 to 15 August 2003, London, UK;
 - the Subgroup on Fisheries Acoustics (WG-FSA-SFA), co-convened by Dr Collins and Dr P. Gasiukov (Russia) – 18 to 22 August 2003, Cambridge, UK.
- (iv) Ad hoc WG-IMAF conducted its meeting as part of WG-FSA-03. It was convened by Prof. Croxall.

1.8 On behalf of the Scientific Committee, the Chair thanked the conveners for their significant contributions to the intersessional meetings. The report of WG-EMM is attached as Annex 4 and that of WG-FSA, including ad hoc WG-IMAF, as Annex 5.

1.9 The Chair noted that the Scientific Committee and its working groups had made excellent progress. Some 183 documents (101 papers at the meetings of WG-FSA and ad hoc WG-IMAF alone) were presented at the meetings of the working groups and associated subgroups during this intersessional period.

1.10 Over the past year, the working groups had:

- reviewed and provisionally accepted a methodology which includes acoustic data to assess the biomass of *Champscephalus gunnari*;
- completed assessments on finfish fisheries;
- agreed on aspects of research needed to obtain assessments of the stocks fished in Subarea 88.1;
- begun reviewing potential methods to be used to allocate krill catch to SSMUs;
- revised the terms of reference for WG-EMM's Subgroup on Protected Areas;
- undertook a workshop as the first phase in a review of CEMP;
- completed a workshop on assessment methods.

In addition, members of the Scientific Committee had participated in the first meeting of the Joint Assessment Group (JAG).

Fisheries

1.11 CCAMLR Member countries actively participated in eight fisheries under conservation measures in force in the 2002/03 season (1 December 2002 to 30 November 2003). These eight fisheries were:

- trawl fishery for *C. gunnari* in Subarea 48.3;
- trawl fishery for *C. gunnari* in Division 58.5.2;
- longline fishery for *Dissostichus eleginoides* in Subarea 48.3;
- trawl and longline fishery for *D. eleginoides* in Division 58.5.2;
- exploratory longline fishery for *Dissostichus* spp. in Division 58.4.2;
- exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1;
- exploratory longline fishery for *Dissostichus* spp. in Subarea 88.2;
- trawl fishery for *Euphausia superba* in Area 48.

1.12 In addition, four other fisheries were conducted in EEZs within the Convention Area:

- longline fishery for *D. eleginoides* in Division 58.5.1 (French EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.6 (French EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.6 (South African EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.7 (South African EEZ).

1.13 Fourteen Members had fished in the 2002/03 season: Australia, Chile, France, Japan, New Zealand, Poland, Republic of Korea, Russian Federation, South Africa, Spain, Ukraine, UK, Uruguay and the USA.

CCAMLR Scheme of International Scientific Observation

1.14 Where required under conservation measures, international scientific observers, nominated in accordance with the scheme, were on board all vessels fishing for toothfish. A number of international scientific observers were also deployed on vessels fishing for other finfish and krill. Observers, both national and international, were deployed on 54 cruises within the Convention Area during the 2002/03 season.

Scientific Committee Representation at Meetings of Other International Organisations

1.15 The Scientific Committee was represented at five meetings of other international organisations. Observers' reports from these meetings were considered in detail under Agenda Item 9.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

2.1 Reports from five cruises on krill vessels in the 2001/02 fishing season were reviewed by WG-EMM. The observer database now holds eight sets of observer data from krill vessels. WG-EMM concluded that several revisions should be made to the krill section of the *Scientific Observers Manual*, including the addition to existing guidelines for sampling larval finfish by-catch in krill catches (Annex 4, paragraph 3.42). Furthermore, it recommended that electronic logbooks should become standard for all scientific observations on krill vessels, and that they be translated into all official languages of the Commission (Annex 4, paragraph 3.45). The Scientific Committee endorsed these recommendations.

2.2 In the 2002/03 season observers were present on 37 longline, 10 finfish trawl and six krill trawl cruises (Annex 5, paragraphs 3.21 to 3.24). Regarding the finfish data, all but one logbook had been received before the WG-FSA meeting, the last one being received during the meeting. The krill cruises finished in October, so although the reports had not been received they were not yet overdue.

2.3 Observers submit their data in electronic or paper logbooks and additionally provide a narrative cruise report. All required information was submitted electronically in the 2002/03 fishing season. However, most observers in Subarea 48.3 had not used the new cruise report format. Despite this, all the data required by the Observer Scheme had been collected and submitted from all areas in the 2002/03 fishing season. Although the failure to use the new format had not significantly affected the quality or resolution of data required from the fishery, the Scientific Committee reiterated that for the 2003/04 fishing season the new report format should be used for all fisheries.

2.4 Some difficulties had been experienced with the observer requirements for by-catch recording, in particular for recording the fate of skate and ray discards, which this year followed a trial format (Annex 5, paragraph 5.284). The UK noted that these difficulties were not related to the failure of observers to use the new report format in Subarea 48.3. WG-FSA was therefore only able to make estimates of the number of rays cut off lines in two areas,

Subarea 48.3 and Division 58.5.2 (Annex 5, Table 5.25). Following these experiences, WG-FSA recommended a revision of this part of the observer requirements and logbooks (Annex 5, paragraphs 10.13 to 10.15).

2.5 In compliance with the instructions of the *Scientific Observers Manual*, observers had recorded conversion factors in the 2002/03 season and reported a similar spread of conversion factors in longline fisheries for toothfish as has been noted in previous seasons. WG-FSA had insufficient time to analyse these data in any more detail, but the Scientific Committee endorsed WG-FSA's request for Members to undertake additional analyses of conversion factors to improve estimates of total removals from all fisheries (Annex 5, paragraphs 3.26 and 3.27). For *C. gunnari* the only processing method is whole and consequently no conversion factors are required.

2.6 WG-FSA noted that in a number of cases incorrect species codes had been used by observers. The Scientific Committee confirmed that Members should inform the Secretariat when they wished to use a new species code, so that the Secretariat may assign one.

2.7 Several observers had commented on issues of safety concerning vessels fishing in high latitudes (Annex 5, paragraph 10.10). The Scientific Committee agreed that it did not have primary competency to comment on this issue, and referred it to the Commission.

2.8 The Scientific Committee endorsed the suggestions for additions or modifications to the *Scientific Observers Manual* made by WG-FSA (Annex 5, paragraphs 10.23 and 10.40). It noted that several observers had indicated that their workload was at capacity. In this light the Scientific Committee noted with appreciation WG-FSA's recommendation that some aspects of current observer duties should be removed from the manual, so as to create time for the suggested additions.

2.9 The Scientific Committee was concerned that the data being collected from observers should be prioritised so as to maximise its value, in particular for the conduct of assessments of target species and the impacts on populations of by-catch species. In this regard, it noted that WG-FSA had asked WG-FSA-SAM to report on the types of data essential for stock assessment purposes (Annex 5, paragraph 10.42), in particular the practicality of alternative data collection methods. It further noted that WG-FSA-SAM was reviewing subsampling methodologies, and asked that this review take into account a cost-benefit analysis incorporating the additional cost of data collection under various subsampling schemes compared with the benefit to assessments of any improvements in the estimation of population parameters.

2.10 The Scientific Committee endorsed the need for a major review of the content and structure of the *Scientific Observers Manual*. It recommended that this activity could be achieved through an intersessional group that comprised technical coordinators and members of WG-FSA, and would be coordinated by the Secretariat (Annex 5, paragraph 10.45).

ECOSYSTEM MONITORING AND MANAGEMENT

3.1 Dr Hewitt presented the report of the meeting of WG-EMM which was held from 18 to 29 August 2003 in Cambridge, UK (Annex 4). Intersessional activities had been conducted by correspondence groups on: the analysis of CEMP data, modifications to the

CCAMLR Scientific Observers Manual, ecosystem modelling approaches, the design of land-based krill predator surveys, and the subdivision of CCAMLR statistical areas into ecologically-based harvesting units. During the meeting, the Advisory Subgroup on Protected Areas, the Subgroup on CEMP Methods, the steering committee for the upcoming workshop on modelling approaches, the correspondence group on predator surveys, an ad hoc subgroup on interpretation of CEMP indices, and an ad hoc subgroup on evaluation of fisheries-derived indices of krill availability met. Also during the meeting, a workshop to review CEMP was conducted.

3.2 Conveners of these subgroups were:

- CEMP Data Analyses – Dr Southwell and Prof. Croxall;
- *Scientific Observers Manual* – Dr S. Kawaguchi (Japan);
- Modelling Approaches – Dr Constable;
- Predator Surveys – Dr Southwell;
- Harvesting Units – Dr Nicol and Dr M. Naganobu (Japan);
- Designation of CEMP Sites – Dr P. Wilson (New Zealand) on behalf of Dr Penhale;
- Methods – Dr Reid;
- Interpretation of CEMP Indices – Dr Reid and Dr G. Watters (USA);
- Fisheries-derived Indices of Krill Availability – Dr Hewitt;
- CEMP Review Workshop – Prof. Croxall and Dr Southwell.

3.3 These activities are summarised in three documents for consideration by the Scientific Committee:

- (i) report of WG-EMM-03 (Annex 4) containing a listing of ‘Key Points for Consideration by the Scientific Committee’ at the end of each major agenda item, as well as the Report of the CEMP Review Workshop (Annex 4, Appendix D);
- (ii) synopses of working papers (SC-CAMLR-XXII/BG/6) considered at the meeting, each containing an abstract and a summary of the findings and/or conclusions as they relate to a particular agenda item;
- (iii) report of the Convener of WG-EMM-03 to SC-CAMLR-XXII (SC-CAMLR-XXII/BG/15) containing appropriate references to paragraphs in the report of WG-EMM-03 (Annex 4).

3.4 Dr Hewitt noted that, similar to recent years, the agenda of WG-EMM-03 was structured to consider the status and trends in the krill fishery, the status and trends in the krill-centric ecosystem, and the status of management advice arising from these considerations.

CEMP Review Workshop

3.5 Dr Hewitt reviewed the history of CEMP which was established in 1987 with two objectives:

- (i) detect and record significant changes in critical components of the ecosystem;
- (ii) distinguish between changes due to the harvesting of marine resources and changes due to environmental variability.

3.6 In 2001 the Scientific Committee agreed, as part of its scheduled plan of work, to commence a review of CEMP at the 2003 meeting of WG-EMM (SC-CAMLR-XX, paragraphs 4.2 to 4.7). The Scientific Committee established the following terms of reference for this review:

- (i) Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives?
- (ii) Do these objectives remain appropriate and/or sufficient?
- (iii) Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?
- (iv) Can useful management advice be derived from CEMP or be used in conjunction with CEMP data?

3.7 A steering committee was established under the co-convenership of Prof. Croxall and Dr Southwell, a plan of intersessional work was adopted and analyses proceeded with considerable support from the Secretariat. The Report of the CEMP Review Workshop is included in Annex 4, Appendix D. Discussion of the workshop report at the meeting of WG-EMM is recorded in Annex 4, paragraphs 2.1 to 2.20.

3.8 During the intersessional period the CEMP datasets were validated and analyses undertaken related to:

- (i) serial correlation and power of the CEMP predator indices to detect change;
- (ii) functional responses between these indices and measures of krill availability.

Interpretation of these analyses as well as additional analyses were undertaken at the workshop.

3.9 The Scientific Committee endorsed the conclusion of the Working Group that serial correlation in the biological indices was not significant; however, indices derived from environmental and fisheries data exhibited more correlation between successive years. Further conclusions were that analysis of the various sources of variability in the CEMP indices and the consequences of such variability on the power to detect change would lead to improvements in the monitoring program. An example of this type of analysis for indices on Adélie penguins was developed at the workshop. The Scientific Committee recommended that such analyses be conducted on the full suite of CEMP indices in the near future.

3.10 The Scientific Committee endorsed the conclusion that krill predator performance was related to krill availability based on analysis of data collected at South Georgia and in the South Shetland Islands, although the form of the relationship differs between the areas. Differences in predator performance between two years of observations in East Antarctica and the Ross Sea were attributed to changes in krill availability in the case of East Antarctica and environmental conditions in the case of the Ross Sea. Nevertheless, it may be possible to use the relationships between predator performance and krill availability for predicting krill

availability and for developing a biological basis for the identification of years in which predator performance was anomalous. The Scientific Committee endorsed the recommendation that the data requirements and analytical procedures required to evaluate the indices of krill availability derived from fisheries data should be defined.

3.11 With regard to the first term of reference (Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives?), the Scientific Committee agreed with the conclusion that CEMP data were appropriate for detecting and recording significant change in some critical components of the ecosystem, but further critical evaluation of the nature, magnitude and statistical significance of changes indicated by the data were necessary. Work also remains to determine how representative the CEMP sites are of their local areas and regions.

3.12 It was noted in Annex 4, paragraph 2.7 that:

- (i) at current harvesting levels it was unlikely that the existing design of CEMP, with the data available to it, would be sufficient to distinguish between ecosystem changes due to harvesting of commercial species and changes due to environmental variability, whether physical or biological;
- (ii) with the existing design of CEMP, it may never be possible to distinguish between these different and potentially confounding causal factors and that the Scientific Committee should seek advice from the Commission on the extent to which further work should be directed towards this topic;
- (iii) without a real ability to separate the confounding effects of harvesting and environmental variation and in the context of uncertainty, the Scientific Committee should seek advice from the Commission about the policy of how management should proceed when a significant change was detected, but no single causal factor could be attributed;
- (iv) one possible method that may assist in the separation of confounding effects of harvesting and environmental variation would be the establishment of an experimental fishing regime whereby fishing would be concentrated in local areas in conjunction with an appropriate predator monitoring program.

3.13 Dr Sushin cautioned that an experiment as described in paragraph 3.12(iv) might have financial implications for the fishery if efforts were directed to areas with low catch efficiencies.

3.14 The Scientific Committee agreed that:

- (i) with regard to the second term of reference (Do these objectives remain appropriate and/or sufficient?), the original objectives of CEMP remained appropriate, but that a third objective 'To develop management advice from CEMP and related data' should be added;
- (ii) with regard to the third term of reference (Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?), many time series of non-CEMP data contain information of considerable value in addressing the objectives of CEMP. Also, the Secretariat should maintain a

register of the wide range of non-CEMP time-series data that were of use to this workshop and of potential utility to future workshops in support of the work of WG-EMM, including datasets derived from South African and French seabird and pinniped monitoring programs in the southern Indian Ocean;

- (iii) additionally, useful indices of krill availability to land-based krill predators could be derived from fishery-dependent data; and indices derived from mackerel icefish data may be of value in monitoring krill in certain regions and should be subjected to the same analyses undertaken for CEMP data;
- (iv) with regard to the fourth term of reference (Can useful management advice be derived from CEMP?):
 - (a) functional responses linking predators to their prey field may be of utility in a management context;
 - (b) behavioural models based on interactions between the aspects of the environment, krill, krill predators and a krill fishery may also be of utility in a management context;
 - (c) simulation studies conducted during the workshop indicated that accounting for the nature of the variability of estimates of krill availability and predator performance could result in improved ability to detect anomalies.

3.15 The Scientific Committee noted a suggestion by Dr Gerrodette (invited expert) that the CEMP indices could be interpreted in a different way to that currently adopted. At present, an anomalous value of an index is one that is outside the normal range, as identified by a test of statistical or biological significance. This is equivalent to testing the null hypothesis of no change. A more appropriate test in the context of precautionary management may be of the null hypothesis that an undesirable change, as identified by the management objectives, has not occurred. This alteration in the ‘burden of proof’ is a common component of other precautionary management regimes.

3.16 The Scientific Committee noted that the workshop should be considered the first phase of the review of CEMP and laid out a plan of future work for WG-EMM. The most important of these tasks include:

- (i) completion of the review of sources and magnitudes of variability in predator response parameters;
- (ii) investigation of the utility of indices derived from haul-by-haul CPUE data as a proxy for direct measures of krill availability;
- (iii) investigation of alternative methods for determining anomalies and predicting krill abundance using predator response curves.

3.17 Prof. J. Beddington (UK) and Dr Constable cautioned that the use of CPUE data as a proxy of biomass could be problematic.

3.18 Looking forward to planned workshops in the future, the Scientific Committee noted the importance of the CEMP review to the selection of appropriate predator–prey–fishery–environment models (scheduled for 2004) and to the evaluation of alternative management procedures (scheduled for 2005).

3.19 Members thanked the Co-conveners Prof. Croxall and Dr Southwell and the Secretariat for their work in preparing for the workshop, and the USA for contributing to the travel support of invited experts.

Status and Trends in the Krill-centric Ecosystem

3.20 Dr Hewitt stated that the Working Group reviewed the status and trends apparent in the CEMP indices provided by the Secretariat and noted that there was little evidence of large-scale deviation from the long-term mean for most indices. However, there was evidence that indices of the performance of predators at Cape Shirreff were abnormally low and that unusual ice conditions in the Ross Sea continue to negatively impact on penguins in that region (Annex 4, paragraphs 4.1 to 4.5).

3.21 The Working Group recognised that the practice of tabulating anomalies in the CEMP indices with the intent of scoring a particular year as ‘good’ or ‘bad’ could be misleading. The Working Group proposed that an ordination approach be developed whereby the nature of the covariation in multivariate CEMP indices could be described and presented on an annual basis. This approach would have the potential to characterise the state of the system in relation to other years and to identify temporary shifts (i.e. anomalies), gradual changes (e.g. trends) or regime shifts. This would utilise all of the available data rather than being restricted to statistical anomalies. The Working Group requested the Secretariat to use this approach when presenting CEMP indices at its next meeting, but also recognised that the new approach may evolve over a longer period of time (Annex 4, paragraphs 4.9 to 4.18 and 4.106 and Figures 1 and 2).

3.22 The Scientific Committee welcomed the examination of alternative approaches to presenting CEMP indices and noted the previous endorsement by the Working Group to take a number of steps in developing presentations and evaluating the utility of these indices (SC-CAMLR-XIX, Annex 4, paragraphs 3.51 and 3.52). In addition, the Scientific Committee noted that it would be useful for the Working Group to consider what might be considered to be the norm in such ordination plots and, as such, what might be a significant departure from the norm. To that end, it might be premature for the Secretariat to routinely present the information in this way until the properties of this, the CSI, and other methods might be better understood, particularly as the Working Group works towards developing a management procedure. Members are encouraged to continue work on developing methods to utilise CEMP data in making decisions on the status of the krill-centric ecosystem.

3.23 The Working Group noted that analyses of several acoustic surveys and commercial catches indicated that krill biomass densities may range from less than 1 to several hundred g m^{-2} , but that viable fishing concentrations require a threshold of 100 g m^{-2} corresponding to catch rates of 3 to 3.5 tonnes hr^{-1} . The Working Group encouraged further analyses to compare the distribution of fishing effort with that predicted from the results of

krill surveys and with the distribution of predator demand, and that such investigations be undertaken by Members with relevant data in all regions of Area 48 (Annex 4, paragraphs 4.19 to 4.28).

3.24 The Working Group noted that it was particularly important to develop hypotheses on the origin and transport of krill and to analyse datasets describing krill demography and distribution in the context of these hypotheses. An understanding of the relative contribution of flux and local retention of krill within different regions may be important to allocating precautionary catch limits to SSMUs and may have implications for the use of the GYM, which currently assumes a single krill population (Annex 4, paragraphs 4.20 to 4.36).

3.25 Prof. Beddington endorsed this general approach to achieve the goal of an improved understanding of krill demography and distribution. Dr Naganobu noted that the South Shetland Islands area was quite complex in terms of hydrography which would present difficulties. Dr Hewitt noted that there were many datasets on krill demography and distribution in the Scotia Sea that should be collectively analysed and that structuring the work in terms of hypotheses would be the best way to proceed to achieve an understanding of the distribution and structure of krill populations.

3.26 The Scientific Committee noted that the Working Group reviewed a number of papers describing foraging tactics and reproductive success of penguins and fur seals in relation to prey availability and other environmental factors. In particular, the 2002/03 season was characterised as one of poor reproductive performance for fur seals breeding at Cape Shirreff (South Shetland Islands), with longer foraging trips, lower frequency of krill in the diet, above-average pup mortality and decreased female survival and natality. The Working Group further noted that this study provided new information on possible CEMP indices for monitoring fur seal performance (Annex 4, paragraphs 4.37 to 4.51).

3.27 Several recent studies describing changes in the physical environment of the Southern Ocean during the latter part of the 20th century and biological responses to these changes were reviewed. The Working Group noted two important issues for CCAMLR: (i) responses to climate change are likely to be regional, and possibly site specific; and (ii) interactions with fisheries may confound responses ascribed to environmental change. Given the number of indications of environmental change in the Convention Area, the Working Group considered that it may be appropriate to produce a coherent overview of environmentally induced variability in the Southern Ocean and to consider potential scenarios that might influence ecological relationships with implications for fisheries management (Annex 4, paragraphs 4.54 to 4.59).

3.28 Dr Hewitt noted that the Working Group reviewed a series of papers on the utility of indices derived from mackerel icefish that may be useful in describing changes in the krill-centric ecosystem and encouraged similar analyses of these indices as applied to the CEMP indices in preparation for the CEMP Review Workshop. These studies should include comparisons with other CEMP and non-CEMP indices from similar locations and reflect krill availability over similar temporal and spatial scales (Annex 4, paragraphs 4.77 to 4.85 and Appendix D, paragraphs 98 to 100).

3.29 The Working Group noted that mackerel icefish was a harvested species, was dependent on krill over some portions of its range and was also preyed on by some of the CEMP indicator species. The Working Group recognised that assessment of ecological

relationships and trophic interactions involving exploited fish stocks would require closer collaboration between WG-EMM and WG-FSA, and further requested advice from the Scientific Committee as to how this may be incorporated into the work of these groups (Annex 4, paragraphs 4.88 to 4.92).

3.30 Dr Everson referred to the indices listed in Annex 4, paragraph 4.82, and referred the Scientific Committee to the report of WG-FSA. He noted that the precise mechanism of how the standing stock was derived has changed and that this index would require consistent methods and areas to be of utility. He further noted the data on condition and diet were most likely to be found in national databases.

3.31 The Scientific Committee endorsed the recommended changes to the *CEMP Standard Methods*, Part IV, Section 5, for the collection of tissue sample to be used to detect chemical indicators of metabolic stress and pollutants (Annex 4, paragraph 4.100 and Appendix E) and to Standard Method C2 (fur seal pup growth rate) as outlined in Annex 4, paragraph 4.104.

Allocation of Krill Catch Limit among SSMUs

3.32 In 2000 the Commission adopted a precautionary catch limit for Antarctic krill of 4 million tonnes in Area 48 and further subdivided the catch limit among Subareas 48.1, 48.2, 48.3 and 48.4 (CCAMLR-XIX, paragraphs 4.16 and 4.17). Concern remained, however, that localised depletion of krill populations could still occur if a large portion of the catch was concentrated in a small part of a subarea. Accordingly, the Commission requested advice from the Scientific Committee as to how the catch limit may be further subdivided so as to reduce potential adverse impacts on land-breeding predators (CCAMLR-XIX, paragraphs 9.16, 9.17 and 10.9 to 10.12).

3.33 In 2002 the Commission established 15 SSMUs in Subareas 48.1, 48.2 and 48.3 and directed the Scientific Committee to consider how the krill catch limit could be allocated among the SSMUs (CCAMLR-XXI, paragraphs 4.5 to 4.8). At its 2003 meeting, the Working Group considered four options that defined the catch limit for an SSMU as:

- (i) proportional to the combined estimated predator demand for krill in that SSMU. This option is predicated on the assumption that a high predator demand implies a high standing stock of krill and/or a high turnover rate;
- (ii) proportional to the estimated standing stock of krill in the SSMU. This is based on the assumption that in all areas where krill occur, emigration balances immigration and high krill biomass densities imply high availability;
- (iii) proportional to the estimated standing stock of krill in the SSMU, less the estimated annual predator demand. This is based on the premise that the amount of krill allocated to the fishery should be determined only after accounting for predator needs. Should the estimated standing stock of krill for an SSMU be less than the predator demand, the catch limit for that SSMU should be zero;
- (iv) an annually adjustable proportion of the catch limit specified by one of the static options (i) to (iii), where the proportion would depend on the value of an

ecosystem monitoring index or a combination of indices. This option may be particularly pertinent for SSMUs where there is a wide range of predator reproductive success associated with large changes in krill availability.

3.34 The Scientific Committee noted that comparing allocations among SSMUs using available data results in the following qualitative conclusions:

- (i) Approximately 65% of total demand for krill by land-based predators in the Scotia Sea is in the vicinity of South Georgia. Under option (i), a correspondingly high proportion of the catch would also be concentrated in this area.
- (ii) Option (ii) leads to a more conservative allocation of catch limits among SSMUs with respect to land-based predators, with approximately 75% of the catch limit being allocated to the pelagic SSMUs.
- (iii) Under option (iii), the proportion of catches allocated to the pelagic SSMUs would increase to approximately 83% and no catch would be allowed in the South Georgia West SSMU.
- (iv) Despite the increased allocation to pelagic SSMUs in options (ii) and (iii), annual variations in krill availability may still result in sufficient competition between land-based predators and the krill fishery for predator demand to exceed the krill standing stock in some SSMUs in some years. Option (iv) was designed to take account of this, however for its implementation, improved indices for krill availability and/or transport into an SSMU may need to be developed.

3.35 At WG-EMM, several members noted that a key implication of subdivision options (ii) and (iii) was a very substantial redirection of krill fishing effort to the pelagic SSMUs, and that this contrasts strongly with the present situation. If indeed the krill catch does increase substantially from its present level, in their view it would not be possible to continue to take the catch from a small number of SSMUs adjacent to predator colonies, either in terms of meeting the needs of the predators or of maintaining an economically viable fishery. In their view, some redistribution of krill fishing effort, particularly towards SSMUs not immediately adjacent to land-based predator colonies, was a desirable and necessary response to substantially increasing krill catches. It was noted, however, that a corollary of a shift to pelagic SSMUs may be that fishing would be taking place in areas in which the fleet had not operated regularly in the past, and for which levels of monitoring were low.

3.36 Other Members argued that competition between fishing vessels and krill predators needed to be proved before appropriate management action can proceed. They also noted recent increases in some predator populations (e.g. fur seals in Subarea 48.3) and that their effects on ecosystem balance and the conservation principles defined in paragraph 3 of Article II of the Convention remains unknown. It was further argued that biological reference points with respect to predator population sizes needed to be established before it was possible to allocate the krill catch limit among SSMUs based on predator demand for food. In addition, these Members noted that fishable concentrations of krill were rare and transient in pelagic SSMUs.

3.37 In respect of the suggestions put forward in paragraph 3.36, Prof. Croxall observed that the burden of proof for competition between fishing vessels and krill predators should reflect an appropriate balance between protecting predators at critical periods in their annual and life cycles and avoiding unnecessary dislocation of krill fishing activities. Furthermore, he did not accept that defining biological reference points is a prerequisite for allocation of krill catch limits amongst SSMUs. He recommended that consideration of biological reference points should not proceed until specific proposals, containing appropriate models and indications of the type of management by which target reference points should be achieved, had been received and evaluated by the Working Group.

3.38 Dr Constable noted that the interpretation of Article II with respect to ‘dependent and related species’ also needed to include ‘recovery of depleted populations’ and that these issues had been addressed in part by the Commission in the late 1980s. In that respect, proposals for changing the approach towards dependent and related species and recovering species, such as proposals for reference points, would need to be developed and submitted for review before they could be incorporated as part of an approach to managing the krill fishery.

3.39 Discussion of the general principles of balancing predator demand and a krill fishery in or near predator foraging grounds raised issues relating to the interpretation of Article II of the Convention which were outside the remit of WG-EMM. These were referred to the Scientific Committee for further consideration.

3.40 The Scientific Committee agreed that an additional option that considers both survey data and historical krill fishing information should be developed, and in order to do so it is essential that all information on historical, current and future krill fishing activities be made available on a fine spatial and temporal scale. The Scientific Committee noted that intersessional work on this topic is required in order that further progress on the subdivision of the precautionary catch limit among SSMUs can be made at the next meeting of WG-EMM.

3.41 It was noted that for the krill catch to exceed 620 000 tonnes, agreement would have to have been reached for the allocation scheme of the precautionary catch limit amongst SSMUs.

3.42 It was noted that the Commission requested recommendations for a subdivision of the precautionary catch limit in Area 48 this year and that further discussion of this topic would take place next year after the WG-EMM modelling workshop.

3.43 The Scientific Committee noted that these options will be considered in discussions that will take place over the next year. The Scientific Committee would welcome any additional options that would allow progress to be made on this issue.

Future Work of WG-EMM

3.44 Following further discussion by the correspondence group on land-based predator surveys, the Scientific Committee endorsed the Working Group plan to initially focus on colonial-breeding penguins, which as a group is both the most tractable of the land-based predators for broad-scale survey and major consumer of krill. Rather than attempting surveys at circumpolar scale, a more prudent approach would be to select a few regions for pilot studies to evaluate methodologies, followed by broader-scale application of evaluated

methods depending on the results of such pilot studies. Further, pilot studies would best focus on regions in East Antarctica and the lower latitudes of West Antarctica, which provide contrasting complexities for surveys and therefore likely differing feasibilities (Annex 4, paragraphs 6.1 to 6.12).

3.45 The Working Group noted that, in accordance with its long-term work plan, it would hold a workshop during its 2004 meeting to develop plausible operating models of the Antarctic marine ecosystem. These models can then be used to test and evaluate candidate management procedures during a workshop scheduled to be held during the 2005 meeting of WG-EMM. The conceptual framework of this two-step process is described in Figure 1, where an operating model describes how the natural world works and how a fishery interacts with it (the left side of the figure). A management procedure includes the operational objectives derived from Article II, the collection and analysis of observational data, and the application of decision rules (the right side of the figure). The Working Group agreed that evaluation of a management procedure would be undertaken by simulating its performance under various operating models. The robustness of a management procedure in meeting the objectives of the Convention, despite the uncertainties of the operating model and parameter estimates, could thus be evaluated (Annex 4, paragraphs 6.13 and 6.14; Figure 1).

3.46 The Scientific Committee endorsed the Working Group's plan that the 2004 workshop would be titled 'Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management' and endorsed the terms of reference for the workshop developed by the steering committee convened by Dr Constable (Annex 4, paragraph 6.17). Additionally, the Scientific Committee endorsed the intersessional work plan developed by the steering committee and welcomed any interim progress reports that may be developed prior to the 2004 meeting of WG-EMM. The Working Group also requested the approval of the Scientific Committee to invite modelling experts and noted that this may have budgetary implications (Annex 4, paragraphs 6.20 to 6.22).

3.47 Dr Constable reported that an ad hoc group of available members of the steering committee met during the Scientific Committee meeting to consider how to proceed and prepare for the workshop. They reiterated the importance of asking Members to involve national experts in the preparations for the workshop and also in the workshop itself. Additionally, it was highly desirable to similarly involve two invited experts in the entire process.

3.48 Preparations include a review of the relevant literature on ecosystem models and software, consideration of requirements for datasets and parameters of interest, and development of an outline of the aims and specifications for ecosystem modelling as it relates to the development of management procedures for krill. Modelling components will include, as appropriate, a food-web model, the environment, the fishery, life history and physiological models and spatial aspects of the ecosystem.

3.49 Members noted the synergy between the work of both WG-EMM and WG-FSA and that the outcome of the workshop would provide a good opportunity to determine the most appropriate mechanism by which to optimise the work of the two working groups.

3.50 The Scientific Committee endorsed the Working Group nomination of Drs Reid and Watters to co-convene the workshop on management procedures to be held during the 2005 meeting of WG-EMM (Annex 4, paragraph 6.25).

3.51 On behalf of the Working Group, Dr Hewitt presented a long-range work plan to the Scientific Committee (Table 1), which outlined the major issues and a timetable for addressing them. The work plan was organised around five broad issues:

- (i) Subdivision of the precautionary catch limit for krill in Area 48 –
The Working Group welcomed initial proposals at its 2003 meeting, encouraged submission of additional proposals in 2004, and noted that it had indicated that it would forward a recommendation to the Scientific Committee at its 2004 meeting. Most participants agreed that this was possible, although some felt that additional time may be required in order to achieve a consensus recommendation.
- (ii) Revised krill management procedure –
Following successful workshops on defining SSMUs in Area 48 and the CEMP review, the Working Group noted that work is progressing according to plan with preparations under way for a workshop on operating models to be held in 2004. With regard to the workshop on management procedures to be held in 2005, the Working Group renewed its request for operational definitions of Article II. The Working Group also noted that reporting requirements from the fishery and monitoring requirements from CEMP will need to be revised.
- (iii) Assessment of predator demand –
The Working Group noted that assessment of predator demand will progress from the present discussion phase to consideration of pilot studies in 2004 and 2005.
- (iv) Subdivision of large FAO statistical areas –
The Working Group noted that the ad hoc Subgroup on Harvesting Units expects to forward recommendations for subdividing Subareas 48.6, 88.1, 88.2 and 88.3 and Divisions 58.4.1 and 58.4.2 to the 2004 meeting of WG-EMM.
- (v) Strategic planning –
The Working Group recalled the Workshop on the Future Agenda of WG-EMM held in 2001, and considered that a similar workshop to consider planning beyond 2005 may be necessary. A planning session for such a possible workshop is scheduled in the revised long-term plan for 2005. One topic could be consideration of whether the Working Group should expand the scope of its work from its current krill-centric focus to include other species and systems (Table 1; Annex 4, paragraphs 6.29 to 6.42).

3.52 The Scientific Committee noted that these plans involved a tremendous amount of work which would require intersessional activities and that work should be well advanced on the development of a management procedure for krill before other substantial work programs are initiated. It also noted that work on specifying the future CEMP should begin in 2005 with discussions on management procedures when monitoring will be an important consideration, rather than in 2004. Nevertheless, the Scientific Committee encouraged the continuation of work on existing CEMP parameters discussed by WG-EMM in time for consideration next year.

3.53 In relation to paragraph 3.51(v), Prof. Croxall, while noting the value of examining the population trends in various ecosystem components, recommended a continued focus on the krill-centric ecosystem. This would not preclude Members from addressing other species.

3.54 Prof. C. Moreno (Chile) noted that the current system is influenced by human perturbations of the past and commented on the value of historical data in modelling efforts. Dr Constable agreed that historical papers could provide data useful to help model future ecosystem trends.

Non-krill Centred Ecosystem

3.55 In addition to consideration of the krill-centric system, considered at WG-EMM, WG-FSA had considered ecosystem pathways that were centred on fish.

3.56 In this context, WG-FSA had encouraged future work to develop methods to incorporate data on interactions between mackerel icefish and upper-trophic level predators into assessment procedures and into ecosystem models involving mackerel icefish as outlined in Annex 5, paragraphs 8.2 to 8.5.

3.57 The Scientific Committee noted that WG-FSA had reviewed a proposed method for using the diet of Antarctic shags (*Phalacrocorax bransfieldensis*) to monitor the abundance of young life history stages of coastal fish species, including those subject to CCAMLR conservation measures. The Scientific Committee considered that the method had been thoroughly evaluated and that future studies of the composition of the fish diet of Antarctic shags should follow this method. The Scientific Committee agreed that the index had the potential to provide information on ecological relationships and changes in populations of certain fish species.

3.58 The Scientific Committee noted that time-series of data of fish composition in the diet of Antarctic shags have the potential to provide useful information to the work of WG-FSA, and Members were encouraged to liaise with the Secretariat on the submission of such time series of data that had been collected following the methods developed for this study (Annex 5, paragraphs 8.6 and 8.7).

3.59 Dr E. Barrera-Oro (Argentina) noted that the monitoring method that uses the diet of Antarctic shags was also applicable to adult stages of many demersal fish species. He pointed out that the aims of this methodology include the monitoring of changes in the abundance of juvenile stages of some fish species that have been the subject of commercial exploitation in the past.

3.60 The Scientific Committee acknowledged the efforts of Argentina and encouraged them to continue their work with Antarctic shags.

3.61 The Scientific Committee recognised the value of using other components of the ecosystem to assist in monitoring trends in fish species that have in the past been affected by human exploitation.

Advisory Subgroup on Protected Areas

3.62 Dr Hewitt summarised the work of the Advisory Subgroup on Protected Areas. Tasks included a review of the status of CEMP site maps and the guidelines for producing maps, a review of the terms of reference of the subgroup, and a review of the membership of the group (Annex 4, paragraphs 5.1 to 5.9).

3.63 Prof. D. Torres (Chile) called attention to SC-CAMLR-XXII/BG/14 'Management Plan for ASPA No. 145 (SSSI No. 27)'. After discussion as to the appropriate pathway and timing for review by CCAMLR, the Scientific Committee recommended that the plan be referred to the Advisory Subgroup on Protected Areas for review during the 2004 meeting of WG-EMM. It was noted that the intent of the Scientific Committee was to follow adopted procedures, while at the same time not delaying the review process unnecessarily.

364 Dr K. Sullivan (New Zealand) informed Members of New Zealand's plans to submit a Protected Area Management Plan for the Balleny Islands to WG-EMM in 2004.

3.65 Prof. Croxall called attention to the terms of reference related to marine protected areas, i.e. to provide advice on the implementation of marine protected areas that may be proposed in accordance with the provisions of Article IX.2(g) of the Convention, including 'the designation of the opening and closing of areas, regions or subregions for purposes of scientific study or conservation, including special areas for protection and scientific study' (Annex 4, paragraph 5.9(v)). He noted that there were a number of recent worldwide efforts, including studies, conferences and scientific research, which focused on marine protected areas, both along coasts and especially on the high seas. He suggested that it would be timely to bring a summary of this activity to the attention of WG-EMM and the Scientific Committee.

3.66 Prof. Croxall recommended that the Advisory Subgroup on Protected Areas review such recent work related to marine protected areas during the intersessional period and to provide background information to the 2004 meeting of WG-EMM.

3.67 Dr Penhale, chair of the Advisory Subgroup on Protected Areas, indicated that this task would be agreeable to the subgroup and that the revised membership of the subgroup should ensure the inclusion of members with expertise in this area.

3.68 The Scientific Committee concurred with these recommendations.

3.69 The Scientific Committee recommended that the Commission endorse the following terms of reference for the Advisory Subgroup on Protected Areas:

- (i) to review the details of proposals relating to designation and protection of CEMP monitoring sites and review of CEMP management plans as required in accordance with Conservation Measure 91-01;
- (ii) to revise and keep under review, as appropriate, guidelines for the production of maps of protected areas relevant to CCAMLR;

- (iii) to develop and keep under review, as appropriate, a methodology for assessment of proposals for marine protected areas forwarded in accordance with Article 6(2) of Annex V of the Protocol on Environmental Protection to the Antarctic Treaty;
- (iv) to provide advice on marine protected areas that seek designation as an ASPA or an ASMA under the Antarctic Treaty;
- (v) to provide advice on the implementation of marine protected areas that may be proposed in accordance with the provisions of Article IX.2(g) of the Convention, including ‘the designation of the opening and closing of areas, regions or subregions for purposes of scientific study or conservation, including special areas for protection and scientific study’.

Advice to the Commission

3.70 Following the CEMP Review Workshop, the Scientific Committee recommended a third objective be added to CEMP – ‘to develop management advice from CEMP and related data’ (paragraph 3.14(i)).

3.71 Given the current design of CEMP, the Scientific Committee noted that it may never be possible to unambiguously attribute causes of ecosystem change to either the actions of the krill fishery or to environmental change, and requested advice from the Commission regarding policy of how management should proceed when a significant change was detected but no single causal factor could be attributed (paragraph 3.12(iii)).

3.72 In response to a request from the Commission, the Scientific Committee noted that four options for subdividing the precautionary catch limit for krill in Area 48 among SSMUs were discussed, and called for additional proposals to be developed during the intersessional period with the expectation of forwarding a recommendation to CCAMLR-XXIII (paragraphs 3.32 to 3.43).

3.73 The Scientific Committee requested that the Commission endorse the long-range work plan of WG-EMM, which addressed four main issues: (i) subdivision of the precautionary yield of krill in Area 48; (iv) development of a revised krill management procedure; (iii) assessment of krill predator demand; and (iv) subdivision of large FAO statistical areas into harvesting units (paragraphs 3.51 and 3.52 and Table 1).

3.74 The Scientific Committee recommended that the Commission endorse the terms of reference for the Advisory Subgroup on Protected Areas as laid out in paragraph 3.69.

3.75 The Scientific Committee recommended that the Management Plan for ASPA No. 145 (SC-CAMLR-XXII/BG/14) be referred to the Subgroup on Protected Areas for review at its meeting during WG-EMM in 2004 (paragraph 3.63).

HARVESTED SPECIES

Krill Resources

Status and Trends

4.1 The krill fishery in 2002/03 has operated in Subareas 48.1, 48.2 and 48.3 and the catch reported at the time of the meeting was 110 334 tonnes (Table 2). The total catch for 2002/03 is expected to be similar to that reported in 2001/02 (125 987 tonnes) once catch figures for the remaining months of 2003 have been received (Table 3).

4.2 Plans for krill fishing in 2003/04 were presented to the Scientific Committee (Table 4).

4.3 The Scientific Committee noted that the projected krill catch for 2003/04 was more than 30% greater than the expected total catch for 2002/03. This projected increase is significant because in most previous years total future catch levels indicated to the Scientific Committee had been at or below existing catch levels.

4.4 Dr Sushin noted that the projected krill catch for 2003/04 may not be realised and any increase could be assessed at the 2004 meeting of WG-EMM.

4.5 Dr Constable noted that if the projected rate of increase were to continue, then the trigger level of 620 000 tonnes in Area 48 could be reached in five to six years and that the fishery may start to expand faster than the capacity of the Scientific Committee to provide management advice. Although such a sustained increase in krill catches over a number of years may be unlikely, the Scientific Committee noted that it did not currently have access to reliable information from which it could assess how likely such an increase might be.

4.6 WG-EMM had reported that it was unable to make any assessment of the developments in the krill fishery because information on future fishery plans by Members was incomplete and/or anecdotal (Annex 4, paragraphs 3.6 to 3.8). The Scientific Committee agreed that annual submission of information on the detailed fishing plans of all Member nations were required and that this would include at a minimum: the number of vessels, the locations of planned fisheries, the months when fishing would proceed and the expected catch levels.

4.7 Although some of this information is provided in verbal reports and in Reports of Members' Activities submitted to the Commission, there was no formal mechanism for the submission of this information in a form that was easily accessible to the Scientific Committee and to WG-EMM.

4.8 Accordingly, a pro forma was designed which would contain the information indicated by WG-EMM as being necessary to plan for any changes in the level of the krill fishery (Annex 6). The Scientific Committee agreed that completed forms should be submitted in advance of the annual meeting of WG-EMM by Members intending to fish for krill in the upcoming season so that appropriate advice could be provided to the Scientific Committee on trends in the krill fishery.

4.9 It was recognised that information that would be presented in this notification would only be preliminary and that operational factors might affect the actual levels of catch in any year. Nevertheless, the Scientific Committee agreed that the standardised provision of such

information on krill fishing plans would be a valuable development in understanding trends in the krill fishery. Further details of fishing activities could also be presented in the Reports of Members' Activities submitted annually to the Commission.

4.10 WG-EMM had requested the Secretariat to report to the Scientific Committee on the possible availability of krill from sources which had not been reporting their catch to CCAMLR (Annex 4, paragraph 3.32). The Secretariat reported that they had recently investigated commercial sources of krill and that all appeared to be the results of fishing by Members which were reporting their catches to CCAMLR.

Advice from WG-EMM

4.11 The Scientific Committee endorsed WG-EMM's recommendation that the Secretariat continue to report krill catches by SSMU (Annex 4, paragraphs 3.9 and 3.10).

4.12 The approaches to validate CEMP indices of krill availability based on fisheries information indicated by WG-EMM (Annex 4, paragraphs 3.9 and 3.10) were endorsed. It was noted that this would require temporary access to haul-by-haul data from the krill fishery and that this research would involve collaboration among scientists in Australia, Japan and Russia. These analyses would take into account the results of the CCAMLR krill CPUE study which was concluded in 1989.

Advice to the Commission

4.13 The projected krill catch for 2003/04 is more than 30% greater than the expected catch for 2002/03 (paragraph 4.3). Six Members expect to be fishing for krill in 2003/04 (Table 4).

4.14 Clarification of Members' krill fishing plans through the submission of standardised information to WG-EMM on the form developed at the meeting would allow the Scientific Committee a better insight into developments in the fishery and would permit an assessment of whether the development of management procedures for krill were keeping pace with operational developments.

Fish Resources

Status and Trends

Fishing Activity in the 2002/03 Season

4.15 Seven fisheries, including two exploratory fisheries, were carried out for finfish under conservation measures in force during the fishing season of 2002/03. These included fisheries for *D. eleginoides* and *C. gunnari* in Subarea 48.3 and Division 58.5.2, and exploratory fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2 and Division 58.4.2. Other fisheries for *D. eleginoides* occurred in the EEZs of South Africa (Subareas 58.6 and 58.7) and France (Subarea 58.6 and Division 58.5.1) by longlines.

4.16 The Scientific Committee noted that catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in the 2002/03 fishing season are summarised in Annex 5, Table 3.1. These had been updated to 3 October 2003 and reported in SC-CAMLR-XXII/BG/1.

4.17 The Scientific Committee noted that catch effort and length data were submitted for all fisheries managed under conservation measures as well as most of the fisheries operating in EEZs.

Reported Catches of *Dissostichus* spp.

4.18 Reported catches of *Dissostichus* spp. are shown in Annex 5, Table 3.1. Inside the CCAMLR Convention Area a total of 15 931 tonnes was reported during the 2002/03 season compared with 15 302 tonnes in the previous season. Catches outside the Convention Area were 18 919 tonnes during the 2002/03 season compared with 35 484 tonnes in the previous season. This information is detailed in Annex 5, Table 3.1. Most of this catch was reportedly taken from Areas 41, 47, 51, 57 and 87.

Estimates of Catch and Effort from IUU Fishing

4.19 These results are set out in Annex 5, Tables 3.1 to 3.3.

4.20 The Scientific Committee noted that the catch of *Dissostichus* spp. outside the Convention Area in 2001/02, and reported in the CDS, was taken mostly in Area 41 (14 032 tonnes) and Area 51 (10 620 tonnes). However, in 2002/03 (to October 2003), most of the catch was reported from Areas 41 (7 108 tonnes) and 87 (4 419 tonnes), and the catch reported from Areas 51 and 57 had contributed 24% of the total catch reported outside the Convention Area (down from 41% in 2001/02).

4.21 Prof. Beddington expressed concern that JAG did not meet prior to the WG-FSA meeting and that, as a consequence, it was not possible to have its definitive estimate of total removals available for use in the assessment process. He further suggested that it would be desirable for JAG to meet prior to WG-FSA in future and that an opportunity should be made for JAG to familiarise itself with the methods used by WG-FSA to estimate total removals, and vice versa, as this may prove useful in the development of a single procedure to be used for compliance and assessment purposes. The Convener of WG-FSA (Dr Everson) concurred with Prof. Beddington's suggestion and reiterated the Working Group's recommendation that JAG be scheduled to meet prior to WG-FSA so that an agreed estimate of total removals was available for the assessment process. The Scientific Committee recommended that the proposal for JAG to meet before WG-FSA and for intersessional work on the development of an agreed procedure be pursued as a matter of priority.

4.22 Dr Constable made the point that the Secretariat had gone to some lengths not to make judgements on the veracity of the information presented in Annex 5, Table 3.1 for the Working Group, including those from the CDS. Dr Constable also noted that the FAO

definition of IUU includes unreported and unregulated fishing in addition to illegal fishing, and that perhaps the Working Group and Scientific Committee should be careful not to infer that all IUU fishing is necessarily associated with illegal catches.

4.23 Further discussion by the Scientific Committee on IUU fishing was reported under Agenda Item 7 (Annex 5, paragraphs 7.4 to 7.10).

Research Surveys

4.24 Research surveys had been undertaken in 2002/03 by the USA in Subarea 48.1 (Annex 5, paragraph 3.28) and Australia in Division 58.5.2 (Annex 5, paragraph 3.30). New Zealand conducted a pilot acoustic study for toothfish and grenadiers in Subarea 88.1 (Annex 5, paragraph 3.33).

4.25 Estimates of total stock biomass in Subarea 48.1 for eight species of finfish calculated from three US surveys (1998, 2001, 2003) have fluctuated with no signal of substantial year classes or significant recruitment for any species. Even though standing stocks of *Gobionotothen gibberifrons* remain the largest relative to all other species, that species appears to have undergone a decline in mean biomass.

4.26 Dr Barrera-Oro pointed out that studies conducted by Argentina on inshore sites of the South Shetland Island area over a period of 20 years (Barrera-Oro et al., 2000; WG-FSA-03/89) are consistent with the results of the offshore survey. He noted that information from research activities inshore complements offshore survey observations. Dr Kock noted that estimates of *G. gibberifrons* biomass from German surveys also indicate a decline and consistently poor recruitment since 1996.

4.27 This observation was also supported by Dr E. Fanta (Brazil) from inshore studies conducted by Brazil in the same area over two decades.

Future Surveys

4.28 The following surveys were notified to WG-FSA:

- USA – from 16 May to 16 July 2004, a bottom trawl survey to Shag Rocks and South Georgia (Subarea 48.3), the South Sandwich Islands (Subarea 48.4) and Bouvet Island (Subarea 48.6) (Annex 5, paragraph 3.28);
- UK – in January 2004, a bottom trawl survey to South Georgia and Shag Rocks (Subarea 48.3) (Annex 5, paragraph 3.47);
- UK – in March 2004, an acoustic and pelagic trawl survey to the north of South Georgia and Shag Rocks (Subarea 48.3) (Annex 5, paragraph 3.48);
- New Zealand – in January to March 2004, biodiversity survey to the Ross Sea (Subarea 88.1) (Annex 5, paragraph 3.49);

- Australia – from December 2003 to January 2004, in the Heard and McDonald Islands area by *Aurora Australis* as part of a larger marine science survey, a random stratified trawl survey to assess the biomass and age structure of *C. gunnari* and the abundance of *D. eleginoides* recruits (Annex 5, paragraph 3.51);
- Australia – in May–June 2004, a random stratified survey in the Heard and McDonald Islands area of Division 58.5.2, to assess the biomass and age structure of *C. gunnari* and the abundance of *D. eleginoides* recruits (Annex 5, paragraph 3.52).

Fish Biology/ Ecology/Demography

4.29 The Scientific Committee noted the papers that were tabled at WG-FSA which included topics on fishing grounds and stock identity, by-catch, *D. eleginoides*, *D. mawsoni*, *C. gunnari* and stone crabs (Annex 5, paragraph 7.1).

4.30 The Scientific Committee noted progress made by the CCAMLR Otolith Network (CON) and noted that there were key aspects of its work that would be taken up by WG-FSA-SAM.

4.31 The Scientific Committee noted the formation of an ad hoc subgroup on tagging of toothfish (Co-conveners Mr N. Smith (New Zealand), Mr Williams and Dr M. Belchier (UK)) and the tagging protocols developed by the subgroup and adopted by WG-FSA. The Scientific Committee recommended that tagging be a requirement of conservation measures in all new and exploratory toothfish fisheries and noted the valuable information already gained from tagging studies in Divisions 58.5.2 and 58.4.2 and Subarea 48.3.

Developments in Assessment Methods

4.32 The Scientific Committee noted the substantial progress made on assessment methods by WG-FSA-SAM at its intersessional meeting held in London, UK, in August 2003, and by WG-FSA-SFA, held the following week in Cambridge, UK. The Scientific Committee thanked the workshop participants and convener and host of WG-FSA-SAM, Drs Constable and G. Kirkwood (UK) respectively, and the conveners of WG-FSA-SFA, Drs Collins and Gasiukov.

4.33 The Scientific Committee acknowledged the substantial contribution of the work of the subgroup to improving the methods and procedures for the assessments at this year's Working Group meeting and endorsed the program of future work identified for WG-FSA-SAM (Annex 5, paragraphs 9.2 to 9.24).

4.34 The Scientific Committee noted the request for the attendance of the Data Manager for the whole meeting and Secretariat support for the final two days of the 2004 WG-FSA-SAM meeting, and recommended that funding for this support be sought from SCAF.

4.35 The Scientific Committee endorsed the Working Group's recommendation that acoustic estimates of biomass could be incorporated into assessments of yield of *C. gunnari* in

Subarea 48.3. It encouraged further work on how to examine the uncertainties associated with these estimates as identified in the workshop report and for incorporating uncertainties into the assessments (Annex 5, paragraph 3.41).

4.36 Dr V. Siegel (European Community) noted the different conclusions reached by WG-FSA-SFA and WG-FSA with respect to whether acoustics could be used for estimating abundance of *C. gunnari*. He asked for clarification on whether the Working Group had discussed the implications of endorsing the use of acoustics for assessment purposes and whether this meant that all future surveys for *C. gunnari* in Subarea 48.3 will need to be done with an acoustics component.

4.37 Dr Everson clarified to the Scientific Committee that bottom trawl surveys would continue to be used for the estimation of standing stock, but acoustic estimates of biomass would be incorporated into assessments of *C. gunnari* in years when such information became available to WG-FSA.

4.38 A number of Members noted the progress that had been made by WG-FSA-SFA and emphasised the need to better understand the different sources of uncertainty associated with estimates of abundance of *C. gunnari* from acoustics. These included the temporal variation in estimates of biomass and the size, age and species composition of the pelagic component.

4.39 Dr V. Sushin (Russia) noted that the results of the WG-FSA-SFA report demonstrated that a large proportion of the biomass of *C. gunnari* could be located in the pelagic zone and that this may include both 1+ and adult fish. He also suggested that, consistent with the Scientific Committee's desire to use the best available scientific evidence, the Scientific Committee should endeavour to develop a new method of assessing stocks of icefish based on combined trawl and acoustic surveys for *C. gunnari*.

4.40 Dr Constable drew the attention of the Scientific Committee to the discussion at WAMI on the potential bias of estimates of biomass from trawl survey data (SC-CAMLR-XX, Annex 5, Appendix D, paragraphs 7.17 to 7.29). Results presented to that workshop showed that sources of bias might be addressed using methods other than through the undertaking of acoustic surveys. In addition, the issue of bias is likely to be different in different parts of the Convention Area. For that reason, he indicated that the method by which acoustic data is incorporated into assessments needs to be evaluated before accepting it as a general requirement in assessments for *C. gunnari*.

4.41 The Scientific Committee noted the need to address these outstanding areas of uncertainty in acoustic estimates of biomass and asked that the implications of using different methods of biomass estimation be considered as part of the evaluation of assessment methods for *C. gunnari* to be undertaken by WG-FSA-SAM.

Assessment and Management Advice

Assessed Fisheries

D. eleginoides at South Georgia (Subarea 48.3)

4.42 The catch limit for the fishery for *D. eleginoides* in Subarea 48.3 in the 2002/03 season was 7 810 tonnes (Conservation Measure 41-02). The total catch of *D. eleginoides* from this fishery, as reported by 3 October 2003 in the catch and effort reporting system, was 7 534 tonnes, most of which had been taken by longline.

Trends in Fishing Vulnerability

4.43 The distribution of annual estimated vulnerabilities indicate a ‘shallow’ (400–500 m) fishing pattern and a ‘deep’ (~1 200 m) fishing pattern (Annex 5, paragraphs 5.88 to 5.94 and Figures 5.4 and 5.5). Observations indicated that fishing in depths of 200 to 400 m resulted in large (>50%) catches of immature fish (Annex 5, paragraph 5.93).

4.44 The Scientific Committee noted the Working Group’s suggestion that some restriction of fishing in shallower waters might be useful. The Scientific Committee agreed with the desirability of reducing catches of immature *D. eleginoides* and encouraged the Working Group to explore potential options and implications for doing so, including restricting fishing in shallower depths, during the intersessional period.

CPUE Standardisation

4.45 The Scientific Committee noted the progress made in developing methods for standardisation of CPUE data from longlines and trawl fisheries that incorporate the various uncertainties (Annex 5, paragraphs 5.96 to 5.103).

Recruitment Series

4.46 The Scientific Committee noted that a review by WG-FSA of estimates of recruitment used in the 2002 assessment of *D. eleginoides* in Subarea 48.3 had identified a number of problems (Annex 5, paragraphs 5.104 to 5.111). In particular, there had been an error in the data extractions for the 2002 UK survey that led to the recruitments in 2001, 2002 and 2003 being substantially overestimated.

4.47 Inconsistencies had also been identified in the analyses of the 1990 UK survey data. As a result, the corresponding recruitment estimates calculated last year were too high and the estimates of recruitment from the 1990 survey may have affected estimates of yield prior to 2002.

4.48 In order to continue to improve the quality control procedures for the assessment process, the Scientific Committee endorsed the recommendation of WG-FSA that validation procedures be developed for all data extractions and analytical procedures and that they be routinely applied during the assessment process.

4.49 Following a discussion that clarified the nature and potential sources of these problems, the Scientific Committee agreed that there was an urgent need to review and evaluate the entire process of estimating *D. eleginoides* recruitment from trawl surveys for use in assessments, including a variety of general analytical and interpretation issues.

4.50 Points discussed by the Scientific Committee that should be considered in this evaluation should include, but not be restricted to, the following:

- (i) the reading of ages, the estimation of growth curves and how age information should be incorporated into the CMIX analyses. In particular, account needs to be taken in the estimation of recruitment of the potential errors and uncertainties in the age information and assignment of ages to mixture components;
- (ii) which age groups should be included in the estimation of recruitment, bearing in mind the extent to which they are fully selected in the survey hauls and the possibility of higher natural mortality in younger age groups;
- (iii) taking account of possible variations in catchability between surveys;
- (iv) the need for a clear set of decision rules to guide those attempting CMIX analyses;
- (v) evaluation of survey design and interannual variation in catchability of age classes for estimation of recruitment series for *D. eleginoides*.

4.51 Prof. Beddington noted the inconsistency in growth and mortality parameters, specifically the M/K ratio and the large difference in that ratio for Subarea 48.3 compared to that in Division 58.5.2. The Scientific Committee recalled the recommendation of WG-FSA-SAM that input parameters for assessments should be checked for internal consistency. It further reiterated the importance of validating estimates of growth and mortality obtained from otolith readings with independent estimates (e.g. from tagging) and the Scientific Committee's desire to address this issue as a matter of urgency.

4.52 The Scientific Committee noted that different ranges of lengths and/or ages have been used to estimate growth parameters and this would be expected to strongly influence the resulting estimates of K and L_{∞} . The Scientific Committee recommended that the issue of consistent approaches to estimation of growth parameters be pursued as part of the work program of WG-FSA-SAM.

4.53 Dr Sushin raised a general concern regarding the potential that current estimates of recruitment from Subarea 48.3 may be overestimated as a result of the mixture analysis method used. He suggested the need to examine the reliability of the current method for estimating recruitments and how the recruitment series is incorporated in assessments of yield using the GYM. He suggested it would be useful to examine alternative methods for

estimating recruitments and assessing yields. The Scientific Committee agreed with the desirability of evaluating all aspects of the assessment process for *D. eleginoides*, and it noted the future work program recommended by WG-FSA to address these issues.

4.54 Dr Constable supported Dr Sushin's desire to evaluate current and alternative methods. He noted that the validation of the GYM by the development of a Java GYM based on the mathematical specifications and codes has partly addressed this issue for the current model and software used to assess long-term yield.

4.55 The Scientific Committee noted the importance of maintaining confidence in the assessment process by evaluating the consequences of changes in the assessment procedure to meeting the objectives of the Commission before adopting them. To that end, it encouraged the further development of an evaluation framework within WG-FSA-SAM and for Members to submit alternative approaches for evaluation.

4.56 The Scientific Committee thanked WG-FSA for its contribution to this difficult assessment and noted that the manner in which the assessments are now done facilitates the direct involvement of a wider range of participants in the assessment process and acknowledged that this improves the rigour and transparency of the assessment process.

Assessment

4.57 The Scientific Committee noted the sensitivity test conducted by the Working Group to investigate the consequences of the changes in the recruitment series on the assessment of yield. The sensitivity tests were:

- (i) a baseline scenario using the recruitment series used in the WG-FSA-02 assessment (SC-CAMLR-XXI, Annex 5, paragraphs 5.60 and 5.61);
- (ii) as for (i), but using the revised recruitments for the 2002 survey calculated during WG-FSA-03;
- (iii) as for (i), but using the revised recruitments for the 1990 and 2002 surveys calculated during WG-FSA-03.

4.58 The precautionary catch limit resulting from use of the original 2002 recruitment series was 7 813 tonnes, a similar level to that estimated last year, as expected. When the revised recruitment series for the 2002 survey was used, the precautionary catch limit was reduced to 5 524 tonnes. When the revised series for both the 1990 and 2002 surveys were used, the precautionary catch limit was reduced further to 1 979 tonnes.

4.59 The Scientific Committee noted that a further review by WG-FSA of the revised recruitments calculated from the 1990 survey data conducted late in the meeting had identified further inconsistencies, such that the revised recruitment estimates might now be too low. WG-FSA did not have time to further revise these estimates.

4.60 Noting that the Working Group was unable to provide a recommended catch limit, the Scientific Committee discussed the potential consequences of the errors and options for a staged approach to align future catch limits with the long-term yield, in the case that the current catch limit is in excess of what would be considered precautionary.

4.61 Dr Sullivan suggested that, in the absence of a recommended catch limit from WG-FSA, it may be appropriate to use the average of the total annual catches (including estimated IUU catches) for the period 1996/97 to 2001/02. Dr Sullivan suggested that it may be reasonable to assume that this was a sustainable level of catch for Subarea 48.3, given there was no evidence of a decline in the standardised CPUE trend for this period (Annex 5, Figure 5.6).

4.62 Dr Kock supported this proposal. He suggested that it should be linked to a staged progression to align the fishery with a revised estimate of long-term yield for Subarea 48.3.

4.63 Various Members expressed some concern with the proposal as the harvest levels may have been set above the true precautionary yield for a number of years given the potential error associated with the estimate of recruitment for the 1990 survey. Other Members expressed some concern with the use of CPUE as an index of stock status. In particular they noted that CPUE is a relatively insensitive index of abundance, due to the formulation of the index and the potential shifts in fishing practices to mask changes in abundance, except in circumstances of dramatic declines in stock size.

4.64 Dr Constable noted that he would be uncomfortable providing advice to the Commission based on trends in CPUE, given the uncertainties associated with the Subarea 48.3 CPUE time series and the unfinished considerations of WG-FSA-SAM on this issue. Dr Constable suggested that an alternative approach for recommending a catch limit for this year would be to recognise that the catch limit should be between 2 000 and 5 500 tonnes, based on the WG-FSA sensitivity analyses, and apply a discount factor to the revised 2002 assessment, recognising that this may still be above a catch limit that might come out of a full review. He recommended that such a proposal would be contingent on: (i) a thorough appraisal of the data and surveys included in the assessment of Subarea 48.3, and (ii) a reassessment of the long-term annual yield be provided to the Scientific Committee in 2004 that provides for consistency between the input parameters, and as far as practicable, the uncertainties in those input parameters.

4.65 The Scientific Committee noted that given the uncertainties in the estimated recruitment series, the Working Group was unable to recommend a specific catch limit for *D. eleginoides* for the 2003/04 fishing season. In view of the effects of corrections to the errors identified with the recruitment series used in the 2002 assessment, the Scientific Committee noted the Working Group's recommendation that whatever catch limit the Commission should adopt for *D. eleginoides* for the 2003/04 fishing season should be substantially less than that which applied in 2002/03 (7 810 tonnes).

4.66 The Scientific Committee noted that the Working Group's use of 'substantially less' in the above recommendation could be widely interpreted depending on perspective and suggested a more quantitative indication would have been useful.

Management Advice for *D. eleginoides* (Subarea 48.3)

4.67 The Scientific Committee noted that WG-FSA was unable to provide specific advice on a catch limit for *D. eleginoides* in Subarea 48.3 in the 2003/04 fishing season (paragraphs 4.65 and 4.66).

4.68 The Scientific Committee agreed that in determining a precautionary catch limit to recommend for the 2003/04 season, it would be appropriate to apply a discount factor to the precautionary yield calculated using the revised estimate of recruitment for 2002, to account for the additional uncertainty in this year's assessment of the stock. Application of a discount factor of 20% would result in a precautionary catch limit of 4 419 tonnes, which is very close to the average total removals (including estimated IUU catches) taken over the seasons 1995/96 to 2001/02 (4 425 tonnes).

4.69 It was noted that between 1995/96 and 2001/02 there was no evidence of a decline in CPUE as standardised by WG-FSA. However, the Scientific Committee noted that as WG-FSA-SAM has not concluded its review of CPUE standardisation methods, it is currently not possible to use stability of catches and CPUEs as a measure of confidence in the long-term sustainability of these average catches.

4.70 The Scientific Committee recommended that the catch limit for *D. eleginoides* in Subarea 48.3 for the 2003/04 season should be 4 420 tonnes with the understanding that a new assessment of long-term yield will be provided next year by WG-FSA.

4.71 The remaining provisions of Conservation Measure 41-02 should be carried forward for the 2003/04 season.

4.72 Any catch of *D. eleginoides* taken in other fisheries in Subarea 48.3 should be counted against the catch limit determined by the Commission.

Priority Work for Future Assessments of *D. eleginoides* in Subarea 48.3

4.73 The Scientific Committee endorsed the program of work identified by WG-FSA for the intersessional period to fully review and revise the recruitment series for Subarea 48.3 as a high priority (Annex 5, paragraphs 9.20 to 9.25). The Scientific Committee recognised the importance of obtaining a consistent and reliable recruitment series for assessing the *D. eleginoides* stock in Subarea 48.3 and emphasised the importance of having this available for review at the 2004 meeting.

4.74 The Scientific Committee noted the Working Group's advice that, because of the precautionary long-term nature of the assessment process, a failure to reliably estimate a precautionary yield in a single year would be less serious than would be the case for a fishery subject to annual assessments of optimised yield. Following the determination of a revised recruitment series for Subarea 48.3 next year, it will become apparent whether or not previous catches have been above those that would have been calculated historically as precautionary yields using that recruitment series. If previous catches have been above precautionary yield levels, then this will be taken into account when calculating subsequent precautionary yields.

4.75 WG-FSA had conducted a preliminary analysis of observer data collected between 1993 and 2003 on proportions of immature *D. eleginoides* in the catch by depth zone. The Scientific Committee noted the analysis conducted by WG-FSA that indicated in the shallowest depth zone (200–400 m) the proportion of immature fish exceeded 50% (Annex 5, paragraph 5.93). The analysis also indicated that only between 5 and 10% of the catch is taken in this depth zone.

4.76 On the basis of this analysis and with a view to providing additional protection to young fish, Dr Sushin proposed that restrictions should be placed on fishing in depths less than 400 m. The Scientific Committee agreed that there may well be value in imposing a restriction of this type, but it felt that further detailed analysis of maturity by length and depth zone would be needed before a definitive recommendation could be developed. The Scientific Committee urged that such analyses be carried out intersessionally, and requested WG-FSA to re-examine this issue at its next meeting.

D. eleginoides at South Sandwich Islands
(Subarea 48.4)

4.77 No new information was made available to WG-FSA for *D. eleginoides* in Subarea 48.4 (South Sandwich Islands) on which to base an update of the assessment.

Management Advice for *D. eleginoides*
(Subarea 48.4)

4.78 The Scientific Committee recommended that Conservation Measure 41-03 be carried forward for 2003/04. As with last year, the Scientific Committee recommended review of the currency of the existing assessment. However, the Scientific Committee noted the advice of WG-FSA that, given the high workload at its meetings, the Working Group was unlikely to be able to review this measure in the near future.

D. eleginoides at Kerguelen Islands (Division 58.5.1)

4.79 The Scientific Committee thanked Prof. G. Duhamel (France) for the provision of haul-by-haul catch and effort data for Division 58.5.1.

4.80 The Scientific Committee was concerned about the declining trend in CPUE and the decreasing average size of fish in the legal catch and noted the concurrent increases in estimated total removals over the same period (Annex 5, paragraphs 5.126 to 5.128).

4.81 Prof. Duhamel noted that the increase in total removals and decline in CPUE was due to increased IUU catches, not legal catches by French vessels.

Management Advice for *D. eleginoides*
(Division 58.5.1)

4.82 Given the dramatic increase in total removals from 2000 onwards and the corresponding decline in standardised CPUE, the Scientific Committee agreed that it is imperative that steps be taken to substantially reduce total removals from 2003 levels.

4.83 The Scientific Committee recommended that Conservation Measure 32-09 remain in force for the period 1 December 2003 to 30 November 2004 in respect of Division 58.5.1.

D. eleginoides at Heard and McDonald Islands
(Division 58.5.2)

4.84 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2002/03 season was 2 879 tonnes (Conservation Measure 41-08) for the period from 1 December 2002 to the end of the Commission meeting in 2003. The catch reported for this division at the time of the Scientific Committee meeting was 2 130 tonnes. It is expected that the catch limit will be reached before the end of the current fishing season.

4.85 Prof. Beddington noted the difference in growth and mortality parameters used in the assessments in Division 58.5.2 and Subarea 48.3. In particular he found it difficult to reconcile the value of the growth parameter (K) used in the assessment in Division 58.5.2 being less than half the value of that used in the assessment in Subarea 48.3. Dr Constable concurred with Prof. Beddington and noted that there was a range of uncertainties which may contribute to the observed differences, including potential biases between readers of otoliths and reader error (i.e. observation error). Dr Constable recommended that estimates of these uncertainties and methods for incorporating them into estimates of parameters are urgently required.

4.86 Dr Jones noted that there were differences in survey design between years that may affect the estimates of recruitment used in GYM assessment of yield. The Scientific Committee noted that this issue has been identified in the future work program of WG-FSA and encouraged Members to submit papers to the next meeting of WG-FSA-SAM examining this issue.

4.87 Prof. Duhamel noted that this year the fishery in Division 58.5.2 included both trawl and longline operations and asked whether vulnerability functions for both methods had been used in the assessment. Dr Constable responded that the vulnerability function for trawl only had been used in this year's assessment and that methods for incorporating vulnerability functions for mixed fisheries will be addressed in the intersessional period.

4.88 The GYM assessment was updated using the updated series of total removals, assuming legal catches equal to the catch limit and a new estimate of IUU catches, and revised recruitment series agreed by WG-FSA (Annex 5, paragraphs 5.132 to 5.137). The estimate of precautionary long-term annual yield was 2 873 tonnes.

Management Advice for *D. eleginoides*
(Division 58.5.2)

4.89 The Scientific Committee recommended that the catch limit for Division 58.5.2 in the 2003/04 season be revised to 2 873 tonnes, representing the long-term annual yield estimate from the GYM. This catch limit is recommended to pertain only to the assessment area which is to the west of 79°20'E.

4.90 The remaining provisions of Conservation Measure 41-08 should be carried forward for the 2003/04 season.

D. eleginoides at Crozet Islands
(Subarea 58.6) inside the EEZ

4.91 The Scientific Committee noted the analyses of haul-by-haul catch and effort data conducted by WG-FSA for Subarea 58.6.

4.92 The Scientific Committee was concerned about the declining trend in CPUE and the decreasing average weight of fish in the legal catch evident from the results of these analyses (Annex 5, paragraphs 5.189 to 5.192).

Management Advice for *D. eleginoides* at
Crozet Islands (Subarea 58.6) inside the EEZ

4.93 The Scientific Committee noted the dramatic decline in CPUE since 2000, even under the relatively low levels of total removals, and stressed that it is imperative that future total removals be reduced until further analyses clarify the cause of the CPUE decline and steps can be taken to conserve the stock.

D. eleginoides at Crozet Islands (Subarea 58.6)
outside the EEZ

4.94 The Scientific Committee recommended that Conservation Measure 32-11, which prohibits targeted fishing for *D. eleginoides* outside the EEZ, remain in force.

D. eleginoides at Prince Edward Islands (Subarea 58.7)
inside the EEZ

4.95 The Scientific Committee welcomed the revised assessment of *D. eleginoides* in the South African EEZ around the Prince Edward Islands (Annex 5, paragraphs 5.194 to 5.201) and noted that it has not been possible to resolve the conflicting signals between the trends in CPUE and length frequency of the catch.

Management Advice for *D. eleginoides* at Prince
Edward Islands (Subarea 58.7) inside the EEZ

4.96 Noting the considerations of the Working Group (Annex 5, paragraph 5.195), the Scientific Committee recommended that the annual total allowable catch in the Prince Edward Islands EEZ should not exceed 300 tonnes, subject to target levels of recovery that might be adopted by the Commission.

D. eleginoides at Prince Edward Islands
(Subarea 58.7) outside the EEZ

4.97 The Scientific Committee recommended that the prohibition of directed fishing in Subarea 58.7 outside the Prince Edward Islands EEZ (Conservation Measure 32-12) should continue.

C. gunnari at South Georgia (Subarea 48.3)

4.98 The catch limit for the fishery for *C. gunnari* in Subarea 48.3 in the 2002/03 season was 2 181 tonnes (Conservation Measure 42-01). This conservation measure included several other conditions applied to this fishery. These included restricting the total catch of *C. gunnari* taken in the period between 1 March to 31 May to 545 tonnes to reduce possible targeting of spawning concentrations.

4.99 All fishing took place between 18 December and 26 February with a total catch of 2 155 tonnes. Twenty-six tonnes of the catch limit remain and the fishing season will remain open until 30 November 2003 (Annex 5, paragraph 5.145).

4.100 The Scientific Committee agreed to incorporate the results from an acoustic survey in 2002 that estimated biomass of a component of the pelagic biomass of *C. gunnari* in the depth range 8–58 m above the bottom into the assessment (Annex 5, paragraphs 5.148 to 5.152).

4.101 The Scientific Committee noted that the Working Group had done two assessments of the precautionary catch limit for *C. gunnari* in 2003/04 and had been unable to agree on a single catch limit (Annex 5, paragraphs 5.169 to 5.172). The first assessment included the age-1+ cohort from 2001/02 and resulted in a projected yield of 3 570 tonnes for the 2003/04 season. The assessment excluding the age-1+ cohort from 2001/02 resulted in a projected yield of 2 205 tonnes for the 2003/04 season (Annex 5, paragraph 5.174).

4.102 Prof. Beddington requested clarification as to the nature of the assumptions made about mortality and recruitment of the age-1+ cohort in the two assessments conducted by the Working Group. Dr G. Parkes (UK) noted that projections were done over two years. In the case excluding age-1 fish, there is an assumption of no recruitment of the age-1+ cohort in either year of the projection. In the assessment including the age-1+ cohort, there is partial recruitment as age-2+ cohort in the first year of the projection and full recruitment as 3 year olds in the second year.

4.103 Dr Sushin suggested that the assessment including the age-1+ cohort should be supported as it takes advantage of the additional information obtained from the acoustic

estimate and should be conservative given it uses the lower 95% CI of the biomass estimate and a comparatively high average value of natural mortality. Other Members supported this suggestion.

4.104 Drs Kock, Jones and others noted the recent paper considered by WG-FSA (WG-FSA-03/74) with respect to the contribution of *C. gunnari* to the diet of gentoo penguins and Antarctic fur seals in Subarea 48.3 and the potential for there to be considerable interannual variation and differences in age-specific natural mortality, particularly in the 1- and 2-year age classes.

4.105 The Scientific Committee noted earlier work that had demonstrated interannual and age-specific differences in the natural mortality of *C. gunnari* (i.e. de la Mare et al., 1998). In light of these uncertainties, some Members expressed concern that there was not sufficient understanding of the factors affecting the abundance of early year classes and that they would not be comfortable recommending the assessment that included the age-1+ cohort.

4.106 Dr Constable noted that the assessment procedure differed from that agreed at WG-FSA-SAM and drew attention to the Scientific Committee's earlier request to fully evaluate new assessment procedures before they are adopted for assessments by WG-FSA.

4.107 Dr E. Marschoff (Argentina) noted that stock estimates are well below the catches taken in the 1980s. He suggested that there appeared to be two strategies for moving forward: (i) continue to take relatively small annual yields, or (ii) close the fishery to allow the stock to recover and noted that this decision pertains to the Commission.

4.108 Prof. Beddington suggested that the two assessments represented 'extremes' of the assumptions about mortality and recruitment to the fishery of age-1 fish over the period of the projections. He expressed some concern about the internal consistency of the parameters used in the assessment, in particular the high value of natural mortality and the low value of *K*, given the values of these parameters used for Division 58.5.2. He suggested that perhaps a catch limit somewhere between the outcomes of the two assessments represented a reasonable way forward. He also noted a fundamental difference of opinion with Dr Marschoff's suggested option to close the fishery.

4.109 Dr Constable concurred with Prof. Beddington that it was useful to compare parameters between areas to better understand the dynamics of *C. gunnari*. He suggested, however, that it may not be reasonable to expect consistency in the parameter estimates used in the assessments given the large differences in the densities of *C. gunnari*, krill and land-based predators between Division 58.5.2 and Subarea 48.3, and the likely effects of these differences on rates of growth and mortality.

Management Advice for *C. gunnari* (Subarea 48.3)

4.110 Having reviewed the assumptions underlying these two assessments, the Scientific Committee agreed that an appropriate precautionary catch limit for *C. gunnari* in Subarea 48.3 for the 2003/04 season lay in the range bounded by the two assessments conducted by WG-FSA (2 205–3 570 tonnes). However, in view of the uncertainties in the natural mortality rates assumed in the assessment that included age-1 fish in the projections

(paragraphs 4.101 to 4.109), and the other uncertainties (Annex 5, paragraphs 5.170 to 5.172), it was unable to recommend a specific precautionary catch limit within this range.

4.111 The Scientific Committee had no information from which to consider or revise its advice of 2002 in respect of the current seasonal limitation in Conservation Measure 42-01. It therefore recommended that these aspects of the conservation measure should be unchanged. The Scientific Committee recommended the continuation of other aspects of Conservation Measure 42-01.

C. gunnari at Kerguelen Islands (Division 58.5.1)

4.112 The last commercial catches of *C. gunnari* in Division 58.5.1 were taken in the 1995/96 season. A survey was undertaken in 2001/02 (WG-FSA-02/65). Current information is that the biomass of *C. gunnari* in the survey area has remained at low levels since 1996/97. The Scientific Committee recommended that the fishery for *C. gunnari* within the French EEZ of Division 58.5.1 should remain closed in the 2003/04 season and continue to be closed until information on stock status is obtained from a survey.

C. gunnari at Heard and McDonald Islands (Division 58.5.2)

4.113 The Scientific Committee noted the details of the 2002/03 fishing season for *C. gunnari* in Division 58.5.2 (Annex 5, paragraphs 5.115 and 5.116). The catch limit for the 2002/03 season was 2 980 tonnes. The reported catch up to 3 October 2003 was 2 343 tonnes.

4.114 The assessment followed the short-term projection method to update catch limits for the 2003/04 season also used for this species last year (see Annex 5, paragraphs 5.181 to 5.184).

4.115 Prof. Beddington noted the large change in projected yield for the coming season in comparison to 2002/03 and questioned whether this was related to the apparent high mortality of 4–5 year olds and poor recruitment in recent years. Dr Constable recalled the discussion at WAMI (SC-CAMLR-XX, Annex 5, Appendix D) where the high levels of recruitment variability in this stock was noted. He also noted that, similar to Subarea 48.3, the 5- and 6-year-old age classes appear to either suffer higher mortality rates or become unavailable to the fishery. Further explanation is given in Annex 5, paragraph 5.182.

4.116 The Scientific Committee recalled its previous discussion with respect to the need to balance interannual variation in yield for the fishery with a long-term sustainable catch, and noted the work program of WG-FSA-SAM had identified the need to develop and evaluate a management procedure for *C. gunnari*.

Management Advice for *C. gunnari* (Division 58.5.2)

4.117 The Scientific Committee recommended that the total catch limit for *C. gunnari* should be revised to 292 tonnes for the period from 1 December 2003 to 30 November 2004.

4.118 The remaining provisions of Conservation Measure 42-02 should be carried forward to the 2003/04 season.

4.119 The Scientific Committee considered ways of providing for stable catches from one year to another given the large fluctuations in the abundance of this species and to avoid harvesting age-2 cohorts entering the fishery during the season that have not been assessed. One suggestion to solve the latter problem was to consider a minimum length of 290 mm from May 2004.

Other Finfish Fisheries

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

4.120 The Scientific Committee noted that WG-FSA considered other finfish fisheries in Subareas 48.1 (Antarctic Peninsula) and 48.2 (South Orkney Islands). Based on the results of a bottom trawl survey conducted by the USA in 2003 in Subarea 48.1, there appears to be little scope to reopen the fisheries in the two subareas in the near future given the comparatively low biomass of the abundant fish species.

Management Advice (Subareas 48.1 and 48.2)

4.121 The Scientific Committee endorsed the advice of WG-FSA that Conservation Measures 32-02 and 32-03 should remain in force.

Electrona carlsbergi (Subarea 48.3)

4.122 No new information was made available to the Scientific Committee on which an update of the previous assessment could be based. The Scientific Committee agreed that in light of the lack of new information or interest in developing the fishery for this species the fishery should be closed until such time that a fishery-independent survey of biomass is undertaken and presented to WG-FSA for review.

Management Advice for *E. carlsbergi* (Subarea 48.3)

4.123 The Scientific Committee recommended that the fishery should be closed until such time that there is a revised assessment of long-term yield from WG-FSA.

4.124 The Scientific Committee recommended that Conservation Measure 43-01 be revoked.

Statements by Argentina and the UK

4.125 Dr Marschoff stated that SC-CAMLR-XXII/4 (Annex 5), as well as some other documents related to WG-FSA and WG-IMAF, contained incorrect references to the territorial status of the Malvinas Islands (Falkland), South Georgia Islands and the South Sandwich Islands attributing them a territorial status they do not have. While reserving its position, Argentina recalled its sovereignty rights over the Malvinas Islands, South Georgia and the South Sandwich Islands and the surrounding waters.

4.126 The UK noted Argentina's statements relating to references in Annex 5 and elsewhere. The UK's position on this issue is well known; the UK has no doubts about its sovereignty over the Falkland Islands, South Georgia and the South Sandwich Islands and the surrounding maritime areas.

4.127 Argentina rejected the views expressed by the UK and reiterated its position.

Fish By-catch associated with Longline and Trawl Fisheries

4.128 There has been much progress towards assessing the long-term status of by-catch taxa. This was identified as an issue for urgent attention at SC-CAMLR-XXI (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.153). The key issues that need to be addressed are:

- assessments of the status of by-catch taxa (particularly rajids and macrourids)
- assessments of the expected impacts of fisheries on by-catch species
- consideration of mitigation measures.

4.129 WG-FSA-03 recommended (Annex 5, paragraph 5.231) that at the next meeting of the Working Group, issues of potential mutual interest to WG-FSA and WG-IMAF should be discussed. These should include:

- estimation of by-catch levels and rates
- assessment of risk, both in terms of geographical areas and population demography
- mitigation measures
- scientific observer duties.

4.130 The Scientific Committee endorsed this program of work.

4.131 Concerning the status of individual species or species groups, insufficient biological information was available at WG-FSA for rajids (skates and rays), and so no assessments were undertaken for these taxa (Annex 5, paragraph 5.234).

4.132 For the other high-priority species group, macrourids (rattails or grenadiers), there were sufficient biological data available to WG-FSA to calculate or revise the value of γ for the three species of *Macrourus* encountered in the fisheries in the CCAMLR Convention Area (Annex 5, paragraphs 5.235 to 5.256). The best estimates of γ were 0.01439 for *M. whitsoni* in Subarea 88.1 (Annex 5, paragraph 5.241), 0.0251 for *M. carinatus* in Division 58.5.2 (Annex 5, paragraph 5.246), 0.01654 for *Macrourus* spp. in Division 58.4.3 (Annex 5,

paragraph 5.251) and 0.02197 for *M. holotrachys* in Subarea 48.3 (Annex 5, paragraph 5.254). These values indicate that these species have relatively low productivity and may be vulnerable to overexploitation.

4.133 WG-FSA noted that no estimates of biomass (B_0) were available for *Macrourus* spp. in Subareas 48.3 or 88.1 and as such, no estimate of precautionary yield could be calculated. The Working Group further noted that an estimate of B_0 is unlikely to be forthcoming in the next few years (Annex 5, paragraph 5.261).

4.134 For *M. carinatus* in Division 58.5.2 an estimate of B_0 was derived using the mean density estimate of *Macrourus* spp. obtained from a research trawl survey of BANZARE Bank in the adjoining Division 58.4.3b, pro-rated to the area of seabed in the same depth range (600–1 500 m) in Division 58.5.2. This gave a mean biomass for Division 58.5.2 of 14 402 tonnes. Applying $\gamma = 0.0251$ gives an estimate of yield for *M. carinatus* in Division 58.5.2 of 360 tonnes (Annex 5, paragraph 5.249). The Scientific Committee accepted this value as the best available estimate of the precautionary by-catch limit.

4.135 The Scientific Committee endorsed the advice of WG-FSA that the application of by-catch limits is to provide adequate protection for by-catch species, with the understanding that the fishery takes steps to reduce and minimise by-catch rates. These by-catch limits, with their attendant uncertainties, should not be used as an indication of long-term sustainable yield, and sustained by-catch at these levels over a number of years would require a revised assessment.

4.136 The Scientific Committee agreed that the development of avoidance and mitigation measures for by-catch species should therefore be given high priority. An incentive for the fishing operators in this regard is the reduction in the ‘nuisance value’ of by-catch supplanting catches of target species.

4.137 The Scientific Committee also endorsed the recommendation of WG-FSA that future work include research leading to the estimation of population parameters and standing stocks for rajids and macrourids. This will become more urgent as the duration of active fisheries increases.

4.138 Dr Constable also noted that paragraphs 9.11 and 9.12 of the WG-FSA report (Annex 5) recommended that until assessments of stock abundance are available, work to refine assessments of those species is not warranted. For such populations, for which there is no indication of an appropriate harvest rate, the emphasis should be on avoidance of capture.

4.139 In the absence of assessments for by-catch species the Scientific Committee endorsed the recommendation of WG-FSA that precautionary measures that place upper limits on by-catch and reduce the potential for localised depletion be adopted.

4.140 The Scientific Committee noted that in 2002, WG-FSA attempted to calculate the total by-catch removals from observer data. An estimate could not be made for all areas because of a lack of data in some cases on the proportion of longline sets observed for by-catch. Also, no data were available on the fish by-catch cut or lost from longlines before being brought on board (Annex 5, paragraph 5.267).

4.141 Although observer logbooks and forms were revised to make provision for such data, most observer reports in the 2002/03 season were submitted on the old forms. However it was possible to calculate estimates of retained and discarded by-catch in all fisheries except those in Subarea 58.6 and Division 58.5.1 using data extracted from Members' own databases. In addition, the amount of by-catch cut from longlines before being brought on board could be calculated for Subarea 48.3 and Division 58.5.2. The Scientific Committee endorsed the request of WG-FSA that Members collecting data in a non-standard format should ensure that all by-catch data are transferred to the CCAMLR database.

4.142 Estimates of retained/discarded by-catch are presented in Annex 5, Table 5.25. For macrourids, the percentage of the target species catch ranges from less than 1% (Division 58.5.2) to 26% (Subarea 58.6). For rajids the percentage ranges from less than 1% (Subarea 48.3) to 20% (Subarea 58.6).

4.143 The Scientific Committee welcomed the attempt by WG-FSA to estimate the amount of by-catch cut or dropped off the line before being brought on board, and the first attempt to estimate the survivorship of these fish in the catch–release process (Annex 5, paragraphs 5.273 to 5.279). Results are summarised in Annex 5, Table 5.26. The Scientific Committee commended the study by the UK on skate survivorship, recognising the operational difficulties involved and the value of the results. It encouraged further studies in this regard, which would provide information on whether there are differences in survivorship between vessels or whether a universal estimate can be applied to each species.

4.144 For Subarea 48.3, the estimate of rajids cut off the line ranges from 37 to 179 tonnes for the 2002/03 season depending on the survival rate assumed, and for Division 58.5.2 the range is 35 to 45 tonnes. For macrourids in Subarea 48.3, the range is 74 to 248 tonnes, although the Scientific Committee noted that as all macrourids are likely to be dead on reaching the surface because of the expansion of their swim-bladders, the higher figure is likely to be correct. In Division 58.5.2 the macrourid mortality was estimated at 5 tonnes.

4.145 The Scientific Committee noted that WG-FSA was unable to assess variations in by-catch level by different vessels (Annex 5, paragraphs 5.280 and 5.281) and that such an analysis could be undertaken intersessionally. The Scientific Committee endorsed this approach to understand inter-vessel differences in by-catch, which could be used to develop mitigation and avoidance measures for by-catch.

4.146 The Scientific Committee also noted the discrepancies in reporting by-catch between the various reporting systems (Annex 5, paragraphs 5.282 to 5.284). In summary, these are:

- STATLANT data underestimate by-catch;
- fine-scale and catch and effort estimates were generally similar although data quality was inconsistent and varied by year and area;
- fine-scale data (haul-by-haul) is the most comprehensive of the three datasets for by-catch.

4.147 The Scientific Committee endorsed WG-FSA's recommendation to report accurately by-catch in all data formats.

4.148 The Scientific Committee noted that WG-FSA had identified a potential conflict of advice to vessels and observers with respect to by-catch in that on the one hand live rajids should be cut from the line, whereas there is also a requirement for observers to collect data and perform survivorship experiments (Annex 5, paragraphs 5.289 to 5.292). The Scientific Committee endorsed WG-FSA's advice that, where possible, all rajids should be cut from lines while still in the water except on the request of the observer during the observer's biological sampling period.

4.149 The Scientific Committee also endorsed WG-FSA's request that Members and observers report, when feasible, the fishing strategies and techniques adopted to minimise by-catch so that these can be considered in the wider context of general measures on by-catch mitigation (Annex 5, paragraphs 5.293 to 5.296).

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4.150 The estimate of precautionary yield for *M. carinatus* in Division 58.5.2 of 360 tonnes should be considered as the precautionary by-catch limit.

4.151 Data on by-catch should be reported as accurately as possible in all data formats.

4.152 Observers should record the proportion of hauls/sets observed for both retained/discarded by-catch and cut off/lost by-catch. In addition, observers should record fish that are cut or lost from longlines.

4.153 The data requirements for fish and invertebrate by-catch and the priority tasks for observers in collecting this information should be reviewed intersessionally by the by-catch subgroup of WG-FSA.

4.154 IUU fishing will result in mortality of by-catch species, and therefore the total removals estimated at this meeting should be treated as minimum estimates.

4.155 When not retained for processing, all rajids should be cut from lines while still in the water where possible, except on the request of the observer during the observer's biological sampling period.

4.156 Members and observers, where feasible, should provide a report to the Secretariat on the methods or strategies of fishing that minimise non-target fish by-catch.

New and Exploratory Fisheries

New and Exploratory Fisheries in 2002/03

4.157 Six conservation measures relating to eight exploratory fisheries were in force during 2002/03, but fishing only occurred in respect of three measures and four fisheries. Information on catches from active exploratory fisheries during 2002/03 is summarised in Annex 5, Table 5.1.

4.158 The only exploratory fishery where significant activity took place was for *Dissostichus* spp. in Subarea 88.1. A total of 1 792 tonnes of *Dissostichus* spp. was taken against a catch limit of 3 760 tonnes. The 2002/03 season was restricted by icebergs and sea-ice. Although the Ross Sea Polynya was open, no fishing took place south of 72°30'S because of safety concerns, therefore little catch was taken from the southern SSRUs.

4.159 Although the overall catch was about 50% of the catch limit for Subarea 88.1, catch limits in two fine-scale rectangles were exceeded by 3%, and the catch limit on SSRU 881C was exceeded by 106 tonnes (13%). It was noted that the catch limits were exceeded because of the high catch rates and the five-day reporting cycle (CCAMLR-XXII/BG/8). It was also noted that currently for each active fishery (e.g. longline fishery in Subarea 88.1 south of 65°S), the Secretariat reported every five days to Members engaged in that fishery and provided an up-to-date total catch of the target species by fine-scale rectangle, SSRU and for the fishery as a whole. However, the Secretariat only forecast closure dates for the fishery as a whole, and did not attempt to forecast closures in fine-scale rectangles or SSRUs.

4.160 Catches in other exploratory fisheries for *Dissostichus* spp. were 106 tonnes in Subarea 88.2 against a catch limit of 375 tonnes, and 117 tonnes in Division 58.4.2 against a catch limit of 500 tonnes.

4.161 The Scientific Committee noted that four Members were in breach of paragraph 9 of Conservation Measure 41-01 which requires Members who have lodged an exploratory fishery notification but decide subsequently not to fish to notify the Secretariat of that fact. Notifications by Members not intending to enter a fishery had only been received from Japan, in respect of five areas, and New Zealand, in respect of one area.

4.162 As part of Conservation Measure 41-01 all vessels are required to carry out a research plan which includes completing a minimum number of research sets on entering an SSRU. Of the 10 vessels fishing in the new and exploratory fisheries, only one Russian vessel failed to complete its quota of research sets. The Scientific Committee welcomed the results of the research activities of the other vessels, which in some cases had completed more than their required 20 research sets per SSRU.

New and Exploratory Fisheries Notified for 2003/04

4.163 A summary of new and exploratory fisheries notifications for 2003/04 is given in SC-CAMLR-XXII/BG/5 Rev. 1 (Annex 5, Table 5.1). There was a total of 31 notifications made by 14 Members. The numbers of vessels for the notifications for exploratory fisheries for *Dissostichus* spp. in 2003/04 are shown, grouped by subarea or division, in Annex 5, Table 5.2. Four notifications were incomplete or not submitted by the deadline. Conservation measures in force for those areas for the 2002/03 season are provided in Annex 5, Table 5.2.

4.164 As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions (Annex 5, Table 5.2). While this is of concern, the Scientific Committee also noted that the experience of previous years indicated that a number of these might not be activated.

4.165 The Scientific Committee noted that there were a number of notifications for Subareas 48.1, 48.2, 58.6, 58.7 (outside EEZs) and Division 58.4.4 where directed fishing on *Dissostichus* spp. is prohibited. The Scientific Committee noted that conservation measures indicated that these will remain closed to the toothfish fishery until a survey has been completed, the results analysed, and the fishery is reopened on the advice of the Scientific Committee to the Commission.

4.166 Other notifications were for fishing in Division 58.4.1 and Subarea 88.3, which were closed to fishing in the 2002/03 season. The Scientific Committee noted that neither area has defined SSRU boundaries or catch limits. There were also notifications for the assessed fisheries in Subarea 48.3 and Division 58.5.2.

4.167 WG-FSA had requested clarification on its role in assessing notifications with regard to closed areas and notifications that were incomplete and those that had been submitted late (Annex 5, paragraph 5.14). It had also requested direction on how to proceed with assessing all-encompassing notifications as opposed to assessing notifications that follow strictly the requirements of the conservation measures.

4.168 The Scientific Committee further noted that notifications fall into two categories:

- (i) notifications to participate in an exploratory fishery that had been active in the previous season and with operational details consistent with existing measures;
- (ii) notifications to fish in subareas and divisions currently closed to fishing by conservation measures and/or with operational details absent or not consistent with existing measures.

4.169 The Scientific Committee was concerned that the large number of notifications placed a considerable workload on WG-FSA and WG-IMAF, which are expected to review all notifications. To allow the Scientific Committee to evaluate how the proposed fishing activities are likely to provide information from which assessments can be made, the Scientific Committee recommended that, in order to undertake exploratory fishing in subareas or divisions currently closed by conservation measures, Members should follow the procedures outlined in Conservation Measure 24-01 (Application of Conservation Measures to Scientific Research). This will require that a research plan be submitted to the Secretariat at least six months in advance of the planned start date.

4.170 Given the considerable workload of WG-FSA and WG-IMAF, the Scientific Committee requested clarification from the Commission on its role in assessing notifications which were submitted late.

4.171 In reviewing the notifications, the Scientific Committee observed that there had been an improvement in specifying intended catches. The Scientific Committee emphasised that intended catch levels should be governed by what is required for economic viability and by operational and data acquisition considerations, as specified in Conservation Measure 21-02.

4.172 The Namibian Representative noted that Namibia had withdrawn notifications CCAMLR-XXII/29 and XXII/31 and did not want them discussed by the Scientific Committee.

4.173 There have been a very large number of notifications for fishing in some localities. It was noted that, depending on the size of the precautionary catch limits, this implies that if all vessels operated simultaneously, the available catch per vessel could be lower than that required for economic viability, especially for those vessels operating in high latitudes where fishing imposes considerable operational difficulties.

4.174 There were also two notifications for exploratory trawl fisheries. An Australian notification is for a trawl fishery for *Dissostichus* spp. and *Macrourus* spp. in Divisions 58.4.3a and 58.4.3b. A Russian notification is for a mixed trawl fishery targeting *Chaenodraco wilsoni*, *Trematomus eulepidotus*, *Lepidonotothen kempfi* and *Pleuragramma antarcticum* and several other Nototheniidae in Division 58.4.2.

4.175 The Scientific Committee noted that some Members have experienced difficulties with some provisions of Conservation Measures 10-04 and 24-02 in that there are potentially contradictory requirements for the holding of fishing licences and for the conduct of bottle tests (Annex 5, paragraph 13.1). This should be drawn to the attention of the Commission.

Small-scale Research Unit (SSRU) Boundaries

4.176 The Scientific Committee recalled its advice from last year to investigate more appropriate SSRU boundaries for Subarea 88.1 during the intersessional period (SC-CAMLR-XXI, Annex 5, paragraphs 5.27 to 5.31).

4.177 The Scientific Committee agreed that the new SSRUs proposed by WG-FSA better captured the irregular shapes of the bathymetric features and fishing grounds encountered in the subarea, and resulted in SSRUs more similar in size to those in other CCAMLR areas. The resulting 12 new SSRUs are shown in Annex 5, Figure 5.1.

4.178 The Scientific Committee recognised that it is becoming difficult to manage the closure of fine-scale rectangles in Subarea 88.1 because of the increase in the number of vessels operating there. The Scientific Committee believed that increasing the numbers of SSRUs, whilst at the same time removing catch limits on fine-scale rectangles, will overcome many of the current problems with area closures. This is because it will drastically reduce the number of subdivisions (fine-scale rectangles) that the Secretariat has to manage, whilst at the same time increasing the catch limit in each new subdivision (SSRU). In general, this means that catch limits will be approached more slowly and be easier to manage. However, some of the proposed SSRUs will likely have catch limits that are equal to or less than the current 100 tonne fine-scale rectangle limit, and would therefore also face the same reporting issues as highlighted for fine-scale rectangles. Other options for better managing catch limits on SSRUs include reducing the amount of effort in SSRUs, more frequent reporting of catches, and, in addition, the forecasting of closures of SSRUs. (At present forecasting is only carried out for larger subareas and divisions.)

4.179 The Scientific Committee recommended that the new SSRUs be adopted and the approaches above be considered in managing the distribution of effort in this exploratory fishery.

4.180 The Scientific Committee discussed the application of this approach to other new and exploratory fisheries in the CCAMLR Convention Area. Although some limited catch and

distributional data were available for Subarea 88.2 and Division 58.4.2, the data were too sparse to revise SSRU boundaries in these areas. The Scientific Committee recommended that the SSRU boundaries for these and other areas be reviewed when more data were available, but consistency could be applied across subareas and divisions for which little information is available.

4.181 The Scientific Committee also noted that there were notifications for exploratory longline fisheries in Division 58.4.1 and Subarea 88.3. This is the first notification to fish in Division 58.4.1 and there are no existing SSRU boundaries for either area. The Scientific Committee recommended that SSRU boundaries be no larger than 10° of longitude to be consistent with SSRU boundaries in other high-latitude subareas and divisions.

Approaches to Setting Catch Limits for Subarea 88.1

4.182 Totals of 1 740 tonnes of *D. mawsoni* and 51 tonnes of *D. eleginoides* were caught during 2002/03. This exploratory fishery has now been in operation for the past six seasons (WG-FSA-03/44). During that time, the total catches of *Dissostichus* spp. have been 41 tonnes in 1998, 296 tonnes in 1999, 745 tonnes in 2000, 659 tonnes in 2001, 1 333 tonnes in 2002 and 1 791 tonnes in 2003.

4.183 For the last three years WG-FSA has used the approach for calculating precautionary yields for *Dissostichus* spp. for Subarea 88.1 outlined in SC-CAMLR-XIX, Annex 5, paragraphs 4.20 to 4.33. This approach is based on analogy with *D. eleginoides* in Subarea 48.3, where yields are calculated based on the estimates of mean recruitment in that population.

4.184 The Scientific Committee noted that the former assessment of yield for Subarea 88.1 should no longer be used because of errors in the estimates of mean recruitment of *D. eleginoides* in Subarea 48.3 (paragraphs 4.36 to 4.48). The corresponding estimates of yield for the whole of Subarea 88.1 based on the alternative Subarea 48.3 recruitment series are given in Table 5. The Scientific Committee noted that in the past these estimates had been discounted by factors ranging from 0.3 to 0.5.

4.185 The Scientific Committee also noted that the existing catch limit of 3 760 tonnes for Subarea 88.1 had been derived by increasing the 2001/02 catch limit by 50%, rather than accepting the corresponding change based on the assessment of Subarea 48.3.

4.186 The Scientific Committee was unable to develop management advice based on assessments of precautionary yields for Subarea 88.1. However, as a precautionary measure the Scientific Committee recommended that the current catch limit should not be exceeded. It further considered that the yield by analogy with the Subarea 48.3 approach should no longer be used to estimate yield in this subarea. It was recognised there was an urgent need to develop methods in this subarea that will provide an independent assessment of long-term sustainable yield for this area.

Approaches to Setting Catch Limits for Subarea 88.2

4.187 An exploratory fishery has now been carried out in Subarea 88.2 for the last two seasons with reported catches of *Dissostichus* spp. of 41 tonnes in 2001/02 in SSRU 882A and 106 tonnes in 2002/03 from SSRU 882E.

4.188 In line with the approach taken for Subarea 88.1, the corresponding estimates of yield for Subarea 88.2 are given in Table 5. Note that these estimates apply only to SSRU 882A.

4.189 The Scientific Committee also noted that the existing catch limit of 375 tonnes for Subarea 88.2 had been derived by increasing the 2001/02 catch limit by 50%. The Scientific Committee was unable to provide any further management advice on appropriate yields or catch limits for Subarea 88.2. However, as a precautionary measure the Scientific Committee recommended that the current catch limit should not be exceeded. It further considered that the yield by analogy with the Subarea 48.3 approach should no longer be used to estimate yield in this subarea. It strongly recommended the need to develop methods in this subarea that will provide an independent assessment of long-term sustainable yield for this area.

Progress towards Assessments of Subarea 88.1

4.190 At last year's meeting the Commission urged Members to undertake further research on methods of monitoring abundance of *Dissostichus* spp. in Subareas 88.1 and 88.2 (CCAMLR-XXI, paragraph 9.18). During the intersessional period New Zealand looked at a number of different approaches including the feasibility of acoustics, standardised CPUE analysis, simulation studies of research sets, and a tagging feasibility study (Annex 5, paragraph 5.46). Of these approaches, New Zealand considered that the implementation of a suitably designed tag-recapture experiment was most likely to succeed.

4.191 At the WG-FSA meeting the relative benefits of trawl surveys, tagging studies, depletion experiments and experimental management of fishing effort were discussed (Annex 5, paragraphs 5.47 to 5.55) and these are summarised in Annex 5, Table 5.4.

4.192 The Scientific Committee recognised the importance of trawl surveys in the assessment process for *Dissostichus* fisheries in Subarea 48.3 and Division 58.5.2. Because of the value and importance of the *Dissostichus* fishery in Subarea 88.1, it recommended that the feasibility of a fishery-independent research survey be determined and a survey be conducted in the future to provide information on recruitment, biomass and distribution that would be valuable for stock assessment purposes. The Scientific Committee noted that there would likely be logistical difficulties such as the large size of Subarea 88.1, as well as uncertain and potentially heavy ice conditions. However, the Scientific Committee noted the success of the multinational CCAMLR-2000 Survey, and recommended options such as surveying a smaller part of the area, or particular SSRUs, and having contingency plans if ice proved to be a problem. They also noted that historical ice charts could be examined that could provide useful information to the design of such a survey.

4.193 The Scientific Committee noted that a tag-recapture experiment on *D. eleginoides* at Macquarie Island had led to an assessment of accessible biomass in the area (Tuck et al., 2003). The Scientific Committee endorsed the inclusion of tagging as a requirement in the research plans for the Subarea 88.1 and 88.2 fisheries for the 2003/04 season. Further details

on tagging protocols are provided in the WG-FSA report (Annex 5, paragraphs 7.11 to 7.18 and Appendix D). It also noted that, at the proposed rate of tagging of one tag per tonne of toothfish catch, it would take at least 10 years before a precise estimate of abundance could be obtained. The Scientific Committee urged WG-FSA to consider how mark-recapture information might be used in the interim with the inclusion of how to incorporate the attendant uncertainties in the assessments. To date, New Zealand vessels have tagged 2 000 fish in these subareas (Annex 5, paragraph 5.62).

4.194 The Scientific Committee considered that additional approaches would be required to provide estimates of biomass in the short to medium term and recommended that, during the intersessional period, the following work program be carried out by Members fishing in Subarea 88.1:

- carry out further tagging simulation studies as detailed in Annex 5, Appendix D, to determine the best approach to tagging in Subarea 88.1 that could lead to an assessment (Annex 5, Appendix D, paragraph 8);
- review practicalities and possible research designs for carrying out a trawl survey on juvenile *Dissostichus* spp. in the Ross Sea (Annex 5, paragraph 5.56);
- carry out simulation studies to determine optimal ways to direct fishing effort, both within and between years, to achieve necessary contrast in fishery and stock parameters that could lead to an assessment.

This approach would include adoption of the proposed SSRUs and implementation of the tagging program in 2003/04, a work program in the intersessional period, with a review at the 2004 CCAMLR meeting, and further implementation of the tagging program and other approaches for the 2004/05 and 2005/06 seasons as discussed below.

4.195 For the 2003/04 season the Scientific Committee recommended that the catch limit for the whole of Subarea 88.1 be apportioned to the SSRUs on the basis of the fishable seabed area (600–1 800 m) and mean CPUE per SSRU. The percentage of the catch for each SSRU is given in Table 6. This will encourage effort to be directed into areas that have been consistently fished in recent years.

4.196 The Scientific Committee noted that in using this approach some SSRUs would end up with low catch limits. It also noted that the Secretariat might have considerable difficulty in managing areas with small catch limits. It advised the Commission to consider these factors when setting catch limits for these SSRUs.

4.197 In some of the proposed SSRUs the large distance between bathymetric features means that there may be operational difficulties in placing 20 research sets meeting the 5 n mile separation criteria as required in Conservation Measure 41-02. The Scientific Committee recommended that this be overcome by requiring only 10 research sets in SSRUs where the fishable seabed area is less than 15 000 km².

4.198 The Scientific Committee recommended that the outcomes of this intersessional work be evaluated at the WG-FSA-SAM meeting in 2004, and the results of that evaluation be considered by WG-FSA and the Scientific Committee in 2004. It also noted that different approaches to obtain the necessary data to lead to an assessment may not be mutually

exclusive. For example, an experiment combining an intensive tagging program and the management of effort in a few SSRUs for two to three years could provide a powerful tool for estimating population abundance and other input parameters required for an independent assessment of yield (Annex 5, paragraph 5.57).

4.199 The Scientific Committee also briefly discussed provisions for by-catch in Subarea 88.1. It advised that the total by-catch limits for the subarea should be the same as for 2002/03, and that catch limits for each SSRU should be pro-rated in the same way as the catch limits for *Dissostichus* spp. It encouraged further work in the intersessional period to examine more appropriate SSRU by-catch levels that are more in accordance with the by-catch distribution and abundance.

Exploratory Longline Fisheries for *Dissostichus* spp.
in Divisions 58.4.1 and 58.4.2

4.200 The Scientific Committee noted that, excluding Namibian proposals, 12 vessels had been notified for fishing in Division 58.4.2 and five vessels notified to fish in Division 58.4.1 for *Dissostichus* spp. using longlines. It also noted that the existing conservation measure, Conservation Measure 41-05, for exploratory longline fishing for *Dissostichus* spp. in Division 58.4.2 has the following elements among others:

- (i) SSRUs are 10° longitude in width;
- (ii) fishing is prohibited in waters less than 550 m to protect benthic communities;
- (iii) further protection to benthic communities is provided by closing half of each SSRU;
- (iv) a catch limit of 100 tonnes per SSRU is applied;
- (v) the overall catch limit for the division is 500 tonnes.

4.201 The Scientific Committee also noted its discussion and consideration of the following points, along with points raised by WG-FSA:

- (i) SSRUs should be no more than 10° longitude in width (Annex 5, paragraphs 5.28, 5.29 and 5.82);
- (ii) fishery activities should be conducted in a manner that they lead to an assessment in the short term (Annex 5, paragraph 5.83);
- (iii) a tagging program combined with concentration of effort in some SSRUs could provide a better understanding of the stock and is likely to be a promising approach that could lead to an assessment at present, pending consideration of simulation trials in the coming year and a review of the potential implementation of research surveys (Annex 5, paragraph 5.83);
- (iv) a research plan should be part of every exploratory fishery (Annex 5, paragraphs 5.72 and 7.12);

- (v) the development of an experimental approach would be desirable to help understand the dynamics of the fishery and for providing important data for assessments (Annex 5, paragraph 5.83), which could be undertaken with the assistance of simulation studies intersessionally.

4.202 It was also noted that the results of this year's exploratory fishery in Division 58.4.2 showed that the implementation of the research sets as currently specified requires a greater area than half an SSRU. Those results also showed which SSRUs would be more accessible given the current understanding of the variability in ice conditions.

4.203 On that basis, it was agreed to recommend the following for the exploratory longline fisheries in Divisions 58.4.1 and 58.4.2 combined:

- (i) 10° longitude SSRUs be established throughout these divisions;
- (ii) the area of Division 58.4.1 north of 60°S be considered as a single SSRU;
- (iii) for protection to benthic communities (SC-CAMLR-XIX, paragraph 9.15), it is recommended that the existing provision to prohibit fishing in waters less than 550 m be retained.

4.204 With respect to setting limits on exploratory catches in each SSRU, some Members recommended that:

- (i) half the 10° longitude SSRUs across Divisions 58.4.1 and 58.4.2 combined have a catch limit of 200 tonnes in each SSRU while the other half have a catch limit of zero until an assessment has been undertaken to determine how the fishery can be developed appropriately across the whole area in the longer term;
- (ii) this approach would be consistent with the existing conservation measure and provide for an orderly development of the fishery, opportunities to gather data from a tagging program and the fishery as well as providing some protection to benthic communities (SC-CAMLR-XIX, paragraph 9.15);
- (iii) based on existing knowledge from the fishery and recognising the operational requirements of the research plan and the difficulties imposed by ice, alternate SSRUs have the catch limit of zero tonnes beginning with the SSRU at the western end of Division 58.4.2 having a catch limit of 200 tonnes and the alternating seven will end with the SSRU at the eastern end of Division 58.4.1 having a catch limit of zero tonnes;
- (iv) the northern SSRU in Division 58.4.1 would have a catch limit of 200 tonnes;
- (v) the variation in catch limits across SSRUs would be reviewed next year by WG-FSA.

4.205 Others did not agree with setting a catch limit of zero tonnes in some areas because it would present operational difficulties due to the variation in ice conditions and the unpredictability of which SSRUs might be accessible. They also indicated that they would prefer data be gathered throughout these divisions for assessment purposes. To that end, they recommended that the catch limit in each SSRU should be 100 tonnes.

Exploratory Trawl Fishery in Division 58.4.2

4.206 The Scientific Committee noted that no advice is available on the notification for an exploratory trawl fishery in Division 58.4.2. In the absence of advice, it draws the attention of the Commission to the following:

- (i) a conservation measure, 237/XX, was established for a similar fishery in 2001;
- (ii) the current notification indicates it will primarily use pelagic trawl methods and does not indicate a request to undertake bottom trawl experiments as specified in the former conservation measure;
- (iii) consideration of trawling in this area in the past has noted the need to provide interim protection to benthic habitats pending research on the potential impacts of bottom trawling (SC-CAMLR-XIX, paragraph 9.15);
- (iv) Russian scientists maintain the view that bottom trawling will be necessary in order to catch fish and that the species indicated in the notification are not found in areas where benthic sponge and coral communities are present. Dr Sushin clarified that the notification talks of the possibility of demersal trawls. Such trawls on Russian vessels are carried out by bottom trawls;
- (v) restriction of the fishery to deeper waters may protect benthic communities but the specified target species are not likely to be found in those waters;
- (vi) consistent approaches in SSRUs and other measures will need to be applied to this fishery and the longline fishery in Division 58.4.2.

Management Advice on Trawl Fishery for *Macrourus* spp. and *Dissostichus* spp. in Divisions 58.4.3a and 58.4.3b

4.207 The assessment of *Macrourus* spp. in Divisions 58.4.3a and 58.4.3b was revised (Annex 5, paragraph 5.251). The Scientific Committee recommended a catch limit of 159 tonnes for Division 58.4.3a and of 26 tonnes in Division 58.4.3b. The Scientific Committee noted that the notification for the catch of *Macrourus* spp. in 2003/04 is for a larger overall total catch (CCAMLR-XXII/25), as it was based on the previous assessment of *Macrourus* spp. in these divisions.

Comments on Research Plans

4.208 In each of the exploratory fishery notifications, the research plans proposed at least met the minimum requirements specified in Conservation Measure 41-01 and in some aspects exceeded them.

4.209 The Scientific Committee did not have time to thoroughly review the research plan and data collection plans specified in Conservation Measure 41-01 during the meeting, but recommended that they be reviewed intersessionally.

Advice to the Commission

4.210 The Scientific Committee recommended that notifications to fish in subareas and divisions currently closed to fishing under conservation measures should follow procedures outlined in Conservation Measure 24-01, which requires that a research plan be submitted to the Secretariat at least six months in advance of the planned start date.

4.211 The Scientific Committee requested clarification from the Commission on how it should deal with late notifications.

4.212 The Scientific Committee recommended that the yield by analogy with Subarea 48.3 should no longer be implemented to determine yields in Subareas 88.1 and 88.2. The Scientific Committee could offer no specific advice on catch limits for the *Dissostichus* spp. fisheries in Subareas 88.1 or 88.2. However, as a precautionary measure the Scientific Committee recommended that the current catch limits should not be exceeded for these two subareas. It recommended that the division of any catch limit agreed by the Commission in Subarea 88.1 should follow the proportions given in Table 6.

4.213 The Scientific Committee recommended the adoption of new SSRUs proposed by WG-FSA and new approaches be considered for managing catch limits in those areas (paragraph 4.178).

4.214 The Scientific Committee recommended the continuation of the research plans in these fisheries with a change that only 10 research sets be required in SSRUs where the fishable seabed area is less than 15 000 km² (paragraph 4.197) and with the addition of the mark-recapture program discussed by WG-FSA.

4.215 The Scientific Committee recommended that, for the exploratory longline fisheries in the combined Divisions 58.4.1 and 58.4.2:

- (i) 10° longitude SSRUs be established throughout these divisions;
- (ii) the area of Division 58.4.1 north of 60°S be considered as a single SSRU;
- (iii) the existing provision to prohibit fishing in water less than 550 m be retained.

4.216 The Scientific Committee drew the Commission's attention to the discussion on catch limits for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 in paragraphs 4.204 and 4.205, indicating considerations on the variation of the existing conservation measure for exploratory longline fishing in Division 58.4.2 and its application to Division 58.4.1.

4.217 The Scientific Committee drew the attention of the Commission to its discussion on the proposed exploratory trawl fishery in Division 58.4.2 in paragraph 4.206.

4.218 The Scientific Committee recommended catch limits of *Macrourus* spp. of 159 tonnes in Division 58.4.3a and 26 tonnes in Division 58.4.3b (paragraph 4.207).

4.219 The attention of the Commission is drawn to the fact that some Members have experienced difficulties with some provisions of Conservation Measures 10-04 and 24-02 in that there are potentially contradictory requirements for the holding of fishing licences and for the conduct of bottle tests (paragraph 4.175).

4.220 With respect to other exploratory longline fisheries, the Scientific Committee drew the attention of the Commission to:

- (i) consideration of the size of SSRUs to be no more than 10° longitude wide (paragraph 4.203);
- (ii) consideration of changes to the research plan (paragraph 4.214);
- (iii) measures contained in Conservation Measure 41-04 for Subarea 48.6 are recommended to remain in force for the coming season also taking account of advice in paragraph 5.38.

Crab Resources

4.221 No target fishery for stone crabs was carried out in 2002/03 and no proposal for the harvest of crabs has yet been received by CCAMLR for the 2003/04 season. The Scientific Committee recommended that existing Conservation Measures 52-01 and 52-02 on stone crabs should remain in force.

Squid Resources

Martialia hyadesi (Subarea 48.3)

4.222 No target fishery for squid was carried out in 2002/03 and no new request has been submitted to CCAMLR to continue exploratory fishing on this species. The Scientific Committee recommended that the existing Conservation Measure 61-01 for the squid *Martialia hyadesi* should remain in force.

INCIDENTAL MORTALITY

5.1 The Scientific Committee reviewed the report of ad hoc WG-IMAF. It endorsed the report and its conclusions and the plan of intersessional work (Annex 5, Appendix E), subject to the comments set out below, and drew these to the attention of the Commission.

Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area in 2003

5.2 The Scientific Committee noted that:

- (i) for Subarea 48.3 the total estimated seabird by-catch in 2003 was only eight birds at a rate of 0.0003 birds/thousand hooks, even lower than the values of the last three years (Annex 5, paragraphs 6.8 and 6.9 and Table 6.3);

- (ii) within the South African EEZs in Subareas 58.6 and 58.7, the total estimated seabird by-catch was seven birds at a rate of 0.003 birds/thousand hooks, maintaining the substantial reduction from the situation two years ago (Annex 5, paragraphs 6.10 and 6.11 and Table 6.3). The causes of this marked improvement are unknown, although fishing effort was still reduced (Annex 5, paragraph 6.11);
- (iii) no incidental mortality of seabirds was observed in Subareas 88.1 (for the seventh successive year), and 88.2 (for the second successive year), nor in Divisions 58.4.2 and 58.5.2 (Annex 5, paragraphs 6.12 to 6.14), presumably due to strict compliance with conservation measures.

5.3 The Scientific Committee particularly noted that the estimated total of seabirds killed (15) represents the lowest estimated seabird by-catch in regulated longline fisheries yet reported for these parts of the Convention Area. It recollected that the comparable figure for 1997, when CCAMLR started to implement conservation measures to address the problem, was 6 589 seabirds killed. It thanked all those involved in conducting and managing fishing operations for their efforts in achieving this excellent result.

5.4 The Scientific Committee noted with concern that no data from longline fishing in French EEZs in Subarea 58.6 and Division 58.5.1 had been submitted for 2003, nor, as requested and promised last year, for 2002 (SC-CAMLR-XXI, paragraph 5.5; Annex 5, paragraphs 6.14 to 6.16). However, it thanked France for sending a scientist to the ad hoc WG-IMAF meeting, for providing information on seabird incidental mortality in these areas for the last two years and a detailed summary on French actions to address the problem (Annex 5, paragraphs 6.19 and 6.20), to be supplemented by a paper on this topic for the Commission meeting (CCAMLR-XXII/57).

5.5 The Scientific Committee noted with serious concern that in the French EEZs in Subarea 58.6 and Division 58.5.1 in 2001/02, 12 057 birds (94% white-chinned petrels) had been killed during setting of 19 million hooks, at a rate of 0.635 birds/thousand hooks, and that in 2002/03, 13 784 birds (93% white-chinned petrels) had been killed during setting of 30 million hooks, at a rate of 0.456 birds/thousand hooks (Annex 5, paragraph 6.19).

5.6 It noted that:

- (i) these levels of seabird by-catch are the highest ever reported for any part of the Convention Area;
- (ii) the by-catch rates are amongst the highest ever reported for the Convention Area (exceeded only by the value of 0.52 birds/thousand hooks for Subareas 58.6 and 58.7 in 1997 – prior to the implementation of effective mitigation measures in the South African EEZs – and those of 0.736 birds/thousand hooks and 2.937 birds/thousand hooks in the French EEZs in 1999 and 2000 respectively (SC-CAMLR-XX, paragraph 4.32));
- (iii) the rates and levels of seabird by-catch in the French EEZs are likely unsustainable for the main seabird populations involved (Annex 5, paragraph 6.22).

5.7 The Scientific Committee endorsed the recommendation that for the longline fisheries in the French EEZs in Subarea 58.6 and Division 58.5.1:

- (i) all current and outstanding data be submitted to CCAMLR as soon as possible for analysis and evaluation in conjunction with any similar analyses by French scientists (Annex 5, paragraph 6.24);
- (ii) these fisheries be managed in strict compliance with Conservation Measure 25-02, together with additional mitigation (as specified in Annex 5, paragraphs 6.28 to 6.30), in respect of line weighting for autoliners, streamer line design and deployment, offal discharge and use of scaring cannons;
- (iii) trials are conducted in the area of existing methods successful in New Zealand at mitigating against by-catch of white-chinned petrels (Annex 5, paragraph 6.31);
- (iv) exchange of fishers takes place between New Zealand and France (Annex 5, paragraph 6.32).

5.8 France responded by stating that it had intensified its efforts to rectify the situation (see Annex 5, paragraph 6.20), involving use and trials of many methods to deter seabirds and by implementing a variety of regulations, including month-long closure of the fishery and vessel-specific by-catch avoidance requirements, all designed to help fishers avoid catching birds. It noted that the seabird by-catch rate in 2003 was significantly lower than in 2002 and that indications from fishing at the start of 2004 were that by-catch rates were lower still.

5.9 However, recognising the gravity of the situation, the potential benefits of collaboration (particularly with fishers and other experts from New Zealand) to address the key elements of the problem and the recognition that measures to ensure rapid sink rates of autolines are essential, France indicated that it intended to implement the recommendations of CCAMLR as summarised in Annex 5, paragraphs 6.28 and 6.29, to the extent that the operational characteristics of its vessels permitted. It further noted that two of its fishing masters would be attending the Commission meeting, facilitating further discussion concerning implementation of these and related recommendations of the Scientific Committee (e.g. Annex 5, paragraphs 6.31 and 6.32).

5.10 The Scientific Committee welcomed these positive responses from France and looked forward to receiving appropriate data and reports in time for the meetings of the Scientific Committee and its working groups next year.

Implementation of Conservation Measures 24-02, 25-02 and 25-03

5.11 The Scientific Committee noted with approval that reports of scientific observers and logbook data indicated that compliance with these conservation measures, relating to mitigation of seabird by-catch, was substantially improved in all subareas and divisions and was again complete in Subareas 88.1 and 88.2. In particular, compliance with streamer line design was now 92% (compared with 86% and 66% in the last two years); night setting compliance was 98% in Subareas 48.3, 58.6 and 58.7; Spanish system line weighting was

100% in Subarea 48.3 (compared with 63% and 60% in the last two years); and the required autoline sink rate of 0.3 m/s was met by all vessels in Subareas 88.1, 88.2 (south of 65°S) and Division 58.4.2 (Annex 5, paragraphs 6.34 to 6.57 and Tables 6.5 to 6.7).

5.12 South Africa re-emphasised its concern relating to compliance failure of vessels fishing in its EEZs in Subareas 58.6 and 58.7 and indicated that it was verifying the circumstances concerning offal discharge by the *South Princess* (Annex 5, paragraph 6.37); it would provide any further relevant information as soon as possible.

5.13 The Scientific Committee noted that in relation to overall compliance with Conservation Measure 25-02, 14 of the 29 vessels (48%), including 8 of 19 in Subarea 48.3, appeared to have fully complied with all measures at all times throughout the Convention Area (Annex 5, paragraph 6.45 and Table 6.7). This compares with 3 of 21 vessels last year (14%).

Research into and Experiences with Longline Mitigating Measures

5.14 The Scientific Committee noted the extensive review of current methods, initiatives and results, especially in relation to improving practices in the Convention Area and to revising the specification of Conservation Measure 25-02 (Annex 5, paragraphs 6.66 to 6.108). It welcomed the successful outcome of trials of integrated weight (IW) longlines, whereby in New Zealand waters by-catch on IW lines and control lines were 1 and 81 white-chinned petrels respectively (Annex 5, paragraph 6.75).

5.15 In respect of the development of IW longlines, the Scientific Committee recollected that this had resulted from a pioneering initiative within CCAMLR between Australian scientists, New Zealand fishers and a Norwegian gear manufacturer. The outcome was becoming one of considerable benefit both to seabirds and to fishers and the fishing industry; it is likely to have global application. The Scientific Committee congratulated all Members involved in the work so far and encouraged other Members to investigate the potential use of IW longlines in their fisheries.

5.16 To enable vital experimental work to take place in the Convention Area in 2003/04, the Scientific Committee endorsed strong support for a trial (the details of which, set out in WG-FSA-03/17, had been endorsed by both WG-IMAF and WG-FSA) of IW lines in Subareas 88.1 and 88.2 in 2003/04, together with exemptions from appropriate conservation measures, in order to develop recommendations for autoline weighting as part of Conservation Measure 25-02 (Annex 5, paragraphs 6.86 to 6.89).

5.17 The Scientific Committee noted the extensive review of most elements of Conservation Measure 25-02, including explaining the basis for the proposed changes to the conservation measure (Annex 5, paragraphs 6.92 to 6.108).

5.18 In response to questions from the Republic of Korea and Russia, it was emphasised that the proposed revisions to the conservation measure are designed to maintain clear and verifiable targets for the mandatory elements of the measure while allowing some flexibility in how these targets are achieved, especially with streamer line design and deployment.

5.19 The Scientific Committee endorsed the proposed revisions to Conservation Measure 25-02, together with the proposed draft text of the measure (Annex 5, Appendix F).

Assessment of Incidental Mortality of Seabirds during IUU Longline Fishing in the Convention Area

5.20 The Scientific Committee noted that:

- (i) the method proposed last year for improving the calculation of estimates of seabird by-catch associated with IUU fishing for toothfish was implemented this year for all parts of the Convention Area where IUU by-catch had been reported (Annex 5, paragraphs 6.112 to 6.116; full details are in SC-CAMLR-XXII/BG/19);
- (ii) a similar approach was applied to the historical data on toothfish removals taking account of information incorporated at the start of this year's meeting;
- (iii) the estimates (median values with the 95% confidence interval range in parentheses) of potential IUU seabird by-catch by area for 2003 (SC-CAMLR-XXII/BG/19) were:

Subarea 48.3:	0 seabirds
Subarea 58.6:	1 622 (1 329–4 330) seabirds
Subarea 58.7:	655 (537–1 749) seabirds
Division 58.5.1:	13 284 (10 888–35 470) seabirds
Division 58.5.2:	1 300 (1 066–3 472) seabirds
Division 58.4.4:	724 (593–1 932) seabirds
Subarea 88.1:	0 seabirds;

- (iv) for 2003, overall estimated potential values, at 17 585 (range 14 412–46 954) seabirds killed, are about 70% of equivalent values for 2001 and 2002 and the lowest value since these estimates commenced in 1996 (Annex 5, paragraph 6.119 and Table 6.8);
- (v) since 1996, an estimated potential total of 187 155 (range 152 381–546 567) seabirds, comprising 41 897 (range of 33 904–132 011) albatrosses, 7 417 (6 059–20 742) giant petrels and 116 130 (95 728–309 932) white-chinned petrels, have been killed in IUU longline fisheries in the Convention Area (Annex 5, paragraph 6.122 and Table 6.8).

5.21 The Scientific Committee endorsed the advice that:

- (i) such levels of mortality remain entirely unsustainable for the populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area (Annex 5, paragraph 6.126), many of which are declining at rates where extinction is possible;
- (ii) the Commission should continue to take stringent measures to combat IUU fishing in the Convention Area (Annex 5, paragraph 6.127).

5.22 The Scientific Committee noted that values for the current and previous years (summarised in Annex 5, Table 6.8) are about one half of those derived from using the previous method (Annex 5, paragraph 6.123), solely because of the changes in the analytical method, rather than reflecting any new information or evaluation. It noted the advice that by-catch rates associated with IUU fishing being used for subareas and divisions in the Indian Ocean were lower than many of the rates reported in regulated fisheries in this area in the last four years. It endorsed the suggested review of seabird by-catch rates used to characterise IUU longline fisheries (Annex 5, paragraph 6.123).

5.23 Dr Constable observed that the new method for deriving estimates of seabird by-catch rates for applying to IUU fishing activities was a considerable improvement, in that it allowed confidence intervals to be placed on the estimate – currently of the median (50%) value. He thanked the Working Group for implementing this but noted that it might be preferable, in addition or instead, to calculate and use the level at which there was an 80% chance that the seabird by-catch levels were at or below a particular value. The Scientific Committee commended this suggestion to the Working Group when undertaking this work next year.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

5.24 The Scientific Committee noted that no new data were reported this year. It asked Members to respond next year to this standing request for information on Convention Area seabirds killed in nearby areas (Annex 5, paragraph 6.131).

Research into the Status and Distribution of Seabirds at Risk

5.25 The Scientific Committee noted that submitted data on:

- (i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrels vulnerable to interactions with longline fisheries;
- (ii) the foraging ranges of populations of these species adequate to assess overlap with areas used by longline fisheries;

are still insufficient for a comprehensive review of these topics. All Members are requested to submit relevant data to next year's meeting (Annex 5, paragraphs 6.133 to 6.137), including information on the extent and location of their seabird by-catch collections to facilitate the development of collaborative research to investigate the origins of birds killed (Annex 5, paragraph 6.158).

5.26 The Scientific Committee noted that important new data on the status and trends of populations of albatrosses and petrels, including changes to their global conservation status (Annex 5, paragraphs 6.138 to 6.155) were discussed and summarised under Agenda Item 6.

International and National Initiatives relating to Incidental Mortality
of Seabirds in relation to Longline Fishing

5.27 The Scientific Committee noted reports on recent and new international initiatives under the auspices of:

- (i) IFF2 – meeting in Hawaii, USA, 19 to 22 November 2002, including a request for CCAMLR Members to consider hosting IFF3 (Annex 5, paragraphs 6.161 to 6.166);
- (ii) ACAP – potential entry into force during 2004 and support for attendance and representation by CCAMLR (Annex 5, paragraphs 6.167 to 6.170);
- (iii) FAO-NPOAs – noting some progress in development of plans (especially by Australia, Brazil, New Zealand, South Africa and the UK) but very limited progress in implementation (Annex 5, paragraphs 6.171 to 6.173).

5.28 In respect of collaboration with relevant RFMOs to address problems of by-catch of seabirds in longline fisheries in areas adjacent to the Convention Area (Annex 5, paragraphs 6.177 to 6.192), the Scientific Committee noted, and/or endorsed as appropriate, the following:

- (i) CCSBT – the report from the November 2001 meeting of the ERSWG had been received (Annex 5, paragraphs 6.179 and 6.180);
- (ii) ICCAT – adopted a resolution on incidental mortality of seabirds at its November 2002 meeting; however concern was expressed that collecting and reporting data on incidental mortality had no specified time frame for implementation (Annex 5, paragraphs 6.181 to 6.183);
- (iii) IOTC – no formal response yet to CCAMLR’s request but a working party on by-catch has been established to which input from CCAMLR in respect of potential by-catch of Convention Area seabirds is recommended (Annex 5, paragraphs 6.184 to 6.187);
- (iv) IATTC – no observer programs in areas where Convention Area birds are likely to be caught (Annex 5, paragraphs 6.188 and 6.189);
- (v) WCPFC – likely to enter into force in 2004; CCAMLR should offer to provide assessments of the potential risk to CCAMLR Convention Area seabirds by vessels fishing in the WCPFC Area (Annex 5, paragraph 6.190);
- (vi) reaffirmation of the desire to organise effective communication and representation of CCAMLR interests at meetings of relevant RFMOs, particularly via appropriate briefing for Members acting as CCAMLR observers (Annex 5, paragraph 6.191);
- (vii) recent initiatives addressing by-catch issues of albatrosses and petrels breeding in the Convention Area by New Zealand, USA and BirdLife International (Annex 5, paragraphs 6.193 to 6.199).

5.29 In respect of Annex 5, paragraph 6.173, Japan stated that it had submitted its NPOA to FAO before the COFI meeting in 2003.

5.30 Dr Naganobu reported that all Japanese southern bluefin tuna longliners operating south of 30°S in the Pacific, Indian and Atlantic Oceans use a tori pole (streamer line) at all times, as this requirement is mandatory for all Commission parties of CCSBT. Furthermore, although some albatross and petrel species may be taken incidentally in the tuna longline fishery operating off Brazil, north of 30°S, few Japanese longliners have operated in this area in recent years. As incidental by-catch of seabirds is quite rare in the subtropical-tropical Indian Ocean he believed that the management of the southern bluefin tuna longline fishery is the most important task for the reduction of incidental take of seabirds in Japanese fisheries in the Southern Hemisphere.

5.31 Dr Fanta noted that a summary of the development of the Brazilian NPOA-Seabirds, of trials of seabird mitigation measures, of requirements for 100% scientific observer coverage on chartered vessels fishing in Brazilian waters and of licence-related incentives for good environmental fishing practice, is provided in SC-CAMLR-XXII/BG/31.

5.32 Prof. Moreno reported that funding had now been acquired to enable a Chilean NPOA-Seabirds to be developed (Fondo de Investigación Pesquera (Chile) (FIP) 2003-21) (including invited experts from Australia, New Zealand and the USA). He indicated the importance of this given that, based on 25% observer coverage, estimates of seabird by-catch in toothfish fisheries within the Chilean EEZ south of 47°S include 1 700 black-browed albatrosses killed annually.

5.33 In respect of the ICCAT resolution, clarification was sought from the European Community (the originator of the resolution eventually adopted) as to why time frames for implementation had not been specified, as contained in the original resolutions proposed by Brazil, China, Japan and the Republic of Korea. Information on the progress of the European Community's NPOA-Seabirds was also requested.

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

5.34 The Scientific Committee noted that:

- (i) of the 21 exploratory longline fisheries approved for 2002/03, only five, in Subareas 88.1 and 88.2 and Division 58.4.2, were operational; no seabird by-catch was reported in any of these fisheries (Annex 5, paragraphs 6.204 and 6.205);
- (ii) the assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised and provided as advice to the Scientific Committee and Commission in SC-CAMLR-XXII/BG/17 (Annex 5, paragraphs 6.201 to 6.203). The only changes to advice in relation to levels of risk of seabird by-catch for any part of the Convention Area were for Divisions 58.4.1 and 58.4.2 (Annex 5,

paragraph 6.207). However, the potential for exemptions for daylight setting in areas of lower risk to seabirds has been clarified and incorporated into the advice (Annex 5, paragraphs 6.208 to 6.211);

- (iii) the 31 proposals by 14 Members for new and exploratory longline fisheries in 15 subareas/divisions of the Convention Area in 2003/04 were addressed, in relation to advice in SC-CAMLR-XXII/BG/17 and Annex 5, Table 6.9 (Annex 5, paragraphs 6.206 and 6.207).

5.35 The Scientific Committee noted that the only potential problems apparently needing resolving in respect of issues relating to incidental mortality of seabirds (Annex 5, Table 6.9 and paragraph 6.207) are:

- (i) inconsistencies in all Namibian proposals with respect to their intention to comply with recommended seabird by-catch mitigation measures, particularly Conservation Measure 25-02, and in respect of fishing seasons;
- (ii) insufficient detail in the Korean proposals for Subareas 88.1 and 88.2 to assess intended compliance with seabird by-catch mitigation measures;
- (iii) the intent in the Norwegian proposal to use only one observer in Subareas 88.1 and 88.2;
- (iv) the intention in the Argentinian proposal for Division 58.5.1 and Subareas 58.6 and 58.7 to fish outside the recommended fishing season.

5.36 In response:

- (i) Namibia indicated that notifications CCAMLR-XXII/29 and XXII/31 had now been withdrawn; subsequent discussion established that in respect of CCAMLR-XXII/30 (for Subarea 48.6), Namibia intended to comply in full with Conservation Measure 25-02;
- (ii) it was reported that discussions with the Republic of Korea established that it intended to comply in full with Conservation Measure 25-02, together with such other related conservation measures as might be required for longline fishing in Subareas 88.1 and 88.2;
- (iii) Argentina indicated that for all its notifications, including those for Division 58.5.1 and Subareas 58.6 and 58.7, it intended to comply with whatever fishing season was established by the Commission for 2003/04, together with all relevant conservation measures;
- (iv) Japan asked that the entry in Annex 5, Table 6.9 in respect of the fishing season specified in its notification for fishing in Subarea 88.1 be corrected to read '1 December 2003 to 31 August 2004', as in the original notification.

5.37 The Scientific Committee noted that the integrated longline weighting experiment proposed for Subarea 88.1, following the experimental design provided in WG-FSA-03/17

and endorsed earlier (paragraph 5.16), would require a specific conservation measure to provide exemption, to the vessels participating in the experiment, for the use of unweighted longlines and to specify appropriate bird by-catch limits for the duration of the experiment.

5.38 The Scientific Committee also noted that in respect of requests to fish during daytime, Conservation Measure 24-02 might need to be amended to permit exemptions from the requirement to set longlines at night, as prescribed in paragraph 3 of Conservation Measure 25-02, for Subareas 48.1, 48.2, 48.4, 48.5, and 48.6 north of 60°S, and Divisions 58.4.1, 58.4.3a and 58.4.3b (Annex 5, paragraphs 6.208 to 6.211).

5.39 The Scientific Committee endorsed the definitions of the nature and status of birds caught (Annex 5, paragraphs 6.214 to 6.217), especially in relation to limits on seabird by-catch; it noted that there may be a need to review appropriate levels of observation to detect accurately low levels of bird by-catch (Annex 5, paragraph 6.218).

Other Incidental Mortality

5.40 The Scientific Committee noted that:

- (i) in the Convention Area in 2003, one southern elephant seal was reported killed in the longline fishery in Subarea 48.3 and three southern elephant seals were reported killed by a longline vessel in Division 58.5.2 (Annex 5, paragraph 6.219);
- (ii) data were provided on interactions between cetaceans and longline fishing, including quantitative estimates of toothfish removals from fishing lines for Subarea 48.3 and for Chilean waters (Annex 5, paragraphs 6.220 and 6.221);
- (iii) Poland reported that its krill trawl fishing vessel in Area 48 caught 73 Antarctic fur seals of which 26 were killed (Annex 5, paragraph 6.226);
- (iv) reports of scientific observers on krill fishing vessels are unavailable until the closure of the krill fishing season, so information from other vessels is lacking.

5.41 Australia reported that, in addition to the seal by-catch reported in paragraph 5.40, as noted in its Members' Activities Report, two Antarctic fur seals and two additional southern elephant seals had been killed in finfish trawl operations in Division 58.5.2.

5.42 The Representative of the Republic of Korea stated that a Korean krill trawler fishing in Area 48 may have caught a number of fur seals at its initial fishing stage, followed by a significant reduction of the capture rate after making escape holes in the net. Details would appear in the report of the scientific observer. However, Korea requested that any Member with experience at avoiding catching seals in trawls or with releasing seals that had been caught, should make this information available.

5.43 The Scientific Committee noted a similar request by WG-FSA (Annex 5, paragraph 6.230) and encouraged Members with relevant experience to make this widely available, including through the IMAF page on the CCAMLR website.

5.44 The Scientific Committee recognised the need to address how best to arrange appropriate reporting of incidental mortality from the krill fishery for consideration at WG-FSA (Annex 5, paragraphs 6.226 to 6.231).

5.45 The Scientific Committee noted that:

- (i) in the trawl fishery for *C. gunnari*/*D. eleginoides* in Division 58.5.2, 15 seabirds were entangled, of which six were killed (Annex 5, paragraph 6.232);
- (ii) in the *C. gunnari* trawl fishery in Subarea 48.3, 43 seabirds were entangled, at least 36 fatally (Annex 5, paragraph 6.233);
- (iii) although levels of seabird by-catch mortality in the trawl fishery in Subarea 48.3 have reduced from 93 in 2001 to 73 in 2002 to 36 in 2003, corresponding by-catch rates of 0.25, 0.15 and 0.20 birds per haul, show no clear trend (Annex 5, paragraphs 6.234 and 6.235 and Table 6.10);
- (iv) considerable new data and information relating to by-catch mitigation in this fishery had been acquired from the reports of scientific observers (Annex 5, paragraphs 6.237 to 6.240).

5.46 The Scientific Committee endorsed the recommendation of WG-FSA that:

- (i) data continue to be collected to improve mitigating measures for the icefish trawl fisheries in Subarea 48.3;
- (ii) Conservation Measure 25-03 should be revised to take account of additional mitigation provisions deriving from recent experiences (Annex 5, paragraphs 6.244, 6.251 and 6.252);
- (iii) review of the current interim seabird by-catch limit for this fishery might be appropriate (Annex 5, paragraphs 6.246 and 6.247);
- (iv) review of measures relating to bottom trawl gear may still be appropriate (Annex 5, paragraphs 6.241 to 6.243).

5.47 Dr Kock noted that in the *C. gunnari* trawl fishery in Subarea 48.3, 15 of the 16 birds killed by the *Sil* had died during a single haul, clearly due to defective operating procedures.

5.48 It was noted that one of the proposed changes to Conservation Measure 25-03 sought to take account of these and similar problems (Annex 5, paragraph 6.252(iii)).

5.49 In respect of advice regarding use of bottom trawl gear, Dr Constable observed that relevant comments exist in Annex 5, paragraphs 5.176, 5.294, 5.295 and 6.241 to 6.243. He suggested that when reviewing this matter WG-FSA should consider the use of open and closed areas as a basis for trials to assess the effects of bottom trawls in order to try to balance the reduction of by-catch of non-target species with impacts on the benthos.

5.50 Dr Kock expressed reservations at recommencing bottom trawling in Subarea 48.3, even in an experimental context.

5.51 The Scientific Committee endorsed the Working Group recommendation that issues relating to the use of bottom trawl gear be examined for all CCAMLR fishing areas in a wider context, both intersessionally and at WG-FSA. Members are requested to submit relevant data and information to WG-FSA intersessionally (Annex 5, paragraph 5.295).

5.52 Prof. Beddington reiterated his concern that when considering the nature and extent of measures to mitigate by-catch of non-target species, the potential levels of impact on the populations concerned was not always taken into full consideration. Thus the situation was very different with respect to albatrosses, where many populations were of globally threatened species in steep decline, compared to Antarctic fur seals whose populations were still increasing very rapidly.

5.53 Concerning the potential revision of *Fish the Sea Not the Sky*, now that the English version is out of print, the Scientific Committee endorsed the recommendation that it might be replaced by appropriate poster material (Annex 5, paragraphs 6.253 to 6.255). It requested the Science Officer, in consultation with WG-IMAF members, to prepare a draft of appropriate material. In the meantime, the English version of the booklet should be made available on the CCAMLR website.

5.54 The Scientific Committee thanked the members of ad hoc WG-IMAF for their work, both intersessionally and at the meeting, and for producing such a comprehensive report.

Advice to the Commission

5.55 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 or advice, as well as topics which may contain the potential for action now or in the near future).

General Advice

5.56 The Commission was requested to note:

- (i) the exceptionally low levels and rates of seabird by-catch in regulated longline fisheries in most parts of the Convention Area in 2003 (paragraphs 5.2 and 5.3);
- (ii) serious concern at levels and rates of seabird by-catch in French EEZs in Subarea 58.6 and Division 58.5.1 (paragraphs 5.5 and 5.6);
- (iii) the very positive assessments of implementation of Conservation Measure 25-02 in 2003 (paragraphs 5.11 to 5.13);
- (iv) progress with research on mitigation measures, especially integrated weighting of longlines, relevant to Conservation Measure 25-02 (paragraphs 5.14 and 5.15);

- (v) estimates of potential seabird by-catch associated with IUU longline fishing in the Convention Area in 2003 (paragraphs 5.20, 5.22 and 5.23);
- (vi) levels of seabird and marine mammal by-catch in fisheries other than longline fisheries in the Convention Area in 2003 (paragraphs 5.40 to 5.42 and 5.45);
- (vii) requests to Members for assistance with avoiding by-catch of seals in krill trawl fisheries (paragraphs 5.40, 5.43 and 5.44);
- (viii) advice concerning reviewing issues relating to the use of bottom trawl gear (paragraphs 5.50 to 5.52).

5.57 The Commission was requested to endorse:

- (i) recommendations of the strict implementation of mitigating measures, trials of such measures and exchange of fishers, in relation to longline fisheries in the French EEZs in Subarea 58.6 and Division 58.5.1 (paragraphs 5.7 to 5.10);
- (ii) support for a key experiment concerning line weighting mitigation measures for autoline longline fishing in the Convention Area (paragraphs 5.16 and 5.37);
- (iii) renewed attempts to acquire data from Members involved in longline fishery operations in areas adjacent to the Convention Area (paragraph 5.24);
- (iv) the need for continued submission by Members of data on seabird population sizes, foraging ranges and provenance of by-catch (paragraph 5.25);
- (v) support for forthcoming international initiatives, especially IFF3 and ACAP (paragraph 5.27);
- (vi) continuing attempts to obtain progress reports on the development and implementation of FAO-NPOAs from Members;
- (vii) definitions of the nature and status of birds caught, relevant to limits to seabird by-catch (paragraph 5.39).

Specific Advice

5.58 The Commission was requested to provide advice, and consider taking action, as appropriate, in respect of:

- (i) suggested revisions to Conservation Measure 25-02 (paragraphs 5.17 to 5.19);
- (ii) suggested revisions to Conservation Measure 25-03 (paragraph 5.46(ii));
- (iii) potential need for revisions to Conservation Measure 24-02 (paragraph 5.38);
- (iv) taking even more stringent measures to combat IUU fishing in the Convention Area in order to protect populations of seabirds at serious risk (paragraph 5.21);

- (v) continuing steps to request RFMOs, with competences in areas adjacent to the Convention Area, to take action in respect of mitigation of seabird by-catch (paragraphs 5.28 and 5.33);
- (vi) advice in relation to proposals for new and exploratory longline fisheries in the Convention Area in 2003 (paragraphs 5.34 to 5.36).

ADDITIONAL MONITORING AND MANAGEMENT ISSUES

Marine Debris

6.1 As requested by the Scientific Committee last year (SC-CAMLR-XXI, paragraph 6.8), the Secretariat prepared a paper on the current status of national surveys on monitoring of marine debris and its impact on marine mammals and seabirds in the Convention Area (SC-CAMLR-XXII/BG/25).

6.2 The CCAMLR marine debris database contains data from 11 sites, all within Area 48. Of these, three sites have data for at least three years that have been collected according to the CCAMLR standard methods. Members, locations and durations are as follows:

- (i) beached marine debris: Chile (Cape Shirreff, Livingston Island, South Shetland Islands 1993 to 1997) and UK (Bird Island, South Georgia 1989 to present, and Signy Island, South Orkney Islands 1991 to present);
- (ii) debris associated with seabird colonies: UK (Bird Island 1993 to present);
- (iii) marine mammal entanglement: UK (Bird Island 1991 to present and Signy Island 1997 to present);
- (iv) hydrocarbon soiling: UK (Bird Island 1993 to present).

6.3 A summary of the trends presented in SC-CAMLR-XXII/BG/25 indicated that:

- (i) marine debris, principally packaging items and fishing gear, reached a peak in the period from 1994 to 1996 at Bird Island and Signy Island and has declined thereafter;
- (ii) the level of marine debris found in seabird colonies at Bird Island has increased particularly since 1998, with fishing gear such as lines and hooks forming the major part of the debris;
- (iii) marine mammal (Antarctic fur seal) entanglement at Bird Island reached a peak in 1993 and showed a decline until 2000, since when there has been a slight increase with packaging bands, synthetic string and longline being the main entanglement material;
- (iv) the number of seabirds contaminated with hydrocarbons remains low.

6.4 The Scientific Committee thanked the Secretariat for its report and recognised that it provided a significant improvement in the presentation of information on the status and trends of marine debris. Members were encouraged to work with the Secretariat during the intersessional period in order to improve presentation and develop standardised procedures for the analysis of marine debris data.

Surveys of Marine Debris on Beaches

6.5 Standardised surveys of marine debris were reported from King George Island, South Shetland Islands (SC-CAMLR-XXII/BG/20), Signy Island, South Orkney Islands (SC-CAMLR-XXII/BG/12) and Bird Island, South Georgia (SC-CAMLR-XXII/BG/10). Fisheries-related debris, including plastic packaging bands, were the dominant debris type in all areas.

Entanglement of Marine Mammals in Marine Debris

6.6 Standardised reporting of the entanglement of Antarctic fur seals in marine debris was reported from Signy Island, South Orkney Islands (SC-CAMLR-XXII/BG/13), where a single entangled animal was recorded between 24 October 2002 and 1 April 2003, and Bird Island, South Georgia (SC-CAMLR-XXII/BG/11) where 25 entangled seals were recorded between 1 April 2002 and 31 March 2003, a reduction of 50% from the previous year. Nylon braid and plastic packaging bands were the most frequently recorded entangling material.

Marine Debris associated with Seabird Colonies

6.7 Marine debris associated with seabirds at Bird Island, South Georgia, from 1 April 2002 to 31 March 2003 was reported in SC-CAMLR-XXII/BG/9. There were 72 items of fishing gear, 58 of which were longlining hooks and line, which was a reduction from the previous year but still higher than the levels recorded between 1993 and 1998.

Seabirds and Marine Mammals Soiled with Hydrocarbons

6.8 Eleven cases of contamination with oil of wandering, black-browed and grey-headed albatrosses were recorded at Bird Island, South Georgia, between 1 April 2002 and 31 March 2003 (SC-CAMLR-XXII/BG/9). In all cases, no more than about 1–2% of the birds' plumage was oiled, and breeding success was apparently not affected.

Submission of Data on Marine Debris

6.9 Dr Fanta reported that the Brazilian Antarctic Program had removed marine debris at Admiralty Bay, King George Island, South Shetland Islands, over the past 20 years. However, there were still difficulties in submitting this data in the CCAMLR standard format.

6.10 Prof. Torres reported that Chile continued to collect marine debris at Cape Shirreff, Livingston Island, South Shetland Islands, in collaboration with the USA, but that these data had not been submitted to the Secretariat in the CCAMLR standard format. Prof. Torres suggested that the continued high incidence of marine debris, particularly plastic packaging bands, may well be indicative of IUU fishing in the region and the Convention Area generally.

6.11 Dr Naganobu reported that, as in the previous years, no fishing gear had been lost from Japanese krill trawlers and that all damaged nets had been disposed of in the incinerators installed on board all of those vessels.

6.12 Dr H. Nion (Uruguay) reported that in addition to the data on marine debris reported in SC-CAMLR-XXII/BG/20, there were no incidents of the entanglement of marine mammals in marine debris, no marine debris associated with seabird colonies or seabirds and marine mammals soiled with hydrocarbons at King George Island, South Shetland Islands.

6.13 Consul D. Chmiel (Poland) reported that during the Polish krill fishing operations no fishing gear had been lost and no marine debris sighted. In accordance with Conservation Measure 25-01, the plastic packaging bands were cut and incinerated on board.

6.14 The Scientific Committee noted that very few Members provided information on marine debris on the CCAMLR standard reporting forms and requested that Members submit such data in order to facilitate the consideration of the status and trends in marine debris by the Scientific Committee (SC-CAMLR-XXI, paragraph 6.23).

6.15 Prof. Torres informed the Scientific Committee that from 20 to 22 August 2003 the Chilean Ministry of Public Health organised the seminar 'VIDA CHILE' in Punta Arenas with the theme 'For a longer and more plentiful life in Magallanes', where a paper entitled 'The marine debris problem in Antarctica' was presented. Arising from this, INACH and Universidad de Magallanes propose to develop a research and education plan to address issues of marine debris in the Magallanes region following the protocols developed by CCAMLR.

6.16 The Scientific Committee welcomed this report of the positive contribution made by CCAMLR to the monitoring of marine debris in regions outside the Convention Area and especially in a location with a number of direct links, both through logistic and fishery operations, to the Antarctic.

Marine Mammal and Bird Populations

6.17 The Scientific Committee noted new data on population status and trends for albatross and petrel species (Annex 5, paragraphs 6.138 to 6.165), including the latest revision of the global conservation status of some species, as reported in the latest (2003) edition of the IUCN/BirdLife International Red List for Birds (WG-FSA-03/101). Although most new data were from populations outside the Convention Area, it was still of considerable concern that four species of albatross (black-browed albatross, Indian and Atlantic yellow-nosed albatrosses and sooty albatross), of relevance to the Convention Area, now meet international criteria for increased global risk of extinction.

6.18 Dr Constable also noted the long-standing desire to assess demographic data in relation to population trends. He suggested that this might be incorporated into the next quinquennial review of the status and trends of marine mammal and bird populations.

6.19 The Scientific Committee recommended that planning for this review should commence at the WG-EMM and WG-IMAF meetings next year. The working groups were requested to develop terms of reference for this review, and to consider the groups and individuals whose expertise and involvement would be most appropriate and valuable. They should prepare proposals for discussion at the Scientific Committee meeting next year.

6.20 The Scientific Committee noted that 14 papers on the status and trends in marine mammal and bird populations in the Southwest Indian Ocean had been considered by WG-EMM (Annex 4, paragraphs 4.60 to 4.69). Several species of seabirds, including sooty and yellow-nosed albatrosses and gentoo, rockhopper and macaroni penguins showed a long-term decline in the population size that was attributed to fishery-induced mortality, avian disease and reduced reproductive performance. In contrast, the populations of king penguin and Antarctic fur seals, both of which fed predominantly on myctophid fish, had undergone considerable increases at a range of sites.

6.21 The Scientific Committee agreed that information from the Southern Indian Ocean had emphasised the importance for some seabirds of incidental mortality associated with fisheries, periodic reductions in food availability associated with changing climatic regimes in the Southern Ocean and the potential utility of comparing the responses of predators to changes in food availability in krill- and non-krill-centred ecosystems.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY ABOUT STOCK SIZE AND SUSTAINABLE YIELD

WG-FSA

7.1 The Scientific Committee took note of the fishery plans which had been updated by the Secretariat. It noted the fishery-related research needs and emphasised the need for necessary changes to the data collection and research plans in order to meet the requirements under Conservation Measure 21-02 (Annex 5, paragraphs 5.299 and 5.300).

7.2 The Scientific Committee noted the desire of SCIC to develop a comprehensive assessment of compliance (CAC) of fishing vessels with conservation measures. It welcomed this initiative to establish a more transparent process of assessment of data obtained from fisheries in as consistent, accurate and verifiable a manner as possible. This should result in a more rigorous assessment of compliance with relevant conservation measures than is currently feasible. An important source of such data is from scientific observers, both through logbooks and observer reports. It was emphasised that these tasks should not compromise observers' other tasks nor their status and role on the vessel.

7.3 The Scientific Committee observed that CCAMLR-XXII/52 proposed one potential method and approach for such comprehensive compliance assessments. It noted that this proposal had been reviewed by WG-FSA (Annex 5, paragraphs 5.302 to 5.306) and WG-IMAF (Annex 5, paragraphs 6.58 to 6.65). It endorsed the main comments from these groups, specifically:

- (i) the importance of ensuring that conservation measures are constructed to be as amenable as possible to objective quantitative monitoring;
- (ii) concern that the proposed approach might result in reducing the standard of compliance. Acceptance of less than 100% compliance with measures would effectively provide a disincentive to fishers to make efforts to achieve the prescribed standards. Many relevant conservation measures (or elements thereof) are only minimum standards and vessels should strive to exceed these standards not just to prevent compliance failure, but also to achieve the best standards of conservation and management;
- (iii) one of the objectives of a compliance score should be to encourage vessels to improve their performance; it would be useful to provide additional incentives for vessels undertaking research;
- (iv) the difficulty, with presently available information, of commenting on priorities and weighting for compliance issues because advice in conservation measures is often best presented as a package rather than as alternative weighted priorities. In addition, combining different conservation measures to derive a total score would be inappropriate where these are designed to address different conservation and management objectives;
- (v) concern that if a threshold total compliance score was less than 100%, this could result in fishers trading off between conservation measures with different weightings to achieve the threshold score. In addition, the method proposed does not address the problem of distinguishing between non-compliant vessels that fail by a small amount and those failing by a large margin.

7.4 The Scientific Committee endorsed the view that the implications of a review of methods of assessing compliance were much more extensive than simply developing a new approach. Any new system would require a comprehensive evaluation of the contents of all conservation measures, of the instructions to observers and inspectors, of the nature, scope and content of the reporting mechanisms and of the details of the data validation, analysis and assessment protocols.

7.5 The Scientific Committee encouraged the Commission to ensure that discussions of the development of assessment procedures for compliance with conservation measures are based on continuing dialogue between SCIC and the Scientific Committee and its working groups.

7.6 Reported catch of *Dissostichus* spp. and estimated catch from IUU fishing in subareas and divisions in the Convention Area, and catch reported in the CDS in areas outside the Convention Area in the 2001/02 and 2002/03 seasons are provided in Annex 5, Table 3.2. The Scientific Committee noted the need to use standard terms surrounding fishing within and outside the CCAMLR Convention Area, and requested the Commission to provide advice on the use of the term 'IUU fishing'.

7.7 It was confirmed that one Spanish vessel fished in Area 51 outside the EEZs and outside the CCAMLR Convention Area and had a scientific observer on board. Catch rates were very variable and *D. eleginoides* were taken. Data were not processed and will be provided next year.

7.8 Catches in Area 47 reported through CDS increased substantially from 655 tonnes to 2 852 tonnes with respect to the previous season (Annex 5, Table 3.2). Catches in FAO Area 41 had declined from 4 472 tonnes in 2001/02 to 1 934 tonnes in 2002/03. In Area 51 catches declined from 10 620 tonnes in 2001/02 to 3 648 tonnes in 2002/03, and in Area 57 from 3 803 tonnes to 858 tonnes. The extent to which this decline had occurred remained debatable. Some Members felt that reported catches had declined substantially. Others were of the opinion that the extent to which catches had decreased remained unclear as catches derived from CDS information were still incomplete with respect to the 2002/03 season.

7.9 CDS data were unlikely to provide all the information needed to estimate the level of IUU catches. The Scientific Committee drew the attention of JAG to the additional use of trade data. The Scientific Committee reiterated, however, that IUU catches are by far too high and would lead to a substantial reduction of the fishery resources in the near future (Annex 5, paragraphs 5.307 to 5.312).

7.10 The Scientific Committee noted that Russian scientists had offered to provide detailed bathymetric data from Area 51 which would allow a better estimate of seabed area to be made (SC-CAMLR-XXI, paragraph 4.36; CCAMLR-XXI, paragraph 8.7). Unfortunately these data were not submitted in time to be considered by the Working Group, but could be analysed in time for next year's meeting. Pending such a review, it was agreed that the best evidence available on seabed areas in the region remains the estimates provided by the Secretariat in SC-CAMLR-XXI, Annex 5, Table 5.32.

7.11 Dr Constable drew the attention of the Scientific Committee to its discussion last year on the effects of IUU fishing on toothfish stocks (SC-CAMLR-XXI, paragraphs 4.32 to 4.41). In particular, the Scientific Committee had considered these effects on the legal catch limits given different rates of IUU catch (SC-CAMLR-XXI, Figure 4). He noted that the Scientific Committee was not in a position to comment at that time on which trajectory the legal catch limit was on, but that more information was now available on the status of stocks in the Indian Ocean and the possible trajectory for the legal catch limits in the near future. On the basis of the report of WG-FSA, the following points could be noted this year for *D. eleginoides* in the Indian Ocean:

- (i) *D. eleginoides* in the Indian Ocean is likely to be a metapopulation with exchange of individuals between shelf areas across the Indian Ocean from east to west and larval transport from west to east (Annex 5, paragraphs 5.143, 7.6 and 7.7);
- (ii) as such, *D. eleginoides* would be a straddling stock across the boundary of the CCAMLR Convention Area;
- (iii) although the exchange between areas has not yet been quantified, the current assessment procedure for estimating yield for *D. eleginoides* will remain satisfactory provided that all removals of fish from cohorts can be appropriately accounted for (Annex 5, paragraph 5.143);

- (iv) no catches should occur in areas for which no understanding of biomass is available;
- (v) the decline of local populations of *D. eleginoides* is evident from the analysis of CPUE data for Subareas 58.6 and 58.7 and Division 58.5.1 (Annex 5, Figures 5.10, 5.11 and 5.16 to 5.18);
- (vi) these declines indicate a significant reduction in biomass of toothfish in these areas, particularly given that the decline of the mean weights of fish in the catches show the fisheries now concentrate on juvenile fish;
- (vii) these results indicate that IUU fishing is having a devastating effect on *D. eleginoides* in the Indian Ocean and on the short-term future of the legal fisheries in some of the CCAMLR subareas and divisions;
- (viii) movement of the IUU fleet into other parts of the CCAMLR Convention Area, including the Atlantic Ocean and the high latitudes, could result in depletion of stocks in those areas in the short term, if IUU catch rates continue at the level reported for the Indian Ocean.

7.12 Prof. Duhamel and Ms T. Akkers (South Africa) reinforced these views given their experience in Division 58.5.1 and Subarea 58.6 and in Subareas 58.6 and 58.7 respectively.

7.13 The Scientific Committee endorsed these views and reiterated its previous statements that the current levels of IUU fishing are unsustainable (SC-CAMLR-XXI, paragraph 4.35).

7.14 During the adoption of the report, the Delegations of Russia and Ukraine expressed their opinion regarding paragraphs 7.11(i) and (ii) that:

- (i) there is insufficient scientific evidence of existence of a metapopulation of toothfish in the Indian Ocean Sector of the Antarctic (Annex 5, paragraphs 7.6 to 7.8); this issue requires further research on population structure throughout the range of the species;
- (ii) the term ‘straddling stock’ has a specific legal meaning and its use has legal implications. Therefore, the use of the term ‘straddling stock’ in the text of the Scientific Committee report is not acceptable.

WG-EMM

7.15 The Scientific Committee endorsed WG-EMM’s request for notification of vessels fishing for krill. This is further discussed under the krill section of this report (paragraphs 4.6 to 4.9).

SCIENTIFIC RESEARCH EXEMPTION

8.1 Conservation Measure 24-01 requires the Commission to be notified of any proposed research surveys that expect to take the taxa and catch limits outlined in Annex 24-01/B.

8.2 The intention of the measure is to:

- allow catches for scientific purposes to be considered as part of any catch limits in force for each species taken;
- provide the opportunity for other Members to review and comment on research plans.

8.3 Scientific research surveys notified to the Secretariat under Conservation Measure 24-01 are placed on the CCAMLR website, which is regularly updated. A table of notification of scientific research surveys in 2003/04 received by the Secretariat by 24 October 2003 is provided in Table 6 of CCAMLR-XXII/BG/8 Rev. 1.

8.4 Last year, the Commission requested the Scientific Committee to review the list of taxa and their expected levels of catch in Annex 24-01/B, taking into account the expected levels below which notification would not be required (CCAMLR-XXI, paragraph 11.26).

8.5 In reviewing Table 6 of CCAMLR-XXII/BG/8 Rev. 1, the Scientific Committee noted that two of the four surveys notified by Australia include a catch of *C. gunnari*, which is not included in Annex 24-01/B, and that in reviewing the list of taxa in Annex 24-01 in the future, consideration of *C. gunnari* might be needed.

8.6 With regard to the catch limit required for notification, the Scientific Committee agreed that a catch limit of 10 tonnes was appropriate for *Dissostichus* spp., but felt that a limit of 50 tonnes was appropriate for *C. gunnari*. In recommending the catch limit for *C. gunnari*, the Scientific Committee noted that catches of >10 tonnes per half-hour tow have occurred occasionally during scientific trawl surveys by the UK and Russia, and that pelagic trawl equipment used by Russia in conjunction with acoustic surveys similarly may result in catches >10 tonnes, and hence that a total catch limit of 10 tonnes could compromise the results of research surveys. The Scientific Committee felt that a 50 tonne limit for *C. gunnari* was both within the spirit of Conservation Measure 24-01 and acceptable for scientific research.

8.7 The Scientific Committee advised the Commission that it would keep Annex 24-01/B under review and provide advice as appropriate.

COOPERATION WITH OTHER ORGANISATIONS

9.1 The Scientific Committee was chaired during this section by Mr López Abellán, Vice-Chair of the Scientific Committee.

Cooperation with the Antarctic Treaty System

CEP

9.2 The report of the Chair of the Scientific Committee (CCAMLR-XXII/BG/11) outlined his participation in CEP-VI under the Madrid Protocol (Madrid, Spain, July 2003). The most important issues of relevance to CCAMLR were:

- (i) CEP addressed the issue of establishing ‘Specially Protected Species’. In contrast to the case for ‘Specially Protected Areas’ where well-established procedures for the cooperation with CCAMLR exist, definitions and procedures for this are still unresolved. The CEP Intersessional Contact Group (ICG) was asked to consider these issues.
- (ii) The ICG was also asked to continue the work under the Terms of Reference agreed by CEP relating to ‘The State of the Antarctic Environment Report’.
- (iii) Subsequent to the CEP meeting, the convener of the ICG asked for CCAMLR to be represented in that group. The Scientific Committee agreed that the Chair of the Scientific Committee should participate in the work of the group.

9.3 The Scientific Committee noted that work on ‘The State of the Antarctic Environment Report’ has been under way for some time and cautioned that the workload of the Scientific Committee did not allow taking on new obligations. It was noted that CCAMLR already summarises data and results from its fisheries and ecosystem monitoring work. CEP should be encouraged to develop – and summarise – work of a complementary nature, including topics such as environmental pollution and diseases.

SCAR

9.4 Dr Fanta, CCAMLR Observer at SCAR and SCAR Observer at CCAMLR, reported on intersessional activities of the SCAR Life Sciences Standing Scientific Group (LSSSG), during the 2002/03 intersessional period (CCAMLR-XXII/BG/32):

- (i) The Group on Evolutionary Biology of Antarctic Organisms – EVOLANTA – held a workshop on ‘Evolutionary Adaptation of Antarctic Marine Organisms’, in Pontignano, Italy, in December 2002, and contributions will be published in a special issue of *Antarctic Science* in 2004. Interaction with groups within CCAMLR conducting research on molecular markers, and stocks identification should be improved, and collaboration established between EVOLANTA and a future WG-FSA initiative to examine ‘The influence of Southern Ocean physical dynamics on the population structure and movements of *D. eleginoides* and *D. mawsoni*’. An EVOLANTA webpage (under construction) aims to be a tool to favour multilateral and international collaboration, and shall establish links with the SCAR and the CCAMLR websites.

- (ii) The Expert Groups on Seals and Birds have continued their work to help SCAR to provide scientific advice to the Antarctic Treaty System on specially protected species. Information and data are supplied to WG-EMM and CEMP every five years.
- (iii) A symposium held in Plymouth, UK, in May 2003, by the Expert Group on Human Biology and Medicine, on 'Extreme Medicine and Antarctica' has outcomes that are important for all those who participate in Antarctic expeditions, surveys or fisheries.
- (iv) A Marine Biodiversity Information Network is proposed aiming to contribute to the compilation, dissemination, and integration of fundamental biodiversity information on Antarctic marine biodiversity for scientific, monitoring, management and conservation purposes, and might provide useful information for ecosystem monitoring purposes in CCAMLR.
- (v) The first part of the XXVIII SCAR meeting will be held in Bremen, Germany, from 25 to 31 July 2004 when LSSSG will meet around an Open Science Conference (www.scar28.org).
- (vi) The IX SCAR Biology International Symposium will be held in Curitiba, Brazil, from 24 to 28 July 2005. A wide participation of Antarctic scientists, including those involved in the work of national programs, SCAR and CCAMLR is expected.

9.5 The Scientific Committee welcomed this report. It noted that in considering establishing any marine biodiversity information network, due consideration should be given to existing Biodiversity Information Networks like OBIS (Ocean Biogeographic Information System) and GBIF (Global Biodiversity Information Facility).

Reports of Observers from International Organisations

IWC

9.6 The IWC Observer, Dr Kock, reported on relevant elements from the meeting of SC-IWC held in Berlin, Germany, 26 May to 6 June 2003 (SC-CAMLR-XXII/BG/2):

- (i) Progress with respect to the collaboration with SO GLOBEC and CCAMLR was presented during two key note lectures given by Dr J. Watkins (IWC–CCAMLR) and Prof. Hofmann (IWC–SO GLOBEC). The presentation on IWC–CAMLR activities focussed on krill, its physical environment, competition and predators. There are marked interactions between the physical environment and population dynamics of krill.
- (ii) The 2002/03 SOWER cruise initially planned to cover the Ross Sea region had to be modified due to the unfavourable ice conditions which provided no access to the Ross Sea.

- (iii) A new abundance estimate was provided from the SOWER cruise 2001/02 for minke whales in the western part of Area V (130–150°E). The estimate was 9 593 (5 950–15 460).
- (iv) A total of 440 minke whales was caught within the CCAMLR Convention Area under the remit of the IWC in 2002/03.
- (v) Blue whales are still found in low numbers. However, over the last 20 years the population of blue whales found in the Southern Ocean has increased 2–3 times from about 700.
- (vi) The Southern Ocean Sanctuary which was established in 1994 will be reviewed by the SC-IWC in 2004.

CCSBT

9.7 A report from the Fourth Meeting of CCSBT-ERSWG held in Tokyo, Japan, from 26 to 28 November 2001 (SC-CAMLR-XXII/BG/21) was introduced by Japan. It contained 10 attachments, several of which indicated the similarity in problems discussed in this group to those of CCAMLR, e.g. regarding mitigation procedures and scientific observer programs.

9.8 The Scientific Committee welcomed this report and encouraged all members of CCSBT to submit to WG-IMAF, papers from the ERSWG relevant to the work of the CCAMLR group. It noted that the meeting was held two years ago and hoped to receive updated information from papers tabled for the next meeting of the group, to be held in February 2004 in New Zealand.

ASOC

9.9 ASOC introduced CCAMLR-XXII/BG/27. It commended the work of WG-FSA and its quick reaction to the discovery of errors in its assessment of toothfish in Subarea 48.3. The most precautionary and conservative advice possible is required at this time to prevent long-term damage to the fishery. ASOC commended the Scientific Committee for agreeing to provide advice to the Commission. It was pleased that the setting of the catch limit in Subarea 48.3 will not be a purely political decision. However, ASOC was disappointed that the Scientific Committee chose to account for only one of the two errors. The most precautionary and practical advice would have been to account for both errors and recommend a lower catch limit. ASOC looked forward to WG-FSA's precautionary and conservative correction next year, which it expected would lead to a much reduced catch limit. ASOC commended WG-EMM's diligence in developing a management plan for krill based on SSMUs that protect predators. It reminded the Scientific Committee of predictions earlier in the week that the trigger level could be reached as soon as five to six years from now. ASOC certainly hoped that the krill management plan is ready. Finally, ASOC reminded the Scientific Committee that the definition of IUU fishing is 'Illegal OR Unreported OR Unregulated Fishing'. Each of these fisheries has similarly damaging effects on marine ecosystems. There have been disturbing discussions this week that suggest that

unregulated fishing in Areas 51 and 57 are not illegal and therefore cause no damage. Unregulated fishing is included in the FAO definition of IUU fishing precisely because it is equally as damaging to the ecosystem as illegal fishing.

Reports of SC-CAMLR Representatives at Meetings of Other International Organisations

CWP

9.10 The Data Manager participated in the 20th Session of the CWP which was held in January 2003 (SC-CAMLR-XXII/BG/4). Topics discussed included:

- development of global initiatives for improving the quality of fishery information, including observer data and statistics on by-catch;
- harmonisation of global fishery statistics and other information on fisheries resources;
- exchange of trade data including information on commodity classification;
- exchange of data on landings and fleet statistics.

9.11 With regard to statistics on by-catch, the Scientific Committee noted that some CWP Members had further developed their by-catch species data collection. However some CWP Members (e.g. IOTC, SPC, CCSBT) were not mandated to collect data on by-catch but are working towards the implementation of data collection.

9.12 At its 20th Session, CWP had urged its members to provide CCAMLR with information on incidental catches of Southern Ocean seabirds and other species arising from fishing in areas adjacent to CCAMLR's Convention Area. In addition, CWP Members were encouraged to consider ways of improving and standardising the reporting of by-catch of non-fish species (e.g. seabirds, turtles).

9.13 CWP is proposing to review and develop quality indicators for fisheries data. This work is linked to the implementation of some elements of FAO's Strategy for Improving Information on Status and Trends of Capture Fisheries and the Code of Conduct for Responsible Fisheries. The proposal will address the needs for improved data quality and methods for maintaining information quality and security. The proposal may also include methodology for developing an understanding of the cost-effectiveness of improved statistical projects and programs in supporting improved fisheries science and better management.

9.14 The Scientific Committee noted that CWP had recommended that any statistical boundary changes should only be implemented if historical data can be adjusted to retain consistent time series.

FIRMS-FIGIS

9.15 CCAMLR-XXII/45 provided a watching brief on FIRMS which is being developed under the auspice of CWP, of which CCAMLR is a member. The central element of FIRMS is a partnership of national institutions, mandated national governments and intergovernmental bodies that hold responsibilities for the preparation and publication of fisheries information. This partnership will be established by bilateral arrangements between the hosting FIRMS partner (FAO) and each of the other FIRMS partners. These arrangements define the responsibilities of the partners and the ownership and security of the information provided.

9.16 The first set of partnership arrangements will be implemented in 2004. The founding partners will be CWP Members and these are likely to include FAO, IATTC, ICCAT, ICES, IOTC, NAFO and SPC. Partners will form a Steering Committee, which will oversee the further development and operation of FIRMS.

9.17 The Scientific Committee recollected the advice last year from WG-FSA (SC-CAMLR-XXI, Annex 5, paragraphs 13.2 to 13.5), in which it reported that it was unable to identify any obvious benefit to WG-FSA from the proposed partnership. It was noted that nothing of relevance had changed to revise this conclusion. Therefore, the Scientific Committee noted that the information system proposed in this FAO initiative might, when further developed, provide benefits for CCAMLR. However, it was felt unnecessary to undertake any formal partnership at this stage. Through its continuing interaction with CWP, the Secretariat was asked to keep the Scientific Committee and its working groups informed of relevant developments.

ICES

9.18 The report from the 2003 meeting of ICES in Tallinn, Estonia, 26 September to 1 October 2003 (SC-CAMLR-XXII/BG/22), was introduced by the rapporteur of this section.

9.19 ICES has the dual function of coordinating and promoting marine research in the North Atlantic and to supply advice to international organisations, foremost the European Commission. The meeting was attended by more than 500 scientists from the 19 ICES Member States and a number of international organisations.

9.20 Many items of interest to CCAMLR were discussed, for example:

- stock recovery and recovery plans;
- management within the precautionary approach;
- the role of benthic communities as indicators of environmental quality and ecosystem change;
- a dialogue meeting on ecosystem approaches will take place in Dublin, Ireland, 26 to 27 April 2004.

9.21 The Scientific Committee noted that additional information, reporting on interactions between working groups and these and new organisations, can be found in the WG-FSA report (e.g. Annex 5, paragraphs 6.161 to 6.197).

Future Cooperation

9.22 The Scientific Committee noted a number of international meetings of relevance to its work and nominated the following observers:

- Deep Sea 2003 Conference, 1 to 5 December 2003, Queenstown, New Zealand – New Zealand;
- Second South American Workshop on Incidental Mortality of Albatrosses and Petrels, 2 to 6 December 2003, Futrono, Valdivia, Chile – Prof. Moreno;
- 5th Meeting of CCSBT-ERSWG, 2 to 5 February 2004, Wellington, New Zealand – New Zealand;
- Fourth World Fisheries Congress, 2 to 6 May 2004, Vancouver, BC, Canada (see SC-CAMLR-XXI, paragraph 9.33) – WG-EMM and WG-FSA Conveners;
- CEP-VII – Antarctic Treaty, 24 May to 4 June 2004, Cape Town, South Africa – Chair, Scientific Committee;
- Third International Symposium on Fish Otolith Research and Application, 11 to 16 July 2004, Townsville, Queensland, Australia – CCAMLR Otolith Network;
- 56th Annual Meeting of the SC-IWC, 29 June to 10 July 2004, Sorrento, Italy – Dr Kock;
- XXVIII SCAR / XVI COMNAP Science Meeting and Symposium, 25 to 31 July 2004, Bremen, Germany – Dr Fanta;
- ICES Annual Science Conference, 22 to 25 September 2004, Vigo, Spain – Belgium;
- SCOR 2004 General Meeting, 27 to 30 September 2004, Venice, Italy – Italy;
- 4th Biennial International Fisheries Observer Conference, 8 to 11 November 2004, Sydney, Australia – Australia;
- Agreement on the Conservation of Albatrosses and Petrels (ACAP), (dates to be decided), Hobart, Australia – Australia.

Future Procedure

9.23 Recognising the complexity of this agenda item and the difficulties posed to participants and rapporteurs by late delivery of reports from observers, the Scientific

Committee agreed again to consider only those reports which had been submitted to the Secretariat by 0900 h on the opening day of its meeting. This requirement should be clearly drawn to the attention of all relevant observers.

BUDGET FOR 2004 AND FORECAST BUDGET FOR 2005

Scientific Committee Budget

10.1 The budget of the Scientific Committee for 2004 and the forecast budget for 2005, as agreed by the Scientific Committee, are summarised in Table 7.

10.2 The budget for 2004 includes the following items:

- (i) preparatory work and participation of two invited experts at WG-EMM's 2004 Workshop on Plausible Ecosystem Models for Testing Approaches to Krill (A\$16 000) (paragraph 3.46; Annex 4, paragraphs 6.23, 6.24 and 6.46);
- (ii) participation by the Data Manager at the 2004 meeting of WG-FSA-SAM (whole meeting), and Secretariat support for the last two days of the meeting (A\$3 500) (paragraph 4.34; Annex 5, paragraph 9.21);
- (iii) independent external review of the GYM software and manual (A\$4 500) (Annex 5, paragraph 9.18);
- (iv) travel for four Secretariat staff to support and participate in the 2004 meeting of WG-EMM (A\$49 700);
- (v) development of documentation and pro forma for the assessments conducted by WG-FSA and reported in background documents (A\$20 000) (paragraphs 10.6 and 10.7; Annex 5, paragraphs 13.2 to 13.5).

10.3 The Scientific Committee recalled that last year WG-FSA had reorganised the meeting format and reporting so as to provide greater transparency and clarity in its work and reduce the size of its reports (SC-CAMLR-XXI, Annex 5, paragraphs 2.1 and 2.2). This reorganisation included the development of SC-CAMLR background documents which aimed to maintain a comprehensive archive of the work of WG-FSA.

10.4 In spite of this, the WG-FSA report was still very large and unwieldy. The Scientific Committee recognised that, to some extent, WG-FSA was a victim of its own success. Much of its work in 2003 was undertaken in subgroups which worked concurrently, and a large range of analyses had been undertaken and reported.

10.5 The Scientific Committee agreed that further intersessional work was required to develop a system of documentation which would enable WG-FSA to maintain a complete archive of its work and to develop a concise report which focussed on the needs of the Scientific Committee and Commission, and provide appropriate information for SCIC.

10.6 The Scientific Committee tasked the Secretariat to develop a system of documentation and pro forma which would enable WG-FSA to maintain a complete archive of its

assessments. The Scientific Committee urged the Secretariat to submit this documentation to the 2004 meeting of WG-FSA-SAM so as to allow that subgroup to review the documentation and ensure an effective transition to the new system at the 2004 meeting of WG-FSA.

10.7 The Scientific Committee agreed that the items identified in paragraph 10.2 were essential for the continued development of the management strategy for the krill fishery, and for validating and developing the assessments of *Dissostichus* spp. and *C. gunnari*. Further, the one-time cost of developing a system of documentation and pro forma for WG-FSA would result in a long-term saving in costs for translation and publication of the reports of that Working Group.

10.8 The Russian Representative noted that, in his opinion, the work described in paragraph 10.2(v) is not high priority, and should the necessary funding be unavailable in 2004, it could be postponed until some time in the future.

10.9 The Scientific Committee also identified two new items for inclusion in its budget for 2005. These were:

- (i) editing, translating and publishing a report from an icefish workshop held by the CCAMLR Otolith Network scheduled in 2005 (A\$5 000) (see SC-CAMLR-XXI, paragraph 10.2);
- (ii) invited experts for the krill management workshop scheduled during the 2005 meeting of WG-EMM (approximately A\$16 000).

Commission Budget

10.10 The Scientific Committee endorsed the following expenditures under the Commission's budget for 2004:

- (i) language support for *CCAMLR Science*;
- (ii) translation of the electronic logbooks into other languages (Annex 4, paragraphs 3.44, 3.45 and 3.51);
- (iii) participation by the Chair in the 2004 meeting of CEP;
- (iv) participation of the Data Manager in the 2004 intersessional meeting of CWP.

10.11 The Scientific Committee noted that the Commission budget for 2004 included a proposal that CCAMLR be represented by a member of the Secretariat at the Fourth World Fisheries Congress to be held in Vancouver, BC, Canada, in May 2004 (A\$5 700).

10.12 The Scientific Committee noted that WG-FSA had recommended changes to the content and format of the *Scientific Observers Manual* (Annex 5, paragraph 10.45), and that these changes may result in costs in editing, translating and publishing a revised version of the manual in 2005. The cost was tentatively estimated at approximately A\$20 000.

10.13 The Scientific Committee noted that the special issue of the *Journal of Deep Sea Research* which will report the results of the CCAMLR-2000 Survey was nearing publication. Final technical editing was under way and the issue is due for publication in 2004. The Scientific Committee recalled that it had set aside an amount of A\$10 000 to assist with the cost of this publication. The Scientific Committee agreed to ensure that this funding would be acquitted as soon as possible.

ADVICE TO SCIC AND SCAF

11.1 The Chair presented the Scientific Committee advice to SCIC and SCAF during the meeting. The advice to SCAF is in Section 10.

Advice to SCIC

11.2 Dr Holt, Scientific Committee Chair, was asked to brief the SCIC Members regarding items of mutual interest to the Scientific Committee and SCIC. He presented an overview of items identified by WG-FSA and endorsed by the Scientific Committee. These included:

- estimates of finfish catches in the Convention Area (Annex 5, paragraphs 3.11 to 3.15 and Tables 3.1 and 3.2);
- estimates of finfish catch and effort from IUU fishing (Annex 5, paragraphs 3.16 to 3.20);
- evaluation of the threats arising from IUU activities with respect to toothfish (Annex 5, paragraphs 5.307 to 5.312);
- incidental mortality of seabirds during unregulated longline fishing in the Convention Area (Annex 5, paragraphs 6.110 to 6.127),
- incidental mortality of seabirds during longline fishing outside the Convention Area (Annex 5, paragraphs 6.128 to 6.132);
- Scheme of International Scientific Observation (Annex 5, paragraphs 10.1 to 10.37);
- information relevant to SCIC (Annex 5, paragraph 10.38) which included advice concerning:
 - observer information on the monitoring of implementation of conservation measures (Annex 5, paragraphs 6.37, 6.54 and 6.260; WG-FSA-03/63 Rev. 1, 03/64 Rev. 1 and 03/65 Rev.1);
 - information relative to offal discharge (Annex 5, paragraphs 6.37 to 6.39);
 - compliance with Conservation Measures 24-02, 25-02 and 25-03 (Annex 5, paragraph 6.260);

- submission of datasets after the agreed deadlines (Annex 5, paragraph 3.7);
- failure of Members to notify of intention not to enter an exploratory fishery (Annex 5, paragraph 5.8);
- failure to conduct a minimum number of research sets on entering an SSRU (Conservation Measure 41-01) (Annex 5, paragraph 5.9);
- vessels exceeding catch limits in fine-scale rectangles and SSRUs (Annex 5, paragraphs 5.67 to 5.69).

11.3 Finally, SCIC was provided with advice regarding CCAMLR-XXII/52 which suggested a potential approach, to be implemented by SCIC, towards developing a new system for undertaking assessment of compliance of fishing vessels with conservation measures. This included advice with respect to toothfish fishing (Annex 5, paragraphs 5.302 to 5.305) and regarding seabird mortality (Annex 5, paragraphs 6.58 to 6.65).

Fishing Seasons

11.4 The Scientific Committee recollected its previous advice (see SC-CAMLR-XXI, paragraphs 11.7 to 11.9 and Annex 5, paragraphs 6.30 to 6.46) relating to the issue of extensions to the longline fishing season once levels of seabird incidental mortality are negligible and vessels have achieved full compliance with all relevant conservation measures.

11.5 It noted the summary of last year's discussions on this topic and the decision by the Commission (Annex 5, paragraphs 6.47 to 6.49; CCAMLR-XXI, paragraphs 5.7 to 5.11) resulting in one vessel being allowed to commence fishing in Subarea 48.3 two weeks earlier (in April) than the start of the main fishing season (Annex 5, paragraphs 6.50 and 6.51).

11.6 It noted that this year full compliance appeared to have been achieved by eight vessels in Subarea 48.3 (Annex 5, Table 6.7) and noted that levels of seabird incidental mortality in this fishery had been negligible.

11.7 The Scientific Committee recommended that, taking into account the advice in Annex 5, paragraphs 6.53 and 6.54:

- (i) extension of the fishing season into April should not be permitted;
- (ii) where a trial season extension is under consideration, that this should only occur in September as an option for any vessel that has achieved full compliance with Conservation Measure 25-02.

SECRETARIAT SUPPORTED ACTIVITIES

Data Management

12.1 The Scientific Committee noted the Data Manager's report (SC-CAMLR-XXII/BG/3) which outlined the role of Data Management and the Data Centre within the Secretariat, and highlighted data management activities in 2002/03.

12.2 The Secretariat manages a wide range of data in support of the work of the Commission and Scientific Committee and their subsidiary bodies. Data are held in relational databases and CCAMLR data requiring a high level of security are stored in a Microsoft SQL database-management system. Most of these data are processed and interrogated by Secretariat staff using a Microsoft Access database interface. The SQL database-management system requires administration and regular maintenance to ensure that the databases are operating efficiently and that the data security measures, including backups, are functioning to the specifications required to maintain data integrity and confidentiality.

12.3 Functional control of Data Management and the Data Centre rests with the Data Manager, except when this relates to specific activities associated with other Secretariat functions (e.g. management of scientific observer data within the context of Compliance and Enforcement as well as management of the CDS by that entity).

12.4 The amount of data processed in 2002/03 was high, and continued to follow the trend reported in recent years. CCAMLR data processed and validated in 2002/03 included: catch and effort reports, fine-scale fishery data, scientific observer data, STATLANT data, research survey data and CEMP data. Many of the activities and analyses involving the Data Centre in 2002/03 have been reported in meeting papers and publications (see SC-CAMLR-XXII/BG/3, Table 2).

12.5 The Data Centre continued to monitor all fisheries conducted under conservation measures in force. Catch and effort information used in monitoring these fisheries is submitted in accordance with the 5-day, 10-day or monthly catch and effort systems; most fisheries are monitored using 5-day catch and effort reports.

12.6 The Scientific Committee noted that the Secretariat's Database Developer had resigned in August 2003, and that the position was presently vacant. Following review of the position and the needs of the Secretariat, recruitment will be initiated following CCAMLR-XXII. As an interim measure, the Secretariat's SQL database-management system is currently maintained by the Scientific Observer Data Analyst, with assistance from the Secretariat's IT staff. Other database work which was being done by the Database Developer has been put on hold.

12.7 The Convener of WG-EMM noted that the work of the Data Management team in 2002/03 had been appreciated by the Working Group, and in particular the preparatory work undertaken prior to the CEMP Review Workshop. Similarly, the conveners of WG-FSA and WG-IMAF noted their groups' reliance on CCAMLR data and their appreciation for the work of the Data Management team.

12.8 Noting that acoustic data are now included in the assessment of *C. gunnari*, the Scientific Committee agreed that a database was needed to contain these data. Such a database should have the following components:

- storage of raw datasets including calibration and noise threshold data
- data extraction protocols and procedures to disregard bad data
- analytical protocols.

12.9 The Data Manager was requested to liaise with WG-FSA-SFA and current acoustic equipment manufacturers and software developers for advice on data storage and collection.

12.10 The Data Manager was also requested to develop a draft plan for consideration by WG-FSA-SAM in 2004.

12.11 The Scientific Committee asked the Secretariat to establish a tagging database for the receipt of tag data submitted by Members in a standard electronic format which would be developed during the intersessional period (Annex 5, paragraph 7.17).

Data Access

Draft Rules for Access and Use of CCAMLR Data

12.12 The Scientific Committee considered the draft rules for access and use of CCAMLR data (CCAMLR-XXII/8 Rev. 1) which had been prepared by the Secretariat giving full consideration of the guidelines established last year (SC-CAMLR-XXI, paragraph 15.1 and Annex 6). The Scientific Committee noted that the draft had been developed in consultation with Members and had been submitted to WG-EMM and WG-FSA for consideration. The working groups had noted the rules without comment (Annex 4, paragraphs 7.15 to 7.17; Annex 5, Appendix C).

12.13 The Scientific Committee noted that the draft rules had also been distributed to Members (COMM CIRC 03/55) and that comments provided to the Secretariat had been included as an attachment to CCAMLR-XXII/8 Rev. 1; comments had been provided by New Zealand.

12.14 The Scientific Committee agreed that paragraph 5 of the draft set of rules required clarification in relation to the types of data involved. An alternative wording was agreed as follows:

‘5. Inclusion of data held in the CCAMLR Data Centre in any publication outside of CCAMLR constitutes release into the public domain.’

12.15 It was also agreed that the disclaimer which appeared on the cover page of all working papers (paragraph 11 of the draft set of rules) should provide guidance on the distribution of papers to people not directly involved at CCAMLR meetings, including those at working groups.

12.16 The Scientific Committee considered the comments provided by New Zealand and agreed to the following in relation to the five bullet points raised by New Zealand (CCAMLR-XXII/8 Rev. 1, Attachment):

- (i) The reports from the Scientific Committee's working groups contained the results of analyses which did not usually include detailed data. However, in cases where detailed data were presented, the Scientific Committee was satisfied that data confidentiality issues would have been adequately considered by the working group at the time of adoption. Further, Members had the opportunity to review all reports prior to their publication (e.g. SC-CAMLR-XXII/4). The Scientific Committee agreed that the procedures for reporting data in the reports of working groups were adequate and respected the rules of access. However, the Scientific Committee agreed that it may be helpful to include a clause in its rules of procedure stating that reports were adopted subject to Members' considerations of data confidentiality in relation to the presentation of results.
- (ii) Analyses of data at meetings of working groups are usually conducted under paragraph 2a of the draft rules (i.e. work specifically outlined and endorsed by the Commission or Scientific Committee). However, analyses are still being developed by WG-FSA and WG-EMM, and results are reported from these each year. The Scientific Committee noted the need for flexibility in the work of its working groups and that requiring to seek permission to use data during working group meetings would be a considerable imposition on the need to be flexible to do assessments or provide advice as the need arises.
- (iii) Issues of data confidentiality within the Secretariat were fully addressed under the CCAMLR Staff Contract and Staff Regulations (CCAMLR-XXII/BG/15). However, the Scientific Committee recognised that issues of data confidentiality also applied to members of working groups participating in meetings where CCAMLR data were being analysed. This latter issue was yet to be addressed adequately, and the Scientific Committee agreed that further steps were needed to ensure that all working group participants were bound by CCAMLR's rules of data confidentiality. It was agreed that all meeting participants should be officially designated by Members or invited by the Scientific Committee. The Committee recognised that potential conflicts of interest may arise when participants attended as representatives of commercial-interest groups (e.g. fishing industry).
- (iv) It was agreed that Members should be able to designate datasets as 'permanently approved for release'.
- (v) The issue of data confidentiality was believed to be adequately covered in paragraph 8 of the draft set of rules.

12.17 Finally, the Scientific Committee agreed that a flow chart illustrating the process for requesting and receiving data would be a useful addition to the documentation.

Procedures for Data Handling and Security

12.18 The Scientific Committee noted that the Secretariat had reviewed its procedures for data handling and security, and had considered future needs to maintain data security when data are circulated outside the Secretariat (CCAMLR-XXII/13).

12.19 It was noted that CCAMLR data are stored securely in the Secretariat's relational database-management system, and this system is maintained regularly to ensure that the databases are operating efficiently and that the data security measures, including backups, are functioning to specification. Strategic input is provided to ensure that data maintenance remains current with best practice and industry standards. Maintaining the security of CCAMLR data has required, and will continue to require, adequate funding in the Secretariat's annual budget.

12.20 The Scientific Committee noted that there was an ongoing need for meeting organisers to ensure that adequate security is provided to CCAMLR data and other information held on the meeting networks. Such networks must be secure, protected by a firewall, protected from viruses, and provide daily backing up of files. The responsibility for providing these arrangements lies with the local organisers of the meetings.

Publications

12.21 In addition to annual reports of CCAMLR, the Scientific Committee noted that the following documents were also published in 2003:

- (i) *CCAMLR Scientific Abstracts* cover abstracts of papers presented in 2002
- (ii) *CCAMLR Science*, Volume 10 (distributed at the meeting)
- (iii) *Statistical Bulletin*, Volume 15
- (iv) Revisions to *Inspectors Manual* and *Scientific Observers Manual*.

Language Support for *CCAMLR Science*

12.22 Last year, the Scientific Committee had agreed to take steps to overcome problems with papers submitted to *CCAMLR Science* for which English was not the author's primary language, and which may need additional assistance with language editing (SC-CAMLR-XXI, paragraphs 12.17 and 12.19 to 12.21). As a result, additional funding had been approved by the Commission for language support for *CCAMLR Science* (see paragraph 10.10).

12.23 The Scientific Committee noted that the Secretariat, in collaboration with the Chair of the Editorial Board, had developed draft guidelines for language support for manuscripts where initial evaluation by the Editor had revealed substantial problems with the English text. These guidelines provided assistance for two categories of papers: those submitted in the official languages of CCAMLR, and those submitted in all other languages of Members.

12.24 The Scientific Committee endorsed the guidelines (Annex 7), and noted that language support may result in a delay for some papers being published in *CCAMLR Science*.

Changes to the *Statistical Bulletin*

12.25 The Scientific Committee noted that two recent changes had impacted on the compilation of CCAMLR's *Statistical Bulletin* (SC-CAMLR-XXII/BG/7). These changes were: (i) publication of data by CCAMLR season rather than by split-year (agreed at SC-CAMLR-XXI); and (ii) a revision of the boundaries in Division 58.4.3 and adjacent areas (agreed at CCAMLR-XX). The *Statistical Bulletins* are based on STATLANT data submitted annually by Members. Therefore the implementation of these changes required the Secretariat to re-interpret historic STATLANT data.

12.26 With respect to the publication of data by CCAMLR season, the Scientific Committee noted the following points:

- In most cases, the change was easily implemented as complete STATLANT data records included a reference to the split-year and month when fishing occurred.
- In a small number of historic datasets, the months were not defined and the change was problematic. The Secretariat had used ancillary fine-scale data, where available, to define the months fished in the incomplete STATLANT data.
- Unfortunately, the fine-scale data coverage of fisheries incompletely reported in STATLANT data was scant (about 0.2% of the catches reported in the STATLANT data).
- As an interim solution, and pending advice from Members, the Secretariat had assumed that all fishing reported in the incomplete STATLANT datasets had been conducted between December and June of each split-year.

12.27 Dr Sushin advised that the Secretariat's interim solution was valid for krill fisheries conducted in Subareas 48.1 and 48.2. However, fishing in Subarea 48.3 has been conducted mostly between March and September.

12.28 The Scientific Committee urged Members to submit, where possible, monthly catch and effort data for the fisheries listed in Table 1 of SC-CAMLR-XXII/BG/7. In addition, the Scientific Committee directed the Secretariat to the detailed descriptions of the krill fisheries during the 1970s which had been published in various BIOMASS reports.

12.29 With respect to the revision of the boundaries in Division 58.4.3 and adjacent areas, the Scientific Committee noted the following points:

- the spatial resolution of STATLANT data is at the level of statistical subareas or divisions;
- the Secretariat had used ancillary fine-scale data to implement appropriate areal changes in the STATLANT data.

12.30 The Scientific Committee agreed that the Secretariat's changes in the STATLANT data were adequate in relation to the revision of boundaries in Division 58.4.3 and adjacent areas.

Draft Rules for Submission of CCAMLR Meeting Papers

12.31 The Scientific Committee considered the draft rules for submission of CCAMLR meeting papers (CCAMLR-XXII/5). The Secretariat had prepared these rules in response to concerns expressed by the Commission and Scientific Committee about the late submission of documents, particularly observers' reports (SC-CAMLR-XXI, paragraph 9.34; CCAMLR-XXI, paragraphs 14.46 to 14.48). The Commission had asked the Secretariat to consult with the Chairs of the Scientific Committee and SCOI intersessionally in order to draw up a set of draft procedures (CCAMLR-XXI, paragraph 18.1).

12.32 The Scientific Committee agreed that the draft rules did not adequately describe the requirements for the submission of papers to the Committee. As a result the Scientific Committee proposed that, for the purpose of its discussion this year, the Commission only consider the draft rules in relation to the submission of papers to the Commission.

12.33 The Scientific Committee agreed that the advice and decisions of the Commission with respect to the draft rules, together with the existing guidelines for the submission of papers to the Scientific Committee, be circulated to WG-EMM and WG-FSA for comment. The Scientific Committee would then develop its rules for submission of meeting papers in the light of advice from the Commission and comments from the working groups.

12.34 The Scientific Committee emphasised that the current timetable, procedures and practices in respect of submission and consideration of documents, as established by its working groups and by the Scientific Committee, shall remain in force at least for the forthcoming year.

INTERSESSIONAL WORK

Intersessional Activities during 2003/04

13.1 The Scientific Committee accepted with great pleasure Italy's invitation to host the 2004 meeting of WG-EMM. The Working Group looked forward to returning to Siena for its 10th meeting, and recalled the very successful first meeting which was held there in 1995.

13.2 The Scientific Committee reviewed and endorsed the intersessional work plans of WG-EMM (Annex 4, Table 3), WG-FSA (Annex 5, Table 12.1) and ad hoc WG-IMAF (Annex 5, Appendix E). Major activities scheduled by the Scientific Committee in the 2003/04 intersessional period are listed in Annex 8.

13.3 The following CCAMLR meetings are planned during the 2003/04 intersessional period:

- WG-FSA-SAM, Siena, Italy, 5 to 9 July 2004, immediately prior to WG-EMM-04
- WG-EMM, Siena, Italy, 12 to 23 July 2004
- WG-FSA, including ad hoc WG-IMAF, Hobart, Australia, 11 to 22 October 2004.

Convener of WG-FSA

13.4 The Scientific Committee noted that this was the last meeting that Dr Everson would be Convener of WG-FSA. He has been active in CCAMLR for many years having served as Chair of the Scientific Committee, Convener of WG-FSA (twice) and Convener of WG-EMM. He will be greatly missed by all Members of the Scientific Committee.

13.5 As agreed at last year's meeting, Dr Hanchet will take over as Convener of WG-FSA, starting from the end of this year's meeting. Members welcomed Dr Hanchet and looked forward to working with him.

Revision of the Scientific Committee Agenda

13.6 The Scientific Committee noted that the Chair had further considered the format of the agenda in consultation with the conveners of WG-EMM and WG-FSA. No further changes had been proposed.

Invitation of Observers to the Next Meeting

13.7 The Scientific Committee agreed that all observers invited to the 2003 meeting would be invited to participate in SC-CAMLR-XXIII.

Next Meeting

13.8 The Scientific Committee noted that arrangements have been made for the next meetings of the Scientific Committee and the Commission to be held in Hobart from 25 October to 5 November 2004.

ELECTION OF THE VICE-CHAIRS OF THE SCIENTIFIC COMMITTEE

14.1 The Scientific Committee noted that one of the Vice-Chairs, Dr Kawaguchi, had resigned from this position in October 2003 due to changed job circumstances. As a result, at the start of its meeting, the Scientific Committee sought nominations for a new Vice-Chair. Dr Sushin was unanimously elected to the position for a term of two regular meetings (2003 and 2004).

14.2 Mr López Abellán's term as Vice-Chair ended with SC-CAMLR-XXII, and the Scientific Committee sought nominations for a new Vice-Chair. Dr Barrera-Oro was unanimously elected to the position for a term of two regular meetings (2004 and 2005).

14.3 The Scientific Committee thanked Dr Kawaguchi and Mr López Abellán for their ongoing contributions to its work.

OTHER BUSINESS

Joint Assessment Group

15.1 Dr M. Richardson (UK), on behalf of the Convener of JAG, briefed the Scientific Committee on the first meeting of the group which was held on 23 and 24 October 2003, immediately following WG-FSA-03 (SCIC-03/13).

15.2 JAG had agreed that for that meeting the group would be given an ad hoc status which would be considered further by SCIC, the Scientific Committee and the Commission. The ad hoc group agreed that its two principal terms of reference should be:

- (i) to develop methods for estimating total removals of toothfish from inside and outside the Convention Area;
- (ii) to develop a comparative methodology for determining compliance with conservation measures.

15.3 The ad hoc group had also developed a work plan to address each term of reference.

15.4 The Scientific Committee was advised that SCIC had endorsed the draft terms of reference prepared by the ad hoc group, and that SCIC had concluded that these terms of reference would be best addressed by two separate groups. The development of methods for estimating the total removals of toothfish and the annual estimation of annual removals would be addressed by JAG, whereas the second term of reference on compliance assessment would be dealt with by SCIC. Accordingly, SCIC had noted the work plans and agreed that these should act as guidelines for the future work of these groups.

15.5 The Scientific Committee noted that the estimates of total removals of toothfish were an essential component of the assessment conducted by WG-FSA, and that total removals had been routinely estimated during the first few days of its meetings. This was problematic because of the time required to derive the estimates of total removals, and also because such estimates were used by WG-FSA without prior endorsement by SCIC.

15.6 The Scientific Committee reiterated the need for estimates of total removals of toothfish to be provided to WG-FSA prior to its meeting so that the annual assessments could incorporate the best available information on total removals of toothfish.

15.7 The Scientific Committee noted its discussion of potential approaches to comprehensive assessment of compliance of fishing vessels with conservation measures in paragraphs 7.2 to 7.5.

Secretariat's Presentations at the Fourth World Fisheries Congress

15.8 The Scientific Committee noted that the Secretariat had submitted two abstracts to the Fourth World Fisheries Congress (CCAMLR-XXII/BG/22). The abstracts reviewed CCAMLR's work in addressing the objectives of the Convention and CCAMLR's approach to managing by-catch. The Scientific Committee expressed concern, particularly in relation to the latter abstract, over the presentation and potential publication of scientific information

derived from the main work of working groups of the Scientific Committee without prior review by those responsible for the work carried out within those groups. It was also concerned at potential overlap between the contents of the by-catch presentation and that of the conveners of WG-EMM and WG-FSA, already endorsed by the Scientific Committee, for presentation at the same meeting. This matter was referred to the Secretariat for immediate consideration in consultation with the Chair of the Scientific Committee and conveners of working groups and to the Commission in respect of any matters of principle involved.

ADOPTION OF THE REPORT

16.1 The report of the Twenty-second meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

17.1 Dr Holt thanked all Members of the Scientific Committee and the rapporteurs for their dedicated work at the meeting. The meetings were becoming increasingly complex and he greatly appreciated the willingness of all to ensure that the meeting was successful.

17.2 Dr Holt thanked Dr Hewitt, Convener of WG-EMM, Dr Everson, Convener of WG-FSA, and Prof. Croxall, Convener of ad hoc WG-IMAF, for their tremendous amount of work undertaken at the working group meetings and in preparation for the Scientific Committee. Dr Holt also thanked the coordinators of the working group subgroups for their efforts in developing detailed elements of the Scientific Committee's work. He also thanked Dr Hanchet for accepting to convene WG-FSA following Dr Everson's retirement.

17.3 Dr Holt thanked the staff of the Secretariat for their relentless work during the meeting and in the intersessional period, and the interpreters and sound technicians for their work during the meeting.

17.4 In closing, Dr Holt thanked Dr Everson for his lifelong contribution to the work of the Scientific Committee which had come a long way over its 22 meetings. Dr Everson had personally contributed great scientific knowledge and leadership in developing the Scientific Committee and its working groups; it was hard to imagine a meeting of CCAMLR without him. The Scientific Committee wished Dr Everson a very happy and rewarding retirement, and he was presented with some 'traditional' gifts.

17.5 Dr Everson thanked the Scientific Committee for its good wishes. This was the last meeting of the Scientific Committee in which he would participate. The work of the Scientific Committee and its working groups had been a major part of Dr Everson's working career, and he was very pleased to see that much progress had been made since CCAMLR had been established. Dr Everson had made many friends in CCAMLR as well as locally in Hobart. He was pleased to note the attendance of young scientists at recent meetings of the Scientific Committee and its working groups, and the enthusiasm of all participants to continue the work of the Scientific Committee. He would always remain interested in this work and wished all Members of the Scientific Committee continued success.

17.6 Members showed their appreciation of Dr Everson with a standing ovation.

17.7 Prof. Croxall, on behalf of the Scientific Committee, thanked Dr Holt for a successful meeting which he had chaired fairly and courteously.

17.8 The meeting was closed.

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Table 1: Revised WG-EMM plan of work scheduled between 2002 and 2005.

Issue	2002	2003	2004	2005
Subdivide Precautionary Catch Limit	Discussion	Initial proposals	Additional proposals Recommendation	
Revised Krill Management Procedure				
Delineation of small-scale management units in Area 48	Workshop (SC-CAMLR-XXI, Annex 4, Appendix D)			
CEMP review	Planning session	Workshop (SC-CAMLR-XXII, Annex 4, Appendix D)	Consideration of further analytical work (SC-CAMLR-XXII, Annex 4, Appendix D, Table 9)	
Selection of appropriate predator–prey–fishery–environment models	Discussion	Planning session	Workshop	
Evaluation of management procedures including objectives, decision rules, performance measures	Discussion	Discussion	Planning session	Workshop
Reporting requirements from fishery	Discussion	Interim requirements adopted by Commission	Consideration of revised requirements	Recommendation
Monitoring requirements from CEMP	Discussion	Discussion	Further assessment of CEMP parameters	Initial specifications
Assessment of Predator Demand				
Large-scale surveys of land-based predators	Discussion	Discussion	Consideration of pilot studies	Consideration of pilot studies
Subdivision of Large FAO Statistical Areas				
Establishment of harvesting units	Discussion	Discussion	Proposals for 48.6, 88.1, 88.2, 88.3, 58.4.1 and 58.4.2 Recommendation	
Strategic Planning	Discussion	Discussion	Discussion	Planning session for possible workshop

Table 2: Catch (tonnes) of target species in the Convention Area for the 2002/03 season (December 2002 to November 2003). Catches reported to date (3 October 2003) in the catch and effort reporting system, unless indicated otherwise.

Species		Member Country	Subarea or Division										Total	
			48*	48.1	48.2	48.3	58.4.2	58.5.1	58.5.2	58.6	58.7	88.1		88.2
Toothfish	<i>Dissostichus eleginoides</i>	Australia					0		2 130					2 130
		Chile				2 881								2 881
		EC – France**						3 686		436				4 122
		EC – Spain				880								880
		EC – UK				1 475								1 475
		Japan				262								262
		Korea, Republic of				296								296
		New Zealand				399						50		449
		Russian Federation				612						1		613
		South Africa				382				24	106	1		513
		Uruguay				347								347
	<i>Dissostichus mawsoni</i>	Australia					117							117
		New Zealand										935	106	1 041
		Russian Federation										663		663
		South Africa										142		142
Total (toothfish)						7 534	117	3 686	2 130	460	106	1 792	106	15 931
Icefish	<i>Champsocephalus gunnari</i>	Australia							2 343					2 343
		Chile				1 003								1 003
		EC – UK				658								658
		Korea, Republic of				494								494
	Total (icefish)						2 155			2 343				4 498
Krill	<i>Euphausia superba</i>	Japan	55 528											55 528
		Korea, Republic of		3 044	4 715	11 527								19 286
		Poland		2783	1 085	5 037								8 905
		Ukraine		324	7 012	10 379								17 715
		USA		1 565	2 551	4 784								8 900
	Total (krill)			55 528	7 716	15 363	31 727							110 334

* Unspecified within Area 48

** Monthly catches

Table 3: Catch (tonnes) of target species in the Convention Area for the 2001/02 season (December 2001 to November 2002). Official record of catch provided by Members in STATLANT data, unless indicated otherwise.

Species		Member Country	Subarea or Division								Total	
			48.1	48.2	48.3	58.5.1	58.5.2	58.6	58.7	88.1		88.2
Toothfish	<i>Dissostichus eleginoides</i>	Australia					2 756					2 756
		Chile			1 545							1 545
		EC – France				4 154		1 158				5 312
		EC – Spain			832							832
		EC – UK			1 728							1 728
		Japan			1							1
		Korea, Republic of			300							300
		New Zealand								12	0	12
		Russian Federation			313							313
		South Africa			332			67	98			497
		Uruguay			693							693
	<i>Dissostichus mawsoni</i>	New Zealand								1 313	41	1 354
	Total (toothfish)				5 744	4 154	2 756	1 225	98	1 325	41	15 343
Icefish	<i>Champsocephalus gunnari</i>	Australia					865					865
		EC – UK			396							396
		Korea, Republic of			602							602
		Poland			296							296
		Russian Federation			1 373							1 373
	Total (icefish)				2 667		865					3 532
	Krill	<i>Euphausia superba</i>	Japan	9 207	23 733	18 139						
Korea, Republic of				8 033	6 320							14 353
Poland				10 646	5 719							16 365
Ukraine				22 585	9 430							32 015
USA			1 439	7 062	3 674							12 175
Total (krill)		10 646	72 059	43 282							125 987	

Table 4: Plans for krill fishing by Members in 2003/04 based on information provided at the meeting and on information contained in Members' reports*.

Member	Number of Vessels	Area to be Fished	Months being Fished	Projected Tonnage	Catch in 2002/03 (as at 3 Oct 2003)
Japan	2	48	Jan–Oct Mar–Aug	60 000	55 528
Korea, Republic of	2	48		25 000	19 286
Poland	1	48		10 000	8 905
Russia	2	48		25 000	0
Ukraine	3 or 4	48		35 000	17 715
USA	1	48		10 000	8 900
Total	11–12			165 000	110 334

* Report of Member's Activities from Poland

Table 5: Yields and catch limits calculated for Subareas 88.1 and 88.2 since 2001/02.

Year	Subarea 88.1		Subarea 88.2	
	Yield ^a	Catch Limit	Yield ^a	Catch Limit
2001/02	5 014	2 508 ^b	500	250 ^b
2002/03	13 882	3 760 ^c	602	375 ^c
2003/04 ^d	6 163		267	
2003/04 ^e	10 814		469	

^a Calculated using Subarea 48.3 recruitment series

^b Calculated by applying a 0.5 discount to the yield estimate

^c Calculated by increasing the 2001/02 catch limit by 50%

^d Calculated using revised recruitments for 1990 and 2002

^e Calculated using revised recruitments for 2002

Table 6: Estimated seabed area for 600–1 800 m (km²) and % catch limit (CPUE multiplied by seabed area) for each of the proposed SSRUs.

SSRU	Area	%
A	4 908	1.3
B	4 318	2.4
C	4 444	6.7
D	49 048	0.0
E	14 797	1.7
F	18 398	1.1
G	7 110	2.5
H	19 245	23.6
I	30 783	23.3
J	43 594	9.5
K	24 695	22.5
L	16 807	5.4
Total	238 148	

Table 7: Scientific Committee budget for 2004 and forecast for 2005.

2003 Budget	Item	2004 Budget	2005 Budget
WG-FSA			
	Meeting		
4 900	Computing facilities	5 000	5 200
25 200	Preparation and Secretariat support	26 000	26 000
<u>29 200</u>	Report completion and translation	<u>50 100</u>	<u>30 100</u>
59 300		81 100	61 300
0	Secretariat support for WG-FSA-SAM	3 500	0
0	Review of GYM	4 500	0
WG-EMM			
	Meeting		
22 700	Preparation and Secretariat support	23 400	24 100
<u>34 200</u>	Report completion and translation	<u>35 200</u>	<u>36 300</u>
56 900		58 600	60 400
Travel for Scientific Committee Program			
48 300	WG-EMM meeting (freight, flights and subsistence)	49 700	51 200
6 000	External experts	16 000	16 000
0	CCAMLR Otolith Network	0	5 000
<u>1 200</u>	Contingency	<u>1 200</u>	<u>1 200</u>
A\$171 700	Total	A\$214 600	A\$195 100

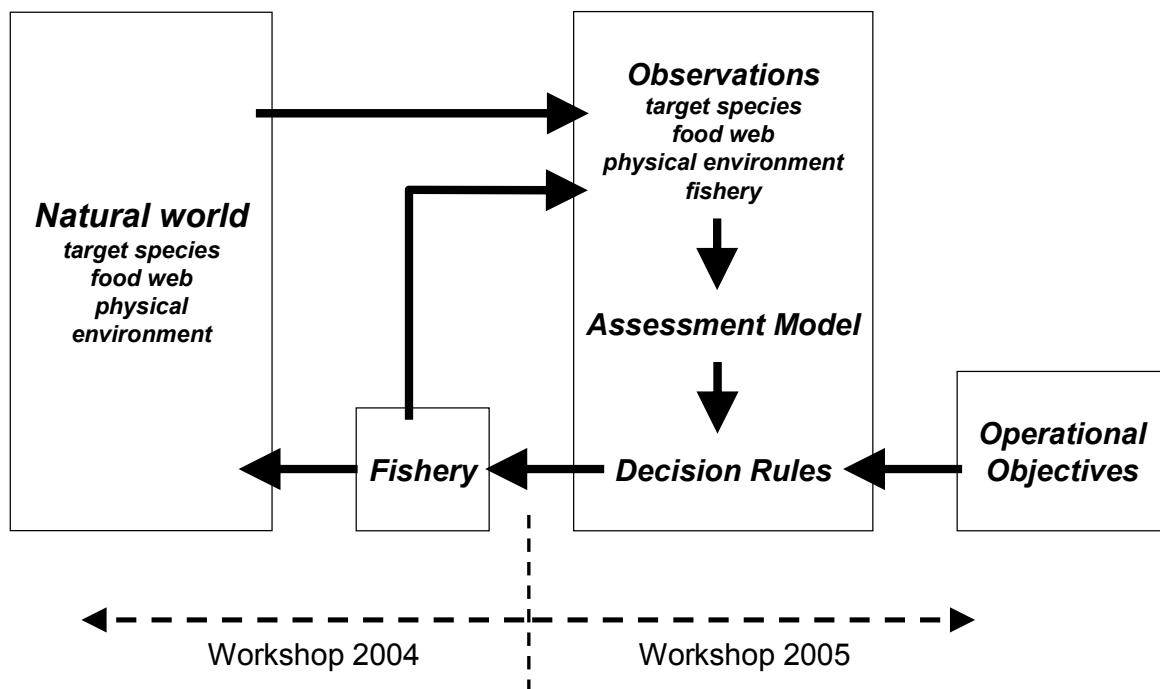


Figure 1: Conceptual framework for the development of a management procedure. The management procedure includes the operational objectives and the consequent field collection of data, the analyses and assessment methods and the decision rules that influence the fisheries interaction with the natural world. Decision rules are framed in terms of what is required to meet the operational objectives given the results of the assessment model. *Operating models capture the range of plausible scenarios of the natural world and how a fishery interacts with that world.*

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CCAMLR-XXII/BG/40	Ice strengthening standards for vessels licensed to fish in high latitudes Delegation of New Zealand
CCAMLR-XXII/BG/41	Brief update on marine acoustic technology and the Antarctic environment Submitted by ASOC
CCAMLR-XXII/BG/42	Withdrawn
CCAMLR-XXII/BG/43	Report of the Scientific Committee Chair to the Commission
CCAMLR-XXII/BG/44	Report of the IUCN – World Conservation Union Submitted by the IUCN – World Conservation Union
CCAMLR-XXII/BG/45	Intervención del Subsecretario de la Comisión Permanente del Pacífico Sur (CPPS) en la 22a reunión de la Comisión para la Conservación de los Recursos Vivos Marinos Antárticos (CCRVMA) Presentada por la Comisión Permanente del Pacífico Sur (CPPS)
CCAMLR-XXII/BG/46	Draft proposal for a census of Antarctic marine life Delegation of Australia
CCAMLR-XXII/BG/47	A tagging protocol for toothfish (<i>Dissostichus</i> spp.) in CCAMLR new and exploratory fisheries Delegations of Australia, New Zealand and the United Kingdom
CCAMLR-XXII/BG/48	Vessel sighting CCAMLR Statistical Area 58.5.2 Delegation of Australia
CCAMLR-XXII/BG/49	CCAMLR Symposium Delegations of Chile and Australia

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

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

1. Opening of the Meeting
 - (i) Adoption of the Agenda
 - (ii) Report of the Chair
 - (iii) Preparation of Advice to SCAF and SCIC
2. CCAMLR Scheme of International Scientific Observation
 - (i) Scientific Observations Conducted in the 2002/03 Fishing Season
 - (ii) Advice to the Commission
3. Ecosystem Monitoring and Management
 - (i) Advice from WG-EMM
 - (ii) Management of Protected Areas
 - (iii) Advice to the Commission
4. Harvested Species
 - (i) Krill Resources
 - (a) Status and Trends
 - (b) Advice from WG-EMM
 - (c) Advice to the Commission
 - (ii) Fish Resources
 - (a) Status and Trends
 - (b) Targeted species
 - (c) Fish By-catch Associated with Longline and Trawl Fisheries
 - (d) Advice from WG-FSA
 - (e) Advice to the Commission
 - (iii) New and Exploratory Fisheries
 - (a) New and Exploratory Fisheries in the 2002/03 Season
 - (b) Notifications for New and Exploratory Fisheries in the 2003/04 Season
 - (c) Revision of Boundaries
 - (d) Advice to the Commission
 - (iv) Crab Resources
 - (a) Status and Trends
 - (b) Advice from WG-FSA
 - (c) Advice to the Commission
 - (v) Squid Resources
 - (a) Status and Trends
 - (b) Advice from WG-FSA
 - (c) Advice to the Commission

5. Incidental Mortality
 - (i) Incidental Mortality of Seabirds and Marine Mammals Arising from Fisheries
 - (ii) Fish By-catch
 - (iii) Advice to the Commission
6. Additional Monitoring and Management Issues
 - (i) Marine Debris
 - (i) Marine Mammal and Bird Populations
 - (iii) Advice to the Commission
7. Management under Conditions of Uncertainty about Stock Size and Sustainable Yield
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. Budget for 2004 and Forecast Budget for 2005
11. Advice to SCIC and SCAF
12. Secretariat Supported Activities
 - (i) Data Management
 - (ii) Data Access
 - (iii) Publications
13. Scientific Committee Activities
 - (i) Intersessional Activities during 2003/04
 - (ii) Revision of the Scientific Committee Agenda
 - (iii) Invitation of Observers to the Next Meeting
 - (iv) Next Meeting
14. Election of Vice-Chairs of the Scientific Committee
15. Other Business
16. Adoption of the Report of the Twenty-second Meeting of the Scientific Committee
17. Close of the Meeting.

**REPORT OF THE WORKING GROUP ON
ECOSYSTEM MONITORING AND MANAGEMENT**
(Cambridge, UK, 18 to 29 August 2003)

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**REPORT OF THE WORKING GROUP ON
ECOSYSTEM MONITORING AND MANAGEMENT**
(Cambridge, UK, 18 to 29 August 2003)

INTRODUCTION

Opening of the Meeting

1.1 The ninth meeting of WG-EMM was held at Girton College, Cambridge, UK, from 18 to 29 August 2003. The meeting was convened by Dr R. Hewitt (USA).

1.2 Dr Hewitt welcomed participants and outlined the program for the meeting. This was the third meeting with a hybrid agenda consisting of plenary and subgroup sessions to discuss core topics, and a workshop (CEMP Review Workshop, Section 2).

Adoption of the Agenda and Organisation of the Meeting

1.3 The Provisional Agenda was discussed and adopted without change (Appendix A).

1.4 The list of participants is included in this report as Appendix B and the List of Documents submitted to the meeting as Appendix C.

1.5 The report was prepared by Drs A. Constable (Australia) and R. Crawford (South Africa), Prof. J. Croxall (UK), Drs I. Everson (UK), M. Goebel (USA), G. Kirkwood (UK), S. Nicol (Australia), D. Ramm (Secretariat), K. Reid (UK), V. Siegel (Germany), C. Southwell (Australia), P. Trathan (UK), W. Trivelpiece (USA) and P. Wilson (New Zealand).

CEMP REVIEW WORKSHOP

2.1 The Working Group discussed the report of the CEMP Review Workshop (WG-EMM-03/62). It endorsed its content and conclusions, subject to comments below, and agreed to include it as Appendix D of the WG-EMM report.

2.2 The Working Group thanked the Secretariat and Steering Committee for the intersessional work on data validation and analysis (Appendix D, paragraphs 130 and 132).

2.3 The Working Group noted the conclusions with regard to analyses of serial correlation and power (Appendix D, paragraph 131) that:

- (i) in general, the amount of serial correlation in the biological indices was not greater than what might be expected by chance alone, but there was more serial correlation in the environmental and fisheries indices (Appendix D, paragraph 23);

- (ii) it would be useful to obtain an improved understanding of the sources of variation in the CEMP indices, including spatial and temporal variability and the consequences of such variability on power to detect trends of varying magnitude, over varying lengths of time, at different numbers of monitoring sites, and under various levels of risk. An example of the type of work necessary to achieve this understanding was developed for indices on Adélie penguins (Appendix D, paragraphs 34 to 38);
- (iii) extending the analysis of the sources of variation to the full suite of CEMP indices may lead to improvements in CEMP. It was recommended that such work should be conducted in the near future (Appendix D, paragraph 39).

2.4 The Working Group also noted the conclusions with regard to functional responses between indices of predator performance and measures of krill availability (Appendix D, paragraph 132) that:

- (i) predator performance appears to be related to krill availability both at South Georgia and at the South Shetland Islands (WG-EMM-03/61) (Appendix D, paragraphs 46 to 48), but the form of the relationship differs between these two areas (Appendix D, paragraph 50);
- (ii) at South Georgia, the relationship between predator performance and krill density was improved when multiple indices of predator performance were combined, but this was not the case for predators at the South Shetland Islands. The workshop identified a number of possible explanations for the different patterns of response by predator at these two locations (Appendix D, paragraphs 49 and 50);
- (iii) differences in predator performance observed in the Mawson region of East Antarctica and at Edmonson Point in the Ross Sea during 2001 and 2003 were attributed to differences in krill biomass at Mawson and to environmental conditions at Edmonson Point (Appendix D, paragraphs 53 to 56);
- (iv) the data requirements and analytical procedures required to evaluate the indices of krill availability derived from fisheries data should be defined (Appendix D, paragraphs 60 to 63);
- (v) it may be possible to use the relationships between predator performance and krill availability for predicting krill availability and for developing a biological basis for the identification of years in which predator performance was anomalous (Appendix D, paragraphs 64 to 66 and Attachment 3);
- (vi) the ability to relate CEMP indices (both singularly and combined) to the long-term demographics of predator populations and how these might respond to long-term trends in the krill resource are critical to future work (Appendix D, paragraph 66).

2.5 In considering the advice to WG-EMM on the terms of reference of the review of CEMP (Appendix D, paragraphs 130 to 136), the Working Group agreed that:

- (i) the review is closely linked to the Working Group's workshops on the selection of appropriate predator-prey-fishery-environment models (2004) and on evaluation of management procedures, including objectives, decision rules and performance measures (2005) (Appendix D, paragraph 83);
- (ii) many of the present replies to the questions posed should be viewed as interim responses based on work in progress (Appendix D, paragraph 84).

2.6 With regard to the first term of reference (Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives¹?), the Working Group agreed that:

- (i) the CEMP data were appropriate for detecting and recording significant change in some critical components of the ecosystem, but further critical evaluation of the nature, magnitude and statistical significance of changes indicated by the data were necessary (Appendix D, paragraph 85);
- (ii) it remains important to determine how representative the CEMP sites are of their local areas and regions (Appendix D, paragraph 86).

2.7 In particular, the Working Group noted the advice that:

- (i) at current harvesting levels it was unlikely that the existing design of CEMP, with the data available to it, would be sufficient to distinguish between ecosystem changes due to harvesting of commercial species and changes due to environmental variability, whether physical or biological (Appendix D, paragraph 87);
- (ii) with the existing design of CEMP, it may never be possible to distinguish between these different and potentially confounding causal factors and that the Scientific Committee should seek advice from the Commission on the extent to which further work should be directed towards this topic (Appendix D, paragraph 87);
- (iii) without a real ability to separate the confounding effects of harvesting and environmental variation and in the context of uncertainty, the Scientific Committee should seek advice from the Commission about the policy of how management should proceed when a significant change was detected, but no single causal factor could be attributed (Appendix D, paragraph 88);
- (iv) one possible method that may assist in the separation of confounding effects of harvesting and environmental variation would be the establishment of an experimental fishing regime whereby fishing would be concentrated in local areas in conjunction with an appropriate predator monitoring program (Appendix D, paragraphs 89 and 90).

¹ The original objectives of CEMP (SC-CAMLR-IV, paragraph 7.2) were to:

- (i) detect and record significant changes in critical components of the ecosystem to serve as a basis for the conservation of Antarctic marine living resources;
- (ii) distinguish between changes due to the harvesting of commercial species and changes due to environmental variability, both physical and biological.

2.8 The Working Group noted that the CEMP review had summarised many examples of effects on predator populations, especially of breeding performance, that related principally (whether directly or indirectly) to environmental effects. These included the acute effects of years of exceptional ice cover, periodic effects ascribed to oceanographic influences, such as ENSO, and long-term changes that may reflect regional shifts in marine processes, potentially linked to climate change phenomena (Appendix D, paragraph 106; WG-EMM-03/53 and 03/59).

2.9 With regard to the second term of reference (Do these objectives remain appropriate and/or sufficient?), the Working Group agreed that the original objectives of CEMP remained appropriate, but that a third objective 'To develop management advice from CEMP and related data' should be added (Appendix D, paragraph 95).

2.10 With regard to the third term of reference (Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?), the Working Group agreed that:

- (i) many time series of non-CEMP data contain information of considerable value in addressing the objectives of CEMP;
- (ii) the Secretariat should maintain a register of the wide range of non-CEMP time-series data that were of use to this workshop and of potential utility to future workshops in support of the work of WG-EMM, including datasets derived from South African and French seabird and pinniped monitoring programs in the southern Indian Ocean (Appendix D, paragraphs 96 and 108; see also Appendix D, Table 9).

2.11 In particular:

- (i) useful indices of krill availability to land-based krill predators could be derived from fishery-dependent data (Appendix D, paragraphs 91 and 92);
- (ii) indices derived from mackerel icefish data may be of value in monitoring krill in certain regions; these indices should be subjected to the same analyses undertaken for CEMP data (Appendix D, paragraphs 98 to 100);
- (iii) holders of other relevant time-series data are encouraged to undertake or collaborate in appropriate analyses (see Appendix D, paragraphs 31 to 42, 46 to 49, 64 to 66, 100 and 108) and report the results to the Working Group.

2.12 In addition, the Working Group agreed that indices derived from pellets regurgitated by Antarctic shags may be of value in monitoring the early life-history stages of coastal fish species, including several of commercial importance. It was recommended that WG-FSA consider how such indices may be useful to its stock assessment and management procedures (Appendix D, paragraphs 101 and 102).

2.13 With regard to the fourth term of reference (Can useful management advice be derived from CEMP?), the Working Group noted that good progress was being made with several promising modelling initiatives, particularly those relating to, or derived from, CSIs and functional relationships (Appendix D, paragraphs 109 and 110).

2.14 It particularly noted that the WG-EMM workshop next year on Plausible Ecosystem Models for Testing Approaches to Krill Management would be considering a variety of relevant approaches (Appendix D, paragraph 136), including:

- (i) behavioural models based on interactions between the aspects of the environment, krill, krill predators and a krill fishery (Appendix D, paragraphs 111 to 115);
- (ii) further work on functional responses linking predators to their prey field (Appendix D, paragraphs 116 to 119);
- (iii) development of simulation studies to improve ability to detect anomalies (Appendix D, paragraphs 119 to 121 and Attachment 3);
- (iv) further consideration of ‘burden of proof’ issues (Appendix D, paragraphs 122 and 123).

2.15 The Working Group noted the advice that, in respect of relationships between ISRs and SSMUs, it would be unlikely that the extensive monitoring and research programs developed within ISRs would be necessary for SSMUs (Appendix D, paragraph 127). It welcomed the provision of a summary of the nature of existing CEMP monitoring within each SSMU (Appendix D, paragraphs 128 and 129 and Table 8).

2.16 The Working Group endorsed the program of intersessional work concerning the development of aspects of the CEMP review (Appendix D, paragraph 138 and Table 9).

2.17 The Working Group requested that the report of the CEMP Review Workshop should include:

- (i) a footnote to Table 8 to indicate the location of the source data, specifying the parameters monitored at each site (WG-EMM-03/24, Table 4);
- (ii) in Figure 1, the location of all sites from where CEMP data are available (i.e. by adding Verner Island, Magnetic Island, Shirley Island, Svarthamaren and Bouvetoya);
- (iii) in the legend to Figure 3, the units of krill density (g m^{-2}).

2.18 Dr Siegel noted that in the original Figure 4 (see also paragraph 57) of the CEMP Review Workshop report, the statistic ‘proportion of krill in the diet’ appeared to include data for *Euphausia* species other than *Euphausia superba* (e.g. for Subarea 58.7). At the Working Group’s request, Figure 4 was subsequently revised and confined to data for *E. superba*.

2.19 The Working Group thanked the Co-conveners, Steering Committee and all workshop participants for ensuring such positive and constructive outcomes for the first phase of the review of CEMP.

Key Points for Consideration by the Scientific Committee

2.20 The Working Group advised the Scientific Committee of the outcome of the first phase of the CEMP review (paragraphs 2.1 to 2.18 and Appendix D). A plan of intersessional work (Appendix D, Table 9) had been developed to address some important tasks, particularly including:

- (i) completion of the review of sources and magnitudes of variability in predator response parameters;
- (ii) investigation of the utility of indices derived from haul-by-haul CPUE data as a proxy for direct measures of krill availability;
- (iii) investigation of alternative methods for determining anomalies and predicting krill abundance using predator response curves.

STATUS AND TRENDS IN THE KRILL FISHERY

Fishing Activity

2001/02 Season

3.1 The provisional total krill catch in 2001/02 (125 987 tonnes) was 20% higher than the catch reported in 2000/01 (104 182 tonnes) (WG-EMM-03/28). The catch in 2001/02 was the highest catch since 1994/95 (135 686 tonnes). Available fine-scale data (10 x 10 n miles) for the 2001/02 season accounted for approximately 70% of the provisional total catch, and these data indicated that fishing in 2001/02 occurred mainly in Subareas 48.2 (64% of catch reported in fine-scale data) and 48.3 (24%). Relatively little fishing occurred in Subarea 48.1 (12%).

3.2 All Member countries fishing submitted monthly catch and effort reports for Area 48 as a whole, or in each of the subareas separately. Three Member countries (Poland, Ukraine and the USA) of the five Members that fished during the season have submitted complete sets of fine-scale data. One other Member (Japan) submitted data for the period December 2001 to June 2002 by the deadline (April 2003, Conservation Measure 23-03), and fine-scale data for the remaining period (July–November 2002) on 29 July 2003.

3.3 Two Member countries submitted STATLANT data covering the whole of the 2001/02 season, while three other Members submitted data for the year ending June 2002. ‘Missing’ STATLANT data for the period July–November 2003 were reconstructed using monthly catch and effort reports; this is a temporary solution to obtain a provisional total catch for the fishery.

3.4 Some Members experienced difficulties in submitting data in line with the new CCAMLR season, but efforts are being made by Members to overcome such problems and realign data submission with the deadline adopted in Conservation Measure 23-03. The total catch of krill reported in Area 48 from the three sources of data is:

- monthly reports – 122 778 tonnes
- fine-scale data – 86 348 tonnes
- STATLANT data – 125 987 tonnes (provisional).

2002/03 Season

3.5 Krill fishing has occurred only in Area 48 in 2002/03, with 74 053 tonnes of krill taken between December 2002 and June 2003. Eight trawlers have fished so far this season, and these are flagged to five Member countries: Japan (3 vessels), Republic of Korea (1 vessel), Poland (1 vessel), Ukraine (2 vessels) and the USA (1 vessel). Catch reported to date is similar to that reported at approximately the same time last year (WG-EMM-02/6), indicating that the current fishing season is following a pattern similar to that reported for the fishery in 2001/02.

Indications for 2003/04

3.6 The Working Group was informed that Japan intended to fish at approximately the same level in the forthcoming season as in the 2002/03 season with two vessels catching about 60 000 tonnes of krill. The US operation is also likely to maintain its current level of activity, although it may introduce a second vessel. No further information was available from other fishing nations.

3.7 The Working Group recalled that at its last meeting it indicated to the Scientific Committee the difficulty it had in understanding the trends in the krill fishery (SC-CAMLR-XXI, Annex 4, paragraphs 2.44 and 2.70) and it noted that representatives from only two of the fishing nations had attended the 2003 meeting of WG-EMM. Consequently, information available to the Working Group on future fishery plans was incomplete, and anecdotal, and was not sufficient to make any assessment of developments in the krill fishery.

3.8 The Scientific Committee was advised that if WG-EMM was expected to assess the status and trends in the krill fishery, then it needed annual submission of information on the detailed fishing plans of all Member nations which would include at a minimum: the number of vessels, the locations of planned fisheries and the expected catch levels.

Catch in SSMUs

3.9 WG-EMM-03/28 provided the first indications of catches in the newly defined SSMUs. The catch of krill in each SSMU over the past 10 fishing seasons indicates major shifts in fishing operations within and between SSMUs. Notably, fishing in the 2001/02 season targeted krill in the South Orkney West SSMU (SOW, Subarea 48.2) and South Georgia East SSMU (SGE, Subarea 48.3), with relatively little fishing reported to date in the Antarctic Peninsula SSMUs (Subareas 48.1 and 48.5). Over the past 10 years, the SOW SSMU has been fished intensely in the seasons 1994/95, 1998/99 and 2001/02. In South

Georgia, fishing has taken place mostly in the SGE SSMU in the seasons 1993/94 to 1997/98, 2000/01 and 2001/02. In the Antarctic Peninsula, catches of krill have been taken mostly in the Drake Passage SSMUs (APDPE and APDPW).

3.10 The Working Group agreed that examination of the krill catch by SSMU was a valuable exercise and that such analyses should continue in future because they would provide information regarding fishery behaviour and potential overlap with foraging land-based predators.

CPUE Analyses

3.11 Between 1977 and 1991 a number of different measures of CPUE were employed in the Soviet krill fishery: catch per fishing day (CFD), catch per extended fishing day (CEFD) and catch per hour (CH) (WG-EMM-03/35). The primary data for all the calculations were catch per haul and haul duration. CEFD represented the catch per day of fishing plus days with no actual catch due to stormy weather or because of the absence of appropriate krill aggregations. This parameter was introduced to evaluate the presence and availability of krill aggregations on the fishing grounds, and the weather conditions, but CEFD also included days spent waiting for fuel, delays because of catch overloading and other economic reasons, so it was difficult to use in fishery forecasting.

3.12 There was a good correlation between mean monthly values of CFD and CEFD, and CFD and CH. Correlation between daily values was poor, due to high fluctuations in haul duration caused by differing fishing strategies. Fishing strategies depended on whether the vessel was producing krill products for human consumption, krill meal or frozen krill. When different strategies were taken into account the mean daily CFD and CH are better correlated. Catch per hour has a different meaning when applied to short hauls and to longer hauls. Catches per hour in short single-swarm oriented krill hauls characterise krill single-swarm density, and in long hauls this parameter characterised krill abundance at a subarea level.

3.13 Depending on the fishing strategy, between 1 and 15 hauls were conducted per day and these ranged in duration from 0.1 to 16 hours; shorter hauls were utilised for higher final product quality, and shorter haul durations resulted in a larger number of hauls per day. Krill fishing vessels could be divided in three groups by their capacity for krill processing: those that could process up to 100–150 tonnes of raw krill per day, those that could process between 70 and 100 tonnes of raw krill per day and those that could only process 40–70 tonnes of raw krill per day.

3.14 The Working Group recognised that WG-EMM-03/35 provided valuable information on the utility of haul-by-haul data from the fishery, but also that it indicated the requirement for operational information from the fishery for the interpretation of CPUE indices and for the standardisation of fisheries-derived measures.

3.15 The Working Group reiterated its need for haul-by-haul data for its scientific work. Aggregated CPUE data lose considerable information and the assessment of the utility of aggregated CPUE for examining trends in krill distribution abundance becomes compromised

unless the data are presented in haul-by-haul form over a number of years. Once such a dataset is available, it would then be possible to make an assessment of whether aggregated data could be used subsequently.

3.16 In addition to the need for haul-by-haul data, the Working Group stressed that there was a requirement for consistency in the reporting of CPUE data by fishing vessels from different nations. In line with the recommendations of SC-CAMLR's CPUE workshop in 1989 (SC-CAMLR-VIII, Annex 4) reporting of CPUE should include an assessment of search time as well as catch per tow. The Working Group also recommended that standardised methods such as GLMs be applied for the analysis of these data, and noted that such analyses would not be possible on aggregated data in the format currently submitted under Conservation Measure 23-06.

3.17 A subgroup was formed during the CEMP Review Workshop to evaluate fisheries-derived CEMP indices with respect to functional relationships of krill-dependent species with the following terms of reference:

- (i) to define analytical procedures
- (ii) to define the data required
- (iii) to specify protocols on submission, curation and use of the data.

3.18 The subgroup was asked to submit its recommendations to WG-EMM under Agenda Item 3.2 (Appendix D, paragraph 63).

3.19 The task of assessing CPUE was divided into a number of categories and the subgroup addressed each of these issues:

Analytical procedures:

- (i) determine sensitivity and power-analysis approaches required for the data validation;
- (ii) identify covariates in GLM for assessing CPUE data (WG-FSA-03/40, paragraphs 2.18 to 2.21).

Data requirements:

- (iii) define areas and seasons for which data are required, based on the existence of predator response data;
- (iv) define scale of data required to conduct analytical procedures.

Submission protocols:

- (v) timetable and delivery of outputs;
- (vi) CCAMLR rules of data access.

3.20 The subgroup recognised that the statistical validation of fisheries-derived indices and the examination of the utility of these indices as proxies for krill availability to predators was a two-stage process. The first part of this process, the validation of the indices, defined the nature of the data required. The second part, evaluating the functional relationships, was based on the existence of CEMP time series of the performance of krill-dependent species, and these would define the spatial and temporal extent of the data required.

3.21 The subgroup also recognised that an important component of this work was to evaluate the relationship between the existing fisheries-derived CEMP parameter (H1) and CEMP-derived predator performance indices. This would require analyses of the relationships between the various fisheries-derived indices from the different fishing fleets. The subgroup recommended that the focus of the analysis should be in Area 48 as there were time series of predator performance from each of the three subareas where krill fishing has consistently occurred; Table 1 provides the location and duration of time series of these CEMP predator parameters for which complementary fisheries-derived indices would be desirable.

3.22 The subgroup recommended that the analysis of the sensitivity and power to detect trends in indices of krill fisheries performance (CPUE), as well as the evaluation of functional responses of dependent species to those indices, should follow the procedures and recommendations arising from the CEMP Review Workshop. In order to facilitate this validation process the following data are required for the analysis of CPUE data: vessel name, experience of the fishing master, vessel type, fishing location, fishing gear, date, time, catch per haul, haul duration and product type; this information should be provided on a haul-by-haul basis. It was recognised that not all these data would be available from all fishing operators in all areas and years.

3.23 The subgroup agreed that haul-by-haul data were necessary for this task and these would allow an assessment of the extent of data aggregation that might be appropriate for the future work of the subgroup. These data were required for the specified task and would be used in accordance with CCAMLR's rules of data access.

3.24 Dr M. Naganobu (Japan) recognised the scientific importance of the use of these data and indicated that the provision of haul-by-haul data from the Japanese fishery would require domestic consultation before the temporary submission of these data for the specified tasks.

3.25 The subgroup recommended that Dr S. Kawaguchi (Australia) should be an appropriate expert to carry out these analyses in cooperation with appropriate data holders and scientists, and he would be approached to conduct these analyses in the intersessional period and provide the results to the 2004 meeting of WG-EMM.

3.26 The Scientific Committee had indicated that haul-by-haul data will also be needed for the subdivision of the krill catch limits amongst SSMUs and the Working Group agreed that this is a further scientific justification for the collection and submission of krill fisheries data on the smallest scale possible.

Description of the Fishery

Fishery Economics

3.27 A recent search of the Internet by the Secretariat failed to locate relevant recent information regarding the market prices of krill. In 2002, WG-EMM asked the Secretariat to contact ICES for information about the number of vessels from North Atlantic fisheries that might potentially enter the krill fishery (SC-CAMLR-XXI, Annex 4, paragraph 2.50). The ICES Secretariat was contacted and agreed to forward WG-EMM's request for information to ICES members; no information had been forthcoming by the start of the meeting.

3.28 Also last year, WG-EMM asked the Secretariat to contact FAO for information on the demand for krill for aquaculture feeds and information on other krill fisheries (SC-CAMLR-XXI, Annex 4, paragraph 2.72). FAO was contacted and provided a copy of an FAO report entitled 'Use of fishmeal and fish oil in aquafeeds: further thoughts on the fishmeal trap' (Fisheries Circular No. 975, 2002).

3.29 The FAO circular reported that: 'The hope for increased fishmeal and oil supplies lies in the use of species that hitherto have not been used for fishmeal production. The two main sources are mesopelagic species and krill. Both species have been caught and used to produce high protein meals. The problem to date is a techno-economic one: with present fishing technologies, the harvesting, preservation and processing costs are in excess of those that fishmeal producers are prepared to pay' (WG-EMM-03/28).

3.30 The FAO circular further emphasised the importance of krill as an aquaculture feed: 'Krill is potentially an excellent nutrient source for feeding farmed fish and crustaceans. Besides providing protein, energy and palatability, it is also a source of essential amino acids, fatty acids and other nutrients. In addition, it has the potential to enhance the pigmentation of aquaculture products, thus increasing their visual quality'. Dr Nicol informed the Working Group that regulatory developments in the European Community will reduce the levels of permitted artificial colouration in farmed fish, and in the USA which will require labelling of artificially coloured farmed fish. These developments are likely to increase demand for krill which is a good source of natural red pigmentation.

3.31 The Working Group noted that some of the information in the FAO circular contained inaccuracies or misstatements (WG-EMM-03/28). These included the potential level of harvest of krill as well as the current level of harvesting. The FAO circular also contained no references to up-to-date publications on the krill fishery or the work of CCAMLR. The Secretariat was requested to contact FAO to address these points and report the outcome to the Scientific Committee and to the 2004 meeting of WG-EMM.

3.32 The Working Group recognised that there was information available on commercial websites that indicated that krill products were available from sources other than those for which CCAMLR regularly receives reports. The Secretariat was requested to contact companies listed on the Fish Information Service website (and any other websites where such information may be found) which were offering krill products for sale. Should any of these companies prove to be actively engaged in krill fisheries in the Convention Area, the countries where they are based should be informed that fishing for krill should be conducted in accordance with CCAMLR's conservation measures and that these included reporting requirements. The Scientific Committee should be informed of the results of these investigations.

Fishing Strategies

3.33 Acoustic assessments of krill density on the grounds fished by Soviet trawlers in Subareas 48.1, 48.2, 48.3 and 48.4 show that in the mid-1980s the fishery was conducted in areas where the mean krill density was greater than $100\text{--}110\text{ g m}^{-2}$ (WG-EMM-03/31). These acoustic observations correspond to estimated trawl density derived from haul-by-haul data

from Soviet trawlers in 1987–1990, and Ukrainian vessels in 2001 and 2002. For these fisheries, a density of 100 g m^{-2} appears to be a threshold value of krill density for fishing operations and this value may apply to current fleet operations as well.

3.34 The Working Group recognised that this paper produced valuable information on the threshold density for krill fisheries and this information might be used to provide indicative maps of where krill fisheries might be expected to develop. Similar analyses of analogous datasets from the historical and current fisheries of other Members were requested and the Working Group acknowledged that this would require the standardisation of such analyses using the finest-scale fisheries information (haul-by-haul data).

Estimation of Krill Density from Commercial Trawls

3.35 WG-EMM-03/21 provided analyses from a combination of experimental and modelling approaches to examine the escapement of krill from trawls. Several factors affected krill escapement. Krill of different sizes escaped from different parts of the net and the degree of escapement probably is related to the design of the net and the behaviour of krill, so a simple assessment was not possible. The catchability of krill trawls appeared to be a stable characteristic for a particular trawl design regardless of the fishing area, but it also varied according to the time of day, swarm parameters and trawling conditions.

3.36 The differential catchability of krill caused by mechanical and behavioural factors affected estimates of krill density derived from simple calculations utilising merely the volume of water filtered. A mathematical model of catchability which takes into account the differences in effectiveness of the various parts of the net, as well as the biological characteristics of the krill, was developed. This provided an improved method for estimating krill density from commercial catches.

Questionnaire on Krill Fishing Strategies

3.37 Two Members submitted completed questionnaires: Poland 51 questionnaires and the USA 13 questionnaires. Most of these data were reported at WG-EMM-02, and all data (64 for 2001/02 and 4 for 2000/01) have been entered into a Secretariat database. No completed questionnaires on krill fishing strategies have been submitted to date for 2002/03.

Regulatory Issues

Scheme of International Scientific Observation

3.38 Five sets of scientific observer data were submitted for the 2001/02 season, collected by CCAMLR international scientific observers on board vessels from Japan, Ukraine and the USA. Currently, the CCAMLR database holds data collected by designated CCAMLR scientific observers from eight krill fishing voyages.

3.39 Several changes to the *Scientific Observers Manual* and electronic logbook (e-logbook) forms were recommended by WG-EMM-02 (SC-CAMLR-XXI, Annex 4, paragraph 2.62). These were related to observations on board krill fishing vessels.

3.40 An intersessional subgroup chaired by Dr Kawaguchi considered these recommendations and drafted the amendments required (WG-EMM-03/55) as follows:

Scientific Observer Manual –

- (i) addition to existing guidelines for sampling of larvae fish by-catch in krill catches to include a section on sampling of fish larger than 7 cm;
- (ii) data collection priorities and requirements for the collection of finfish by-catch (including larvae fish) and krill biological data;

e-logbook forms –

- (i) revised form K4 ‘Krill Biological Data Collection’ and K6 ‘Conversion Factors’, with instructions;
- (ii) new form K5b ‘Finfish larvae by-catch’ with instructions.

3.41 A task group comprising Drs J. Watkins (UK), V. Sushin (Russia), Hewitt and E. Sabourenkov (Secretariat) was established during the WG-EMM meeting to consider the amendments proposed. The task group recommended that WG-EMM approve the amendments proposed and forward them to WG-FSA for information/comments, and to the Scientific Committee for approval. It was agreed by WG-EMM.

3.42 In respect to the proposed addition of a new section to the manual with data collection priorities and sampling requirements for the collection of finfish by-catch in krill biological data, WG-EMM agreed that these should be incorporated into existing sections of the manual which already contain information on the same subject.

3.43 In respect to revision of the colour chart for krill feeding observations (SC-CAMLR-XXI, Annex 4, paragraph 2.62), WG-EMM noted that this had been postponed by the subgroup until 2004.

3.44 The task group also considered a number of general matters related to the production and use of the *Scientific Observers Manual* and e-logbooks. It advised WG-EMM that:

- (i) e-logbooks have proved to be an indispensable tool for the collection and submission of data and their subsequent download to the Secretariat’s database;
- (ii) existing e-logbooks should be translated into all official languages of CCAMLR;
- (iii) the use of e-logbooks should become standard for all scientific observations on board fishing vessels;
- (iv) publication of printable versions of observer logbooks should be continued in order to provide backup means for recording and reporting data;

- (v) the e-logbook for observations on board krill fishing vessels as prepared by the Secretariat and amended at this meeting, should be adopted as a standard and its printable version be included in the *Scientific Observers Manual*.

3.45 WG-EMM agreed with this advice and forwarded it for further consultation with and approval by WG-FSA and the Scientific Committee. In doing so, WG-EMM noted that translation of krill e-logbooks in other languages would need to be done during 2004, preferably by February–March, and that it would have financial implications for the Secretariat.

Krill Fishery Plan

3.46 The Working Group noted that the Secretariat had updated the plan for the krill fishery (WG-EMM-03/28).

Key Points for Consideration by the Scientific Committee

3.47 The Working Group recalled that at its last meeting it indicated to the Scientific Committee the difficulty that it had in understanding the trends in the krill fishery (SC-CAMLR-XXI, Annex 4, paragraphs 2.44 and 2.70) and it noted that representatives from only two of the fishing nations had attended the 2003 meeting of WG-EMM. Consequently, information available to the Working Group on future fisheries plans was incomplete, and anecdotal, and was not sufficient to make any assessment of developments in the krill fishery (paragraph 3.7).

3.48 The Scientific Committee was advised that if WG-EMM was expected to assess the status and trends in the krill fishery, then it needed annual submission of information on the detailed fishing plans of all Member nations which would include: the number of vessels, the locations of planned fisheries and the expected catch levels (paragraph 3.8).

3.49 The Working Group tasked Dr Kawaguchi with evaluating fisheries-derived CEMP indices with respect to functional relationships of krill-dependent species. This would require the temporary submission of time series of haul-by-haul data from the krill fisheries (paragraphs 3.17 to 3.26).

3.50 The Working Group requested analyses of historical and current fisheries datasets to determine threshold densities for krill fishery operations (paragraph 3.34).

3.51 The Working Group recommended that e-logbooks for scientific observation on board fishing vessels be translated into all official languages of CCAMLR (paragraph 3.45). This was referred to WG-FSA and the Scientific Committee for further consideration and would require allocation of appropriate funds.

STATUS AND TRENDS IN THE KRILL-CENTRIC ECOSYSTEM

Status of Predators, Krill Resource and Environmental Influences

CEMP Indices

4.1 Dr Ramm presented the annual report of trends and anomalies in CEMP indices (WG-EMM-03/24) provided by the Secretariat. The report included a summary of intersessional progress in data validation, a new measure of fishery overlap, and preparatory work for the CEMP Review Workshop.

4.2 The Fishing to Predation Index (FPI) defined by Everson (2002) was introduced as Index H3d. FPI is the ratio of the amount of krill taken by commercial fishing compared to the amount of krill required by predators. An increase in FPI indicates that fishing is taking a larger proportion of the available krill and consequently fishing is more likely to be having an impact on the dependent species.

4.3 Index H3a (standardised realised overlap based on the Agnew–Phegan model) was discontinued as a CEMP index following the recommendation of WG-EMM (SC-CAMLR-XXI, Annex 4, paragraph 3.40).

4.4 The Working Group recommended that the Secretariat investigate the feasibility of calculating overlap indices for each of the SSMUs and also recognised that there would be a need to review the utility of the different overlap indices again, including for purposes relevant to the management of SSMUs.

4.5 WG-EMM-03/24 suggested that in the context of 2003 there was little evidence of large-scale deviation from the long-term mean for most indices, however, there was evidence that indices of the performance of predators at Cape Shirreff were abnormally low (e.g. WG-EMM-03/54) and that unusual ice conditions in the Ross Sea continue to negatively impact on penguins in that region (Appendix D, paragraphs 54 and 132(iii); WG-EMM-03/59).

4.6 With regard to anomalies for 2003, it was noted that in the list of indices, which showed a positive anomaly for 2003, four (A5a Adélie penguin foraging trip duration at Béchervaise Island, C1 fur seal foraging trip duration at Cape Shirreff, Livingston Island, C2b fur seal pup growth rate at Cape Shirreff and A2 Adélie penguin incubation shift at Edmonson Point) should have been listed as negative anomalies. It was subsequently discovered that the ‘trend correction’ (see ‘sign’ in Table 2, WG-EMM-03/24) had not been applied to the anomalies, resulting in a misinterpretation of negative and positive anomalies in the indices for which a correction of –1 applies, including foraging trip duration and incubation shift.

4.7 A recommendation was made that data originators be asked to review the annual report of CEMP indices and anomalies, in order to identify any such transformation errors, some time prior to the compilation and submission of future reports to WG-EMM.

4.8 With regard to Index C2b, fur seal pup growth rate, a recommendation to use pup growth deviates based on Reid (2002) instead of growth rate was made. In the case of Cape Shirreff C2b 2003, if growth deviates were used instead of growth rates this index would be recorded as having a negative instead of a positive anomaly. It was recommended that further discussion of this topic be undertaken by the Subgroup on Methods.

4.9 Dr Kirkwood cautioned against undue emphasis on anomalies and the summing of anomalies to assign years to a qualitative category such as ‘good’ or ‘bad’ without due regard to the biological and statistical nature of these anomalies.

4.10 The Working Group recognised the need to provide an improved annual assessment of anomalies and trends of CEMP indices and tasked a subgroup on representation of CEMP indices (comprising Drs B. Bergström (Sweden), Goebel, Ramm, Reid and G. Watters (USA)). The terms of reference for the subgroup were to:

- examine the utility of the current approach to presenting anomalies in individual indices to provide assessment of the status of the ecosystem;
- define a process for the presentation and interpretation of CEMP indices to produce a status-of-the-ecosystem index each year with respect to long-term means/trends;
- define species as well as spatial and temporal framework in which to produce combined indices and to evaluate the use of CSIs in providing syntheses of CEMP indices.

4.11 Notwithstanding issues of the sign and magnitude of individual indices and the nature of the anomalies reported in WG-EMM-03/24, the subgroup considered that the current approach to presenting a balance of positive and negative anomalies was inappropriate and of limited utility to the future work of WG-EMM.

4.12 The subgroup recommended that a distinction be made between the types of indices used in any approach such that indices with different properties (including the level of serial autocorrelation) were not compared directly. The combination of both predator-derived and physical indices from several areas of the CCAMLR Convention Area meant that only a very subjective interpretation of the state of the ecosystem was possible.

4.13 An approach which described the ‘state’ of the ecosystem relative to other years was recognised to be more desirable as it would have the potential to identify temporary shifts in the state of the ecosystem (i.e. anomalies), gradual changes (i.e. trends) or regime shifts. In particular, the subgroup recommended an approach that utilised all of the available data rather than being restricted to the presentation of statistical anomalies.

4.14 The subgroup proposed that an ordination approach be developed whereby the nature of the covariation in multivariate CEMP indices could be described and presented on an annual basis. This approach would serve to change from an emphasis of describing a year as ‘good’ or ‘bad’ to one in which the status of each year might be categorised with respect to other years in the time series.

4.15 Dr Watters provided a presentation to the Working Group of such an ordination approach using a hypothetical example of the results of an ordination approach where a time series of data is plotted for predator performance, physical indices (i.e. environmental conditions) and fishery performance (Figure 1). This example described the status of the current year and trends in indices, where the first two ordination axes described variability in indices that reflect ‘winter’ and ‘summer’ processes and these axes are used to describe a time series of predator performance indices (Figure 2). The subgroup suggested that this approach could be applied independently for each ISR.

4.16 In addition, there should be an emphasis on highlighting ‘genuine’ anomalies, e.g. the iceberg situation in the Ross Sea (Appendix D, paragraphs 54 and 132(iii)), rather than statistical anomalies that would be expected to occur by chance in each year.

4.17 There was recognition by the Working Group that the inclusion of non-CEMP time series (e.g. krill density estimates) may be important in this approach.

4.18 The Working Group thanked members of the subgroup for their efforts and endorsed the ordination approach to examining CEMP indices over a time frame that would allow the Secretariat to present the results to the next meeting of WG-EMM. However they recognised that this would be a process that might evolve over a longer time frame.

Krill

4.19 The Working Group considered documents describing results on biomass estimates from krill acoustic surveys in the Scotia Sea and the South Shetland Islands (WG-EMM-03/6, 03/30 and 03/31) and on krill demography from a net sampling survey around South Georgia (WG-EMM-03/40).

4.20 WG-EMM-03/6 analysed annual data from an 11-year time series of single- and multi-frequency acoustic surveys in the Elephant Island area conducted by the US AMLR Program. The reanalyses of the surveys improved accuracy by (i) characterising and deleting system noise, (ii) compensating for diel vertical migration, and (iii) employing a multi-frequency technique for delineating volume backscattering (S_v) due to krill.

4.21 Estimates of mean krill biomass density from the first and second surveys of each year (January and March) are generally not significantly different. Application of a filter using a dB difference between 38 and 120 kHz (where $4 < \text{dB difference} < 16$) captured most aggregations of krill, but also included some identified as myctophids and smaller zooplankton. Application of a second filter using a difference between 120 and 200 KHz (where $-4 < \text{dB difference} < 2$) eliminated the non-krill targets while retaining most of the krill aggregations.

4.22 Estimated biomass density ranged from 1 to 60 g m⁻². From a mid-range level in 1992, biomass density decreased to a minimum in 1994, increased to a peak in 1998 and decreased again thereafter. The paper suggested that changes in density are consistent with changes in reproductive success. A truncated Fourier series fit to the acoustic estimates led to the conclusion that the majority of the variance was explained by three- and eight-year cycles. The model also predicted an increase in krill biomass density in 2003 and 2004, which is supported by the cycles in sea-ice extent and recruitment.

4.23 WG-EMM-03/31 examined former USSR and Russian acoustic survey data and compared the biomass density estimates with results obtained from commercial net samples from the fishing areas used by the former USSR, Russia and Ukraine in the Scotia Sea. The results indicated that vessels fishing where krill biomass was at least 100 to 120 g m⁻² achieved a sustainable yield of 3 to 3.5 tonnes per hour. Below this threshold level vessels left the fishing grounds. The authors concluded that this commercially viable threshold level exceeded a critical minimum level of predator demand (24 g m⁻² (Boyd, 2001)) and therefore the fishing fleet and dependent predators should have different density niches to exploit.

4.24 WG-EMM-03/30 gave results of an acoustic survey in the South Georgia area in February–March 2002. Survey transects were located within the 500 m isobath. Mean survey density was 45 g m^{-2} . Almost 50% of the survey area showed a biomass density of less than 6.9 g m^{-2} . Over 70% of the biomass was concentrated in the areas to the northeast and northwest of the island. In some locations near-bottom aggregations exceeded 100 g m^{-2} . Using a research vessel to fish for these aggregations with a commercial-sized midwater trawl yielded up to 1 tonne per half-hour trawling. Potential fishing locations were mapped using a threshold level of 100 g m^{-2} . Mean biomass density in these locations was 849 g m^{-2} .

4.25 The paper concluded that the biomass density in the western area was too low for a sustainable fishery, but in this area the krill density exceeded the critical minimum level of predator demand for krill-dependent predators. Thus the observed density was considered to meet the needs of predators feeding in this area during the critical period.

4.26 However, the Working Group could not agree with the conclusion of WG-EMM-03/31 that there is no overlap between predators and the fishery simply due to different threshold levels in their minimum density demand. Predators will certainly exploit krill concentrations above 100 g m^{-2} and therefore compete with a potential fishery operation.

4.27 The Working Group also felt it premature to agree in principal with the conclusion of WG-EMM-03/30 that the spatial segregation between predators and the fishery to the west of South Georgia is a commonly observed phenomenon. It was noted that predators concentrate in the western area during the breeding season, but at other times of the year the overlap with current fishing areas may be more important.

4.28 The Working Group welcomed the estimation of threshold levels for commercial operations as an important step forward in predicting where potential fishing could occur. Further work was encouraged firstly to compare the distribution of actual fishing with that predicted from distribution of threshold levels, and secondly, to compare predicted krill fishing areas in relation to distribution of predator demand in the area. The Working Group encouraged all Members with relevant data to undertake such analyses for all subareas of Area 48. When undertaking such comparisons the Working Group stressed that the temporal and spatial scales used for predator and fishery density estimates should be comparable.

4.29 WG-EMM-03/40 described the distribution of krill size classes north of South Georgia during summer 1988. Small krill (mode 33 mm) dominated the area 7 to 40 n miles offshore, while larger krill (mode 49 mm) occurred beyond this zone. An intermediate zone from 30 to 60 n miles offshore contained a mixture of small and large krill and this zone was considered to be the boundary between Weddell and ACC water masses.

4.30 The small-sized krill component contained two different spatially separated cohorts (means 32 and 35 mm). It was suggested that the larger cohort experienced a longer retention time in the area and thus a more prolonged growth period. During a second survey period in the same year the difference between these two cohorts increased to 6 mm.

4.31 The authors hypothesise that the ACC and Weddell current systems carry krill with different origin and different length frequencies into the area north of South Georgia. The currents may form quasi-stationary eddies which aggregate krill and increase retention times. These aggregations are then appropriate targets for the krill fishery.

4.32 Dr Watkins noted that UK surveys in the South Georgia region in other years usually showed an east–west split in size classes with large krill occurring at the western end. A marked onshore–offshore size distribution as seen in WG-EMM-03/40 had not been seen in other years.

4.33 Dr Reid explained that a similar pattern of bimodal size compositions of krill in January being replaced by a unimodal distribution in March has regularly been observed in predator diet samples from South Georgia, however, such changes did not appear to be associated with changes in the on-shelf/off-shelf foraging distribution.

4.34 The Working Group noted that although spatial variability in krill size composition around South Georgia may represent krill from different sources, ascribing the origin of these krill based on their size composition was not straightforward.

4.35 The Working Group noted more generally that there are a number of datasets describing aspects of krill demography and distribution that have not yet been presented to the Working Group. Members were encouraged to identify such datasets and submit synopses or analyses. It was recognised that compilation of such datasets into time series could provide valuable information on temporal and spatial variation in krill demography.

4.36 The Working Group recognised that it was particularly important to develop hypotheses on origin and transport of krill for use in management of krill. An understanding of the relative contribution of flux and local retention of krill within different regions may be very important for allocating precautionary catch limits to SSMUs. Similarly an understanding of the different origins of krill has implications for the use of the GYM, which currently assumes a single krill population.

Predator Trends

4.37 WG-EMM-03/29 compared data on stomach contents and food masses from approximately 1 200 Adélie, gentoo and chinstrap penguins breeding at Admiralty Bay, South Shetland Islands, during the chick-rearing period between the years 1981 and 2000. Krill accounted for 93–99% of all prey for each species by frequency of occurrence and by mass. There were significant differences in food-load masses within species among years, but a high degree of coherence among the three species as to the years of high versus low food loads. The paper noted significant differences in the percentage of digested contents in the stomach loads among the three species and found that the digested portion of individual stomach loads increased annually over the chick-rearing period in all species. The paper hypothesised that the digested food mass may represent approximately twice the energy value of a comparable mass of fresh krill in the same penguin’s stomach. It further discussed the implications of this hypothesis to studies of penguin energetics, and suggested that estimates of energy requirements derived from using the double-labelled water technique may be biased by the absorption of dietary water from krill in the penguin’s gut.

4.38 The Working Group noted that the digested portion of food loads in penguin stomachs would likely influence future estimates of predator consumption rates, particularly for Adélie and chinstrap penguins, which typically have approximately 50% of their stomach contents in a digested state. Further discussion established that the percentage of digested contents in

penguins' stomachs did not vary between years with shorter versus longer foraging trips, but remained very consistent across years. This suggested that the digested contents were not a function of time spent at sea foraging, but rather species-specific adaptations to delivering energy to their respective chicks.

4.39 WG-EMM-03/37 recorded the foraging trip patterns and diving behaviour of chinstrap penguins breeding at Signy Island during January 2002. Foraging trip patterns were bimodal, with short diurnal trips of 7.8 hours constituting the majority (74%) of all trips and longer overnight trips averaging 19.9 hours the remainder. Diving depths of chinstrap penguins in this study were deeper than previously reported at this site in earlier years and deeper than dives reported elsewhere in the literature for this species. The paper reported a new pattern of dives typically associated with benthic foraging in marine animals, yet analysis of stomach contents from birds exhibiting this dive pattern showed that they fed almost exclusively on Antarctic krill. The results highlighted the potential importance of benthic feeding on Antarctic krill, a previously undescribed foraging strategy, thus providing new insights into predator-prey interactions within the Antarctic marine ecosystem.

4.40 The Working Group suggested that a benthic inshore distribution of krill could represent a potentially important source of error in krill biomass estimation in some regions. Further investigations into krill distributions in these habitats are required to determine the potential importance of these habitats to krill biomass estimates and predator-prey interactions.

4.41 WG-EMM-03/38 examined the at-sea distribution and critical foraging habitat of female Antarctic fur seals breeding at South Georgia. Breeding season foraging trips were largely constrained to within 100 km of the island and tended to be concentrated in similar areas at the Continental Shelf edge. Although bathymetry was suggested as the proximate cause explaining the observed foraging distributions, interannual variation in the characteristics and distribution of water masses, and differences in prey availability within these water masses, was suggested to be the ultimate cause explaining the fur seal foraging patterns. Energetic calculations of food demand by female fur seals during the breeding season suggested that they can potentially consume most of the krill present in some regions where they are foraging intensively. During winter, when female fur seals are no longer constrained by pup rearing, they disperse over a wide area, but are concentrated in two regions of known high productivity. Animals were tracked northwest to the Patagonian Continental Shelf, and south to the Antarctic pack-ice edge. It was suggested that these two different wintering areas may represent habitat preferences of individuals, but further studies are needed to test this hypothesis.

4.42 The Working Group noted that a proportion of the female Antarctic fur seal population spent the winter in the vicinity of the Patagonian Shelf, outside the CCAMLR Convention Area. It recollected that the pattern of widely dispersed wintering areas of individuals from the same breeding colony was also reported last year for Adélie and chinstrap penguins breeding in the South Shetland Islands (WG-EMM-02/55).

4.43 WG-EMM-03/39 measured heart rate, abdominal temperature and diving depth in female macaroni penguins during the 1998/99 breeding season at South Georgia. Analysis of these variables allowed estimation of the mass-specific rate of oxygen consumption while diving. In common with other diving birds, macaroni penguins exhibited significant changes in heart rate during dives and 95% of all dives recorded were within the calculated aerobic

dive limit (cADL) for this species. This suggested that factors other than physiological ones are most important in determining diving behaviour. Such factors might include progressive effects of multiple dives during bouts and the location and density of krill patches on which animals feed. Thus, the ability to locate prey patches may be more important to the foraging behaviour of macaroni and other penguins than their ability to repeatedly dive to the depth of their prey.

4.44 The Working Group noted the potential utility of heart rate measures as a method for estimating metabolic rates and calculating aerobic dive limits (ADL) in penguins. It was further noted that estimates of ADL derived in the paper were in close agreement with earlier published data on Adélie penguins using O₂ consumption methods (Culik, 1994). This supported the suggestion that ADL rates derived from the doubly-labelled water method may contain important biases (WG-EMM-03/29).

4.45 WG-EMM-03/44 described interannual differences in Adélie penguin predator indices from Béchervaise Island during two seasons (2001 and 2003) of different krill abundance. Acoustic surveys from research cruises undertaken during the penguin breeding season reported approximately three times (see paragraph 4.46) as much krill within the survey region in 2001 compared to that found in 2003. Adélie penguins foraged farther from their breeding colony and had significantly longer mean foraging trips in 2003. In addition, adults returned with smaller food loads and had significantly more fish (mostly *Pleuragramma antarcticum*) in their diets in 2003. Breeding success was also significantly lower in 2003. The authors suggested that CEMP Indices A5 (foraging trip duration) and A8 (meal mass), respond significantly to interannual variations in krill biomass when measurements are at similar spatio-temporal scales.

4.46 Dr Nicol informed the Working Group that the krill biomass calculations for the 2003 season indicated a 20-fold decrease in the krill biomass estimate for the 2003 season, compared to the 2001 season (rather than the three-fold difference estimated in the paper). He also confirmed that the survey area was a 100 x 100 km grid (10 000 km², not 100 km² as stated in the paper).

4.47 WG-EMM-03/54 examined performance indices for Antarctic fur seals breeding at two sites in the South Shetland Islands. A total of five indices were derived from the two CEMP standard methods (C1 and C2b) currently reported as part of CEMP. An additional 10 measures of predator performance were summarised and data were presented in Table 2 of the paper. Pup growth rate (C2b) was recalculated for the 1997/98 to 2001/02 seasons at Cape Shirreff, to facilitate comparisons among sites. The 2002/03 season was characterised as one of poor reproductive performance for fur seals at Cape Shirreff; with longer foraging trips, lower frequency of krill in the diet, above-average pup mortality, and decreased female survival and natality. The Working Group noted that the paper offers substantial new information on possible future CEMP predator parameters that could be developed into standard methods for fur seal monitoring in the future.

4.48 WG-EMM-03/58 reported low concentrations of polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB) and dichloro-diphenyl-trichloroethane (DDT) in the stomach contents of Adélie penguins breeding at Edmonson Point in the Ross Sea. Higher concentrations of these persistent organic pollutants (POPs) were found in stomachs with higher krill contents. The authors suggested that despite the low overall concentration of POPs in the samples, penguins should be periodically monitored since there is no information

about toxicity threshold levels for penguins. This is particularly important as contaminant input through the diet is considerable. In addition, the authors pointed out that this method is non-invasive and samples can easily be collected as part of routine diet studies under CEMP Standard Method A8. The authors recommended updating the protocol for collecting samples for toxicological analysis (*CEMP Standard Methods*, Part IV, Section 5, paragraphs 1 to 3) in order to provide additional information for collecting samples utilising these new techniques.

4.49 The Working Group endorsed the suggestion that the toxicological methods be updated to add the new techniques outlined here and suggested that the new methods from WG-EMM-03/57 on blood and tissue sampling be included in the update. It was noted that the methodology was developed primarily to provide guidance in how to collect and preserve samples in response to acute events or outbreaks at study sites such that causal factors related to these events might be assessed subsequently.

4.50 WG-EMM-03/59 examined CEMP Standard Methods A2 (incubation shift durations), A6 (breeding success) and A9 (chronology) during the 2001 and 2003 seasons at Edmonson Point in the Ross Sea. The 2003 season was characterised by unusually heavy and persistent sea-ice throughout the breeding season and strong southerly winds with heavy snowfall in December. In that year foraging trips during the incubation period were significantly longer, breeding was delayed and breeding success was reduced due to heavy ice and snow. The authors attributed these results to a combination of environmental factors operating over the 2003 season; they highlighted the importance of collecting environmental data concurrent with predator data when monitoring for CEMP.

4.51 The Working Group noted that concurrent data on prey abundance was not available for this region in either year of the study, so this could not be assessed. The authors also indicated that data on foraging trip durations were available, but were as yet unanalysed.

Environmental Trends

Long-term Physical Data of Potential Use in Ecosystem Analyses

4.52 WG-EMM-03/20 reported that VNIRO continues to monitor sea-surface temperature in Subarea 48.3 (around South Georgia). The monthly SST maps (with resolution of 1° latitude by 1° longitude) have been constructed from GOES-E and Meteosat-7 daily satellite data that have incorporated real-time data from ships and buoys.

4.53 WG-EMM-03/46 reported on recent work to update the DPOI described by Naganobu et al. (1999). The index is now available from January 1952 to May 2003 and describes sea-level pressure differences across the Drake Passage between Rio Gallegos (51°32'S 69°17'W), Argentina and Base Esperanza (63°24'S 56°59'W), at the tip of the Antarctic Peninsula.

Ecosystem Analyses involving Long-term Physical Data

4.54 The authors of WG-EMM-03/53 highlighted the fact that the physical environment in the Southern Ocean is changing and that these recent changes have been most apparent during

the later part of the 20th century. The authors particularly focused on the increasing air temperatures at various Southern Ocean locations and the increasing water temperatures in the ACC.

4.55 The authors related concurrent changes in the southern Indian Ocean populations of a number of high-trophic-level predators, including seals, penguins and flying seabirds, to the changes in the physical environment. They noted that warming influences from outside the area, particularly from the tropical Indian Ocean, may have contributed to these changes. The authors suggested that the increasing temperatures are related to profound functional changes in the southern Indian Ocean ecosystem, including impacts on primary and secondary production and impacts on the food resources used by the high-trophic-level predator populations.

4.56 The authors noted that for some species, the observed population changes have occurred with a time lag when compared with changes in temperature. The period of the time lag varied between sites for some species (e.g. wandering albatross) although generally time lags occurred over similar time scales. Of the species considered, only two have increased whilst most others have decreased. Based on this evidence, the authors suggested that a regime shift has occurred in the southern Indian Ocean ecosystem.

4.57 This paper highlighted two important issues for CCAMLR, that:

- (i) responses to climate change are likely to be regional and will probably be site specific and depend on local productivity and foraging conditions;
- (ii) for some species, interactions with fisheries may confound or complicate signals potentially ascribed to environmental change.

4.58 The Working Group recalled that there had been a complementary discussion in the CEMP Review Workshop (Appendix D, paragraphs 104 to 106) with respect to changes in the physical environment in the Indian Ocean and that there had been a number of papers presented to this Working Group in the past that indicated similar processes occurring in the Scotia Sea.

4.59 Given the number of indications of environmental change in the CCAMLR Convention Area, the Working Group considered that it may be appropriate to produce a coherent overview of environmentally induced variability in the Southern Ocean and consider potential change scenarios that might influence ecological relationships with implications for fisheries management.

Status and Trends of Seabirds and Seals in the Southwest Indian Ocean

4.60 Long-term population trends of land-breeding seals and seabirds were reported for several localities in the southern Indian Ocean. For particular species there was often consistency in trends across localities (WG-EMM-03/53). Several different trends were evident. For most species there was a decrease in numbers, sometimes followed by a recovery. However, a few species increased during the period of observation, notably king penguins at the Kerguelen, Crozet and possibly Prince Edward Islands, and sub-Antarctic fur

seals at Amsterdam and the Prince Edward Islands (WG-EMM-03/53 and 03/18). These are species that feed mainly on myctophids in this region (WG-EMM-03/53). Antarctic fur seals have increased at Prince Edward Island (WG-EMM-03/18).

4.61 Most studied species, for which myctophids are not the primary diet component, decreased (WG-EMM-03/53). Amongst populations that showed a decrease and subsequent partial recovery were wandering albatrosses at the Kerguelen and Crozet Islands (WG-EMM-03/53) and Marion Island (WG-EMM-03/11), grey-headed albatrosses, northern giant petrels, southern giant petrels and white-chinned petrels at Marion Island (Nel et al., 2002), Adélie penguins at Syowa (WG-EMM-03/53) and black-browed albatrosses at Campbell Island, south of New Zealand in the western Pacific Ocean (WG-EMM-03/53). For the albatrosses and petrels at Marion Island, the trends corresponded with trends in pelagic longline fishing effort of tunas in the southern Indian Ocean and are thought to be related to mortality of birds in this fishery (Nel et al., 2002).

4.62 Female wandering albatrosses forage farther from Marion Island than males, come more often into contact with the pelagic longline fishery for tuna and have a lower survival rate (93% versus 96% per annum). Following mate loss, males take longer to replace a mate than females. The survival of adult wandering albatrosses at Marion Island is significantly related to that at the Crozet Islands (WG-EMM-03/11). At Marion Island, the proportion of mature wandering albatrosses that breed is positively related to the ENSO index. Following a decrease from the mid-1980s to the mid-1990s, breeding success has stabilised at Marion Island, possibly as a result of supplementary food being provided by discards and offal from the demersal longline fishery for toothfish there (WG-EMM-03/11). The trend in wandering albatrosses at Marion Island lagged behind those at the Kerguelen and Crozet Islands by about four years, similar to the later warming at Marion Island, suggesting some environmental modulation. As the trends in wandering albatross populations at all these localities followed the warming by several years, environment was thought to have influenced breeding or recruitment rather than survival (WG-EMM-03/53).

4.63 Several populations of birds that forage over wide areas have decreased with no apparent sign of recovery. These include both species of sooty albatross at Marion Island in the 1990s, possibly attributable to mortality in longline fisheries (WG-EMM-03/8), and yellow-nosed albatrosses at Amsterdam Island since the mid-1980s. Avian cholera played an important part in the latter through mortality of adults and especially chicks. It is also suspected to have caused mortality of Amsterdam albatrosses and sooty albatrosses at Amsterdam Island (WG-EMM-03/32).

4.64 Amongst seabirds that forage nearer to breeding colonies that have decreased, with no sign of recovery, are rockhopper penguins at Amsterdam Island (WG-EMM-03/53) and gentoo, rockhopper and macaroni penguins and Crozet shags at Marion Island (WG-EMM-03/16, 03/10, 03/15 and 03/17). At Marion Island, the decreases are most clear for species that feed near the island and are all thought to be at least partly attributable to inadequate reproduction. This is likely to have resulted from an altered availability of food, which (although there are no estimates of prey abundance) is suggested by a decrease in colony size of shags, a changed dominance in nototheniid prey in the diet of shags, a low mass at fledging of rockhopper penguins and a relationship between mass at fledging and contribution of fish to the diet of macaroni penguins.

4.65 At Marion Island, there have also been decreases in populations of two larids (sub-Antarctic skuas and kelp gulls), possibly associated with decreases in penguin populations (WG-EMM-03/8).

4.66 The climate in the southern Indian Ocean warmed between the mid-1960s and the mid-1980s. Because warming near Marion Island was later than at localities farther east, this may have resulted from intrusion of Indian Ocean water (WG-EMM-03/53). At Marion Island, mean surface air temperature increased by 1.2°C between 1969 and 1999 and annual precipitation decreased between the mid-1960s and the mid-1990s (Smith, 2002). SST increased by about 1.4°C between 1949 and 1998, compared with an increase of about 0.5°C at Gough Island (Melice et al., in press).

4.67 In 1997/98, coincident with the large El Niño of that period, there was unusually good or poor breeding by nine species of surface-nesting seabirds at Marion Island. Conditions favoured offshore feeders, whereas inshore feeders were generally adversely affected (WG-EMM-03/13). As has been suggested previously (e.g. Croxall, 1992), more widespread monitoring may elucidate how climatic perturbations influence seabirds and seals in the Southern Ocean. Climatic warming may increase the possibility of outbreaks of disease at subtropical and sub-Antarctic localities (WG-EMM-03/19 and 03/32).

4.68 For wandering albatrosses there is interchange of fledglings between the Crozet and Prince Edward Island breeding localities, indicating an advantage of considering management of these two sites at a metapopulation level (WG-EMM-03/41). Countering the adverse effects of climate change is likely to pose the greatest challenge to conservation of seabirds at the Prince Edward Islands (WG-EMM-03/14).

4.69 There was discussion on the increase of fur seals at several localities. It was noted that populations had increased both in areas where their main prey is krill and also in areas where myctophids and other zooplankton are their principal food. Rates and timing of fur seal population increase have been different in different areas and the South Georgia population may already have overshot pre-exploitation levels. There was also potential for interaction between fur seals and seabird species, e.g. through predation, displacement of breeding birds and competition for resources.

4.70 In respect of the data discussed in paragraph 4.66, it was noted that there was useful information not only in annual indices of temperature increases but in seasonal indices too, as had been reported for the Antarctic Peninsula.

4.71 Dr Constable indicated that a major biological survey of Heard Island would be undertaken in 2003/04, the results of which would be reported at the next meeting.

4.72 The Working Group agreed that information from the southern Indian Ocean had re-emphasised the importance for some seabirds of incidental mortality in fisheries, the periodic occurrence of extreme food shortage, the dynamic nature of Southern Ocean systems and the utility of comparing responses of predators in krill-based and non-krill systems (see also Appendix D, paragraphs 103 to 108).

Further Approaches to Ecosystem Assessment and Management

4.73 WG-EMM-03/33 and 03/34 presented behavioural models of the interactions between krill and their penguin predators and the effects of a krill fishery. WG-EMM-03/33 modelled habitat selection by krill, controlled by their diel vertical migration, and the foraging strategies of penguins, identifying stable strategies that maximised expected fitness. This model was then extended in WG-EMM-03/34 to investigate the effect of a krill fishery on this system. Increased fishing pressure offshore is predicted to decrease penguin food intake and thereby decrease their survival and reproduction. Incorporation of krill behavioural responses in the model leads to the effects of the krill fishery being stronger than would be expected simply from the absolute biomass removed by the fishery. Poorer environmental conditions are predicted to increase the effect of krill fishing on penguin success. It is also suggested that changes in penguin foraging behaviour can be used to assess the effect of local fishing on penguin reproductive success.

4.74 The Working Group recollected that these papers are the latest in a series of papers by these authors stemming from initiatives started in 1996 and 1997 to develop detailed models of the interactions between krill, land-based predators and the krill fishery (SC-CAMLR-XIV, Annex 4, paragraphs 7.23 and 7.24; SC-CAMLR-XV, Annex 4, paragraphs 6.47 to 6.55). It agreed that models described in the current papers represented a considerable refinement of those discussed in recent years (Alonzo and Mangel, 2001; Butterworth and Thomson, 1995; Butterworth et al., 1994, 1997; Mangel and Switzer, 1998; Switzer and Mangel, 1996).

4.75 WG-EMM-03/33 and 03/34 had been reviewed and discussed by the CEMP Review Workshop (Appendix D, paragraphs 111 to 115). In addition to the comments recorded there, the following points were made.

- (i) Dr Sushin indicated that, while these papers were theoretically interesting, he felt they were currently unsuitable for practical use in management, because the structure and the assumptions of the models were unrealistic.
- (ii) While the assumption that penguins species on which the model is based are obligate krill feeders during their reproductive period in the areas considered, this is not true of all penguin species in all areas, some of which may switch to alternative prey species when krill are sparse. In consequence, some modifications to the models may be necessary if they are to be fully applicable to all penguins at all times of year.
- (iii) Given the better knowledge of penguin foraging behaviour now available, it may well be possible to identify the elements of foraging trip duration that are most relevant to prey capture success. In this case, the final suggestion in WG-EMM-03/34 that changes in penguin foraging behaviour might be used to assess the effect of local fishing on penguin reproductive success could well be currently practicable. If so, an examination by the Subgroup on Methods may be warranted.

4.76 The Working Group endorsed the conclusions of the workshop (Appendix D, paragraph 115) that individuals with relevant expertise should consider the formulation,

assumption and parameterisation of these models carefully, with a view to the likely incorporation of such approaches into the WG-EMM workshop activities planned for 2004 and 2005.

Other Prey Species

Review of Tabled Papers

Mackerel Icefish

4.77 The mackerel icefish has a widespread distribution in the Atlantic and Indian Ocean sectors of the low-Antarctic region. It has been fished commercially since the 1970s and is currently fished around South Georgia (Subarea 48.3) and Heard Island (Division 58.5.2). In the Atlantic Ocean sector krill is a major prey item. Other prey species are taken in the Indian Ocean sector. Information provided to CCAMLR has been summarised into a 'Species Profile' as WG-FSA-03/4 and a list of published papers is set out in WG-FSA-03/5. These papers provide background information that will be updated annually by WG-FSA, from which ecosystem monitoring and management advice on mackerel icefish can be developed. WG-EMM-03/4, 03/7, 03/42 and 03/60 provided new information on biology and ecology of relevance in an ecosystem context.

4.78 Mackerel icefish are found over quite a wide geographical range within the CCAMLR Convention Area and are subject to subtle differences in their habitat. In WG-EMM-03/4, biological information is evaluated from which the following generalised latitudinal cline was developed. Fish living in the north:

- mature one year earlier than those in the south
- have a shorter life span relative to those further south
- possibly do not spawn more than two to three times
- produce more eggs per unit of body mass than those further south.

4.79 WG-EMM-03/4 noted that increases in fur seals in recent decades have probably increased predation pressure on mackerel icefish and may have a major effect reducing stock abundance.

4.80 Two papers, WG-EMM-03/7 and 03/60 considered age and growth of mackerel icefish in Subarea 48.3 using information from a number of seasons. Both papers demonstrated differences in growth rate that appear to be related to variation in the availability of krill, the preferred food of mackerel icefish in that region, as well as variation in environmental conditions such as temperature. WG-EMM-03/60 noted that the strong 1983/84 year class occurred at a time when fishing intensity was high. It noted that the one-year-old fish tend to be pelagic and are undersampled by the bottom trawls of research surveys and the wider mesh nets of the commercial fleets. The presence of strong year classes consequently does not become apparent until they are recruited to the commercial stock. They can be estimated using acoustics and this would provide valuable information for management of the stocks and also for ecosystem assessment.

4.81 Differences in size at age have also been noted in WG-EMM-03/7, with mean size at age being negatively correlated with sea-surface temperature from the preceding summer. It

is suggested that this may be due to a change in the range of sea-surface temperatures over the South Georgia Shelf, whereby winters have become slightly cooler and summers slightly warmer over the period from 1960 to 1990. In addition to this trend, it was noted that there are consistent differences in recruitment and mortality rates and the time of hatching at Shag Rocks in comparison with South Georgia. It is suggested that a combination of signals in krill, fish and other krill predators indicates possible ecosystem changes in Subarea 48.3 between 1980 and 2002.

4.82 WG-EMM-03/42 outlined a series of indices that might provide insights into ecosystem interactions involving mackerel icefish. Information is taken largely from WG-FSA-03/4. The following indices were outlined:

- (i) Standing stock:
The index is based on data from bottom trawl surveys by Argentina, Australia, Germany, Poland, Russia and the former USSR, UK and the USA. Although the results are available in the reports of WG-FSA it was noted that they should be re-evaluated by the current standard method and take account of the sampling region.
- (ii) Cohort strength and recruitment:
This information is derived each year for the stock assessments undertaken by WG-FSA.
- (iii) Natural mortality rate:
This is known to vary each year although precise annual estimators are not yet available. Currently it is thought to be at least twice the value in the 1960s.
- (iv) Length of age classes 1 and 2:
This has been demonstrated to vary with environmental conditions and areas (see also WG-EMM-03/7 and 03/60).
- (v) Condition:
This has been shown to have a functional relationship with observed krill abundance in Subarea 48.3.
- (vi) Gonad maturation:
There are clear differences between seasons although some further work is needed to complete definitions of the most appropriate indices. This work should include a consideration of mature fish that fail to spawn.
- (vii) Diet:
Information is available from research vessel surveys and observers on commercial vessels and has been presented as standardised indices.

4.83 The Working Group noted that these indices had been considered by the CEMP Review Workshop (Appendix D, paragraphs 98 to 100) and agreed with the proposals for future action in that report.

4.84 The Working Group also noted that extension of the estimation of standing stock to include acoustic estimates of juvenile icefish had been proposed in WG-EMM-03/60 and discussed by WG-FSA-SFA.

4.85 The Working Group noted that in order to investigate the interactions between icefish, krill and predators, information on distribution and vertical migration will be required.

Antarctic Shags

4.86 WG-EMM-03/5 provided a summary of monitoring research on Antarctic shags over the past five years. This work had been considered during the CEMP Review Workshop (Appendix D, paragraph 101) and by the Subgroup on Methods (paragraphs 4.93 to 4.96).

Myctophids and Squid

4.87 No papers were tabled on these species groups. The Working Group encouraged further research on these groups of relevance to understanding the krill-centred system.

Information on Status and Trends in the Krill-centred System Arising from Research on Other Species

4.88 The Working Group noted that although there was good evidence that indices from icefish could provide useful information on the status and trends of krill, further work was needed, as outlined in Appendix D, paragraph 100, before it could be incorporated into assessments. The Working Group encouraged work on this topic.

4.89 Several members reminded the Working Group that mackerel icefish was a harvested species, was dependent, at least in Area 48 on krill, and was preyed on by some of the CEMP species. This had been raised previously as a result of the Workshop on Assessment Methods for Icefish (SC-CAMLR-XX, Annex 5, Appendix D, paragraph 8.7) and supported by the Working Group (SC-CAMLR-XXI, Annex 4, paragraph 3.100).

4.90 In further discussion it was suggested that an appropriate way to improve assessments of ecosystem considerations relating to species other than krill and dependent species already covered with CEMP might be:

- (i) to ensure that standard methods and/or indices were available, the appropriateness of which had been endorsed by relevant CCAMLR working groups;
- (ii) to bring forward for consideration the results of analyses to investigate patterns of variation (including trends and anomalies) in such indices, including analyses in conjunction with indices relating to predators, prey and environment already adopted by CCAMLR.

4.91 It was recognised that this process would benefit from, if not require, closer collaboration between WG-EMM and WG-FSA. The Working Group recommended that this proposal be discussed further at the forthcoming meeting of WG-FSA.

4.92 In recognition of the potential importance of non-krill components of the ecosystem, the Working Group asked the Scientific Committee to provide advice on how the ecological relationships and trophic interactions involving non-krill-centric components of the Southern Ocean, including exploited stocks of finfish, should be included in the work of both WG-EMM and WG-FSA (see paragraph 4.90).

Methods

New Methods

4.93 WG-EMM-03/5 described a method for determining the qualitative composition of the fish diet of Antarctic shags (accepting that this method is suitable for all *Phalacrocorax* species in the CCAMLR region). The subgroup noted that this method had been presented in a tabled paper and previously considered by the Working Group, and that it had been through the peer-review process and evaluated with regard to its suitability for CCAMLR following the procedure described in SC-CAMLR-XXI, Annex 4, paragraph 3.114.

4.94 The Subgroup on Methods considered that this method had been thoroughly evaluated and was suitable for potential adoption as a CEMP standard method, and that future studies of the composition of the fish diet of Antarctic shags should follow this method.

4.95 In considering whether this method was appropriate for formal adoption as a CEMP standard method, the Working Group noted that this predator-derived index did not relate to the krill-centred system and questioned whether it had the potential to provide information of utility to the aims of CEMP.

4.96 The Working Group agreed that the index had the potential to provide information on ecological relationships and changes in populations of certain fish species and recommended that the method be referred to WG-FSA in order that it may provide advice on how the data gained using this standard method might be used in the work of that group.

Modifications to Current Methods

4.97 WG-EMM-03/45 described the data requirement for demographic studies of Adélie penguins in response to a request (SC-CAMLR-XXI, Annex 4, paragraphs 3.46 and 3.47) for standard methods for determining demographic parameters. The paper noted that CEMP Standard Method A4 is adequate until such time as the requirements for data are more closely defined.

4.98 The subgroup did not agree with the assertion in the paper that any form of demographic study requires individual birds to be marked as fledglings and that whatever marking system is used it must remain with the bird for its life span. The subgroup felt that information on adult survival may be gained from marking adult birds and recording the presence of these birds in subsequent years. The subgroup recognised that acquiring annual estimates of adult survival was of fundamental importance to the interpretation of long-term population time series.

4.99 In the context of penguin demography studies, the subgroup recognised that it was essential to appropriately evaluate the impact of band loss on demographic parameters. In addition, it recommended that existing estimates of band-induced mortality rates should be reviewed in respect of new developments in band design.

Developments

4.100 WG-EMM-03/57 and 03/58 outlined approaches to detecting chemical indicators of metabolic stress and pollutants in free-living penguins that have the potential to provide useful collateral information to aid interpretation of CEMP indices. The subgroup considered that these methods represented a potential change in emphasis from determining causes of lethal events to detecting sub-lethal effects that might influence other indices. The Working Group agreed with the suggested revision of *CEMP Standard Methods*, Part IV, Section 5 provided by Dr S. Corsolini (Italy) (see Appendix E).

4.101 WG-EMM-03/21 presented a model relating net mensuration and impact on catchability of krill, however the subgroup recognised that it did not have the relevant expertise to fully assess these methods and recommended that the analysis should be referred to WG-FSA for evaluation (see paragraphs 3.35 and 3.36).

4.102 WG-EMM-03/42 presented a series of indices from mackerel icefish that may be suitable as CEMP indices, or that may provide complementary data with which to interpret other CEMP indices. The subgroup noted that the discussion of these potential indices in the CEMP Review Workshop (Appendix D, paragraphs 97 to 100) had suggested that there was a need for thorough evaluation of the properties of such indices and that there was also a need to assess the likelihood of collection of icefish data on a regular/annual basis.

Consideration of Methods for Collecting Non-CEMP Parameters associated with Existing CEMP Parameters Arising from the CEMP Review Workshop

4.103 Analysis of CEMP Index C2b from South Georgia (Reid, 2002) and the South Shetland Islands, carried out during the CEMP Review Workshop, indicated that there was a problem with the representation of the rate of pup growth following the standard method such that in years of apparently poor foraging indices, pup growth rates appeared to be high. The problem was overcome at South Georgia (Reid, 2002) using a summed growth deviate to produce a biologically plausible index of the mass at age of fur seal pups. However, the subgroup recognised that this summed growth deviate may not be appropriate where the number of sampling dates varies between years (as is the case in the Cape Shirreff time series). An analysis of the mean growth deviate compared to the summed growth deviate indicated that the mean was an appropriate index and was not dependent on the number of sampling occasions.

4.104 The Working Group evaluated the existing data for Index C2b (fur seal pup growth rate) and recommended the following changes to the standard method in order to more appropriately represent the deviation from the mean mass at age:

An index of growth deviate (gd) in year y should be calculated as follows:

let N_y be the number of sampling occasions in year y such that I_y is the set of ages in days since the median pupping date on which sampling occurred in year y , e.g. $I_y = [30,60,90]$, $N_y = 3$;

for each i in the set I_y in year y calculate $m_{(y,i)}$, the mean mass of pups at age i in year y ;

calculate the regression relationship $m_{(y,i)} = a + bi$ for all years y and ages i ;

for each year calculate the growth deviate (gd_y) where:

$$gd_y = \frac{\sum_i (m_{(i,y)} - a - bi)}{N_y}$$

Future Surveys

4.105 There were no future surveys reported to the Working Group.

Key Points for Consideration by the Scientific Committee

4.106 The Working Group considered that the current approach to derive summaries based on the balance of positive and negative anomalies was inappropriate and of limited utility in providing an annual assessment of anomalies and trends of CEMP indices (paragraphs 4.9 to 4.11). It proposed that an ordination approach be developed whereby the nature of the covariation in multivariate CEMP indices could be described and presented on an annual basis. This approach would have the potential to characterise the state of the system in relation to other years and to identify temporary shifts (i.e. anomalies), gradual changes (e.g. trends) or regime shifts. This would utilise all of the available data rather than being restricted to statistical anomalies (paragraphs 4.13 to 4.18).

4.107 A comparison of acoustic survey data biomass density with estimates obtained from commercial net samples from the fishing areas in the Scotia Sea indicated that fishing vessels were only able to operate in areas where krill biomass was at least 100 to 120 g m⁻², achieving a sustained yield of 3 to 3.5 tonnes per hour. Further work was encouraged to:

- (i) compare the distribution of fishing effort with that predicted from the distribution of threshold density levels;
- (ii) compare predicted krill fishing areas in relation to distribution of predator demand in the area (paragraphs 4.24 and 4.26).

The Working Group encouraged all Members with relevant data to undertake such analyses for all subareas of Area 48.

4.108 The Working Group recognised that it was particularly important to determine the relative contribution of flux and local retention of krill within different regions as this may be very important for allocating precautionary catch limits to SSMUs and may have implications for the use of the GYM, which currently assumes a single krill population (paragraph 4.36).

4.109 Given numerous indications of environmental change in the CCAMLR Convention Area, the Working Group considered that it may be appropriate to obtain a coherent overview of environmentally induced variability in the Southern Ocean and to consider potential change scenarios that might influence ecological relationships with implications for fisheries management (paragraphs 4.59 and 4.60).

4.110 The Working Group evaluated the existing data for Index C2b (fur seal pup growth rate) and recommended the following changes to the standard method in order to more appropriately represent the deviation from the mean mass at age (paragraph 4.104):

An index of growth deviate (gd) in year y should be calculated as follows:

let N_y be the number of sampling occasions in year y such that I_y is the set of ages in days since the median pupping date on which sampling occurred in year y , e.g. $I_y = [30, 60, 90]$, $N_y = 3$;

for each i in the set I_y in year y calculate $m_{(y,i)}$, the mean mass of pups at age i in year y ;

calculate the regression relationship $m_{(y,i)} = a + bi$ for all years y and ages i ;

for each year calculate the growth deviate (gd_y) where:

$$gd_y = \frac{\sum_i (m_{(i,y)} - a - bi)}{N_y}$$

4.111 The Working Group recognised that improving the critical assessment of the ecological relationships and trophic interactions involving non-krill-centric components of the Southern Ocean, including exploited stocks of finfish, would require closer collaboration between WG-EMM and WG-FSA (paragraphs 4.90 and 4.91).

4.112 The Working Group asked the Scientific Committee to provide advice on how the ecological relationships and trophic interactions involving non-krill-centric components of the Southern Ocean, including exploited stocks of finfish, should be included in the work of both WG-EMM and WG-FSA (see paragraph 4.92).

STATUS OF MANAGEMENT ADVICE

Advisory Subgroup on Protected Areas

5.1 The Advisory Subgroup on Protected Areas met and considered tasks assigned to it. The tasks included:

- (i) submission of revised maps for CEMP sites;
- (ii) revision of guidelines for the production of maps of protected areas;
- (iii) revision of the subgroup's terms of reference, based on CCAMLR decisions related to the evaluation of Antarctic Treaty management plans containing marine areas that are submitted to CCAMLR for approval;
- (iv) review current membership of the group.

5.2 The subgroup noted that most of the required maps have been submitted. Members have access to these maps on the CEMP pages of the CCAMLR website. However, there were revised maps of three CEMP sites (Admiralty Bay, Anvers Island and Elephant Island) still to be submitted. The subgroup suggested that the USA and Brazil be requested to review the CEMP status at each of the remaining sites and provide maps if appropriate.

5.3 With regard to the existing guidelines for production of CEMP site maps, the subgroup took note of guidelines adopted by the ATCM at CEP-I for the production of maps of ASPAs and ASMAs. The subgroup recommended that the Secretariat be requested to review intersessionally the existing CEMP guidelines and prepare a draft of map production requirements for both terrestrial areas (i.e. CEMP sites) and marine protected areas (i.e. areas proposed in accordance with Article IX.2(g)). This should be done in consultation with members of the subgroup.

5.4 The subgroup noted that CEP had adopted revised 'Guidelines for consideration of new and revised draft ASPA and ASMA management plans' (CEP-VI, Annex IV). The guidelines contain a procedure for submitting plans to CCAMLR for consideration as required in accordance with the ATCM Environmental Protocol, Annex V, Article 6.

5.5 The subgroup decided not to review its membership in the absence of Dr P. Penhale (USA), but to ask Dr Penhale to review the group's membership intersessionally.

5.6 The subgroup noted that 'The science of marine reserves' was published in a special issue of *Ecological Applications*, 13 (1) in February 2003. The subgroup felt this publication would provide valuable background information for any future assessment of proposals for marine protected areas.

5.7 The Working Group reviewed WG-EMM-03/22. This paper summarised the terms of reference of the subgroup in a manner that properly places the tasks in the context of CCAMLR decisions (SC-CAMLR-XXI, paragraph 3.32; SC-CAMLR-XXI, Annex 4, paragraph 5.15).

5.8 The Working Group thanked Dr Sabourenkov for producing an excellent paper, which is a valuable document tracking the history of the evolution of the subgroup's terms of reference since the group was established in 1992.

5.9 The Working Group reviewed the following terms of reference for the Advisory Subgroup on Protected Areas and agreed to forward them for approval and adoption by the Scientific Committee:

- (i) to review the details of proposals relating to designation and protection of CEMP monitoring sites and review of CEMP management plans as required in accordance with Conservation Measure 91-01;
- (ii) to revise and keep under review, as appropriate, guidelines for the production of maps of protected areas relevant to CCAMLR;
- (iii) to develop and keep under review, as appropriate, a methodology for assessment of proposals for marine protected areas forwarded in accordance with Article 6(2) of Annex V of the Protocol on Environmental Protection to the Antarctic Treaty;
- (iv) to provide advice on marine protected areas that seek designation as an ASPA or an ASMA under the Antarctic Treaty;
- (v) to provide advice on the implementation of marine protected areas that may be proposed in accordance with the provisions of Article IX.2(g) of the Convention, including 'the designation of the opening and closing of areas, regions or subregions for purposes of scientific study or conservation, including special areas for protection and scientific study'.

Harvesting Units

5.10 The ad hoc Subgroup on Harvesting Units examined the information that was available to it on krill and environmental data. It recognised that combining datasets from a range of sources would be useful for the determination of potential boundaries of harvesting units.

5.11 Krill distributions were available from SC-CAMLR-XX/BG/24, pages 1 to 11, and these were derived from the *Discovery Reports* (Mackintosh, 1973) and Voronina (1998); the position of frontal zones was available from Belkin and Gordon (1996) and Orsi et al. (1995); the surface layer (0–200 m) temperature from Naganobu and Komaki (1993); geostrophic flow from Gordon and Baker (1986) and Naganobu (1992, 1993, 1994); and additional satellite-derived information was available on ocean colour and sea-ice that might prove useful. These and other data would be utilised in assessing potential boundaries for harvesting units.

5.12 The Working Group agreed to correspond intersessionally and produce a document outlining new harvesting units of appropriate size for catch reporting of the krill fishery, concentrating principally on Subareas 48.6, 88.1, 88.2 and 88.3, and Divisions 58.4.1 and 58.4.2, for consideration at the 2004 meeting of WG-EMM.

Small-scale Management Units

5.13 In 2001, the Commission agreed on a precautionary catch limit for Antarctic krill of 4 million tonnes in Area 48. It further subdivided this catch limit among Subareas 48.1 (1.008 million tonnes), 48.2 (1.104 million tonnes), 48.3 (1.056 million tonnes) and 48.4

(0.832 million tonnes), in order to distribute fishing effort and thereby reduce the potential impact of fishing on land-based predators. Concern remained, however, that localised depletion of krill populations could still occur if all a subarea catch limit was taken within a small part of that subarea. Accordingly, the Commission further agreed that the total catch in Area 48 shall not exceed 620 000 tonnes until the precautionary catch limit had been subdivided amongst SSMUs (Conservation Measure 51-01). Specifications for SSMUs had been proposed by WG-EMM-02 and these were subsequently endorsed by the Scientific Committee and adopted by the Commission. The SSMUs are shown in Figure 3.

5.14 With the aim of stimulating discussion on possible means of subdividing the precautionary catch limit amongst SSMUs, WG-EMM-03/36 presented four possible options for performing the subdivision. Under each option, the catch limit for an SSMU is a specified proportion of the total precautionary catch limit. The options considered were:

1. The catch limit for an SSMU should be proportional to the combined estimated predator demand for krill in that SSMU. This option is predicated on the assumption that a high predator demand implies a high standing stock of krill and/or a high turnover rate.
2. The catch limit for an SSMU should be proportional to the estimated standing stock of krill in the SSMU. This is based on the assumption that in all areas where krill occur, emigration balances immigration and high krill biomass densities imply high availability.
3. The catch limit for an SSMU should be proportional to the estimated standing stock of krill in the SSMU, less the estimated annual predator demand. This is based on the premise that the amount of krill allocated to the fishery should be determined only after accounting for predator needs. Should the estimated standing stock of krill for an SSMU be less than the predator demand, the catch limit for that SSMU should be zero.
4. The catch limit for an SSMU should be calculated as an annually adjustable proportion of the catch limit specified by one of the static options 1 to 3, where the proportion would depend on the value of an ecosystem monitoring index or a combination of indices. This option may be particularly pertinent for SSMUs where there is a wide range of predator reproductive success associated with large changes in krill availability.

5.15 Reviewing the application of each of the options to the subdivision of the precautionary catch limit amongst SSMUs based on available estimates of predator demand and krill standing stock, WG-EMM-03/36 reached the following qualitative conclusions:

- (i) Approximately 65% of total demand for krill by land-based predators in the Scotia Sea is in the vicinity of South Georgia. Under option 1, a correspondingly high proportion of the catch would also be concentrated in this area.
- (ii) Option 2 leads to a more conservative allocation of catch limits among SSMUs with respect to land-based predators, with approximately 75% of the catch limit being allocated to the pelagic SSMUs.

- (iii) Under option 3, the proportion of catches allocated to the pelagic SSMUs would increase to approximately 83% and no catch would be allowed in the South Georgia West SSMU.
- (iv) Despite the increased allocation to pelagic SSMUs in options 2 and 3, annual variations in krill availability may still result in sufficient competition between land-based predators and the krill fishery for predator demand to exceed the krill standing stock in some SSMUs in some years. Option 4 was designed to take account of this, however for its implementation, improved indices for krill availability and/or transport into an SSMU may need to be developed.

5.16 The authors of WG-EMM-03/36 emphasised that other subdivision options could be devised and that the options presented could be further developed and improved. In particular, no preference was expressed amongst the options and it was not intended that a particular option should be selected from amongst them. Rather, the paper was intended to facilitate discussion and highlight the likely implications of different types of allocation schemes.

5.17 It was noted that there were two separate motivations for the establishment of SSMUs. The first is the need to address the Commission's specific request to spatially subdivide the catch limit such that a large proportion of the catch was not concentrated in a small portion of a subarea. The second is that SSMUs are likely to form the structural basis for long-term krill management strategies, the development of which is the basis for the two WG-EMM modelling workshops planned for 2004 and 2005. WG-EMM-03/36 was aimed at the first of these reasons.

5.18 It was further emphasised that, according to the Commission's decision last year, the need to implement a subdivision of the precautionary catch limit amongst SSMUs would only arise when the total krill catch in Area 48 approached a level of 620 000 tonnes. Current catches are a small fraction of that level.

5.19 Dr Watkins noted that Table 5 of WG-EMM-03/28 reveals that, over the past 10 years, three SSMUs (Antarctic Peninsula Drake Passage West, South Orkney West and South Georgia East) have accounted on average for 66% of the total krill catch in Area 48, and two others (Antarctic Peninsula Drake Passage East and Antarctic Peninsula Elephant Island) account for a further 20% of the total. Thus, at present, the vast majority of the krill catch is taken in just five SSMUs. In contrast, recorded catches in the last decade in the pelagic SSMUs have generally been very small, with the exception of isolated years in which the annual catch in pelagic SSMUs exceeded 6 000 tonnes (1995 and 1996 in Subarea 48.1 and 2000 in Subarea 48.3).

5.20 During the meeting, Dr Ramm was able to extend the time series of historic catches by SSMU back to 1988, and these data are shown in Table 2. Dr Ramm advised that for years prior to 1988, there were insufficient fine-scale krill catch data to allow reliable subdivision by SSMU. The most notable feature of the additional data in this table was that substantial catches (exceeding 7 000 tonnes) had been taken in the pelagic SSMU in Subarea 48.1 in each of the years from 1988 to 1992. Dr Ramm indicated that these were largely catches taken by the Japanese krill fleet. The Working Group agreed that these data were very useful and may provide a starting point for developing an alternative subdivision option incorporating information on historical catches.

5.21 Several members noted that a key implication of subdivision options 1 and 2 was a very substantial redirection of krill fishing effort to the pelagic SSMUs, and that this contrasts strongly with the present situation. If indeed the krill catch does increase substantially from its present level, in their view it would not be possible to continue to take the catch from a small number of SSMUs adjacent to predator colonies, either in terms of meeting the needs of the predators or of maintaining an economically viable fishery. In their view, redistributing krill fishing effort, particularly towards SSMUs not immediately adjacent to land-based predator colonies, was a desirable and necessary response to substantially increasing krill catches. It was noted, however, that a corollary of a shift to pelagic SSMUs was that fishing would be taking place in areas in which the fleet had not operated regularly in the past, and for which levels of monitoring were low.

5.22 Dr Sushin indicated that he had a number of specific objections to the options for allocation of precautionary catch limits described in WG-EMM-03/36, but before detailing them, he wished to make some more general comments:

- (i) The basic hypothesis in the proposed precautionary catch limit allocations among SSMUs is the hypothesis that competition exists between the fishing vessels and krill predators for krill resources, and that it is assumed that the fishery always succeeds in that competition. However, this hypothesis has not been proved with scientific facts. Moreover, the results of some research provide evidence for the lack of any competition (e.g. WG-EMM-02/63 Rev.1 and 03/31). Any attempt to implement this hypothesis in practice is likely to result in displacement of the krill fishing fleet from the fishing grounds into the areas where a krill fishery is impossible in view of low krill concentrations. In addition, one of the Convention principles is violated, namely that conservation includes 'rational utilisation', since rational utilisation implies appropriate fishery efficiency.
- (ii) The conservation principles defined in paragraph 3 of Article II of the Convention are actually replaced with the single principle, i.e. to ensure food demands of predators, taking into account their abundance for the recent years. At the same time the abundance of predators ensuring the ecosystem balance and conservation principles defined in paragraph 3 of Article II of the Convention remains unknown. In addition, the fact that the size of several populations has significantly increased in recent years (e.g. fur seals in Subarea 48.3) and could negatively affect other species is not taken into consideration. For example, the increase of fur seal abundance could result in a sharp increase of predator pressure on the icefish population, preventing the latter's stock restoration (e.g. WG-EMM-03/42 and paragraphs 4.77 to 4.85). First of all, it is necessary to determine appropriate biological reference points of predator population size in compliance with the conservation principles defined in paragraph 3 of Article II of the Convention. In future, predator food demand should be estimated on the basis of these biological reference points. Only when this has been done would it be possible to agree to precautionary catch limit allocations based on predator demands.

5.23 Prof. Croxall noted that:

- (i) good circumstantial or inferential evidence exists for potential competition for krill between fishing vessels and krill predators, especially based on relative and absolute consumption rates in local areas and at particularly critical times of year for predators;
- (ii) evidence to the contrary, even for selected areas of SSMUs with the greatest spatial and temporal differences between fishing operations and some of the critical areas/times for land-based krill predators (e.g. WG-EMM-02/63 Rev. 1 and 03/31) was at best inconclusive, as noted last year (SC-CAMLR-XXI, Annex 4, paragraph 3.38);
- (iii) nevertheless, in seeking to implement management of krill fishing at the scale of SSMUs, he believed that WG-EMM was striving to find the appropriate balance between protecting the livelihood of krill-dependent species and avoiding unnecessary restriction to the operations of the fishery. He expressed disappointment at a situation whereby, after 10 years during which many Members had expressed serious concern over the potential effect on krill predators of existing krill fishing at local scales and critical periods, without achieving any regulation or management of the krill fishery at these scales, some Members now apparently saw no reason for some redistribution of krill fishing effort even if a fishery of thrice the current magnitude were to develop within SSMUs;
- (iv) as a result of earlier discussions on how to manage spatio-temporal overlap between the krill fishery and predator foraging areas, in 1991 and 1992 the Scientific Committee requested information from those responsible for krill fishing, on the extent to which it is possible to fish commercially for krill outside these times and areas of particular overlap (SC-CAMLR-XI, paragraph 5.40; SC-CAMLR-XII, paragraphs 8.42 to 8.44). Unfortunately, no such information has yet been forthcoming and it would be very timely to recommence this dialogue.

5.24 In respect of the apparent assertion in paragraph 5.22 that competition between fishing vessels and krill predators needs to be proved before appropriate management action can proceed, several members disagreed and noted that an alternative requirement could be to demonstrate that the fishery had no impact on krill predators. They noted, however, that several earlier meetings of the Scientific Committee and its working groups had discussed how to deal with the uncertainties involved by means of changes in the distribution of fishing effort (including by closed areas and seasons) without requiring either type of proof.

5.25 While several members indicated that they disagreed with Dr Sushin's interpretation of Article II of the Convention, the Convener advised the Working Group that discussion of this topic was beyond the remit of WG-EMM and it should be deferred for consideration by the Scientific Committee. Rather, discussion of WG-EMM-03/36 during WG-EMM should be restricted to strictly scientific issues.

5.26 Dr Sushin then outlined his specific objections to the allocation options in WG-EMM-03/36 as follows:

- (i) Option 1 is based on the hypothesis that the productivity of the prey population can be assessed through predator demand. This would be true only if the size of the predator population is controlled only by krill availability. However, this fact has not been proved. In different SSMUs, predator abundance can be limited by a variety of factors. In areas with rougher conditions (such as Subareas 48.1 and 48.2), factors such as the short summer season, lower mean annual temperatures, fewer areas suitable for reproduction etc. are essential. The fact that in subareas with high krill abundance (e.g. Subarea 48.2) relatively low predator abundance is observed, provides evidence that predator abundance is not proportional to krill abundance in all areas.
- (ii) In option 2, the assumption is made that the results of a single acoustic survey provide adequate estimates of the standing stock of krill in each SSMU. However, biomass as assessed by one survey provides estimates proportional to standing stock only in areas comparable to the population distribution area (e.g. Area 48 as a whole). In small areas with strong water dynamics, the flux factor needs to be taken into consideration. In addition, to apply option 2 it is necessary to prove that krill biomass ratio among SSMUs estimated in the CCAMLR-2000 Survey remains unchanged for a sufficiently long period (at least comparable to the fishing season duration). However, this assumption is absolutely incredible in view of the current ideas about water dynamics, krill drift and mechanisms of formation of local krill aggregations.
- (iii) Option 3 is also unacceptable as it includes all the problems mentioned for the first two options described above.
- (iv) The fourth option can only be seriously discussed following assessment of the extent to which some CEMP indices (or their combination) used in 'predator performance' estimation and these estimates themselves comply with the principles defined in paragraph 3 of Article II of the Convention. WG-EMM-02/36 does not provide any explanation of this.

5.27 Given the problems associated with basing a subdivision of catches on the results of a single large-scale krill survey, the Working Group agreed that there was a need to develop an additional alternative subdivision option that takes account of both the survey data and information from historical krill catches.

5.28 The Working Group agreed that as it begins to address the issue of subdivision of catches amongst SSMUs, it is now essential that all available information on historical, current and possible future krill fishing activities be made available on a fine spatial and temporal scale.

5.29 One of the obvious attractions of the current major krill fishing grounds is that fishable concentrations of krill can reliably be found there each year. Results of the CCAMLR-2000 Survey did indicate that fishable concentrations of krill were found in pelagic areas within Area 48 (SC-CAMLR-XVII, Annex 4, Appendix D). However, these results represent a snapshot of krill densities at one point in a year. Dr Sushin noted that as a rule, such

concentrations in open waters tended to exist in one place for only a short time (e.g. between several days and three weeks). The lack of predictability in locating fishable concentrations of krill in open waters meant that commercial fishing in such areas was unlikely to be viable.

5.30 Summarising the discussions on SSMUs, the Convener observed that WG-EMM-03/36 had definitely served its intended purpose – that of stimulating debate on how the precautionary catch limit in Area 48 could be subdivided. The debate had identified a need to refine options presented in that paper and the assumptions and calculations on which they were based. In order that further progress can be made on this topic, it was agreed that there is also a clear need to develop other alternative subdivision options, including ones that took account of historical fishing information. Members were urged to work on these topics intersessionally, with a view to presenting papers on revised or alternative subdivision options and making substantial further progress at the next WG-EMM meeting.

Analytical Models

5.31 Dr Constable reported on the first meeting of the WG-FSA Subgroup on Assessment Methods held at Imperial College, London, from 12 to 15 August 2003. This subgroup is of interest to WG-EMM because it reviews and evaluates analytical and assessment methods which are used to analyse surveys, estimate parameters or determine yields of fish stocks. It also has responsibility for determining what methods are appropriate to be used in the work of WG-FSA. Therefore, one of its primary tasks was to develop an agenda for the assessments at the coming meeting of WG-FSA. The following paragraphs provide a summary of the points of interest to WG-EMM.

5.32 CMIX is used by WG-EMM to determine the strengths of a single year class of krill as a proportion of the population based on length-density data arising from net samples (de la Mare, 1994). The subgroup discussed the use of CMIX and the potential difficulties of some kinds of data. It has recommended that CMIX continue to be used until further evaluation has been completed. Such evaluation is to include simulation testing to help compare the merits of different approaches to mixture analyses. In the meantime, the subgroup recommended that the diagnostic outputs provided from CMIX should be reviewed closely to help determine the reliability of the estimates of densities of fish in each year class from the haul-by-haul length-density data.

5.33 The Working Group noted that the Excel add-in for using CMIX from within Excel was still the main interface other than the development of text files. A manual is available for assisting in the use of CMIX, including details of the diagnostic outputs (de la Mare et al., 2002). The Australian Antarctic Division is currently developing a database version similar to the interface of the GYM.

5.34 The GYM is used by WG-EMM to undertake the assessments of precautionary yield of krill. The subgroup considered the advances in the development of the GYM in recent years, noting that the full manual and model specifications are now available. This year, the GYM has been extended to enable projections for a known age structure and/or biomass, which is required for the short-term assessment of yield in mackerel icefish. Such projections also enable simulations and assessments of population conservation and recovery, which may be of interest to WG-EMM. The new version, manual and specifications are available on the

Australian Antarctic Division website (www.antdiv.gov.au). A database with examples is also available. This database contains example validation routines that enable the user to validate for themselves the way the GYM works. It was also noted that the GYM has been translated into Java (Java GYM) to help validate the software. The subgroup had noted that the JGYM was slower in completing its trials but provided similar, but not identical, results to the GYM. It noted that the causes of differences between the JGYM and the GYM remain to be determined and a validation program has been proposed.

5.35 WG-EMM has an interest in standardising time series of CPUE in the krill fishery. At present, WG-FSA standardises the catch series in Patagonian toothfish fisheries using GLMs. The method for GLM standardisation was reviewed this year. There are some issues remaining on model construction and the appropriateness of some data used in these assessments. Nevertheless, GLMs may be a method that WG-EMM could consider in the analysis of CPUE. It was noted that the input data for GLMs needed to be haul-by-haul data in order that the importance of factors influencing CPUE can be adequately assessed (see paragraph 3.16).

5.36 WG-EMM primarily uses acoustics to estimate abundance of krill. The subgroup considered methods for integrating data from acoustic and trawl surveys for mackerel icefish. Some progress was made on the form of the assessment. However, the final assessment would be contingent on the outcomes of WG-FSA-SFA which met concurrently with WG-EMM.

5.37 WG-FSA will be required to revise its assessment on myctophid fish in the South Atlantic. In order to advance this revision, the subgroup requested assistance from WG-EMM in estimating the abundance of myctophid fish in this region using the results from the CCAMLR-2000 Survey. Dr Hewitt indicated that the USA is preparing a manuscript on the abundance of myctophids from that survey. Although the analysis does not differentiate between myctophid species, the Working Group noted that this may provide a basis for the work of WG-FSA and encouraged Dr Hewitt to have the manuscript submitted to WG-FSA for consideration.

5.38 In its future work, the subgroup is developing a framework to evaluate the different approaches to management, including the robustness of decisions to uncertainties arising from different kinds of monitoring data and assessment models. This is of interest to WG-EMM because of its work in developing a management procedure for krill.

5.39 The subgroup noted the advances in the development of Fish Heaven, a spatially-structured simulation model that can include multiple species (although not interacting at this stage), habitat quality maps for each species (which influence the movement of fish across the landscape), multiple fisheries (commercial and research activities) and a management structure for monitoring, assessing and specifying harvest activities. This model can be used as an operating model to test management procedures. As an example, Fish Heaven can interface directly with the GYM in determining catch limits each year within the simulation.

Existing Conservation Measures

5.40 No changes to existing CCAMLR conservation measures were proposed.

Key Points for Consideration by the Scientific Committee

5.41 The Working Group recommended that the Scientific Committee endorse the proposed revised terms of reference for the Advisory Subgroup on Protected Areas, as listed in paragraph 5.9.

5.42 The Working Group will correspond intersessionally and produce a document outlining new krill harvesting units of appropriate size for catch reporting of the krill fishery, for consideration at WG-EMM-04. Principal concentration will be on Subareas 48.6, 88.1, 88.2 and 88.3, and Divisions 58.4.1 and 58.4.2 (paragraphs 5.10 to 5.12).

5.43 A paper (WG-EMM-03/36) presenting possible ways in which precautionary catch limits in subareas of Area 48 could be subdivided amongst SSMUs provoked extensive discussions within the Working Group. Application of several of these options would lead to a substantial redirection of krill fishing to pelagic SSMUs, in contrast to the current situation in which fishing is concentrated in a small number of SSMUs adjacent to land-based predator colonies (paragraphs 5.13 to 5.21).

5.44 Discussion of the general principles of balancing predator demand and a krill fishery in or near predator foraging grounds raised issues relating to the interpretation of Article II of the Convention which were outside the remit of WG-EMM. These were referred to the Scientific Committee for further consideration (paragraphs 5.22 to 5.25).

5.45 It was agreed that there was a need to refine the subdivision options presented in WG-EMM-03/36. There is also a need to develop additional options, including ones taking account of both survey data and historical krill fishing information. Intersessional work on these topics is required in order that substantial further progress on precautionary catch limit subdivision can be made at the next WG-EMM meeting (paragraphs 5.26 to 5.30).

5.46 The attention of the Scientific Committee is drawn to the progress made in development of analytical models and software tools of relevance to WG-EMM during the recent meeting of the WG-FSA Subgroup on Assessment Methods (see paragraphs 5.31 to 5.39).

5.47 No changes to existing CCAMLR conservation measures were proposed (paragraph 5.40).

FUTURE WORK

Land-based Predator Surveys

6.1 In considering the feasibility of broad-scale surveys of land-based predators, the Working Group recognised four main groups of predators on the basis of the methods likely

to be appropriate: colonial-breeding penguins, surface-nesting flying birds, burrow-nesting flying birds and colonial-breeding seals. The Working Group agreed that because colonial-breeding penguins were both the most tractable of these groups and a major consumer of krill, that initial efforts would best be focused on them.

6.2 With regard to surveys of colonial-breeding penguins, the Working Group considered it likely that the most feasible survey protocol would involve the initial use of satellite imagery, augmented by existing knowledge where possible, to locate colonies, followed by estimation of density within colonies from aerial photography.

6.3 Two sources of satellite imagery are possible. Firstly, there are numerous commercial companies that can provide satellite imagery of good quality, but the cost is likely to be substantial. WG-EMM-03/51 outlined some specifications and costs of such commercial satellite imagery. Coverage and resolution of commercial imagery is projected to improve in the future. Alternatively, it may be possible to obtain satellite images of superior quality from the US Government National Imagery and Mapping Agency (NIMA) at minimal cost, subject to security clearance and likely restrictions on publication of those images. Dr Goebel has made initial enquiries with the Civil Applications Committee, NIMA, about the availability of satellite images and will continue these discussions intersessionally. In particular, there was a need to know whether there was any substantial trade-off between the resolution of images and spatial coverage in images obtained from NIMA.

6.4 WG-EMM-03/51 reviewed previous attempts to ground truth the use of satellites for locating penguin colonies in East Antarctica, the Ross Sea and the Crozet Peninsula. Although the extent of ground truthing is very limited, the studies show that satellites have great potential for this purpose. However, the studies also allude to the need for further evaluation with respect to the spectral response of surrounding material, variability in the spectral response of guano due to environmental features, inadequate or ambiguous signal from guano, and spatial resolution of the technology and/or penguin breeding sites. Developments in satellite technology since the time of these studies will have alleviated some issues such as spatial resolution. The authors argue that consideration of survey design options may address some deficiencies in current satellite technology.

6.5 The Working Group considered that further evaluation or ground truthing would best be undertaken in an experimental framework and should, where possible, be undertaken in collaboration with existing field work. In this regard, the correspondence group agreed to work intersessionally to (i) identify those factors most likely to confound our ability to identify penguin colonies from satellite imagery at a regional level, such that these factors could form the basis of an experimental program, and (ii) compile current and planned future field work by various investigators within and outside CEMP to assist in assessing the feasibility of undertaking experimental evaluation in collaboration with existing field research.

6.6 Once the location of colonies has been determined over large scales, a second stage of survey will require estimation of penguin or nest density within colonies. The Working Group agreed that aerial photography is likely to be the most successful method for this purpose.

6.7 The Working Group discussed the feasibility of using unmanned aircraft as a platform for aerial photography, of which there are many types and designs on the market. WG-EMM-03/50 reviewed the advantages and disadvantages of one such type named the 'Aerosonde'. The British Antarctic Survey has also been investigating unmanned aircraft for this purpose. Although superficially attractive, the Working Group considered there were numerous disadvantages that were evident with this platform. Most unmanned aircraft are designed as high-speed data collection platforms, which may not be appropriate for aerial photography. Performance was likely to be adversely affected by strong wind and/or icing, and navigation in mountainous terrain is likely to be difficult. Currently the Aerosonde would be no cheaper to operate than conventional aircraft.

6.8 Infra-red photography is a possible alternative to conventional aerial photography for counting penguins. Although the Working Group considered infra-red photography to be of limited utility, it was agreed that further assessment would be given to this option before ruling it out.

6.9 It was recognised that any broad-scale survey would need to take into account the breeding biology of the target species, in that the actual number of breeding and non-breeding birds varies throughout the breeding season and at different locations. Existing data on nest attendance and breeding chronology would be particularly valuable in identifying optimal time windows for survey work and/or forming the basis of corrections for counts outside the optimal time period. It would be particularly important to incorporate any uncertainties into any such corrections. The CEMP database may be one source for such data for penguins, but the Working Group recommended enquiring elsewhere for additional relevant data. Additionally or alternatively, it may be necessary to conduct 'calibration' counts through the breeding season in conjunction with broad-scale surveys.

6.10 The Working Group recognised that it would not be possible to undertake a census or total count of colonial-breeding penguins over broad-scale regions, and hence considered that some form of sample survey would be required. Careful consideration of an optimal sampling design would be important. The possibility of undertaking simulation studies of various candidate sampling designs using real data was discussed with the view to identifying an optimal design prior to a survey being conducted. The results of several regional surveys that have been published in papers or reports indicated that mapping colony boundaries at relatively fine detail, might form the basis of such an investigation. Using a GIS, it might be possible to overlay various sampling designs, such as selection of whole islands, selection of transects across colonies, plots within colonies, or colonies, and examine the bias and precision in relation to sampling effort and design. This approach might be extended further to simulate location of colonies by satellites with varying degrees of spatial resolution and classification error. The Working Group considered this avenue of investigation worthy of further development.

6.11 Rather than attempting surveys at circumpolar scale at the first instance, the Working Group considered that a more prudent approach would be to select a few regions for pilot studies to evaluate methodologies and designs, followed by broader-scale application of evaluated methods depending on the results of such pilot studies. In this regard, it was agreed that regions in East Antarctica and the lower latitudes of West Antarctica would provide contrasting complexities and therefore may present differing feasibilities.

6.12 Given the above staged approach, the Working Group agreed that preparation of a prospectus and detailed background document, as recommended in last year's advice to the Scientific Committee (SC-CAMLR-XXI, Annex 4, paragraphs 6.26 and 6.51) in the context of surveys at circumpolar scale and for all predator groups, was unnecessary at this stage of investigation, but may be useful at a later date.

Workshop on Management Models

6.13 WG-EMM noted the discussion at its last meeting regarding the development of ecosystem models (SC-CAMLR-XXI, Annex 4, paragraphs 6.27 to 6.31). It also noted that this will be the topic for the workshop at WG-EMM next year as part of its program of work (SC-CAMLR-XXI, Annex 4, Table 3). As identified in that work plan, a workshop on developing management procedures for krill will be held in 2005. The aim of the workshop associated with WG-EMM-04 is to develop plausible 'operating' models of the Antarctic marine ecosystem that will facilitate the evaluation of management procedures as part of the workshop in 2005. To that end, the working group recalled the conceptual framework for the development of a management procedure illustrated in Figure 4.

6.14 A management procedure includes the operational objectives related to Article II and the consequent field collection of data (such as data on catch, target species and predators through CEMP), the analyses and assessment methods, and the decision rules that influence the fisheries interaction with the natural world. Decision rules are framed in terms of what is required to meet the operational objectives given the results of the assessment model. The Working Group agreed that the evaluation of management procedures would be undertaken by simulating how well the management procedure would perform under different plausible scenarios, of how the natural world worked and how the fishery interacted with the natural world. In this way, the robustness of the management procedure in meeting the objectives of the Convention, despite the uncertainties in our understanding of the natural world and in the data collection and assessment processes, can be evaluated. The plausible scenarios are often called 'operating models', i.e. alternative models of the natural world and how the fishery interacts with it (the left side of Figure 1).

6.15 In preparation for the workshop next year, a steering committee was formed to consider the organisation of the workshop, its terms of reference and a work plan for the coming year.

6.16 It was agreed that the steering committee would comprise Drs Constable (Coordinator) and C. Davies (Australia), P. Gasiukov (Russia) and S. Hill (UK), Prof. E. Hofmann, Drs Kirkwood, E. Murphy (UK), Naganobu, Ramm, Reid, Southwell, Trathan and Watters. Drs Hewitt (Convener, WG-EMM) and R. Holt (Chair, Scientific Committee) will be *ex officio* members of the steering committee.

6.17 The Working Group agreed that the workshop would be titled 'Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management'. The terms of reference for the workshop were agreed to be:

- (i) to review approaches used to model marine ecosystems, including:
 - (a) the theory and concepts used to model food-web dynamics, the influence of physical factors on those dynamics, and the operations of fishing fleets;
 - (b) the degree to which approximations could be used to form ‘minimally realistic’ models²;
 - (c) the types of software or computer simulation environments used to implement ecosystem models;
- (ii) to consider plausible operating models for the Antarctic marine ecosystem, including:
 - (a) models of the physical environment;
 - (b) food-web linkages and their relative importance;
 - (c) dynamics of the krill fishing fleet;
 - (d) spatial and temporal characteristics of models and their potential limitations in space and time;
 - (e) bounding parameters used in the models;
- (iii) to advance a program of work to develop and implement operating models that can be used to investigate the robustness of different management approaches to underlying uncertainties in the ecological, fishery, monitoring and assessment systems, including:
 - (a) the development and/or testing of software;
 - (b) specification of requirements of software, including diagnostic features, ability to test the efficacy of observation programs, such as different kinds of monitoring of predators, prey and the fishery;
 - (c) consideration of spatial and temporal characterisation of the physical environment (ice, oceanography) that could be used to parameterise the models.

6.18 The Working Group noted that term of reference (iii)(c) could also be used to help with the design of the spatial and temporal monitoring of the physical environment, as well as other aspects associated with CEMP.

6.19 In reviewing existing modelling approaches and considering future approaches for use by the Working Group, it was agreed that other bodies involved in similar modelling evaluations, such as the JGOFS Regional Testbed Program, should be consulted. The Working Group agreed that it would be useful to invite one or two experts with experience

² A minimally realistic model of an ecosystem is one that includes just sufficient components and interactions to enable the key dynamics of the system to be realistically portrayed.

across a variety of modelling approaches, such as from the JGOFS or other programs. It also noted that expertise from the WG-FSA Subgroup on Assessment Methods might be useful in this workshop. The Working Group also requested that Members consider bringing additional modelling experts, if possible, to contribute to the work at the workshop.

6.20 The steering committee was tasked with specifying an intersessional program of work to prepare for the workshop prior to the Scientific Committee meeting this year, including:

- (i) advising the Scientific Committee of proposals for contributions from invited experts either during the intersessional period or at the workshop;
- (ii) developing a review of the available literature on development of ecosystem models;
- (iii) identifying the availability of software and other simulation environments;
- (iv) preliminary consideration of the requirements for datasets, estimates of parameters and other aspects related to the second term of reference.

6.21 The Working Group agreed that intersessional work in preparation for the workshop should aim to address the first term of reference and, as far as practicable, the second term of reference in time for discussion at the workshop. In particular, it agreed that sensitivity tests of the available models would be valuable to identify how the outputs might vary between models based on the same input parameters.

6.22 An interim progress report of the steering committee will be circulated at the Scientific Committee meeting. The steering committee members facilitating this work are indicated in parentheses. It is intended that this report will provide, *inter alia*:

- (i) advice on the potential contributions from experts in preparation for the workshop and in participating in the development of models at the workshop (Drs Hill and Southwell);
- (ii) a first attempt at drawing together relevant literature and information on the development of ecosystem models elsewhere as per the first term of reference (Prof. Hofmann and Dr Murphy);
- (iii) a catalogue of available software and other simulation environments for ecosystem modelling (Drs Ramm, Watters and Gasiukov);
- (iv) preliminary consideration of the requirements for datasets, estimates of parameters and other aspects related to the second term of reference (Drs Trathan, Reid and Naganobu);
- (v) preliminary outline of the aims and specifications for ecosystem modelling as it relates to the development of management procedures for krill (Drs Constable, Davies and Kirkwood).

6.23 The steering committee has noted that the areas of expertise that could be brought to this work include:

- (i) development of operating models for the purpose of evaluating management procedures;
- (ii) development of models that take account of biological and physical coupling;
- (iii) different approaches in food-web modelling;
- (iv) development of spatially structured food-web models;
- (v) development of foraging models in large-scale systems which may include optimal foraging models.

6.24 The Working Group felt that additional expertise in relation to term of reference (ii)(c), dynamics of the krill fishing fleet, would be desirable. Dr Sushin suggested that Dr S. Kasatkina (Russia) could make a valuable contribution on this issue, and Dr D. Miller (Secretariat) noted that a representative of the Secretariat would also be helpful. The Working Group recommended that the Scientific Committee give consideration to additional expertise in relation to specific issues that would benefit the workshop.

Workshop on Management Procedures

6.25 The Working Group noted that initial planning for the Workshop on Management Procedures in 2005 was under way. In this regard, Dr Hewitt suggested that the workshop be co-convened by Drs Reid and Watters. The Working Group agreed with Dr Hewitt's suggestion.

Long-term Work Plan

2003/04 Intersessional Work

6.26 Tasks identified by the Working Group for the 2003/04 intersessional period are listed in Table 3.

6.27 The Working Group welcomed the invitation from Italy to host the 2004 meeting in Siena, Italy, within the period from 5 July to 10 August. It was noted that specific dates for WG-EMM-04 will need to be determined at the Scientific Committee meeting, and should take into account, where possible, a concurrent SCAR conference in Bremen, Germany, from 26 to 28 July, and the need to coordinate with the Subgroup on Assessment Methods of WG-FSA.

Historical Record of Work Undertaken by WG-EMM

6.28 The Working Group thanked the Secretariat for preparing WG-EMM-03/23, which outlined in tabular form the historical development of tasks put forward and completed by WG-EMM since 2001. The Working Group endorsed the utility and format of the paper and encouraged the Secretariat to undertake similar summaries in the future.

Long-term Work Plan

6.29 The long-term work plan of the Working Group (SC-CAMLR-XXI, Annex 4, Table 3) was revised to reflect recent progress and the need for future work. A revised work plan is outlined in Table 4.

6.30 The Working Group welcomed initial proposals for the subdivision of the precautionary catch limit in Area 48 at this meeting (paragraphs 5.14 to 5.16) and encouraged the submission of additional proposals in 2004. The Working Group noted that it had indicated to the Scientific Committee that it would forward a recommendation on this topic in 2004. Most participants agreed that this was possible. However, some participants felt that additional time may be needed to achieve a consensus recommendation.

6.31 Following the review of CEMP (paragraphs 2.1 to 2.18), further analytical work has been identified to occur intersessionally before the 2004 meeting (Appendix D, Table 9).

6.32 Following the establishment of a steering committee, terms of reference and an initial intersessional work plan at this meeting, preliminary work is on target for the workshop on predator–prey–fishery–environment models in 2004 (paragraphs 6.15 to 6.22).

6.33 In considering the work plan for the evaluation of management procedures, Dr Sushin indicated that there is a need to elaborate the scientific basis for the setting of reference points for predator population size as a basis for management.

6.34 Dr Hewitt noted that evaluation of management procedures will require the definition of specific operational objectives to reflect the intent of Article II of the Convention, and recalled the long-standing request for operational definitions of Article II at WG-EMM. Dr Hewitt indicated that the Working Group would welcome such submissions at any of its future meetings prior to the 2005 workshop.

6.35 A planning session for the 2005 Workshop on Management Procedures is scheduled to occur at the 2004 meeting of WG-EMM.

6.36 The Working Group noted the comment by the Scientific Committee that the current reporting requirements from the krill fishery (Conservation Measure 23-06) should be considered as interim requirements, and that haul-by-haul data reported by 10-day periods will be required once the precautionary catch limit is subdivided among SSMUs (SC-CAMLR-XXI, paragraphs 4.25 to 4.27). In addition, when adopting the SSMUs in Area 48, the Commission noted that the submission of haul-by-haul data is necessary for future assessments of activities in these units (CCAMLR-XXI, paragraph 4.9(iii)).

6.37 The Working Group recognised that, following the CEMP review (paragraphs 2.1 to 2.18) and the proposed development of management procedures at the 2005 workshop, CEMP will undergo a process of refinement and refocusing in the future as management procedures and objectives are clarified.

6.38 The Working Group noted the progress report provided by the ad hoc Subgroup on Harvesting Units at this meeting (paragraphs 5.10 and 5.11) and also noted that further recommendations for Subareas 48.6, 88.1, 88.2 and 88.3, and Divisions 58.4.1 and 58.4.2 would be provided at the 2004 meeting of WG-EMM (paragraph 5.12).

6.39 Work on the assessment of predator demand will move from the present discussion stage to the consideration of pilot studies in 2004 and 2005 (paragraph 6.11).

6.40 The Working Group noted that the initial 2002–2005 work plan outlined in SC-CAMLR-XXI, Annex 4, Table 3, has been very useful in guiding progress towards its long-term goal of developing a feedback approach to manage the krill fishery. However, the Working Group recognised that as the end of that time frame approaches, attention needs to be given to planning beyond 2005.

6.41 The Working Group recalled the workshop in 2001 that resulted in the present work plan, and considered that a similar workshop to revise the current plan may be necessary at some time in the future. A planning session for such a possible workshop is scheduled in the revised plan for 2005 under the subtitle ‘Strategic Planning’.

6.42 The Working Group discussed whether the scope of its work should expand from its current krill-centric focus to include other species and systems. The consensus of the Working Group was to remain focused on the krill-centric system for the immediate future, but that the issue could be addressed in a future strategic review of the work plan. In that context, it was thought that the workshop on predator–prey–fishery–environment models in 2004 might point to other elements of the system in need of attention. Paragraph 4.90 discusses a way to improve assessments of ecosystem considerations relating to species other than krill and dependent species.

Key Points for Consideration by the Scientific Committee

Predator Surveys

6.43 Following further discussion by the correspondence group on land-based predator surveys, the Working Group agreed that work should initially focus on colonial-breeding penguins, which as a group are both the most tractable of the land-based predators for broad-scale survey and major consumers of krill (paragraph 6.1).

6.44 The Working Group also agreed that rather than attempting surveys at circumpolar scale at the first instance, a more prudent approach would be to select a few regions for pilot studies to evaluate methodologies, followed by broader-scale application of evaluated methods depending on the results of such pilot studies. The Working Group agreed that pilot studies would best focus on regions in East Antarctica and the lower latitudes of West Antarctica, which provide contrasting complexities for surveys and therefore likely differing feasibilities (paragraph 6.11).

6.45 Given the above staged approach, the Working Group agreed that preparation of a prospectus and detailed background document, as recommended in last year's advice to the Scientific Committee in the context of surveys at circumpolar scale and for all predator species (SC-CAMLR-XXI, Annex 4, paragraphs 6.26 and 6.51), was unnecessary at this stage of investigation, but may be useful at a later date (paragraph 6.12). The Working Group requested the correspondence group to continue intersessional work to further progress on the land-based predator survey initiative.

Workshop on Management Models

6.46 In preparation for a workshop next year on ecosystem models (titled 'Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management'), a steering committee was established to consider terms of reference and an intersessional work plan for the coming year. The Working Group endorsed and accepted the work of the steering committee. An interim progress report of the steering committee will be circulated at the Scientific Committee meeting (paragraph 6.22).

6.47 The Working Group endorsed the principle of inviting one or two experts with experience across a variety of modelling approaches (paragraph 6.23), and noted that this would have budgetary implications for the Scientific Committee. The Working Group also recommended that the Scientific Committee give consideration to additional expertise in relation to specific issues that would benefit the workshop (paragraph 6.24).

Workshop on Management Procedures

6.48 The Working Group recommended that the Workshop on Management Procedures planned for 2005 be co-convened by Drs Reid and Watters (paragraph 6.25).

Long-term Work Plan

6.49 The Working Group reviewed progress towards its long-term goal of developing a feedback approach to manage the krill fishery. The revised work plan is summarised in Table 4. Work identified by the Working Group for the 2003/04 intersessional period is listed in Table 3. Tasks identified by the Working Group for the steering committee for the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management are noted in paragraphs 6.20 to 6.22.

Next Meeting of WG-EMM

6.50 The Working Group welcomed the invitation from Italy to host the 2004 meeting in Siena, Italy, within the period from 5 July to 10 August. It was noted that specific dates for WG-EMM-04 will need to be determined at the Scientific Committee meeting, and should

take into account, where possible, a concurrent SCAR conference in Bremen, Germany, from 26 to 28 July, and the need to coordinate with the Subgroup on Assessment Methods of WG-FSA (paragraph 6.27).

OTHER BUSINESS

Krill Workshop

7.1 An international workshop on understanding living krill for improved management and stock assessment was held at Port of Nagoya Public Aquarium, Nagoya, Japan, from 1 to 4 October 2002 (WG-EMM-03/56). The workshop included presentations and discussions of research on live krill. Twelve papers from the meeting will be published in a special volume of the journal *Marine and Freshwater Behaviour and Physiology* in late 2003. WG-EMM thanked the conveners of the meeting (Dr Kawaguchi and Mr Y. Hirano) and the sponsors (Fisheries Research Agency, Fisheries Agency, Port of Nagoya Public Aquarium) for supporting this important meeting.

Krill Survey Methodology

7.2 Dr Bergström advised that he had submitted a proposal to the European Union Program for funding for a series of four courses and a symposium on micronekton and krill survey methodology. This series is to be known as 'Krill Survey Methodology (KrillSUME)' and the proposal was developed with the assistance of Drs Everson, Siegel, Hewitt and D. Demer (USA).

7.3 Each course will introduce up to 15 young scientists to internationally accepted acoustic- and net-sampling protocols used by CCAMLR Members. The courses will be based at the Kristineberg Marine Research Station (Sweden) and will use Nordic krill (*Meganyctiphanes norvegica*) in Gullmarsfjorden as a proxy for Antarctic krill in the Southern Ocean. The courses will be held in the spring and autumn of 2004 and 2005, with a concluding symposium scheduled at the end of the two-year period.

7.4 The Working Group thanked Dr Bergström for his efforts in developing the proposal, and hoped that funding can be secured for this important series of courses.

Informal Ross Sea Research Meeting

7.5 Dr Wilson advised that an informal meeting had been held in Cambridge, UK, on 20 August 2003, between various CCAMLR Members involved in research in the Ross Sea. The meeting was attended by Drs S. Corsolini and S. Olmastroni (Italy), E. Fanta (Brazil), S. Hanchet, K. Sullivan and P. Wilson (New Zealand).

7.6 The aim of the meeting was to informally investigate how the various groups conducting research in the Ross Sea might best aid and assist each other by collaboration where appropriate and by data and hardware/logistics sharing. Issues such as ecosystem

modelling, toothfish ecology, the currently running latitudinal-gradient study, krill studies and biodiversity work were briefly discussed. One suggestion for the future was to hold another Ross Sea workshop in New Zealand in 2006. The focus could be on modelling the Ross Sea marine ecosystem. Models developed at the next WG-EMM meeting could form the basis of such a study.

7.7 The Working Group welcomed these plans for enhanced collaboration and encouraged further developments and reports to CCAMLR.

IWC

7.8 In the report of the CCAMLR Observer, Dr K.-H. Kock (Germany), at the 55th Meeting of the IWC Scientific Committee held in Berlin, Germany, from 26 May to 6 June 2003 (SC-CAMLR-XXII/BG/2), it was noted that the IWC is planning work on defining the edge of the Antarctic sea-ice. The findings of such work may be of interest to WG-EMM in the context of the current sea-ice definitions used in generating CEMP Indices F2a (sea-ice cover in September), F2b (proportion of the year which is free of ice) and F2c (weeks when sea-ice is within 100 km of a site). The Secretariat was requested to ensure that CCAMLR was kept in touch with relevant developments from this work.

Modelling Antarctic Ecosystems

7.9 WG-EMM noted that a workshop on modelling Antarctic Ecosystems was held at the University of British Columbia, Vancouver, Canada, in April 2003. The workshop aimed to capture the critical features of Antarctic ecology in ECOPATH/ECOSIM-based models and forecast the impacts of fisheries and climate change on Antarctic ecosystems. The edited proceedings from the workshop will be published as a Fisheries Centre Research Report. Dr Hill attended the workshop and agreed to arrange for a copy of the proceedings to be lodged with the Secretariat.

SO GLOBEC

7.10 WG-EMM noted the information on SO GLOBEC which Prof. Hoffman reported at the CEMP Review Workshop (Appendix D, paragraphs 69 to 76). In addition, Dr Nicol advised that the marine science survey conducted by Australia off the Mawson Coast in East Antarctica in 2003 was held under the auspices of SO GLOBEC.

Fourth World Fisheries Congress

7.11 Last year, the Scientific Committee endorsed the proposal by WG-EMM and WG-FSA for the involvement of the conveners of these working groups in the planning of a

session on the Southern Ocean at the Fourth World Fisheries Congress, 2 to 6 May 2004, Vancouver, Canada (SC-CAMLR-XXI, paragraph 9.33). This is an important opportunity to present CCAMLR science and resource management in a global context.

7.12 WG-EMM noted that Drs Everson and Hewitt had prepared and submitted an abstract describing case studies on CCAMLR's management of krill, icefish and toothfish fisheries. In addition, the Secretariat had prepared complementary abstracts on the management of by-catch and a comparison between CCAMLR's management efforts and those of other regional management organisations. Participation by the Secretariat at the congress will be discussed at SC-CAMLR-XXII.

Deep Sea 2003 Conference

7.13 The Working Group noted that planning for the Deep Sea 2003 Conference, which is being co-sponsored by CCAMLR, is well under way. Drs Miller and Sabourenkov are members of the Steering Committee and Program Committee respectively. The meeting will be held in Queenstown, New Zealand, from 1 to 5 December 2003 and will focus on the governance and management of deep-sea fisheries. Related workshops are planned for the week immediately prior to the conference. Information and registration is available from www.deepsea.govt.nz.

Collaborative Project

7.14 Prof. Croxall had been informed of a collaborative program by Ukraine and Bulgaria on research into gentoo penguin breeding biology at Vernadsky Station, Antarctic Peninsula (Ukraine) and Livingston Island, South Shetland Islands (Bulgaria). The Working Group noted that this research may be relevant to CCAMLR and could potentially contribute to CEMP if sites and methods were (or could be) selected and applied in accordance with CEMP standard methods. The Secretariat was requested to contact Ukraine and Bulgaria, seek further information on the scope of this research and report to the meeting of the Scientific Committee.

Revision of the Rules for Access and Use of CCAMLR Data

7.15 Last year, the Commission tasked the Secretariat with consulting Members to develop a draft set of rules for access to CCAMLR data based on advice provided by the Scientific Committee (CCAMLR-XXI, paragraphs 4.67 and 4.68; SC-CAMLR-XXI, Annex 6).

7.16 In developing a draft set of rules, the Secretariat built on, and revised, the current Rules for Access and Use of CCAMLR Data (CCAMLR-XXII/8). The key principles being addressed and underlying CCAMLR data access are (i) data submission and access to be facilitated in respect of CCAMLR endorsed work; (ii) data security protected on submission and archiving; (iii) Secretariat to serve as secure data archive; (iv) data access governed by specified guidelines; (v) any data use to be specifically defined; (vi) distinction between data for CCAMLR work endorsed by the Commission and/or Scientific Committee and individual

requests by Members (and/or others) not explicitly related to CCAMLR work program; (vii) guidelines required for specifying data and accompanying levels of security on release, particularly in terms of requests as per the latter part of (vi) above; and (viii) Secretariat to administer data guidelines.

7.17 The Working Group noted the draft set of rules and thanked the Secretariat for this work.

Publication of Results from the CCAMLR-2000 Survey

7.18 Dr Watkins informed the Working Group of the status of the special issue of *Deep-Sea Research* for the CCAMLR-2000 Survey. Papers had now been reviewed and 16 papers revised in accordance with the reviewers recommendations. These papers have been sent to a technical editor who was editing the papers to ensure consistency of terminology and language. Final author approval of the technical editing had been received for five papers and was awaited for another six papers. The remaining six papers were currently undergoing technical editing and would be sent out to authors for approval soon.

7.19 To ensure that papers were ready to be submitted to *Deep-Sea Research* as soon as possible, authors would be asked to return any comments on the final edits within two weeks of receiving them. The editor and technical editor would assume that after this period all changes would be taken as approved by authors. Dr Watkins will liaise with the editor of *Deep-Sea Research* to ensure that the money allocated from this year's CCAMLR budget for publication of the papers can be utilised within the present financial year.

7.20 Dr Watkins further informed the Working Group that he had made a presentation entitled 'The CCAMLR-2000 Synoptic Survey: a synthesis of an interdisciplinary, multi-ship international biological oceanography cruise in the Southern Ocean' on behalf of co-authors (Drs Grant, Sushin, Hewitt, Naganobu, Brandon, Murphy and Siegel) at the biennial UK Marine Science Symposium in September 2002.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

8.1 The report of the ninth meeting of WG-EMM was adopted.

8.2 In closing the meeting, Dr Hewitt thanked all participants for contributing to the meeting and the workshop. The Working Group had completed another key stage in its five-year work plan.

8.3 Dr Hewitt also thanked the local organisers of the meeting, led by Prof. Croxall and Dr Reid, for hosting the meeting in the historic setting of Girton College and for providing excellent support.

8.4 Dr Hewitt thanked the Secretariat for their work in support of WG-EMM, both at the meeting and during the intersessional period.

8.5 Prof. Croxall, on behalf of the Working Group, thanked Dr Hewitt for leading the Working Group through another successful meeting.

8.6 The meeting was closed.

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Table 1: Location and duration of time series of CEMP predator parameters in Area 48.

[illegible]

Table 2: Annual and 5-year catch (tonnes) of krill by subarea and SSMU for the past 15 fishing seasons. Antarctic Peninsula SSMUs: Pelagic Area (APPA); Bransfield Strait East (APBSE); Bransfield Strait West (APBSW); Drake Passage East (APDPE); Drake Passage West (APDPW); Antarctic Peninsula West (APW); Antarctic Peninsula East (APE); Elephant Island (APEI). South Orkney Islands SSMUs: Pelagic Area (SOPA); North East (SONE); South East (SOSE); West (SOW). South Georgia SSMUs: Pelagic Area (SGPA); East (SGE); West (SGW). Data Source: fine-scale data weighed to STATLANT data (FS%: percent of catch in STATLANT data reported in the fine-scale data).

Subarea	SSMU	CCAMLR Season (e.g. 1993: 1 December 1992–30 November 1993)														
		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
48.1	APPA	9376	8474	6090	7069	7363	62	11	8873	6287	1721	4031	2961	1472	6	47
48.1	APBSE	0	0	106	1078	35	0	0	0	0	13	102	908	4028	763	139
48.1	APBSW	0	17	0	6	5	49	108	190	503	87	677	19	5350	4071	419
48.1	APDPE	32020	37612	13832	17266	23689	1059	1077	3102	5714	17474	18775	10651	22771	20592	2127
48.1	APDPW	9711	17158	691	16149	44554	34084	26517	12393	36323	20370	24105	11285	32515	27426	6857
48.1	APE	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0
48.1	APEI	22818	42046	23975	30949	6948	2708	17847	15955	12485	9136	5783	8908	11534	5175	6037
48.1	APW	28	33	8		17	0	5	0	0	0	2867	3883	109	539	0
48.2	SOPA	4703	72936	81821	5497	39434	1433	4	29	41	0	631	1004	3185	2	77
48.2	SONE	4394	14	12659	13378	2967	4703	81	1351	3	91	305	3448	1145	1522	3734
48.2	SOSE	19601	0	0	0	0	0	1317	25	0	0	0	12576	1511	2823	1293
48.2	SOW	71199	15370	129087	148673	52971	8357	18062	50434	2105	8	6066	46315	11265	1252	75089
48.3	SGPA	107307	1411	11351	7485	410	132	385	432	15	0	53	0	6375	408	44
48.3	SGE	107666	157200	89571	79005	60872	3712	20118	42604	24973	26647	23284	0	11465	28380	28719
48.3	SGW	24	0	6908	4763	18344	11890	11	297	2685	106	3419	0	1705	11223	1405
Other		106	0	0	0	55	38	0	0	0	0	0	0	0	0	0
Total		388953	352271	376099	331318	257663	68227	85544	135686	91156	75653	90098	101957	114430	104182	125987
FS%		98	100	100	96	91	98	100	95	100	100	99	100	99	89	69

Subarea	SSMU	Total Catch (tonnes)			Percent Catch		
		1988–1992	1993–1997	1998–2002	1988–1992	1993–1997	1998–2002
48.1	APPA	38371	16863	8513	2	4	2
48.1	APBSE	1218	13	5939	0	0	1
48.1	APBSW	29	929	10534	0	0	2
48.1	APDPE	124419	28270	74899	7	6	14
48.1	APDPW	88263	125573	102168	5	28	19
48.1	APE	0	25	0	0	0	0
48.1	APEI	126735	57497	37433	7	13	7
48.1	APW	86	5	7395	0	0	1
48.2	SOPA	204391	1349	4899	12	0	1
48.2	SONE	33412	5703	10153	2	1	2
48.2	SOSE	19601	1328	18203	1	0	3
48.2	SOW	417299	77393	139981	24	17	26
48.3	SGPA	127964	943	6879	7	0	1
48.3	SGE	494314	117040	91830	29	26	17
48.3	SGW	30040	13687	17749	2	3	3
Other		160	33	0	0	0	0
Total		1706304	446650	536575	100	100	100

Table 3: List of tasks identified by WG-EMM for the 2003/04 intersessional period. The paragraph numbers (Ref.) refer to this report unless stated otherwise.
√ – general request, √√ – high priority.

	Task	Ref.	Priority	Action Required	
				Members	Secretariat
CEMP Review Workshop					
1.	Accomplish tasks identified by the workshop as listed in Appendix D, Table 9, particularly key tasks.	2.16, 2.20	√ √√	Members identified (tasks 1 to 6)	Secretariat (tasks 1 and 7)
Status and trends in krill fisheries					
2.	Request Members to include in their krill fishing plans, as a minimum, information specified by WG-EMM.	3.8, 3.48	√√	Members	Remind
3.	Request Members to maintain consistency in the reporting of CPUE data which should include, in particular, search time as well as catch per tow.	3.16	√	Members	Remind
4.	Carry out analyses of the sensitivity and power to detect trends in indices of krill fisheries performance (CPUE) and the evaluation of functional responses of dependent species to those indices.	3.22–3.25, 3.49	√√	Dr Kawaguchi in cooperation with data holders	Assist and participate as required
5.	Reiterate the need for haul-by-haul data for WG-EMM scientific work.	3.14	√√	Members	Advise
6.	Contact companies offering krill for sale on the Internet, identify companies actively engaged in krill fishing in the Convention Area, contact base countries of such companies and request compliance with CCAMLR conservation measures.	3.32	√		Implement
Scientific Observers Manual					
7.	Revise the manual to incorporate new krill data collection and sampling requirements, and guidelines for sampling by-catch fish larger than 7 cm.	3.40–3.42	√	WG-FSA be advised	Implement
8.	Translate existing e-logbooks into all official languages of CCAMLR.	3.44(ii)	√	WG-FSA be advised	Implement
9.	Include krill observation logbook in the standard set of logbooks published in the manual.	3.44(v)	√		Implement
10.	Revise krill colour chart for its subsequent inclusion in the manual.	3.43	√	Dr Kawaguchi	Remind
Status of the krill-centric ecosystem					
11.	Request data owners to review the annual report of CEMP indices and anomalies (WG-EMM-03/24) prior to the compilation and submission of future reports to WG-EMM.	4.7	√	Data owners	Implement
12.	Start implementing the ordination approach to examining CEMP indices.	4.18	√√	WG-EMM	Implement

	Task	Ref.	Priority	Action Required	
				Members	Secretariat
13.	Investigate the feasibility of calculating fishery–predator overlap indices for each of the SSMUs.	4.4	√		Implement
14.	Identify the existence of datasets describing aspects of krill demography and distribution, and submit their synopses or analyses.	4.35	√	Members	Encourage
15.	Update protocols for collecting samples for toxicological analysis for inclusion in the <i>CEMP Standard Methods</i> , Part IV, Section 5.	4.48, 4.49	√		Implement
16.	Refer Method T1 to WG-FSA in order that it may provide advice on how the data obtained by this method might be used in the work of that group.	4.94–4.96	√	WG-FSA	Forward a request
17.	Amend Index C2b as decided by WG-EMM.	4.104	√		Implement
18.	Request WG-FSA to consider how to improve the assessment of ecosystem considerations relating to species other than krill.	4.90, 4.91	√		
Status of management advice					
19.	Request Members to review the status of CEMP sites for which updated maps have not yet been submitted and provide maps, if appropriate.	5.2	√	Brazil, USA	Remind
20.	Prepare draft of updated guidelines for production of maps for both CEMP sites and marine protected areas to be proposed in accordance with Article IX.2(g) of the Convention.	5.3	√		Implement
21.	Review membership of the Advisory Subgroup on Protected Areas.	5.5	√	Subgroup Convener	Implement
22.	Produce an outline of new harvesting units of appropriate size for krill catch reporting for Subareas 48.6, 88.1, 88.2 and 88.3, Divisions 58.4.1 and 58.4.2.	5.12	√√	Members	Remind
23.	Develop additional options for subdivision of krill precautionary catch limits, including options that takes account of historical fishing information; prepare proposals for WG-EMM.	5.27, 5.28, 5.30	√√	Members	Remind
Future work of WG-EMM					
24.	Prepare for the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management as required in accordance with the adopted plan of intersessional work.	4.76, 6.19–6.24	√√	Implement (Steering Committee and identified scientists)	Implement specific tasks identified
25.	Develop an experimental framework for ground truthing satellite imagery for locating penguin colonies.	6.5	√	Correspondence group	Remind

	Task	Ref.	Priority	Action Required	
				Members	Secretariat
26.	Continue evaluation of sources for obtaining satellite imagery.	6.3	√	Correspondence group	
27.	Enquire about availability of data, other than in CEMP database, on penguin nest attendance and breeding chronology.	6.9	√	Correspondence group	Implement
28.	Keep under review the IWC work on defining the edge of the Antarctic sea-ice.	7.8	√	CCAMLR Observers at IWC	Implement
29.	Obtain information on collaborative research on gentoo penguins by Bulgaria and Ukraine.	7.14	√	Ukraine, Bulgaria	Implement
Other considerations					
30.	Continue analyses of krill catch by SSMU.	3.10	√	Secretariat	Remind
31.	Conduct analyses of threshold krill density for krill fisheries using the finest-scale fisheries information.	3.34, 3.50, 4.107	√√	Members	Remind
32.	Carry out work to compare the distribution of actual fishing with that predicted from distribution of threshold levels for Subareas 48.1 and 48.3.	4.28	√	Members	Remind
33.	Develop hypotheses on origin and transport of krill for use in management of krill.	4.36	√	Members	Remind
34.	Conduct investigations into krill distribution in inshore habitats.	4.40	√	Members	Remind
35.	Consider obtaining a coherent overview of environmentally induced variability in the Southern Ocean and consider potential change scenarios that might influence ecological relationships with implication to fisheries management.	4.59	√	Members	Remind
36.	Carry out work on the evaluation of icefish indices which are of relevance to studies of the krill-centred ecosystem.	4.88	√	Members	Remind
37.	Investigate designs for surveying abundance of colonial-breeding penguins over broad-scale regions.	6.10	√	Members	Remind

Table 4: Revised plan of work scheduled between 2002 and 2005.

Issue	2002	2003	2004	2005
Subdivide Precautionary Catch Limit	Discussion	Initial proposals	Additional proposals Recommendation	
Revised Krill Management Procedure				
Delineation of small-scale management units in Area 48	Workshop (SC-CAMLR-XXI, Annex 4, Appendix D)			
CEMP review	Planning session	Workshop (SC-CAMLR-XXII, Annex 4, Appendix D)	Consideration of further analytical work (SC-CAMLR-XXII, Annex 4, Appendix D, Table 9)	
Selection of appropriate predator–prey–fishery–environment models	Discussion	Planning session	Workshop	
Evaluation of management procedures including objectives, decision rules, performance measures	Discussion	Discussion	Planning session	Workshop
Reporting requirements from fishery	Discussion	Interim requirements adopted by Commission	Consideration of revised requirements	Recommendation
Monitoring requirements from CEMP	Discussion	Discussion	Initial specifications	Revised specifications
Assessment of Predator Demand				
Large-scale surveys of land-based predators	Discussion	Discussion	Consideration of pilot studies	Consideration of pilot studies
Subdivision of Large FAO Statistical Areas				
Establishment of harvesting units	Discussion	Discussion	Proposals for 48.6, 88.1, 88.2, 88.3, 58.4.1 and 58.4.2 Recommendation	
Strategic Planning	Discussion	Discussion	Discussion	Planning session for possible workshop

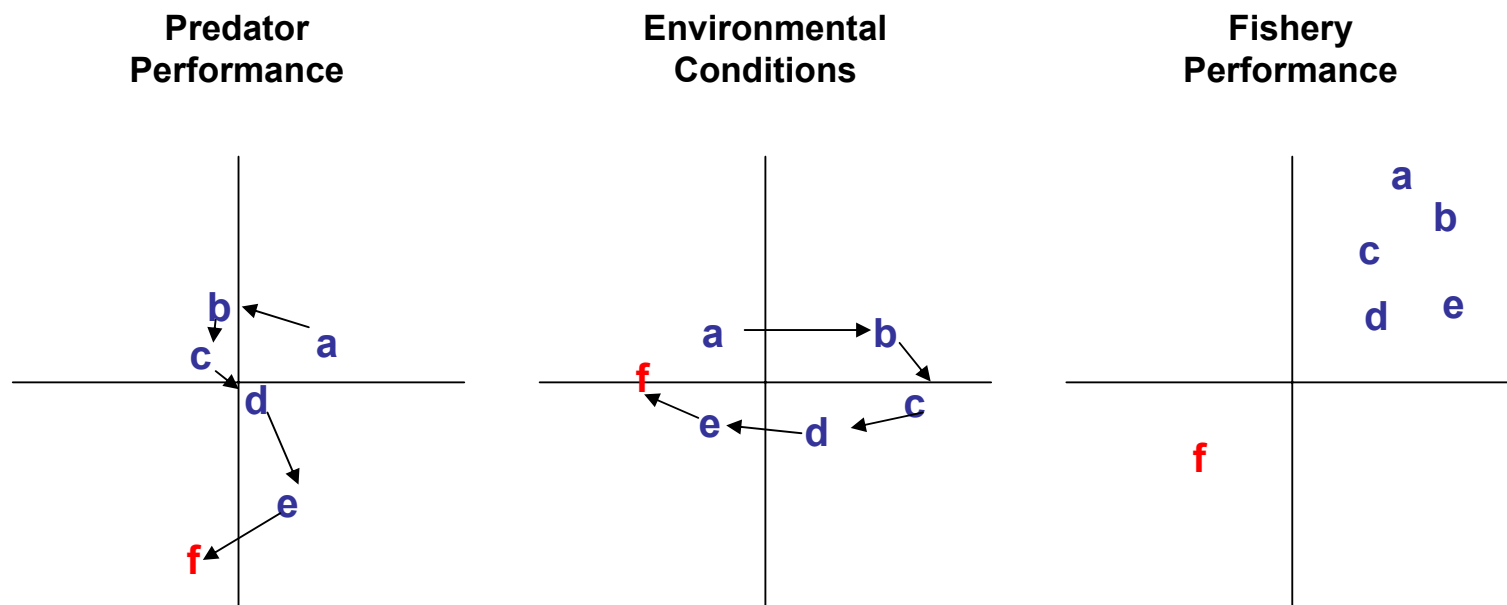


Figure 1: A hypothetical example of possible results of an ordination approach where a time series of data (a–f, where a–f denote years) are plotted for predator performance, physical indices (i.e. environmental conditions) and fishery performance. The three examples identify scenarios showing a trend in predator performance, a cyclical process in environmental conditions and an anomaly in year f in fisheries performance.

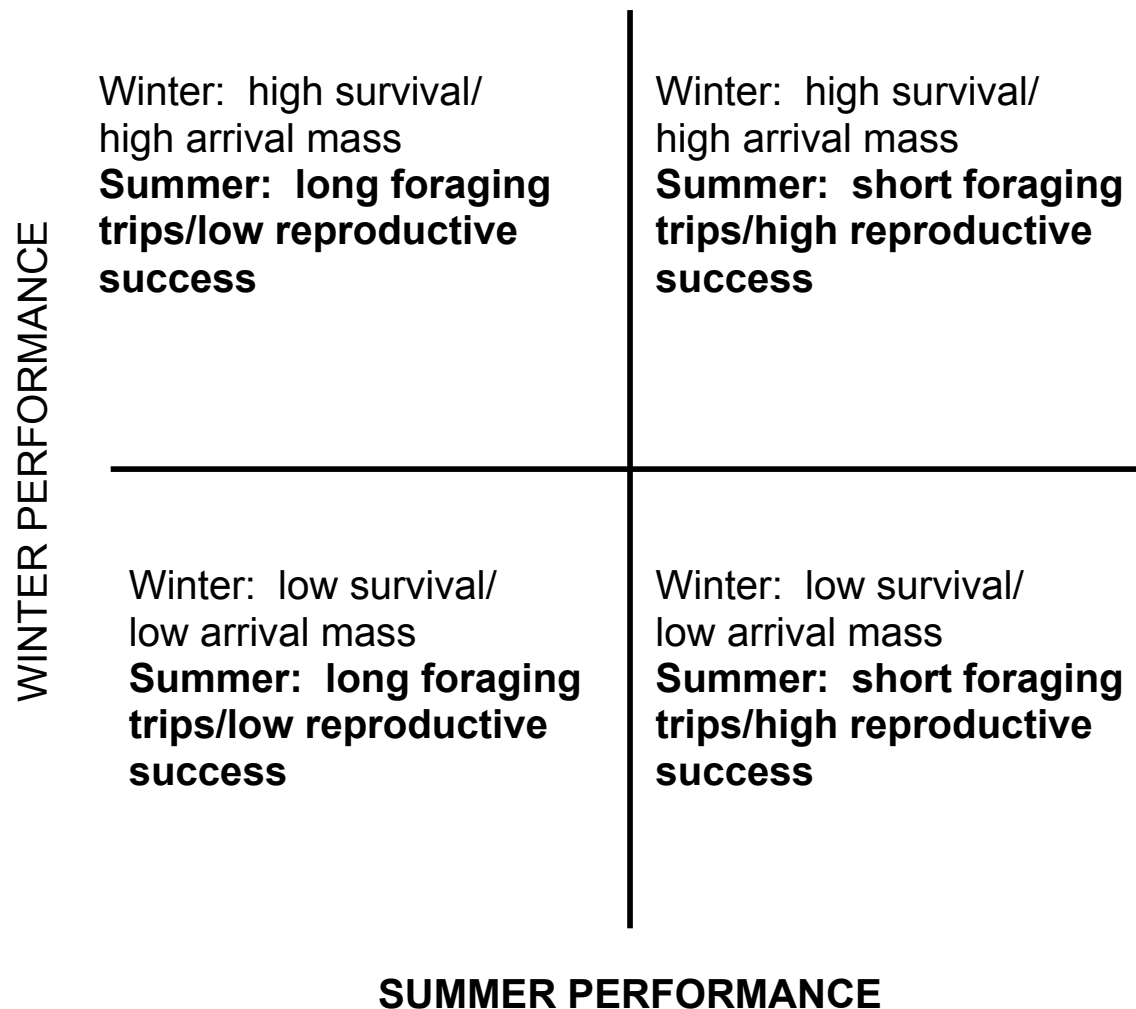


Figure 2: An interpretive example of predator performance indices where the first two ordination axes describe variability in indices that reflect 'winter' and 'summer' processes that might be used for a time series of CEMP indices for any given ISR.

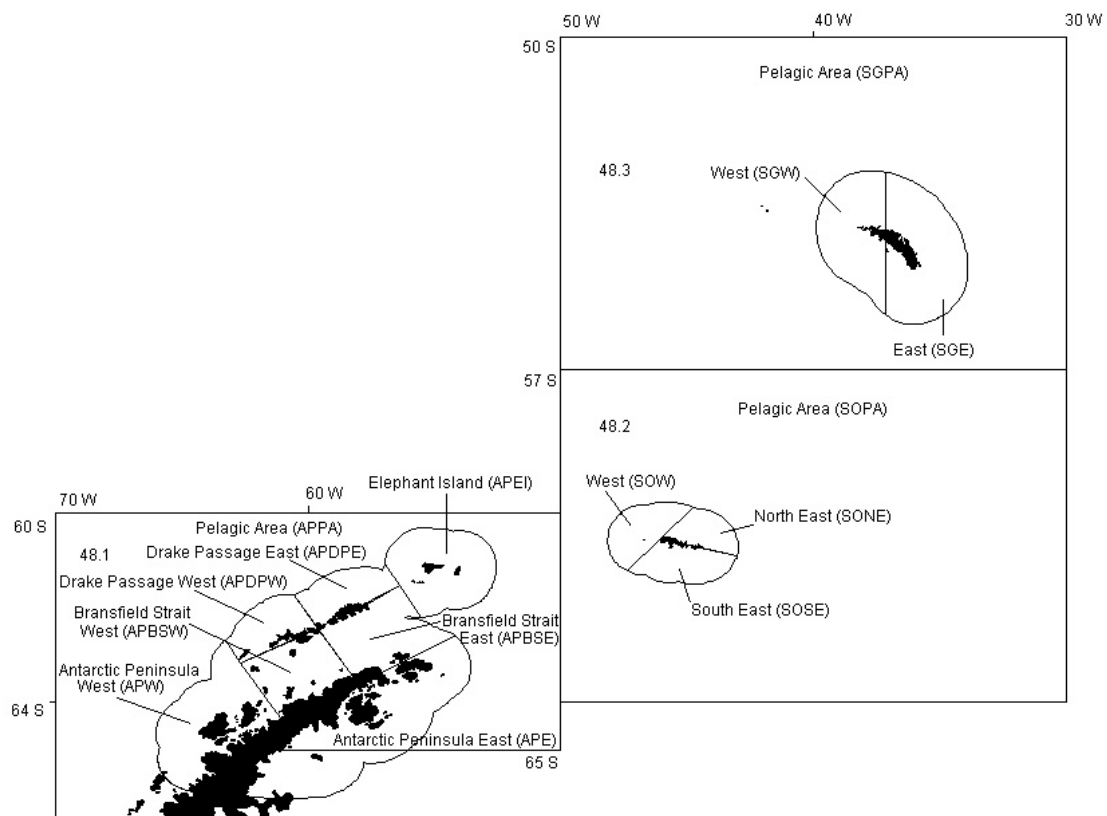


Figure 3: Location of small-scale management units.

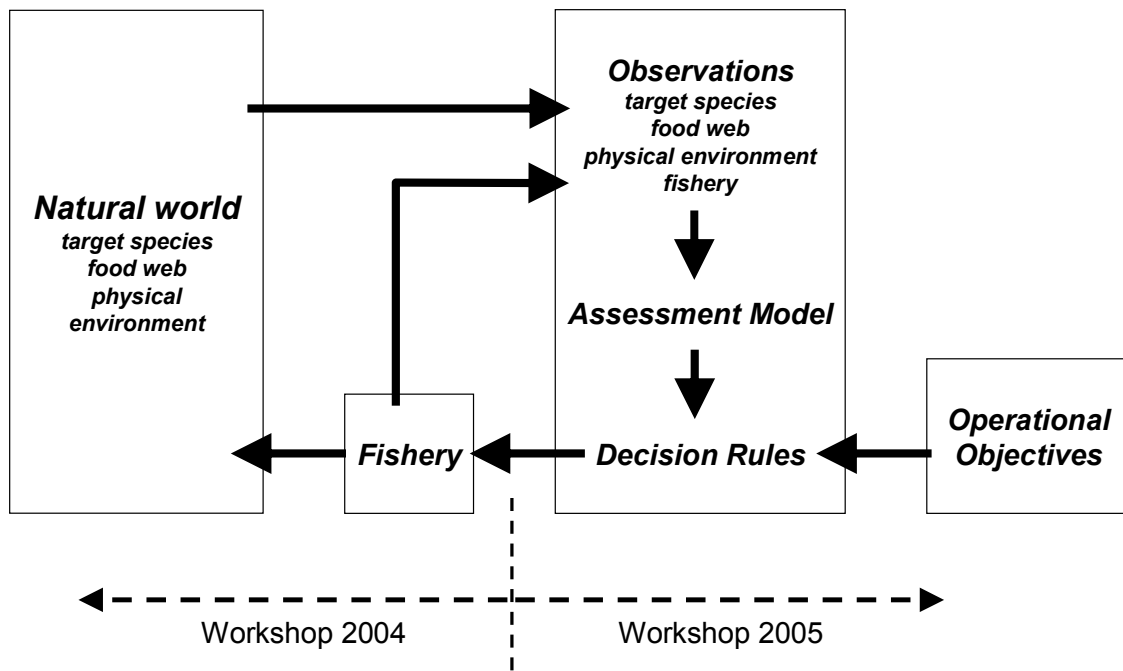


Figure 4: Conceptual framework for the development of a management procedure. The management procedure includes the operational objectives and the consequent field collection of data, the analyses and assessment methods and the decision rules that influence the fisheries interaction with the natural world. Decision rules are framed in terms of what is required to meet the operational objectives given the results of the assessment model. *Operating models capture the range of plausible scenarios of the natural world and how a fishery interacts with that world.*

AGENDA

Working Group on Ecosystem Monitoring and Management
(Cambridge, UK, 18 to 29 August 2003)

1. Introduction
 - 1.1 Opening of the meeting
 - 1.2 Adoption of the agenda and organisation of the meeting
2. CEMP Review Workshop
3. Status and trends in the krill fishery
 - 3.1 Fishing activity
 - 3.2 Description of the fishery
 - 3.3 Regulatory issues
 - 3.4 Key points for consideration by the Scientific Committee
4. Status and trends in the krill-centric ecosystem
 - 4.1 Status of predators, krill resource and environmental influences
 - 4.2 Further approaches to ecosystem assessment and management
 - 4.3 Other prey species
 - 4.4 Methods
 - 4.5 Future surveys
 - 4.6 Key points for consideration by the Scientific Committee
5. Status of management advice
 - 5.1 Designation of protected areas
 - 5.2 Harvesting units
 - 5.3 Small-scale management units
 - 5.4 Analytical models
 - 5.5 Existing conservation measures
 - 5.6 Key points for consideration by the Scientific Committee
6. Future work
 - 6.1 Predator surveys
 - 6.2 Workshop on Management Models
 - 6.3 Long-term work plan
 - 6.4 Key points for consideration by the Scientific Committee
7. Other business
8. Adoption of report and close of meeting.

LIST OF PARTICIPANTS

Working Group on Ecosystem Monitoring and Management
(Cambridge, UK, 18 to 29 August 2003)

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LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Cambridge, UK, 18 to 29 August 2003)

WG-EMM-03/1	Provisional Agenda and Provisional Annotated Agenda for the 2003 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-03/2	List of participants
WG-EMM-03/3	List of documents
WG-EMM-03/4	Shedding new light on the life cycle of mackerel icefish in the Southern Ocean K.-H. Kock (Germany) and I. Everson (United Kingdom) (<i>Journal of Fish Biology</i> , in press)
WG-EMM-03/5	The use of Antarctic shags to monitor coastal fish populations: evaluation and proposals after five years of test of a standard method R. Casaux and E. Barrera-Oro (Argentina) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/6	An 8-year cycle in krill biomass density inferred from acoustic surveys conducted in the vicinity of the South Shetland Islands during the austral summers of 1991/1992 through 2001/2002 R.P. Hewitt, D.A. Demer and J.H. Emery (USA) (<i>Aquatic Living Resources</i> , in press)
WG-EMM-03/7	Mackerel icefish size and age at South Georgia and Shag Rocks A.W. North (United Kingdom)
WG-EMM-03/8	Populations of surface-nesting seabirds at Marion Island, 1994/95 to 2002/03 R.J.M. Crawford, J. Cooper, B.M. Dyer, M.D. Greyling, N.T.W. Klages, P.G. Ryan, S.L. Petersen, L.G. Underhill, L. Upfold, W. Wilkinson, M.S. de Villiers, S. du Plessis, M. du Toit, T.M. Leshoro, A.B. Makhado, M.S. Mason, D. Merkle, D. Tshingana, V.L. Ward and P.A. Whittington (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))

- WG-EMM-03/9 Counts of surface-nesting seabirds breeding at Prince Edward Island, summer 2001/02
P.G. Ryan, J. Cooper, B.M. Dyer, L.G. Underhill,
R.J.M. Crawford and M.N Bester (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/10 Decrease in numbers of the eastern rockhopper penguins
Eudyptes chrysocome filholi at Marion Island, 1994/95
to 2002/03
R.J.M. Crawford, J. Cooper, B.M. Dyer, M.D. Greyling,
N.T.W. Klages, D.C. Nel, J.L. Nel, S.L. Petersen and
A.C. Wolfaardt (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/11 Population dynamics of the wandering albatross *Diomedea
exulans* at Marion Island: long-line fishing and environmental
influences
D.C. Nel, F. Taylor, P.G. Ryan and J. Cooper (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/12 The oldest known banded wandering albatross *Diomedea exulans*
at the Prince Edward Islands
J. Cooper (South Africa), H. Battam, C. Loves, P. J. Milburn
and L.E. Smith (Australia)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/13 Unusual breeding by seabirds at Marion Island during 1997/98
R.J.M. Crawford, C.M. Duncombe Rae, D.C. Nel and J. Cooper
(South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/14 Conserving surface-nesting seabirds at the Prince Edward
Islands: the roles of research, monitoring and legislation
R.J.M. Crawford and J. Cooper (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/15 Population of macaroni penguins *Eudyptes chrysolophus* at
Marion Island, 1994/95 to 2002/03, with information on breeding
and diet
R.J.M. Crawford, J. Cooper and B.M. Dyer (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))
- WG-EMM-03/16 Population and breeding of the gentoo penguin *Pygoscelis papua*
at Marion Island, 1994/95 to 2002/03
R.J.M. Crawford, J. Cooper, M. du Toit, M.D. Greyling,
B. Hanise, C.L. Holness, D.G. Keith, J.L. Nel, S.L. Petersen,
K. Spencer, D. Tshingana and A.C. Wolfaardt (South Africa)
(*African Journal of Marine Science*, 25, in press (2003))

WG-EMM-03/17	Population, breeding, diet and conservation of Crozet shag <i>Phalacrocorax [atricaps] melanogenis</i> at Marion Island, 1994/95 to 2002/03 R.J.M. Crawford, J. Cooper, B.M. Dyer, A.C. Wolfaardt, D. Tshingana, K. Spencer, S.L. Petersen, J.L. Nel, D.G. Keith, C.L. Holness, B. Hanise, M.D. Greyling and M. du Toit (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/18	Population numbers of fur seals at Prince Edward Island, Southern Ocean M.N. Bester, P.G. Ryan and B.M. Dyer (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/19	Absence of haematozoa in breeding macaroni <i>Eudyptes chrysolophus</i> and rockhopper <i>E. chrysocome</i> penguins at Marion Island A. Schultz and S.L. Petersen (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/20	Modern mean monthly SST and SST anomalies off South Georgia during recent years (based on satellite data) G.P. Vanyushin (Russia)
WG-EMM-03/21	Differentiated catchability of trawls as a method for a more precise estimate of density of krill swarms and its biomass V. Akishin (Russia)
WG-EMM-03/22	WG-EMM Subgroup on Protected Sites: Terms of Reference – summary of CCAMLR decisions Secretariat
WG-EMM-03/23	History of development and completion of tasks put forward by WG-EMM (2001/02) Secretariat
WG-EMM-03/24	CEMP Indices 2003: analysis of anomalies and trends CCAMLR Secretariat
WG-EMM-03/25	General information about CEMP CCAMLR Secretariat
WG-EMM-03/26	Preliminary analyses in support of the CEMP Review Workshop: power analyses CCAMLR Secretariat

WG-EMM-03/27	Preliminary analyses in support of the CEMP Review Workshop: serial correlations CCAMLR Secretariat
WG-EMM-03/28	Krill fishery information CCAMLR Secretariat
WG-EMM-03/29	Diets of sympatrically breeding Adélie, gentoo and chinstrap penguins from Admiralty Bay, South Shetland Islands, Antarctica, 1981 to 2000 W.Z. Trivelpiece (USA), K. Salwicka (Poland) and S.G. Trivelpiece (USA)
WG-EMM-03/30	Krill biomass and density distribution in February–March 2002 in Subarea 48.3 S.M. Kasatkina and A.P. Malyshko (Russia)
WG-EMM-03/31	On commercial significance of krill aggregations S.M. Kasatkina (Russia) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/32	Diseases outbreak threatens Southern Ocean albatrosses H. Weimerskirch (France) (<i>Biological Conservation</i> , submitted)
WG-EMM-03/33	Ecological games in space and time: the distribution and abundance of Antarctic krill and penguins S.H. Alonzo, P.V. Switzer and M. Mangel (USA) (<i>Ecology</i> , 84 (6): 1598–1607 (2003))
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WG-EMM-03/35	Different CPUE types in Soviet krill fishery statistics in 1977–1992 F.F. Litvinov, A.Z. Sundakov and V. Arkhipov (Russia) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/36	Options for allocating the precautionary catch limit of krill among small-scale management units in the Scotia Sea R.P. Hewitt, G. Watters (USA) and P.N. Trathan (United Kingdom) (<i>CCAMLR Science</i> , submitted)

- WG-EMM-03/37 Foraging strategies of chinstrap penguins at Signy Island, Antarctica: importance of benthic feeding on Antarctic krill
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J. Cooper (South Africa) and H. Weimerskirch (France)
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I. Everson (United Kingdom), K.-H. Kock (Germany) and A.W. North (United Kingdom)
- WG-EMM-03/43 Ecosystem indicators: factors affecting the choice of predator performance indices for use in monitoring programmes
K. Reid (United Kingdom)
- WG-EMM-03/44 Adélie penguin foraging behaviour and breeding success in seasons of contrasting krill availability (Mawson Coast, Antarctica)
J. Clarke, M. Tierney, S. Candy, S. Nicol, L. Irvine and K. Kerry (Australia)
- WG-EMM-03/45 Demographic studies for CEMP
K.R. Kerry, J.R. Clarke and L.M. Emmerson (Australia)
- WG-EMM-03/46 Short note: time series of Drake Passage Oscillation Index (DPOI) from 1952 to 2003, Antarctica
M. Naganobu and K. Kutsuwada (Japan)

WG-EMM-03/47	Spatial variability and power to detect regional-scale trends C. Southwell and L. Emmerson (Australia)
WG-EMM-03/48	Sources of variability associated with Adélie penguin CEMP parameters measured at Béchervaise Island, East Antarctica L.M. Emmerson, C. Southwell, J. Clarke and K. Kerry (Australia) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/49	The effect of temporal variability on power analysis predictions for Adélie penguin CEMP parameters at Béchervaise Island L.M. Emmerson and C. Southwell (Australia) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/50	An unmanned aerial vehicle as a platform for aerial photography of land-based predator populations in Antarctica: specifications and suitability of the Aerosonde Mark III L. Irvine and C. Southwell (Australia)
WG-EMM-03/51	The utility of satellite remote sensing for identifying the location and size of penguin breeding sites in Antarctica: a review of previous work and specifications of some current satellite sensors C. Southwell and L. Meyer (Australia)
WG-EMM-03/52	Power analyses of CEMP indices for penguins at Admiralty Bay and fur seals at Cape Shirreff and Seal Island G.M. Watters, R.P. Hewitt, W.Z. Trivelpiece and M.E. Goebel (USA)
WG-EMM-03/53	Trends in bird and seal populations as indicators of a system shift in the Southern Ocean H. Weimerskirch, P. Inchausti, C. Guinet and C. Barbraud (France) (<i>Antarctic Science</i> , 15 (2): 249–256 (2003))
WG-EMM-03/54	Antarctic fur seal predator performance indices for the South Shetland Islands 1987/88–2002/03 M.E. Goebel (USA)
WG-EMM-03/55	Suggestions on revision of <i>CCAMLR Scientific Observers Manual</i> S. Kawaguchi, R. Williams (Australia) and E. Appleyard (CCAMLR Secretariat)
WG-EMM-03/56	Report of the international workshop on understanding living krill for improved management and stock assessment S. Kawaguchi (Australia) and M. Naganobu (Japan)

WG-EMM-03/57	Developing a non-lethal approach for assessing endocrine disruptors in Antarctic seabirds S. Corsolini (Italy), W.Z. Trivelpiece (USA) and S. Focardi (Italy)
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WG-EMM-03/60	Growth of mackerel icefish (<i>Champsocephalus gunnari</i>) and age-size composition of populations in subarea of South Georgia K.V. Shust and E.N. Kuznetsova (Russia)
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WG-EMM-03/62	Report of the CEMP Review Workshop (Cambridge, UK, 18 to 22 August 2003)
Other Documents	
CCAMLR-XXII/8	Draft Rules of Access to and Use of CCAMLR Data Secretariat
SC-CAMLR-XXII/BG/2	Observer's Report from the 55th Meeting of the Scientific Committee of the International Whaling Commission, Berlin, Germany, 26 May–6 June 2003 CCAMLR Observer (K.-H. Kock, Germany)
WG-FSA-03/4	Species profile: mackerel icefish I. Everson (United Kingdom)
WG-FSA-03/5	Bibliography on mackerel icefish K.-H. Kock (Germany) and I. Everson (United Kingdom) Ecosystem approach to fisheries: some developments in the FAO Submitted by the Secretariat

CEMP REVIEW WORKSHOP
(Cambridge, UK, 18 to 22 August 2003)

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REPORT OF THE CEMP REVIEW WORKSHOP

(Cambridge, UK, 18 to 22 August 2003)

INTRODUCTION

Background

In 2001 the Scientific Committee agreed, as part of its scheduled plan of work, to commence a review of the CCAMLR Ecosystem Monitoring Program (CEMP) at the 2003 meeting of WG-EMM. The Scientific Committee established the following terms of reference for this review (SC-CAMLR-XX, Annex 4, paragraphs 5.16 and 5.17):

- (i) Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives¹?
 - (ii) Do these objectives remain appropriate and/or sufficient?
 - (iii) Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?
 - (iv) Can useful management advice be derived from CEMP or be used in conjunction with CEMP data?
2. An interim steering committee, convened by Prof. J. Croxall (UK), met during the WG-EMM 2002 meeting and prepared a report and plan of intersessional work that was subsequently adopted by WG-EMM and the Scientific Committee (SC-CAMLR-XXI, Annex 4, Appendix E; SC-CAMLR-XXI, paragraphs 6.1 to 6.16).
3. The Scientific Committee agreed that the inauguration of CEMP (in 1987) and its subsequent development and implementation represented an outstanding achievement of CCAMLR. It noted that major new programs of monitoring and directed research in support of CEMP had been initiated by Australia, Japan, South Africa, UK and the USA, together with significant additional contributions by Argentina, Chile, Germany, New Zealand and the former USSR. The value of these programs and of the time series of data collected in consistent fashion as part of CEMP was recognised worldwide.
4. Nonetheless, it endorsed the timeliness of reviewing CEMP, especially to assess the strengths and weaknesses of the existing program and the limitations these might impose for meeting the original objectives, and potential additions and improvements to the existing program.
5. The Steering Committee for the Review of CEMP (members indicated on the list of participants (Attachment 1)) was co-convened by Prof. Croxall and Dr C. Southwell (Australia). Meetings were held to discuss and further develop the implementation of the

¹ The original objectives of CEMP (SC-CAMLR-IV, paragraph 7.2) were to:

- (i) detect and record significant changes in critical components of the ecosystem to serve as a basis for the conservation of Antarctic marine living resources;
- (ii) distinguish between changes due to the harvesting of commercial species and changes due to environmental variability, both physical and biological.

intersessional work plan (SC-CAMLR-XXI, Annex 4, Appendix E, Attachment 4) on 3 August 2002 at Big Sky, Montana, USA (Interim Steering Committee), and on 24 October 2002 at Hobart, Australia. Various subgroups were established to coordinate and undertake intersessional work.

6. The reports of the above meetings, details of the revised intersessional work plan, the coordinators of the subgroups on data analysis, krill and environmental data, and references to appropriate background literature were all made available on the CCAMLR website from early December 2002.

Opening of the Meeting

7. The Co-conveners welcomed participants (Attachment 1) and thanked the UK hosts and the local organising committee for their assistance with the arrangements for the meeting, and the CCAMLR Secretariat for support during intersessional planning and at the meeting itself.

8. The Preliminary Agenda was adopted with minor changes (Attachment 2).

9. The report was prepared by Prof. Croxall, Drs M. Goebel (USA), R. Hewitt (USA), G. Kirkwood (UK), E. Murphy (UK), S. Nicol (Australia), D. Ramm (Secretariat), K. Reid (UK), Southwell, P. Trathan (UK), W. Trivelpiece (USA) and G. Watters (USA).

GENERAL REVIEW OF DATA, SUPPORTING PAPERS AND OTHER MATERIALS AVAILABLE

10. CEMP data available to the workshop are listed in detail in WG-EMM-03/24 and are summarised in terms of sites (for locations see Figure 1) and the number of years for which data for each parameter of each species are available (Table 1).

11. In preparing the CEMP data for the workshop, a process of validation and logic testing was prescribed by the Steering Committee and carried out by the CCAMLR Data Manager and his staff. Data were checked logically using database queries; data owners were contacted where appropriate to clarify or resubmit any data which failed these tests. It was noted that CEMP data submission for some sites was limited to the essential data defined in the CEMP standard methods.

12. These data had been analysed in terms of anomalies and trends (WG-EMM-03/24) as well as for their power to detect change (WG-EMM-03/26 and 03/27; see paragraphs 22, 23, 31, 85 and 109).

13. The Steering Committee had emphasised the importance of acquiring and analysing non-CEMP time-series data which had been collected in a standardised fashion as an adjunct to the time series of CEMP data. The Secretariat noted, however, that despite requests for such sets of non-CEMP data, only one had been submitted prior to the workshop and was therefore the only one available for analysis during the meeting. However, a number of papers submitted to the meeting contained summaries of non-CEMP data (Table 2).

14. The workshop noted that there were notable time series of non-CEMP data, particularly for physical variables over a wide geographic range. These data included information on: DPOI (WG-EMM-03/46), satellite imagery of sea-ice, sea-surface temperature (e.g. WG-EMM-03/20) and meteorological data. There was also information available from other scientific programs such as SO GLOBEC and the Italian Antarctic Program. These datasets could be used to augment data from the CEMP database and can be used to set up future analyses.

15. The Steering Committee had indicated the kinds of non-CEMP data that would be relevant and desirable for its analyses (Table 3). Notable absences of non-CEMP data available to the workshop included time series of krill abundance and distribution from areas other than Elephant Island, time series for pelagic predators (whales and crabeater seals) and time series of fisheries information from sources other than the former USSR.

UPDATE ON INTERSESSIONAL WORK

Data Availability and Validation

16. Validation and logic testing on all CEMP data were undertaken by the Secretariat during the intersessional period and is now completed for data submitted to June 2003. This validation process is ongoing and will continue to be applied to all data submissions.

17. Validations were carried out with special attention paid to the tasks set by the Interim Steering Committee (SC-CAMLR-XXI, Annex 4, paragraph 6.12 and Appendix E, Attachment 4). Data were checked logically using database queries; data owners were contacted where appropriate to clarify or resubmit any data which failed these tests.

18. CEMP data available at the workshop were reported in WG-EMM-03/24 and 03/25 (see data matrix) and summarised in Table 1. CCAMLR fishery data available at the workshop were reported in WG-EMM-03/28.

19. Non-CEMP data available at the workshop were reported in Table 2. Only one set of data had been submitted in advance of the workshop and was therefore available for analysis.

SENSITIVITY ANALYSES

20. The Interim Steering Committee for the CEMP Review established a correspondence group that was tasked with undertaking preliminary intersessional discussion and analyses on the sensitivity and power to detect trends in CEMP indices. The correspondence group consisted of Drs Hewitt, Watters and Southwell.

21. The correspondence group reviewed available power analysis software programs at the commencement of their work and, after some consideration of various programs' respective strengths and weaknesses, suggested the DOS program MONITOR for exploratory analyses (see also paragraph 24). During the course of intersessional work, several limitations and constraints became evident in this software. Nevertheless, the process of intersessional

discussion and analysis using MONITOR was valuable in exploring concepts, assessing the magnitude of variability both temporally and spatially where possible, and exploring the implications of this variability on power to detect trends.

22. The correspondence group completed a number of exploratory analyses during the intersessional period, and these analyses were presented to the workshop in WG-EMM-03/26, 03/27, 03/47 to 03/49 and 03/52. The analyses considered sources and estimates of spatial and temporal variability and their consequences on power to detect trends of varying magnitude, in relation to monitoring program parameters such as duration of monitoring, number of sites monitored, Type I error levels and one- or two-sided tests.

23. Serial correlation in CEMP indices, which may affect predictions of power, was examined by the Secretariat during the intersessional period. Results of this work were presented as WG-EMM-03/27. Autocorrelation functions were estimated for 157 of the 198 biological time series and 64 of the 80 environmental and fishery time series in the CEMP database. The remaining time series could not be analysed due to insufficient or invariant data. Serial correlation occurred in 4, 10 and 33% of the biological time series at alpha levels of 0.05, 0.10 and 0.20 respectively (i.e. not more frequently than would be expected by chance alone). Generally, serial correlation was more prevalent in time series of population size, CEMP Indices A3 and B1a. Serial correlation occurred in 23, 38 and 55% of the environmental and fishery time series at alpha levels of 0.05, 0.10 and 0.20 respectively. Generally, serial correlation appeared more prevalent in time series of CEMP Indices H3b and F2c.

24. The documents submitted by members of the correspondence group (archived at the Secretariat and available on request) contained a variety of related results, and the workshop decided to review these results by deliberating on three topic areas:

- (i) outlining issues and problems identified during the work of the correspondence group (paragraphs 25 to 30);
- (ii) providing a synopsis of the analytical results prepared by the correspondence group (paragraphs 31 to 39);
- (iii) discussing alternative approaches to power analysis (paragraphs 40 to 43).

Issues and Problems Identified by the Correspondence Group

25. The workshop acknowledged that only some of the CEMP parameters might be expected to show a sustained, gradual change in relation to changing krill availability and hence be suitable for trend analysis as undertaken by MONITOR, and that alternative methods of detecting change would be required for parameters that exhibited a sudden change. The nature of expected change would reflect the shape of the predator response relationship with krill availability, which was being investigated in parallel prior to and at the workshop by separate correspondence group and subgroup.

26. The workshop recognised that it was important to identify appropriate sources of variability for input to power analyses. There was some intersessional discussion regarding process and measurement error, and the workshop paid particular attention to this issue during the CEMP review (paragraphs 33 to 39).

27. The workshop discussed the issue of one- and two-tailed tests in the context of a traditional hypothesis-testing approach and alternative approaches such as Bayesian methods. With regard to hypothesis-testing approaches, three alternatives were discussed: (i) a one-tailed test initially at pre-impact when only a uni-directional change was required to be detected, then subsequently a two-tailed test after detection of a detrimental effect to determine whether the effect has been reversed or not; (ii) use of a two-tailed test at all stages of monitoring; and (iii) the use of 'asymmetrical' one-tailed tests as a compromise between (i) and (ii). The appropriate choice from these and possibly other options would need to be considered in relation to specific management objectives and decision rules yet to be established.

28. The workshop noted that in undertaking power analyses it was critical to specify the effect size that is required to be detected. This would also need to be considered in conjunction with the establishment of specific management objectives and decision rules, and may need to take account of the demographic characteristics of the species.

29. Two types of error may be expected when trying to detect an environmental impact. A Type I error is the probability of falsely concluding an effect has occurred, and a Type II error the probability of failing to detect a real effect. Power is the inverse of a Type II error, or the probability of successfully detecting a real effect. The traditional hypothesis-testing approach has tended to consider only Type I errors and by convention has used Type I error levels of 0.05. Use of this error level in management would mean that management action would be taken unnecessarily one in 20 times. Since the probability of one type of error occurring varies inversely with the other, this approach places a low priority on Type II errors and leads to reduced power. However, in assessing environmental impacts it may be preferable to take a precautionary approach by giving higher priority to Type II errors, since the cost of management action in response to occasional false reports of change may be considered an acceptable trade-off to waiting for definitive change, at which time there may be fewer management options. Consequently in undertaking preliminary power analyses, the correspondence group considered a range of Type I error levels from the traditional level of 0.05 to higher levels of 0.10 and 0.20.

30. The workshop discussed the need to consider power analysis within the context of the management framework within which a monitoring program is operating. There is a need to distinguish between power in a statistical context and power in a management context. In a management context for CCAMLR, power would need to take into consideration the time lag due to delayed effects of demographics as well as the time lag for statistical detection, such that detection and recovery would be possible within two to three decades of an impact occurring.

Synopsis of the Analytical Results prepared by the Correspondence Group

31. In attempting to summarise the analytical results presented in WG-EMM-03/26, 03/47 to 03/49 and 03/52, the workshop noted both the exploratory nature of the analyses (paragraphs 21 and 22) that were conducted and the variety of difficulties that the correspondence group had with identifying appropriate inputs to the power analysis software (paragraphs 25 to 30). In view of these points, the workshop agreed that the objectives of the CEMP review might best be accomplished by gaining an improved understanding of the nature of variation in the CEMP indices rather than by studying specific results from these documents.

32. Identifying the source of variability in CEMP indices is useful for at least two reasons. First, it would be useful to separate measurement variance (uncertainty arising from the observation of a phenomenon and summarising observations in the form of an index) from process variance (uncertainty arising from environmental forcing, variability in demographic parameters etc.). Such separation would facilitate identification of those indices for which increased sample size or alternative observation protocols could reduce uncertainty. Ultimately, reductions in uncertainty may increase power to detect trends. The workshop recognised, however, that first it is not always feasible to increase precision in a CEMP index because of fiscal and logistic constraints, and, second, that reducing measurement uncertainty will not guarantee an increase in power to detect trends if the total amount of variation in the index remains large.

33. A second, useful reason to identify the source of variability in CEMP indices relates to the level at which data are summarised in the development of such indices. It is possible that summarised data contain too many levels of variation to be useful indices. For example, foraging trip duration is dependent on the immediate energetic requirements of an individual animal. If individual variability in foraging trip duration is not preserved, it is possible that an index which is developed from combined data would have limited utility for detecting trends. This could occur if the between-individual variability is greater than the interannual variability in foraging trip duration. In general, identifying the sources of variability in CEMP indices can illustrate whether improvements can be made by alternative levels of data aggregation.

34. The workshop attempted to identify sources of variation (process variation and measurement variation) in CEMP Indices A3 (breeding population size), A5a (mean foraging trip duration) and A6c (breeding success) for Adélie penguins at a number of CEMP sites. An upper limit for measurement variance in Index A3 was assumed to be determined by the guidelines specified in the standard method for that index (i.e. that replicate counts should be made until such time as those counts are within 10% of each other). Measurement variance in Index A5a was estimated by computing the standard error of the index from numbers of foraging trips recorded in the CEMP database. Measurement variance in Index A6c was estimated from the properties of the binomial distribution. Empirical estimates of process variation in all three indices were developed directly from the time-series data in the CEMP database.

35. Measurement variance in Indices A3 and A6a for Adélie penguins may be relatively small (Tables 4 and 5 respectively). This result has two possible implications: (i) sample sizes for these indices have likely been sufficient; (ii) uncertainty in these indices may not have stemmed from the ways in which these data were collected and summarised in the

CEMP database. The workshop noted, however, that it is possible that assuming replicate counts are within 10% of each other may both overestimate the level of measurement variance in Index A3 for small colonies and underestimate this level for large colonies. It was recognised that the only way to resolve this issue would be to analyse the replicate counts used to develop Index A3 at two or three of the largest and smallest colonies. The workshop agreed that these counts should be compiled and analysed as part of its future work.

36. The workshop also noted that Standard Method A3a may predispose Members to monitor relatively small colonies. This could lead to bias because animals in large colonies may respond to changes in krill availability differently than animals in small colonies. It was noted that Standard Method A3b does describe methods for counting animals from aerial photographs, and these are appropriate for use on large colonies.

37. Finally, with respect to Index A3, the workshop recalled the generally high degree of serial correlation in indices of population size and noted that such serial correlation is likely an important component of the process variation in these indices. Thus, in the future, it might be desirable to compute the power of non-linear models to detect trend in Index A3.

38. In contrast to Indices A3 and A6c, measurement variance in Index A5a for Adélie penguins appears to be relatively large (Table 6). This suggests that it may be possible to reduce uncertainty in this index by either collecting additional data or summarising the foraging trip data in an alternative way. The workshop noted that variation in foraging trip duration is determined by individually and temporally specific energetic requirements (paragraph 33), and agreed that a first attempt to reduce uncertainty in Index A5a should be to account for this variability in the index. Such an approach might lead to a revised standard method or to the submission of additional data. The workshop further emphasised that Index A5a is a potentially valuable index for evaluating changes in krill availability, and, given the complexity of variation in foraging trip duration, work on this index should be a priority.

39. The workshop agreed that the exploratory analysis of variation in the CEMP indices for Adélie penguins was informative, and future work to extend this analysis to include other CEMP indices, species and sites may lead to improvements in CEMP. Such work might best be accomplished by convening a small subgroup comprising individuals familiar with the collection and summarisation of CEMP data and with statistical knowledge.

Alternative Approaches to Power Analysis

40. The subgroup considered that any future consideration of power should be undertaken within the framework of a monitoring program designed to meet explicit and specific management objectives. Therefore, explicit and specific statements of management objectives are a priority.

41. Bayesian or maximum likelihood approaches, in which different candidate models are fitted to data in an attempt to better understand those that best explain the observed patterns, were recommended as possible alternatives to the traditional hypothesis-testing approach. Simulation and data-assimilative approaches could also be used to investigate optimal designs for proposed monitoring programs within the context of fixed sampling constraints.

Data-assimilative models minimise the degree of misfit between data and observations, thereby giving simulations that are accurate to the level allowed by the dynamical model and the input datasets. Data-assimilative models allow exploration of the type and frequency of data that are needed, the structure of the dynamical model, and the degree of accuracy that is needed in the observations that are input to the model. The CEMP time series, which extend for more than 20 years for some sites, would be more than adequate for development and testing of data-assimilative models. This approach has been used in the development of meteorological monitoring networks for weather prediction, the implementation of oceanographic sampling programs, and for analyses of historical multi-disciplinary oceanographic datasets.

42. The workshop recognised that a monitoring program that aimed to detect an effect at scales appropriate to management may require a different design to a monitoring program that aims to attribute causality, given fixed sampling constraints. Such contrasting designs may need to be applied within differing spatial contexts and measure different sets of parameters.

43. In a later plenary session, it was suggested that another alternative was to test for the absence of an undesirable change, as opposed to the usual test for the absence of any change (paragraphs 122 and 123).

PREDATOR PARAMETERS AS INDICATORS OF KRILL AVAILABILITY

44. A subgroup was convened to consider the relationship between the response of krill-dependent predators to krill abundance. The Terms of the Reference for that group were to:

- (i) update the intersessional comparisons of the response of krill-dependent predators to krill in Subareas 48.1 and 48.3;
- (ii) examine different functional response models and to identify sources of data with which to investigate models;
- (iii) investigate the options for predicting krill abundance based on the functional response of krill predators.

Update of the Intersessional Comparisons of the Response of Krill-dependent Predators to Krill in Subareas 48.1 and 48.3

45. The subgroup recognised that whereas there are no CEMP data on prey abundance, there are long time series of krill abundance estimates from Subareas 48.1 (WG-EMM-03/06, 03/54, 03/61) and 48.3 (WG-EMM-03/43) and that these are the areas from which there are the longest time series of predator performance parameter; hence these regions formed the focus of the data analysis conducted in the intersessional period and during the workshop.

46. Using indices of predator performance from four species of krill-eating predator together with independent ship-based acoustic estimates of krill abundance from South Georgia (Subarea 48.3), WG-EMM-03/43 examined the relationship between a range of

indices of predator performance and krill abundance. Predator parameters that reflected processes occurring during the summer showed the closest relationship with krill abundance, especially those for species with foraging ranges similar to the spatial scales at which krill surveys were undertaken. Using combinations of indices that reflect processes at the same temporal scale to produce CSIs, showed an increased fit to the krill abundance data compared to any of the individual parameters. Population size parameters showed no such functional response relationship with annual krill abundance estimates.

47. This analysis emphasised the importance of identifying the spatial, and especially the temporal scales, over which indices of krill-dependent species operate (Figure 2) and the importance of this in identifying those indices, either individually or combined, that show the closest relationship with krill abundance.

48. WG-EMM-03/61 presented analyses of a suite of CEMP and non-CEMP predator performance indices collected at Admiralty Bay and Cape Shirreff, South Shetland Islands (Subarea 48.1), to assess the characteristics of the individual parameters and their relationships to krill abundance indices. The analysis of these parameters indicated that body mass and egg size/mass measurements have low overall CVs (<10%), whereas breeding success, population change and foraging trip duration have relative high (25–50%) CVs. The results of linear regression analyses of individual predator indices and krill biomass density for the South Shetland Islands indicated that Adélie penguin incubation shift durations, gentoo penguin population size changes, and gentoo penguin egg masses were significantly correlated with krill biomass density.

49. The analysis presented in WG-EMM-03/43 suggests that combining variables into standardised indices has the advantage of not only reducing the dimensionality of the data to a form in which it is readily interpretable but also, by encapsulating the variability inherent in the suite of parameters, provides a better fit of the functional response of predators to changes in krill abundance. Following this approach, CSIs were calculated using those parameters that reflect ‘summer’ variables for Adélie, chinstrap and gentoo penguins from Admiralty Bay and Cape Shirreff (WG-EMM-03/61) and from Antarctic fur seals at Cape Shirreff (WG-EMM-03/54) in order to investigate the form of the relationship with the krill data presented in WG-EMM-03/36 for the Elephant Island region.

50. It was noted that the apparent relationships between predator performance and krill biomass density from data collected in the vicinity of the South Shetland Islands was not of the same form as that from data collected at South Georgia (Figure 3). In considering potential reasons why the predator–prey functional relationships at Admiralty Bay and Cape Shirreff did not appear to follow the same Holling Type II relationships that were found for predators at South Georgia, the subgroup discussed the following:

- (i) The krill biomass data used in the South Shetland Islands analyses were derived from a series of surveys conducted on a survey grid centred on Elephant Island (WG-EMM-03/6), whereas estimates of krill biomass derived for monitored predator foraging areas near Admiralty Bay and Cape Shirreff may be more appropriate. Accordingly, a times series of krill biomass densities for these areas was generated by: (a) noting the strong correlation between density estimates in the Elephant Island stratum and the South stratum (encompassing the foraging area of predators monitored at Admiralty Bay) and the West stratum (encompassing the foraging area of predators monitored at Cape Shirreff) of

recent US AMLR Program surveys ($r^2 = 0.91$, $n = 5$, and $r^2 = 0.89$, $n = 6$ respectively); and (b) generating a longer times series for the South and West strata based on results from the Elephant Island strata. However, the spatial refinement of the krill biomass density estimates did not substantially change the relationships between krill and CSIs of predator performance.

- (ii) The difference in length of data time series at different sites is considerable and this may be a particularly important consideration for Cape Shirreff where most data exist only from 1998.
 - (iii) The South Georgia time series includes two years, 1991 and 1994, when predator performance and krill density estimates were exceptionally low. Although lower krill densities than those measured for South Georgia have been recorded in the South Shetland Islands, these have not been associated with the same level of reduced reproductive performance in predators.
 - (iv) The amplitude of variability of krill biomass densities may be greater at South Georgia than at the South Shetland Islands, arising from differences in krill demographic parameters (WG-EMM-02/16), thereby producing a greater range of predator response values.
 - (v) Krill biomass densities, although apparently suitable for defining functional relationships for predators foraging from South Georgia, may not be the best parameter for defining functional relationships for predators in general or at other sites. In past working group deliberations other parameters have been considered, for example, mean distance of prey from predator colonies, mean depth of prey, persistence of prey over time (Hewitt et al., 1997). These, as well as other potential parameters (e.g. intensity, density and/or size of patches) may warrant further exploration. In essence, this highlights the need to better understand the relationship between the measures of the abundance of krill and the availability of that krill to predators.
51. Whilst the CSI approach is able to accommodate missing values, the subgroup recognised that, where there were systematic biases in the reasons for the absence of data, this posed a particular problem in reflecting krill abundance.
52. In particular, the subgroup considered the importance of identifying those indices that may not be available for measurement under certain conditions, e.g. during situations of complete breeding failure where it is not possible to measure indices such as foraging trip duration when none of the study birds return to the colony. Where such methodological biases exist these monitoring parameters may be of limited utility to CEMP.
53. WG-EMM-03/44 described the relationship between krill availability and predator performance in the Mawson region of East Antarctica. Shipboard acoustic surveys of krill indicated that more than three times as much krill was present during the survey period in 2001 than in 2003 and this was reflected in the reproductive performance of Adélie penguins at Béchervaise Island. Penguins travelled further to forage in 2003 than 2001, remained at sea for longer, brought back smaller meals and achieved lower breeding success. Fish (mostly *Pleuragramma antarcticum*) contributed significantly to the diet in 2003 but was only a minor component in 2001.

54. In welcoming this integrated analysis of predator performance and prey availability, the workshop noted that WG-EMM-03/59 reported a similar contrast in the reproductive performance for Adélie penguins between 2001 and 2003 at Edmonson Point in the Ross Sea, however, the reasons for the latter had been attributed to unusual sea-ice and weather conditions during critical periods of the breeding season.

55. Dr Nicol informed the workshop that meteorological data from Béchervaise Island from both 2001 and 2003 did not indicate any anomalous events that might have contributed to the differences in breeding success.

56. Dr S. Olmastroni (Italy) informed the workshop that there were no measurements of krill abundance in the vicinity of the Edmonson Point colony. In considering the potential for such confounding problems in the interpretation of CEMP data, the subgroup recognised the importance of collecting data for a suite of parameters of predator performance and environmental conditions.

Indicator Species

57. The workshop recognised that the extent to which predators are dependent on krill may have a large influence on their potential utility as indicator species. This level of dependence should be reflected in the proportion of krill (by mass) in the diet. An analysis of the diet parameters (A8) in the CEMP database indicates that there are considerable intra-specific regional differences with the dietary dominance of krill being greatest in Area 48 in all species, especially for chinstrap penguins (Figure 4). The variability in dietary dominance of krill may reflect differences in alternative prey resources as well as the extent to which species are obligate krill feeders in different locations.

58. However, the workshop noted that although krill comprised 50% of the diet of gentoo penguins in Subarea 48.3, this species had the best fit to the functional response between predator-specific CSI and krill abundance of the range of CEMP species at South Georgia ($r^2 = 0.6$; WG-EMM-03/43).

Sources of Available Data with which to Examine Functional Responses

59. Drs K. Shust and V. Sushin (Russia) reminded the workshop that it was difficult to assess the distribution, density, aggregation structure and biomass of krill from small-scale surveys that have been undertaken in locally restricted areas and within relatively restricted time periods. When oceanographic flux and advection of krill are taken into account, there are potential impacts both on the assessment of the stock and the amount of krill available to predators.

60. They suggested that information from the commercial fishery could therefore be extremely useful in augmenting predator-prey analyses as they may reflect the distribution and density of krill concentrations. They further suggested that CPUE indices derived from the commercial fishing fleet could provide useful information that could be included in analyses of CEMP indices, krill distribution, predator consumption and the potential impact on predators of catches made by the fishing fleet.

61. The workshop considered the utility of using fishery-based indices as a proxy for krill density when examining the functional response of predators to availability of their prey (krill). It noted that such proxies could be extremely valuable in a variety of contexts; thus, they could help inform those studies where information on predators and krill have been collected on an annual basis for some years (e.g. South Georgia and South Shetland Islands), as well as other areas where regular krill surveys have not been conducted annually (e.g. South Orkney Islands).

62. Dr Sushin reminded the workshop that there was an index of the krill fishery performance in the CEMP database (CEMP Index H1) although there were no analyses of these indices presented at this workshop. The workshop agreed that in order to fully evaluate these indices of fishery performance, these data should be subjected to the same evaluation procedures as other CEMP indices. The workshop recommended that such an analysis of the sensitivity and power to detect trends in indices of krill fisheries performance and the evaluation of functional responses of dependent species to those indices should follow the procedures and recommendations arising from this workshop.

63. The workshop established a subgroup (comprising Drs Hewitt (Convener), M. Naganobu (Japan), Nicol, Reid and Sushin) on the evaluation of fisheries-derived CEMP indices with respect to functional relationships of krill-dependent species with the following terms of reference:

- (i) to define analytical procedures
- (ii) to define the data required
- (iii) to specify protocols for the submission, curation and use of the data.

This subgroup was asked to submit their recommendations to WG-EMM-03 under Agenda Item 3.2.

Predicting Krill Abundance Based on the Functional Response of Krill Predators

64. Drs A. Constable (Australia) and Murphy investigated approaches to predicting krill abundance based on the functional response of krill predators. This involved the development of a simulation framework to evaluate the influence of the choice of functional response model and the CV associated with the estimates of predator performance. The inclusion of the error associated with the estimation of krill density estimates will have a large impact on the utility of predator response functions to predict krill abundance (details are presented in Attachment 3).

65. Dr R. Crawford (South Africa) indicated that it was important to recognise the importance of these predator response functions both in terms of predicting krill abundance and in their intrinsic value in understanding the potential consequences of changes in krill abundance on krill dependent predators.

66. The workshop recognised that the ability to relate concurrent indicators of predator performance to changes in krill when measured at appropriate scale was an important

advance. However, it further recognised that the ability to relate these indices to the long-term demographics of predator populations and how these might respond to long-term trends in the krill resource is critical to future work on this topic.

ENVIRONMENTAL PARAMETERS

Relevance of Non-CEMP Data to the CEMP Review

67. WG-EMM-03/20 reported that VNIRO have been monitoring sea-surface temperature in Subarea 48.3 (around South Georgia) since December 1989. The monthly SST maps (with resolution of 1° latitude by 1° longitude) have been constructed from GOES-E and Meteosat-7 daily satellite data that have incorporated real-time data from vessels and buoys. The workshop recognised the utility of such data and the potential to extract indices that could be included in analyses of CEMP data, other predator data and fishery data.

68. WG-EMM-03/46 reported on recent work to update the DPOI described by Naganobu et al. (1999). The index is now available from January 1952 to May 2003 and describes sea-level pressure differences across the Drake Passage between Rio Gallegos (51°32'S 69°17'W), Argentina, and Base Esperanza (63°24'S 56°59'W), at the tip of the Antarctic Peninsula. The workshop recognised the potential utility of the DPOI to the work of CEMP.

Relevance of Southern Ocean GLOBEC

69. Prof. E. Hofmann (Invited Expert) informed the workshop about the success of the recent field studies carried out by the SO GLOBEC multinational science program. The primary objective of SO GLOBEC is to understand the physical and biological processes that control the abundance, distribution and population variability of Antarctic krill (*Euphausia superba*). Addressing this objective requires concurrent studies of the habitat, predators and competitors of Antarctic krill. The SO GLOBEC program is focused on understanding winter processes, especially those that contribute to overwinter survival of Antarctic krill.

70. The west Antarctic Peninsula was chosen as one of the regions for SO GLOBEC field programs because this area is known to include large populations of Antarctic krill and predators, such as Adélie penguins and seals, and dependable winter sea-ice. The region of the west Antarctic Peninsula studied during the SO GLOBEC field effort was centred around Marguerite Bay and extended across the continental shelf to the seaward side of the southern boundary of the ACC. The US and German Antarctic programs undertook large SO GLOBEC field efforts in the west Antarctic Peninsula region.

71. The US SO GLOBEC field effort consisted of four process cruises, four survey cruises and three current meter mooring deployment and/or recovery cruises which took place during the austral autumn and winter of 2001 and 2002. Data collected during these cruises consisted of measurements of hydrographic distributions, sea-ice properties and distribution, hydroacoustic and net-derived zooplankton distributions, phytoplankton pigment distributions and rates of primary production, ecology and physiology of Antarctic krill and zooplankton, fish abundance and distribution, seabird abundance and distribution, penguin abundance and distribution and diet sampling, seal abundance and distribution and physiology, penguin and

seal tagging and cetacean abundance and distribution. These data are now undergoing analyses and some of these results are presented in a special issue of *Deep-Sea Research* devoted to SO GLOBEC, which will be published in early 2004.

72. One of the results emerging from analyses of the US SO GLOBEC datasets is the importance of CDW to the physical and biological processes on the west Antarctic Peninsula continental shelf. CDW is a large water mass that is transported by the ACC and is identified by its relatively warm (1.5°C to 2.0°C) and salty (34.65‰ to 34.72‰) characteristics. This water mass also contains high concentrations of macronutrients and also micronutrients, such as iron. Along the west Antarctic Peninsula the ACC is located along the outer continental shelf edge, which puts CDW at depths of 200 to 500 m. In regions of topographic variability, CDW intrudes onto the continental shelf and floods the shelf below 150 m. Areas where CDW intrudes onto the west Antarctic Peninsula continental shelf are characterised by variable topography and deep trenches that extend from the outer to inner shelf. In particular, the Marguerite Trough provides a conduit for the movement of CDW from the outer shelf to the innermost part of Marguerite Bay. Thus, the regions of CDW intrusion and upwelling are persistent over time.

73. Once on the continental shelf, CDW upwells via a range of processes that introduce heat, salt and nutrients into the upper water column. The introduction of heat to the upper ocean affects sea-ice thickness and concentration as shelf surface waters remain above freezing in winter, producing reduced sea-ice thickness and concentration. Thus, CDW is an integral part of the heat and sea-ice budgets developed for west Antarctic Peninsula continental shelf waters.

74. Diatom-dominated phytoplankton blooms characterise the areas where CDW upwells. This is believed to result from the high silica and possibly iron concentrations associated with CDW. These upwelling areas provide a dependable supply of food for grazers, such as Antarctic krill. As such, these regions may represent preferred sites for biological production along the west Antarctic Peninsula continental shelf. Dr P. Wilson (New Zealand) reported that in the Ross Sea an analogous scenario seems to be operating in relation to increased primary productivity and penetration of CDW. Thus, where diatom-dominated blooms occur, penetration of CDW also occurs. Prof. Hofmann confirmed that where blooms of *Phaeocystis* occur, penetration of CDW is likely to be minimal or absent. Dr Nicol noted that the deep waters around Heard Island are not iron rich; Prof. Hofmann suggested that there existed a shelf-slope front around the island and that this potentially prevented the iron-rich CDW from flooding the shelf.

75. Prof. Hofmann reported how the emerging results from SO GLOBEC could be of use to CEMP. Firstly, she indicated that the results showed that the physical and biological structure of Antarctic continental shelf waters are largely controlled by one particular water mass, CDW. Secondly, that the distribution of this water results in regions of consistent and dependable enhanced biological production, which is reflected in the overall food web. Thus, the effects of this physical and biological structure may influence CEMP indices, especially those indices collected from predator colonies that are in close proximity to areas where CDW upwells. Knowledge of where these areas occur may therefore be an important part of analyses for some of the CEMP data.

76. Prof. Hofmann reported how it may be possible to include information about CDW distribution in the predator-based measurements that are being made by CEMP. Recent work,

undertaken by Dr D. Costa (University of California, Santa Cruz, USA) as part of SO GLOBEC, showed the feasibility of instrumenting crabeater seals with PTTs that also contain temperature and salinity sensors. Preliminary analyses of the temperature and salinity data from these tags show that it is possible to use these data to characterise the thermohaline properties of the portion of the water column sampled by the seals. In many instances, the depth to which the seals dive is sufficient to encounter CDW. Thus, incorporation of this technology into CEMP measurements would allow sampling of the oceanographic conditions within the predator foraging area. The inclusion of temperature and salinity sensors in predator tags is becoming a proven technology and the experiences from SO GLOBEC provide a basis from which additional uses and analyses of these data can be developed.

General Conclusions

77. Following Prof. Hofmann's presentation about SO GLOBEC, the workshop considered various issues related to the krill fishery in the light of the information presented.

78. Prof. Hofmann suggested that the strongest correlations between krill and hydrography occurred with modified CDW rather than with CDW *per se*; indeed recently upwelled or recently modified CDW often show poor relationships with krill. In Marguerite Bay, relationships between secondary production and modified CDW are strong, thus the workshop expressed some surprise that the krill fishery had not developed in this area. Dr Naganobu agreed and further emphasised that variability in Antarctic Surface Water was also important for the krill fishing fleet.

79. Dr Naganobu noted that there was considerable variability in water mass structure in the fishing grounds to the north of the South Shetland Islands. Prof. Hofmann suggested that in this region the ACC did not always occur in close proximity to either the shelf or the land boundaries. This large-scale movement of the ACC potentially has a number of consequences at both small and medium scales. For example, when the ACC moved offshore from the land, waters from Bransfield Strait and from the Weddell Sea can move into the region. Prof. Hofmann indicated that understanding such movement of the ACC was critical to understanding the ecosystem. She suggested that the role of atmospheric forcing may be crucial in this process at a local scale.

80. The workshop recognised that our understanding about large-scale environmental affects and their impact on small- and medium-scale processes continued to increase with the advent of new and sophisticated modelling studies. Indeed, the confidence in modern global circulation models (GCMs) is such that they now potentially offer valuable insights into how the physical environment can be monitored in a way that provides useful information for management. Studies about the levels of spatial and temporal variability present in such GCMs could help identify the necessary scales for a field-based, or satellite-based, environmental monitoring program.

81. Such an approach could potentially lead to the collation of new and relevant environmental data (at a range of scales) that may eventually prove to be of value as covariates when examining predator-prey functional response relationships. Such data would also help identify the degree to which sites were likely to be representative of their local and/or regional area.

82. The workshop recognised that a number of environmental parameters are potentially important covariates in analyses of predator–prey interactions. It therefore considered that it would be valuable to produce a matrix of environmental parameters that potentially confound the analysis of predator–prey functional response relationships. The workshop acknowledged that producing such a matrix was beyond the scope of the current CEMP Review Workshop, but recommended that work continue intersessionally to develop such a matrix. Table 1 outlines a pro-forma layout that the workshop considered appropriate; it recognised that for some species for some areas the content of the matrix would be sparse.

RESPONSES TO THE TERMS OF REFERENCE FOR THE CEMP REVIEW

83. The workshop noted that the review of CEMP is a key element in the work plan of WG-EMM, being closely linked to its main workshop activities planned for 2004/05, (SC-CAMLR-XXI, Table 1) viz:

- (i) selection of appropriate predator–prey–fishery–environment models (2004);
- (ii) evaluation of management procedures, including objectives, decision rules and performance measures (2005).

84. The workshop also noted that the present meeting represents only the commencement of a review of CEMP. Therefore replies to the questions posed by means of the terms of reference should be seen, in many cases, as interim responses based on work in progress.

Are the Nature and Use of the Existing CEMP Data still Appropriate for Addressing the Original Objectives?

85. Previous discussions (SC-CAMLR-XXI, Annex 4, Appendix E, paragraph 11) by the Interim Steering Committee had concluded that CEMP data were likely to be appropriate for detecting and recording significant change in some critical components of the ecosystem. The workshop endorsed this conclusion, but also emphasised that critical evaluation of the nature, magnitude and statistical significance of changes indicated by CEMP data was necessary. The work on power analysis and sensitivity undertaken by the workshop (see also WG-EMM-03/26, 03/27, 03/47 to 03/49 and 03/52) was crucial in this respect for identifying the sources and magnitude of variation in CEMP data.

86. During previous discussions (SC-CAMLR-XXI, Annex 4, Appendix E, paragraph 12), the Interim Steering Committee had considered that the design of CEMP should be evaluated in order to determine whether the construction of the monitoring program was adequate to assess changes before and after potential environmental perturbation at the scales appropriate to management decisions. However, in considering this issue, the workshop now recognised that CEMP had not been designed *per se*, rather it had been formed by the incorporation or development of research within national programs. It remains important therefore, to determine how representative these sites are of their local areas and regions.

87. The workshop further recalled (SC-CAMLR-XXI, Annex 4, Appendix E, paragraph 13) that at current harvesting levels it was unlikely that the existing design of

CEMP, with the data available to it, would be sufficient to distinguish between ecosystem changes due to harvesting of commercial species and changes due to environmental variability, whether physical or biological. The workshop reiterated this conclusion and further noted that with the existing design of CEMP it may never be possible to distinguish between these different and potentially confounding causal factors. As a result, the workshop felt that the Scientific Committee should seek advice from the Commission on the extent to which further work should be directed towards this topic.

88. Within any ecosystem monitoring program, there will always remain a level of uncertainty when assessing predator–prey interactions; a direct consequence of this is that there will always be associated levels of uncertainty in management advice. Without a real ability to separate the confounding effects of harvesting and environmental variation and in the context of uncertainty, the workshop felt that the Scientific Committee should seek advice from the Commission about the policy of how management should proceed when a significant change was detected, but no causal factor could be attributed.

89. The workshop considered that one possible method that could potentially lead to a separation between the confounding effects of harvesting and environmental variation was to initiate a structured fishing experiment that concentrated fishing effort in the vicinity of specifically selected predator colonies. If the Commission determined that it was desirable to initiate such an experiment with the power to distinguish between these confounding effects, an appropriate structured monitoring program would also be required. This would be necessary as it is unlikely that the existing design of CEMP would be sufficient.

90. Dr Sushin suggested that a structured fishing experiment may have economic consequences for the commercial fishery. Prof. Croxall agreed but noted that:

- (i) the nature of these consequences, if any, would depend on the design and location of the experiment;
- (ii) until the concept and detail of any such experiment was approved, consideration of fishery economics might be premature.

91. The workshop recognised that the number of indices that describe harvested components remains small. It therefore welcomed the suggestion of Dr Shust that future analyses should take into account fishery-derived information describing the distribution and biomass of krill. Dr Shust emphasised that the marine ecosystem is dynamic and that the potential overlap between dependent species and the commercial fishery probably varies. Given the dynamic nature of the system, the workshop agreed that further details from the commercial fleet were essential.

92. The workshop recommended the prompt evaluation and production of appropriate indices. However, it was recognised as critical to have the involvement of experienced ecologists and fisheries scientists in order to establish which indices would adequately describe the relevant operations of the fishery. The workshop proposed that intersessional work be undertaken to develop suitable indices based on fisheries data.

93. The workshop recognised that Antarctic krill and those species that were dependent on it were central to CEMP. Other data describing the krill-centric system were also available, but were not a component of CEMP. Further data were also available that described the

non-krill-centric system (see Tables 1 to 3). Most CEMP data originate from the west Antarctic Peninsula and the Scotia Sea, though considerable data holdings are also available from the East Antarctic. Data holdings from the Ross Sea and the Indian Ocean are still relatively sparse. Incorporating data from other locations will be important as it is now recognised that the Southern Ocean contains a number of regional components that may differ from each other in important ways.

94. The workshop recognised that the existing CEMP has many strengths. Thus, the program has provided an extremely valuable description of the Southern Ocean that was not previously available; it has provided exceptional time series of data relating to key components in the ecosystem; and it has documented a number of events where environmental variability has been positively attributed as the reason for decreases in predator breeding performance. Such events include extensive sea-ice around colonies or colonies blocked by icebergs; other such events have occurred in localities where no fishery has been operating. The workshop agreed that the existing CEMP continues to have considerable management utility.

Do these Objectives remain Appropriate and Sufficient?

95. Previous discussions (SC-CAMLR-XXI, Annex 4, Appendix E, paragraph 15) by the Interim Steering Committee had concluded that the existing objectives of CEMP remain appropriate. The workshop reiterated this conclusion, and agreed that an additional objective was now necessary. This was, that 'Appropriate management advice should be developed from CEMP and related data'.

Are Additional Data Available which should be Incorporated in CEMP or be Used in Conjunction with CEMP Data?

96. The workshop has found valuable a number of datasets that are not part of the standard CEMP, particularly those that have been collected for a number of years using standardised procedures. Given the wide variety of non-CEMP datasets that have been of use to this workshop and the potential number that could be of use to the 2004 Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management, the workshop recognised that it would be inappropriate to incorporate all these data into the CEMP databases. Therefore, it recommended that:

- (i) the Secretariat should maintain a register of non-CEMP time-series data of potential utility for the work program of WG-EMM and its subgroups and workshops;
- (ii) conveners of WG-EMM workshops and subgroups should, in relation to their terms of reference and objectives, determine which of these data (and other appropriate data) would be useful for their work, especially in relation to the development of management advice.

97. Details about two time series of non-CEMP data were presented: WG-EMM-03/42 and 03/05. The first of these described potential monitoring information from mackerel icefish, the second from Antarctic shags.

98. Dr I. Everson (UK) explained that icefish are potentially a very useful species for monitoring krill, being an important predator of krill over the shelf at a number of Antarctic and sub-Antarctic islands. Dr Shust agreed and reminded the workshop that icefish diet had a greater proportion of other euphausiids as well as *Themisto* at some locations, particularly in the Indian Ocean.

99. WG-EMM-03/42 described several possible indices that may have application to the work of CEMP. Dr Everson emphasised that these were not currently proposed as standard CEMP indices, rather these indices reflected the data currently available. He considered that three indices, in particular standing stock, condition and diet, may have some utility to CEMP; the others (cohort strength and recruitment, natural mortality, gonad maturation and size of age 1 and age 2 fish), may be useful in the future, pending further study.

100. The workshop recommended that the data owners/originators carry out any necessary work to refine these icefish indices. They should then subject the indices to the same analyses as undertaken for CEMP indices. This should include comparison with other CEMP and non-CEMP indices from similar locations and reflect krill availability over similar temporal and spatial scales.

101. Prof. Croxall introduced WG-EMM-03/05, reporting research on Antarctic shags carried out by Argentinean colleagues over a number of years, including the results of a five-year evaluation of the methods and results of a pilot study. WG-EMM-03/05 described the way in which the standardised analysis of pellets can be used for estimating qualitatively and quantitatively the diet of shags and how this can reflect differences in fish availability between seasons and areas. The workshop thanked its Argentinean colleagues for their careful work.

102. Dr Hewitt reminded the workshop that it had previously agreed that a detailed analysis of the non-krill-centric component of the ecosystem would be beyond the scope of the current CEMP Review Workshop (SC-CAMLR-XXI, Annex 4, Appendix E, paragraph 17). However, the workshop recognised that this work on shags had potential utility to both WG-EMM and WG-FSA as it provided information about potentially important ecosystem interactions. The workshop agreed that WG-EMM-03/05 demonstrated that an appropriate method now existed for monitoring aspects of the abundance of young life-history stages of coastal fish species, including those of commercial importance which were subject to CCAMLR conservation measures. It requested WG-FSA to evaluate ways in which such data could be useful to its stock assessment and management procedures.

103. The workshop noted that the papers for the WG-EMM meeting included a wealth of material on the status and trends of seabird and seal populations for the southwest Indian Ocean (WG-EMM-03/8 to 03/19, 03/22 and 03/53). These papers would be more fully discussed in WG-EMM Agenda Item 4.1.5, but the content of several papers contained matters of relevance to the CEMP Review Workshop.

104. First, many papers summarised time-series data on dependent species (WG-EMM-03/8, 03/10, 03/11, 03/15 to 03/18, 03/32 and 03/53), in many cases substantially

updating data and interpretations most recently reviewed by Woehler et al. (2001) and considered by WG-EMM at its 2000 meeting. In addition, several of the species reported on are CEMP indicator species (WG-EMM-03/8, 03/15, 03/16, 03/18 and 03/53). It was recognised that such data from a region where krill is not the main prey of any of the species involved, form a valuable resource for comparison with CEMP data for the same species in areas where krill is the main diet.

105. Second, several of the papers made convincing cases that some trends in dependent species populations may relate to causes other than changes in prey availability (e.g. by-catch mortality in longline fisheries; WG-EMM-03/8, 03/11 and 03/14) or local disease effects (WG-EMM-03/32).

106. Third, several papers described effects likely due to changes in prey availability at different spatial and temporal scales, ranging from the temporary acute effects on breeding performance due to ENSO-type effects (WG-EMM-03/13 and 03/17) to potential shifts in climatic and oceanographic regimes in the sub-Antarctic Southern Ocean (WG-EMM-03/17 and 03/53). In addition, some papers suggested that interactions between different dependent species may be influencing population trajectories and reproductive performance (WG-EMM-03/17 and 03/18).

107. The workshop recognised that the valuable information and ideas contained in these papers complemented earlier reviews of analogous processes of krill-centric systems, particularly in the Atlantic sector (e.g. Area 48 Workshop (SC-CAMLR-XVII, Annex 4, Appendix D)).

108. Many features of the long-term data on population trends and dynamics, arising from studies by South African and French scientists in the Indian Ocean are of considerable relevance to the work of CCAMLR, including CEMP, and it was hoped that the data in these papers (and updates thereof) could continue to be made available for work related to the review of CEMP.

Can Useful Management Advice be Derived from CEMP or be Used in Conjunction with CEMP Data?

109. Previous discussions (SC-CAMLR-XXI, Annex 4, Appendix E, paragraphs 22 to 24) by the Interim Steering Committee had concluded that intersessional work to develop models that would contribute to appropriate management advice was necessary. It recognised that valuable progress had been made (and will continue to be made), particularly work relating to the development of CSIs and functional responses (WG-EMM-03/43), and work relating to power analyses and sensitivity (WG-EMM-03/26, 03/27, 03/47, 03/49 and 03/52). The workshop recognised that such work had the potential to contribute to appropriate management advice.

110. The workshop further considered two different modelling approaches. The first approach (WG-EMM-03/33 and 03/34) allows the consideration of a spatial, dynamic ecological interaction between predators and their prey using a life-history perspective. The

second method relates indices of upper-trophic level species to indices of independent ship-based acoustic estimates of krill abundance through functional responses (WG-EMM-03/43).

Behavioural Models

111. Dr Hewitt informed the workshop that the behavioural models developed by the authors of WG-EMM-03/33 and 03/34 had considered the vertical movement of krill, aspects of penguin foraging behaviour and interactions with the krill fishery. These papers suggest that changes in species' abundance and distribution caused by human disturbances can have indirect effects on other species in a community. However, a fuller understanding of how individual behaviour determines interactions within and between species is required if such effects are to be incorporated into ecosystem approaches to management. The behavioural model predicts that increased fishing pressure offshore will lead to behavioural responses of krill and reduced penguin food intake. Given the documented links between krill and penguins, this also leads to a prediction of decreased penguin survival and reproduction. Krill behaviour is predicted to cause stronger effects from krill fisheries than those explained solely by the percentage of biomass removed. Environmental conditions that decrease krill growth rates or cause krill to spend time in deeper water are also predicted to increase the magnitude of the effect of fishing on penguin reproductive success. The authors show that changes in penguin foraging behaviour can be used to assess the impact of local fisheries on penguin reproductive success.

112. Results from WG-EMM-03/33 and 03/34 demonstrate that an understanding of predator–prey interactions, indirect effects between species, and individual behaviour, is important to our ability to manage populations, particularly if, as suggested by WG-EMM-03/34, the population dynamics of these species may respond to changes in the abundance of their prey at time scales that are too long to be used in a management context. The workshop asked Dr Hewitt to convey its thanks to Drs S. Alonzo and P. Switzer (USA) and Prof. M. Mangel (USA) for their useful contribution.

113. Dr Southwell reported that concurrent predator–prey studies at Béchervaise Island have indicated that foraging trip duration may be a sensitive indicator of krill availability (see paragraph 33). Further field studies and modelling work targeting the interactions between foraging behaviour and krill diel vertical migration may therefore prove useful for the future WG-EMM Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management.

114. Dr Sushin noted that WG-EMM-03/34 described a theoretical modelling scenario, and that as a consequence the potential utility of the model to provide advice was untested. It was agreed that the parameterisation of such models was critical and that careful validation with field observations was important.

115. The workshop therefore suggested that individuals with relevant expertise consider the model carefully with a view to providing advice, given the likely incorporation of such approaches into the WG-EMM workshop activities planned for 2004 and 2005.

Functional Responses

116. The workshop agreed that there had been significant developments in work on functional responses during the intersessional period, as described in WG-EMM-03/43 and 03/61. It was noted that a range of factors could affect the ability to fit such functions to the available krill and predator data. These included: spatial and temporal scale mismatches in the predator and prey datasets, and the fact that predators may not be obligate krill feeders and therefore the relationships may be affected by prey switching. The workshop discussion highlighted that such effects may require changes in the mathematical functions used to characterise the relationships.

117. The question of whether it is possible to estimate changes in krill abundance using predator performance indices was raised. It was noted that there is considerably more information available about predator performance than there are direct measures of local krill availability. If so, it may be possible to use the information from the predator indices to predict krill availability.

118. The workshop noted that a more explicit examination of the assumptions on which the response curve fitting is undertaken would be valuable. It was noted that it would be possible to simulate some of the effects of including estimated error distributions in the estimates of krill abundance and predator performance. It should then be possible to examine the implications for fitting predator response curves and the ability to detect changes in krill abundance.

119. Preliminary simulation studies undertaken by workshop members are reported in Attachment 3. The simulations indicated that the nature of the variability observed had significant implications for our capacity to characterise and quantify underlying predator response curves. The initial results highlighted that the current methods for determining anomalies could be improved by taking account of the nature of the variability of the krill abundance and predator performance estimates. These preliminary studies indicate that there would also be implications for how the analyses of data on krill abundance might be developed to improve the capacity to detect anomalies.

120. The workshop considered that an important aspect of the approach was that it could provide the potential for determining unusual events based on biologically significant criteria rather than just statistical significance.

121. The workshop noted that the time for developing and considering the simulations reported in Attachment 3 was severely constrained. The information presented in the appendix, although very provisional, did indicate the approach should be further developed and reported in detail. This should include further simulation work to determine the robustness of the approaches for detecting anomalies and changes in krill abundance. The workshop considered that this development was an important and novel outcome from the meeting and requested the workshop members involved (Drs Constable and Murphy) to develop the simulation studies and present a detailed account for the forthcoming Scientific Committee meeting.

Burden of Proof

122. Given the goal of precautionary management, Dr T. Gerrodette (Invited Expert) suggested that the CEMP indices could be interpreted in a different way to that currently adopted. At present, an anomalous value of an index is one that is outside the normal range, as identified by a test of statistical or biological significance. This is equivalent to testing the null hypothesis of no change. A more appropriate test in the context of precautionary management may be of the null hypothesis that an undesirable change, as identified by the management objectives, has not occurred. This alteration in the 'burden of proof' is a common component of other precautionary management regimes.

123. The workshop considered this to be a useful suggestion and recommended that it be considered further at the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management.

OTHER MATTERS

Relationships between ISRs and SSMUs

124. Last year WG-EMM requested that the review of CEMP consider the utility of ISRs and whether the proposed SSMUs might provide a suitable alternative structure for future work on the relationships between krill, predators and fisheries (SC-CAMLR-XXI, Annex 4, paragraph 5.31).

125. It was recollected that the original formulation of CEMP distinguished two categories of operations: ISRs and network sites. The former were delimited regions (in Subarea 48.3 (South Georgia), Subarea 48.1 (Antarctic Peninsula) and Division 58.4.2 (Prydz Bay)), within which a wide range of monitoring studies, together with associated directed research, would be undertaken in order to provide insights into the nature and dynamics of prey-krill-environment interactions, including those in relation to fisheries.

126. Network sites were envisaged as locations providing as wide as possible geographic distribution of monitoring activities, albeit with a restricted range of variables being monitored at each site.

127. Although the nature of activities within SSMUs is still under discussion, it was felt unlikely that the extensive monitoring and research programs developed within ISRs would be necessary for each SSMU.

128. However, the envisaged subdivision of precautionary catch limits into SSMUs might need to be accompanied by monitoring of appropriate indicators to assess the efficacy of the management process and objectives. Initial ideas on the scope and nature of such monitoring should be sought once the nature of the precautionary catch limits and associated management operations and objectives were clarified.

129. The nature of existing CEMP monitoring within each ISR, SSMU and subarea/division is summarised in Table 8.

ADVICE TO WG-EMM

Preparatory Work

130. CEMP data were comprehensively validated prior to the workshop. Summaries of available CEMP data and fishery data were prepared by the Secretariat (paragraphs 10, 11, 16 to 18). Although only one non-CEMP dataset was submitted to the Secretariat prior to the workshop, many such datasets were made available in background documents (paragraphs 13 and 14). Notable absences of non-CEMP data included information on krill abundance and distribution from areas other than Elephant Island and South Georgia, and fisheries information from sources other than the former USSR (paragraph 15). Analyses undertaken related to: (i) serial correlation and power of the CEMP predator indices; and (ii) functional responses between these indices and measures of krill availability.

Results of Analyses

131. With regard to analyses of serial correlation and power, the workshop concluded that:

- (i) in general, the amount of serial correlation in the biological indices was not greater than what might be expected by chance alone, but there was more serial correlation in the environmental and fisheries indices (paragraph 23);
- (ii) it would be useful to obtain an improved understanding of the sources of variation in the CEMP indices, including spatial and temporal variability and the consequences of such variability on power to detect trends of varying magnitude, over varying lengths of time, at different numbers of monitoring sites, and under various levels of risk. An example of the type of work necessary to achieve this understanding was developed for indices on Adélie penguins (paragraphs 34 to 38);
- (iii) extending the analysis of the sources of variation to the full suite of CEMP indices may lead to improvements in CEMP. It is recommended that such work should be conducted in the near future (paragraph 39).

132. With regard to functional responses between indices of predator performance and measures of krill availability, the workshop concluded that:

- (i) predator performance appears to be related to krill availability both at South Georgia and at the South Shetland Islands (WG-EMM-03/61) (paragraphs 46 to 48), but the form of the relationship differs between these two areas (paragraph 50);
- (ii) at South Georgia, the relationship between predator performance and krill density was improved when multiple indices of predator performance were combined, but this was not the case for predators at the South Shetland Islands. The workshop identified a number of possible explanations for the different patterns of response by predators at these two locations (paragraphs 49 and 50);

- (iii) differences in predator performance during 2001 and 2003 were also observed in the Mawson region of East Antarctica and at Edmonson Point in the Ross Sea (paragraphs 53 to 56). In the former case, this difference was attributed to differences in krill biomass, and in the latter case it was attributed to environmental conditions;
- (iv) the data requirements and analytical procedures required to evaluate the indices of krill availability derived from fisheries data should be defined. A subgroup was formed to do this and to report its recommendations to WG-EMM-03 (paragraphs 60 to 63);
- (v) it may be possible to use the relationships between predator performance and krill availability for predicting krill availability and for developing a biological basis for the identification of years in which predator performance was anomalous (paragraphs 64 to 66 and Attachment 3);
- (vi) the ability to relate CEMP indices (both singularly and combined) to the long-term demographics of predator populations and how these might respond to long-term trends in the krill resource are critical to future work (paragraph 66).

Responses to Terms of Reference

133. With regard to the first term of reference (Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives?), the workshop concluded that:

- (i) the CEMP data were appropriate for detecting and recording significant change in some critical components of the ecosystem, but also emphasised that critical evaluation of the nature, magnitude and statistical significance of changes indicated by the data were necessary (paragraph 85);
- (ii) it was not possible to distinguish between ecosystem changes due to harvesting of commercial species and changes due to environmental variability. It was recommended that the Scientific Committee seek advice from the Commission about the policy of how management should proceed when a significant change was detected but no causal factor could be attributed (paragraphs 87 and 88);
- (iii) one possible method that may assist in the separation of confounding effects of harvesting and environmental variation would be the establishment of an experimental fishing regime whereby fishing would be concentrated in local areas in conjunction with an appropriate predator monitoring program (paragraphs 89 and 90);
- (iv) useful indices of krill availability to land-based krill predators could be derived from fishery-dependent data. Intersessional work was established to address this (paragraphs 91 and 92).

134. With regard to the second term of reference (Do these objectives remain appropriate and/or sufficient?), the workshop concluded that the original objectives of CEMP remained appropriate. However, a third objective should be added 'To develop management advice from CEMP and related data' (paragraph 95).

135. With regard to the third term of reference (Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?), the workshop concluded that:

- (i) the Secretariat should maintain a register of the wide range of non-CEMP time-series data that were of use to this workshop and of potential utility to future workshops in support of the work of WG-EMM, including datasets derived from South African and French seabird and pinniped monitoring programs in the southern Indian Ocean (paragraphs 96 and 108);
- (ii) indices derived from mackerel icefish data may be of value in monitoring krill in certain regions; these indices should be subjected to the same analyses undertaken for CEMP data (paragraphs 98 to 100);
- (iii) indices derived from pellets regurgitated by Antarctic shags may be of value in monitoring the early life-history stages of coastal fish species, including several of commercial importance. It was recommended that WG-FSA consider how such indices may be useful to its stock assessment and management procedures (paragraphs 101 and 102).

136. With regard to the fourth term of reference (Can useful management advice be derived from CEMP?), the workshop concluded that:

- (i) behavioural models based on interactions between the aspects of the environment, krill, krill predators and a krill fishery may be of utility in a management context, although correct parameterisation and validation of such models was critical to their use (paragraphs 111 to 115);
- (ii) functional responses linking predators to their prey field may also be of utility in a management context, although several confounding factors were identified requiring further work (paragraphs 116 to 119);
- (iii) simulation studies conducted during the workshop indicated that accounting for the nature of the variability of estimates of krill availability and predator performance could result in improved ability to detect anomalies (paragraphs 119 to 121 and Attachment 3);
- (iv) further consideration of 'burden of proof' issues might be timely (paragraphs 122 and 123);
- (v) all the above topics might appropriately be considered at the WG-EMM Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management.

137. The workshop considered the relationship between ISRs and SSMUs, and concluded that it would be unlikely that the extensive monitoring and research programs developed

within ISRs would be necessary for SSMUs (paragraph 127). Nevertheless, monitoring within SSMUs might need to be extensive and the workshop summarised the nature of existing CEMP monitoring within each SSMU (paragraphs 128 and 129 and Table 8).

Future Work

138. A program of future work was defined and is summarised in Table 9.

ADOPTION OF REPORT AND CLOSE OF WORKSHOP

139. The report, with figures, tables and attachment, was adopted.

140. The Convener of WG-EMM, Dr Hewitt, thanked the Co-conveners for their hard work in coordinating and organising the workshop and their guidance throughout in ensuring its success.

141. The Co-conveners thanked all the participants, particularly the members of the CEMP Review Steering Committee and of the intersessional and workshop subgroups. They thanked the invited experts for their valuable contributions, all the owners and originators of submitted data, without which the review could not have taken place, and the Secretariat for their unfailing support both intersessionally and at the workshop.

142. The workshop closed on 22 August 2003.

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Table 1: Summary data matrix for CEMP biological indices currently held in the CEMP database. Number of years for which data are available. A1: weight of adult penguin on arrival; A2: duration of penguin incubation shift; A3: penguin breeding population size; A5a: duration of penguin foraging; A6: penguin breeding success (a: chicks fledged per egg laid; b: % potential chicks; c: chicks fledged per chicks hatched); A7: penguin chick weight at fledging; A8: weight of stomach contents of adult penguins; A8: diet composition of adult penguin (b: proportion; c: occurrence); B1a: albatross breeding population size; B1b: albatross breeding success; B5c: petrel breeding population size; C1: duration of fur seal cow foraging; C2b: growth rate of fur seal pups.

Species	Site	Biological Index															
		A1	A2	A3	A5a	A6a	A6c	A7	A8	A8b	A8c	B1a	B1b	B5c	C1	C2b	
<i>Arctocephalus gazella</i> (SEA)	Bird Island (BIG)														14	14	
	Bouvetoya (Bouvet Island) (BOI)														2	2	
	Cape Shirreff (CSS)														6	10	
	Seal Island (SES)														7	8	
<i>Diomedea melanophrys</i> (DIM)	Bird Island (BIG)											28	28				
<i>Eudyptes chrysolophus</i> (EUC)	Bird Island (BIG)	15		28		27		15	15	15	15						
	Bouvetoya (Bouvet Island) (BOI)			2	2	2			2	2	2						
	Elephant Island (Stinker Point) (EIS)			1		1		1	2	2	2						
	Marion Island (MAR)	9		9			9	9	9	9	9						
	Seal Island (SES)				1		7	1									
<i>Pygoscelis adeliae</i> (PYD)	Admiralty Bay (ADB)		21	26		3		18	18	18	18						
	Anvers Island (Antarctic Peninsula) (AIP)			8	10		10	10	10	10	10						
	Béchervaise Island (BEE)	12	13	13	11	12	12	12	11	11	11						
	Edmonson Point (EDP)	2	5	9	1	7	6	3	5	5	5						
	Esperanza Station (Hope Bay) (ESP)	6	8	9		9		8									
	Laurie Island (LAO)	3		8		7			6	6	6						
	Magnetic Island (Prydz Bay) (MAD)		1	1			1	1									
	Ross Island (ROS)			21													
	Shirley Island (Casey Station) (SHI)			1	1	1	1		1	1	1						
	Signy Island (SIO)			13		13		7	7	7	7						
	Stranger Point (King George Island) (SPS)	2		9		8			2	2	2						
	Syowa Station (SYO)			22													
	Verner Island (Mawson Station) (VIM)	1		6													

(continued)

Table 1 (continued)

[illegible]

Table 2: Non-CEMP data available at the workshop.

Type of Data	Years	Availability
BIOLOGICAL DATA		
Antarctic and sub-Antarctic seabirds and seals		
Status and trends of seabirds	Various times, areas	Woehler et al., 2001
<i>Predators at South Georgia</i>		
Black-browed albatross peak mass	1989–2003	Submitted to Secretariat
Fur seal median pupping date	1984–2003	Submitted to Secretariat
Fur seal pup production	1979–2003	Submitted to Secretariat
Fur seal birth mass	1984–2003	Submitted to Secretariat
Fur seal frequency of fish in diet	1999–2003	Submitted to Secretariat
Fur seal pup survival	1979–2003	Submitted to Secretariat
Fur seal growth deviate	1989–2003	Submitted to Secretariat
<i>Predators at South Shetland Islands</i>		
Predator parameters	1978–2003	WG-EMM-03/61
Penguin population parameters	1981–2000	WG-EMM-03/29
Fur seal performance indices	1987–2003	WG-EMM-03/54
<i>Predators in Indian Ocean</i>		
Seabird population parameters	2001–2002	WG-EMM-03/9
Seabird population parameters, diet	1980s, 1994–2003	WG-EMM-03/8, 10, 11, 13, 15, 16, 17
Seabird population parameters	1950s–2000	WG-EMM-03/53
Fur seal population parameters	2001	WG-EMM-03/18
<i>Predators in Eastern Antarctica</i>		
Penguin population parameters	2000–2003	WG-EMM-03/59
Penguin foraging and breeding	2001–2003	WG-EMM-03/44
Icefish		
Standing stock	Various times, areas	WG-EMM-03/42
Cohort strength, recruitment	Various times, areas	WG-EMM-03/42
Natural mortality	Various times, areas	WG-EMM-03/42
Length at age 1+ and 2+ years	Various times, areas	WG-EMM-03/42
Condition	Various times, areas	WG-EMM-03/42
Gonad maturity	Various times, areas	WG-EMM-03/42
Diet	Various times, areas	WG-EMM-03/42
Size and age	1987–2002	WG-EMM-03/7
Age and growth	Various times	WG-EMM-03/60
Species profile	Various times	WG-FSA-03/4
Coastal fish populations		
Shag diet	Various years	WG-EMM-03/5
Krill		
CPUE	1977–1992	WG-EMM-03/35
<i>Krill at South Georgia</i>		
Length index	1991–2003	Submitted to Secretariat
Density	1981–2003	Submitted to Secretariat
Biomass and density	2002	WG-EMM-03/30
Size	1988	WG-EMM-03/40
<i>Krill at South Shetland Islands</i>		
Biomass and density	1991–2002	WG-EMM-03/6
Abundance	1978–2003	WG-EMM-03/61
<i>Krill in Eastern Antarctica</i>		
Biomass and density	2001–2003	WG-EMM-03/44
SO GLOBEC		
Plankton, krill and predators	2001–2002	globec.who.edu/globec

(continued)

Table 2 (continued)

Type of Data	Years	Availability
ENVIRONMENTAL DATA		
DPOI	1952–2003	WG-EMM-03/46
SST adjacent to South Georgia	1989–2003	WG-EMM-03/20
Air temperature Indian Ocean	1950s–2000	WG-EMM-03/53
Sea-ice at South Shetland Islands	1978–2003	WG-EMM-03/61
SO GLOBEC Southwest Atlantic		
Hydrography, sea-ice, currents, bathymetry, meteorology	2001–2002	globec.whoi.edu/globec
Ross Sea		
Automatic weather stations	1987–1999	meteo.pnra.it
Air temperature data	1984–2003	meteo.pnra.it
Synoptic data	1994–2003	meteo.pnra.it
Satellite images	1998–2003	meteo.pnra.it

Table 3: Types of data of known or potential utility in relation to CEMP (SC-CAMLR-XXI, Annex 4, Appendix E, Table 1).

KRILL	METEOROLOGY AT CEMP SITE
Abundance	Precipitation
Distribution	Air temperature
Demographics	
Condition	PREDATOR PARAMETERS (non-CEMP)
Fisheries performance	Demographics
	Diet composition
PELAGIC PREDATORS	DATA FROM OTHER BODIES/PROGRAMS
Whales	IWC
Crabeater seals	SCAR
Icefish	France
BIOLOGICAL ENVIRONMENT	LTER
Primary productivity	
Other prey species	DATA FROM ‘NON-KRILL’ FISHERIES
Salps	IMAF
	Icefish
PHYSICAL ENVIRONMENT	Squid
Sea-ice	Myctophids
Frontal positions	
ENSO	
DPOI	
SST	
Surface-layer temperature	

Table 4: Sources of variation in CEMP index A3 (breeding population size) for Adélie penguins at a variety of CEMP sites. Proportions represent the proportion of the total variation in a time series from the CEMP database.

CEMP Site	Proportion Representing Process Variation	Proportion Representing Measurement Variation
Admiralty Bay (ADB)	0.9880	0.0120
Béchervaise Island (BEE)	0.9355	0.0645
Ross Island (ROS)	0.9983	0.0017
Anvers Island (AIP)	0.9238	0.0762
Edmonson Point (EDP)	0.9937	0.0063
Esperanza Station (ESP)	0.9879	0.0121
Laurie Island (LAO)	0.8068	0.1932
Signy Island (SIO)	0.9587	0.0413
Stranger Point (SPS)	0.9599	0.0401
Syowa Station (SYO)	0.9925	0.0075
Verner Island (VIM*)	-2.6463	3.6463

* The estimate of measurement variation at this site was greater than the total amount of variation empirically estimated from the CEMP database, suggesting that the assumption used to develop an estimate of the measurement error was positively biased in this case.

Table 5: Sources of variation in CEMP index A5a (mean foraging trip duration) for Adélie penguins at three CEMP sites. Proportions represent the proportion of the total variation in a time series from the CEMP database.

CEMP Site	Proportion Representing Process Variation	Proportion Representing Measurement Variation
Admiralty Bay (ADB*)	-0.3470	1.3470
Béchervaise Island (BEE)	0.3389	0.6611
Anvers Island (AIP)	0.6758	0.3242

* The estimate of measurement variation at this site was greater than the total amount of variation empirically estimated from the CEMP database, suggesting that variation in foraging-trip duration among individuals and among trips is a large source of variation that data in the CEMP database cannot account for.

Table 6: Sources of variation in CEMP index A6c (breeding success) for Adélie penguins at three CEMP sites. Proportions represent the proportion of the total variation in a time series from the CEMP database.

CEMP Site	Proportion Representing Process Variation	Proportion Representing Measurement Variation
Admiralty Bay (ADB)	0.9957	0.0043
Béchervaise Island (BEE)	0.9911	0.0089

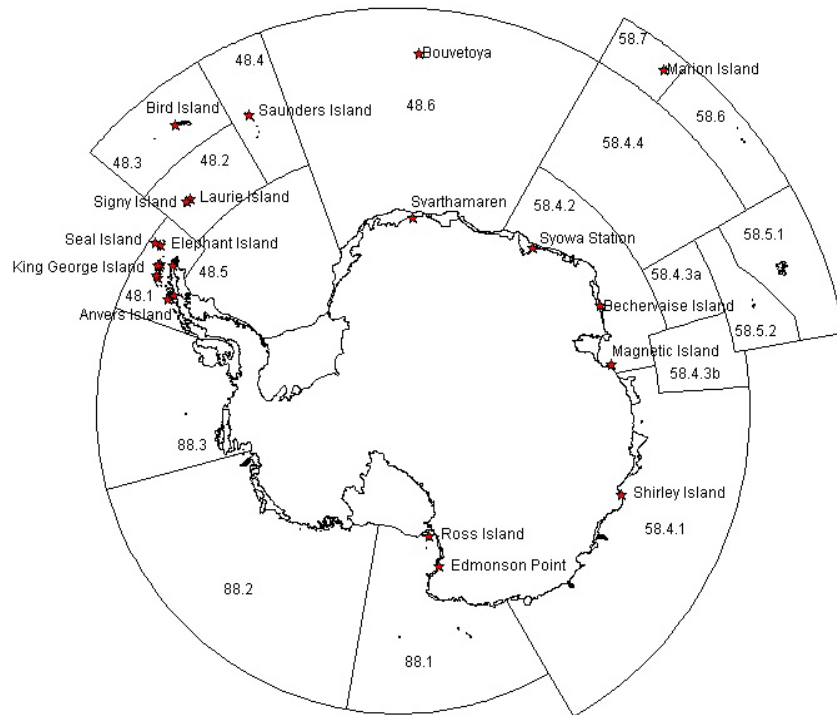
Table 7: Examples of environmental covariates, potentially important in relationships between krill predators and their prey. Numbers indicate the relative ranking between regions (1 = minimal influence, 2 = moderate influence, 3 = major influence).

	Sea-Ice	Fast-ice and Icebergs	Total Sum of Ranking
Scotia Sea			
South Georgia	1	1	2
South Orkney Islands	3	2	5
South Shetland Islands	3	2	5
Ross Sea	3	3	6
East Antarctica	3	3	6

Table 9: Future work for the 2003/04 intersessional period.

	Task/Topic	Paragraphs of Report	Responsibility	Comments
1.	Further examine the sources and magnitudes of variability in predator response parameters.	39	Data Manager, UK, USA, Southwell	Hold an analysis meeting during the 2003/04 intersessional period.
2.	Further work on defining the relationship between estimates of krill abundance and availability to dependent species.	50(v)	UK, USA	
3.	Within the CSI approach, identify indices where systematic biases might be inherent in missing data.	51 and 52	UK, Australia	
4.	Investigate the utility of haul-by-haul CPUE data as a proxy for direct measures of krill availability, with a view to further analyses of functional relationships for research purposes.	59 to 63	Hewitt, Naganobu, Nicol, Reid, Sushin	Terms of Reference are in paragraph 63. Interim report to 2003 meeting of WG-EMM.
5.	Investigate alternate methods for determining anomalies by using predator response curves for a predator parameter or composite index.	64 to 66, 119 to 121 and Attachment 3	Constable, Murphy	Interim report to the 2003 meeting of the Scientific Committee.
6.	Develop a matrix of environmental parameters that are potentially important covariates in the analyses of predator–prey interactions.	82 and Table 7	Trathan, Wilson, Southwell	
7.	Maintain a register of non-CEMP time-series data of potential utility for future CEMP work.	96	Secretariat	Commence with data listed in Table 2. Review and incorporate other datasets/sources after discussion with members of the CEMP Review Steering Committee and/or conveners of Scientific Committee working groups.

(a)



(b)

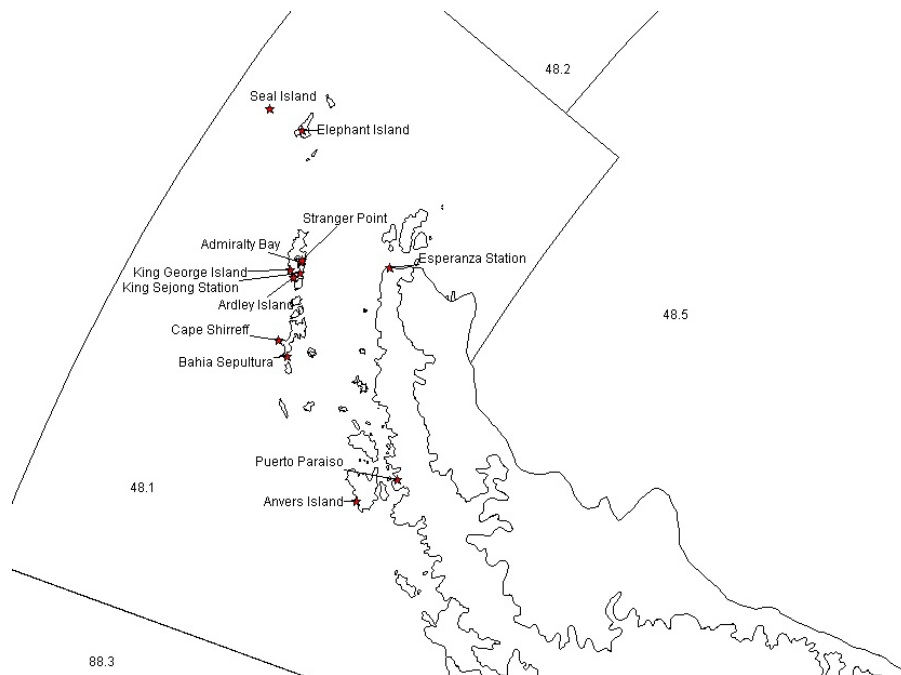


Figure 1: Location of CEMP sites (star). General view (a) and Antarctic Peninsula (b).

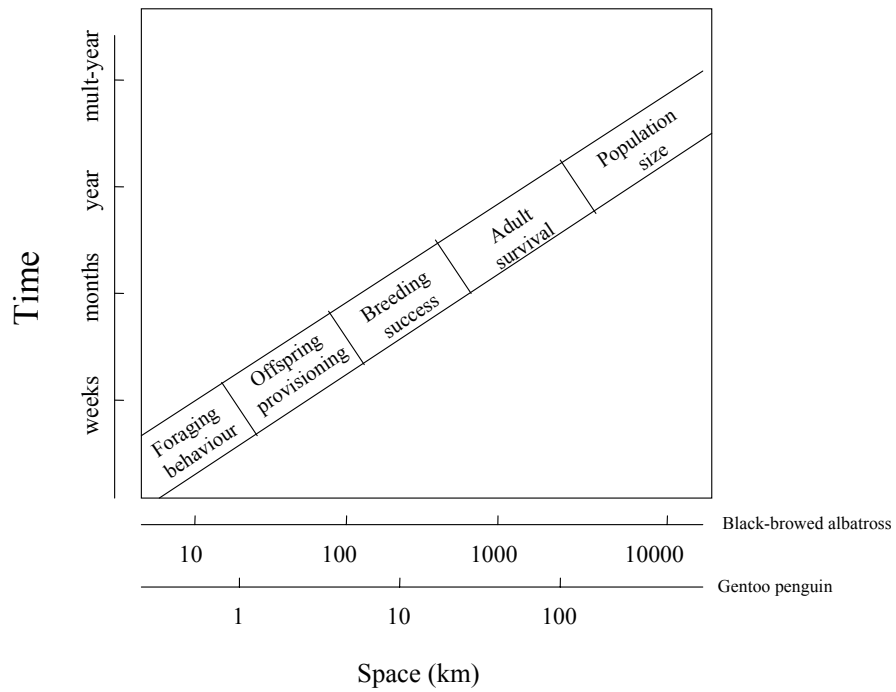


Figure 2: The spatial and temporal scales over which indices of predator performance reflect ecosystem processes. The x-axes scales reflect the two extremes within the group of predators in the CEMP database (from WG-EMM-03/43).

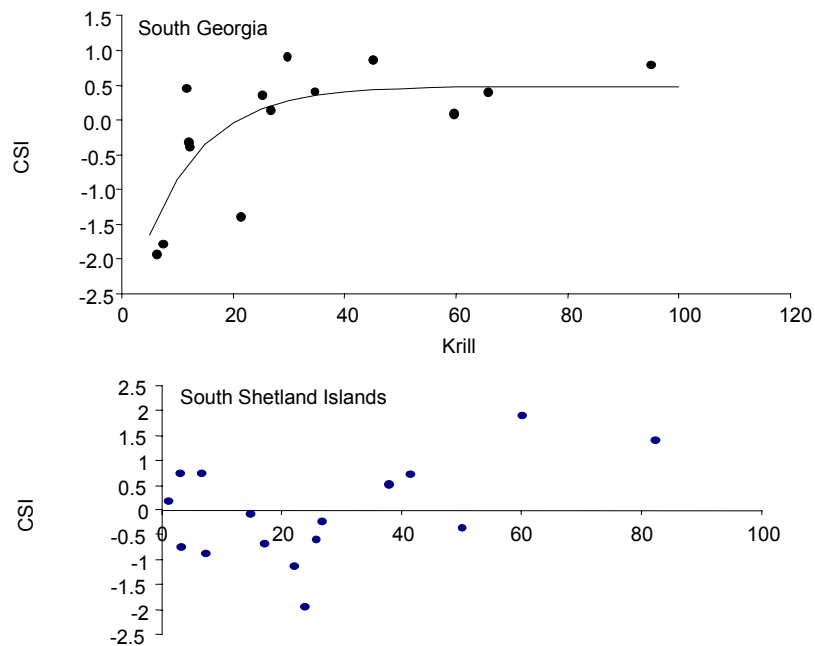


Figure 3: The relationship between krill density (g m^{-2}) and CSI of predator performance at South Georgia and South Shetland Islands.

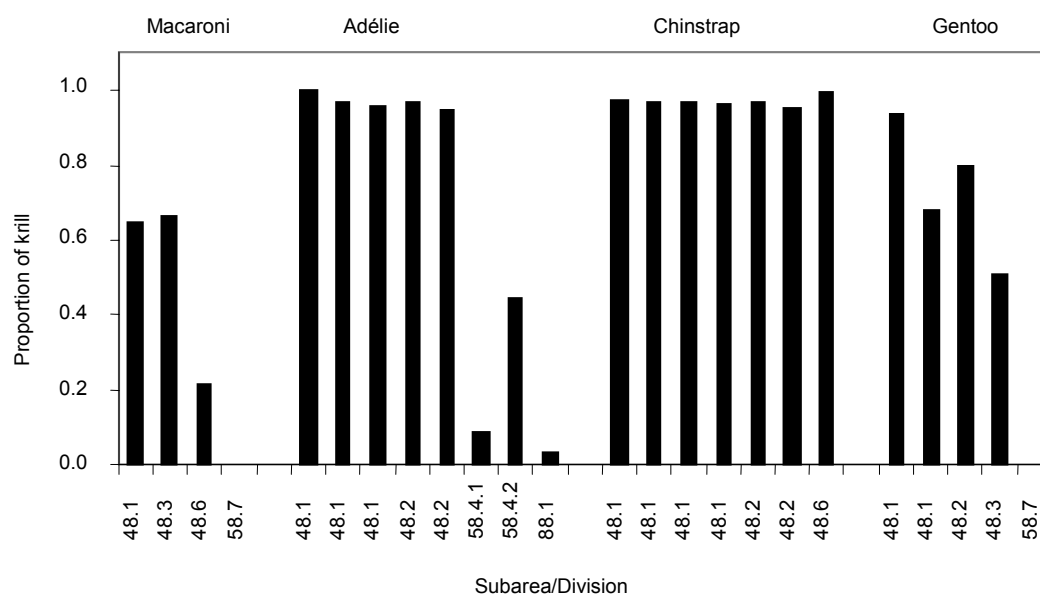


Figure 4: The mean proportion by mass of krill (*Euphausia superba*) in the diet of penguins. Data from the CEMP database.

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CEMP Review Workshop
(Cambridge, UK, 18 to 22 August 2003)

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AGENDA

CEMP Review Workshop
(Cambridge, UK, 18 to 22 August 2003)

1. Introduction
 - 1.1 Adoption of agenda and work plan
 - 1.2 Operational issues and appointment of rapporteurs
2. General review of planning and preparatory work
3. General review of data, supporting papers and other materials available
4. CEMP Review Workshop
 - 4.1 Defining those indices which, either singly or in combination, are the most informative biologically
 - 4.1.1 Update on intersessional work
 - (i) Data availability and validation
 - (a) CEMP data: spatial and temporal availability, by species and parameter (data matrices)
 - (b) Non-CEMP data: spatial and temporal availability, by species and parameter (data matrices)
 - (ii) Sensitivity analyses
 - (a) Spatial and temporal correlation issues and solutions
 - (b) Type I and type II error level considerations
 - (c) Effect size and form of change considerations
 - (d) Progress on analysis of western Antarctic data
 - (e) Progress on analysis of eastern Antarctic data
 - (iii) Issues related to predator parameters as indicators of krill availability
 - 4.1.2 Predator parameters as indicators of krill availability
 - (i) Prey parameters
 - (a) Availability of predator/krill data
 - (b) Proxies to krill data
 - (ii) Functional relationships
 - (a) Availability of predator/krill or proxy data
 - (b) Modelling relationships

- (iii) Composite indices
 - (iv) Indicator species
 - (v) Responsiveness
 - 4.1.3 Environmental parameters
 - 4.1.4 Sensitivity analyses
 - (i) Time required to detect a trend
 - (ii) Frequency of monitoring
 - (iii) Number of monitoring sites
 - (iv) Interactions and trade-offs between monitoring program parameters
 - 4.1.5 Appropriateness of parameters to monitoring at different scales and for different purposes
- 4.2 Implementation considerations
- 4.3 Management advice considerations
- 4.4 Further work on the workshop theme program
- 5. Responses to the Terms of Reference for the CEMP Review
 - 5.1 Are the nature and use of the existing CEMP data still appropriate for addressing the original objectives?
 - 5.2 Do these objectives remain appropriate and/or sufficient?
 - 5.3 Are additional data available which should be incorporated in CEMP or be used in conjunction with CEMP data?
 - 5.4 Can useful management advice be derived from CEMP or be used in conjunction with CEMP data?
- 6. Other matters
 - 6.1 Potential links between ISRs and SSMUs
- 7. Further work
- 8. Advice to WG-EMM.

USING PREDATOR RESPONSE CURVES TO DECIDE ON THE STATUS OF KRILL AVAILABILITY: UPDATING THE DEFINITION OF ANOMALIES IN PREDATOR CONDITION – PRELIMINARY ANALYSES

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A number of predator parameters monitored in CEMP have been shown, using non-linear regression, to be correlated to krill availability. These relationships will be termed ‘predator response’ curves in this note. The aim of this note is to consider the use of predator response curves in helping make decisions about the status of krill availability in a given year, based on the magnitude of the predator parameter or composite index for that year. In doing so, the note will consider the types of data available, the uncertainties associated with the analysis and consideration about how decisions on krill availability might be made.

BACKGROUND

2. Currently, the determination of extreme years for predators is through a two-tailed test of anomalies. This test determines whether the value of a predator parameter or a composite index is outside the generally observed norm, i.e. less than the lower 2.5 percentile or above the 97.5 percentile of the baseline series. This identifies very good or very poor years, whichever sign they may be assigned.

3. Over the last five years, data have been used for estimating predator response curves, using non-linear regression techniques. These data comprise:

- (i) individual predator parameters estimated for a year
- (ii) relative estimates of krill abundance for a given year.

4. The predator parameters may be combined into CSIs, first presented to WG-EMM in 1997 (de la Mare, 1997) and later elaborated in de la Mare and Constable (2000) and Boyd and Murray (2001).

5. Difficulties arise with these datasets when data may not be available for some years (de la Mare and Constable, 2000). This is critical if they are more likely to be the low krill years.

COMPARING PREDATOR RESPONSE CURVES TO FUNCTIONAL FEEDING RELATIONSHIPS

6. Functional relationships are often considered in the form of functional feeding relationships which relate the consumption rate of a predator to prey (krill) abundance. In this

case, the relationship will begin at the origin and increase in some form, usually to an asymptote. Two types of relationship are usually considered – Holling Type II and Holling Type III. These are illustrated in Figure 1.

7. The formulation of the relationship is

$$f(k_d, k_{0.5}, q) = \frac{k^{q+1}}{k_{0.5} + k^{q+1}} \quad (1)$$

where k_d is krill density, $k_{0.5}$ is the krill density when the function equals half the range and q is a shape parameter such that the function is a Holling Type II when $q = 0$ and Holling Type III when $q > 0$.

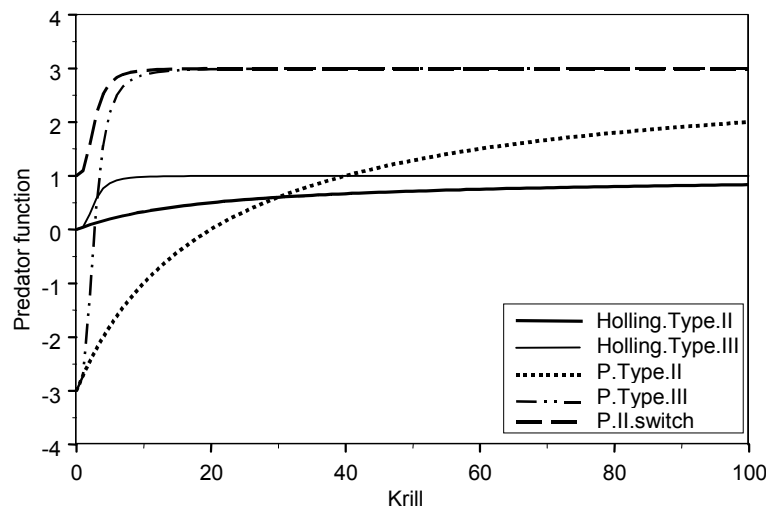


Figure 1: Predator functions in response to hypothetical levels of krill availability. The Holling Type II and Type III functions are functional feeding relationships. The P.Type II and Type III functions are predator response curves based on the respective functional feeding relationships but not restricted to the origin. The P.II.switch curve illustrates the potential effect of prey switching on the predator response, such that the predator remains relatively unaffected when krill are absent.

8. The predator response curves considered by WG-EMM differ from the feeding relationships in four main ways:

- (i) estimate a response (parameter/s) of predator performance relative to availability of the prey (krill) species;
- (ii) prey switching or other factors may result in relationship not beginning at the origin;
- (iii) the shape function may be influenced by many factors other than the prey;
- (iv) combined indices potentially range from $-\infty$ to $+\infty$.

9. The formulation of the predator response curve is based on the equation above, such that

$$P(P_{range}, k_d, k_{0.5}, q) = P_{range} \left[\frac{k^{q+1}}{k_{0.5} + k^{q+1}} \right] + P_0 \quad (2)$$

where P_{range} is the range of the predator response from P_0 , which is the value of the predator response when krill availability is zero, and the upper asymptote.

10. Examples of predator responses based on the Holling Type II and III formulations as well as the effect of prey switching are shown in Figure 1.

UTILITY OF PREDATOR RESPONSE CURVES

11. Predator response curves have been proposed to be used to facilitate decisions on when krill abundance is seriously affecting predators (Boyd, 2002). Alternatively, in the absence of estimates of krill availability, these curves might be used to help estimate from predator parameters what the status of the krill availability is for a given year. A question is whether such an approach might also be useful for areas where predator parameters may be monitored but little information is available on krill availability.

12. A number of uncertainties may influence the utility of this approach.

- (i) The correlation between the predator response variable and krill availability may be poor and may not appropriately match the spatial and temporal scales or locations of the krill time series.
- (ii) Predators may not be obligate krill feeders and therefore the relationship may be influenced by prey switching or other factors.
- (iii) The abundance of krill is highly variable, approximating a lognormal distribution, which means that the chances of sampling at the lower end of krill availability will be low and potentially problematic in short time series of data, such that the ability to estimate the curvature in the relationship may be poor.
- (iv) The probability of sampling at the lower end may also be reduced further by autocorrelation in the time series of krill abundance, which could also lead to autocorrelation in the predator response.
- (v) The estimates of krill availability have uncertainty as well with errors considered to be lognormally distributed.
- (vi) Uncertainties in the underlying model of predator response to krill availability, e.g. difference between Type II and Type III approaches.
- (vii) The error function for the predator response may not be correctly modelled with a Gaussian or lognormal.

13. The results of some of these uncertainties are illustrated in Figure 2 which shows a predator response curve that then is sampled according to error functions on both krill availability and the predator response. This set of samples is then used to illustrate the issues below.

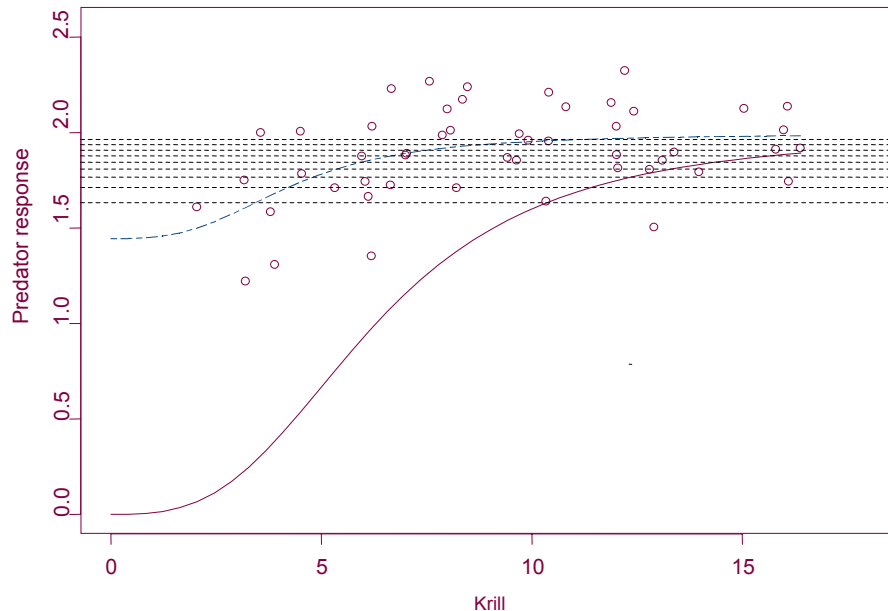


Figure 2: Predator response related to theoretical krill availability. Points are estimates of the predator response to estimates of krill abundance. The solid line shows the Type III relationship. The dashed line shows the fitted relationship using non-linear regression estimating P_{range} , P_0 and $K_{0.5}$. Horizontal dashed lines show the 0.05 percentile intervals starting at the lower 0.05 percentile and increasing to the 0.5 percentile. The shift of the points to the left of the true predator response curve is because of the lognormal error function in the krill estimates (based on the range of CVs observed at the Antarctic Peninsula).

14. The parameters in equation 2 (except for q in this simulation) were estimated using a non-linear regression (see Figure 2). The percentiles for the asymptote were estimated based on the residuals of the fit and the estimate of P_{range} plus P_0 .

DECIDING ON STATUS OF KRILL AVAILABILITY

15. In order to decide on the status of krill availability based on the estimate of predator response, the relationship needs to be viewed as krill availability as predicted by a function of predator response. Figure 2 has been replotted in Figure 3 to reflect this change of view.

16. Figure 3 illustrates how there is little or no information above the lower 0.05 percentile of the predator response for estimating the availability of krill. Therefore, the first step is to determine an appropriate percentile of predator response, above which the data would be excluded from an assessment of krill availability under the assumption that the krill availability is likely to be sufficient for predators. The area of interest would then be below that percentile.

17. Figure 3 also provides the current approach to estimating anomalies where the lower 0.025 percentile and upper 0.975 percentile are shown. It also shows a one-tailed test of anomalies such as the lower 0.1 percentile illustrated.

18. In this example, it would appear that the estimation of the predator response asymptote and its variance provides an opportunity to revise the view of anomaly such that an anomaly would be any value of the predator response falling below the critical percentile.

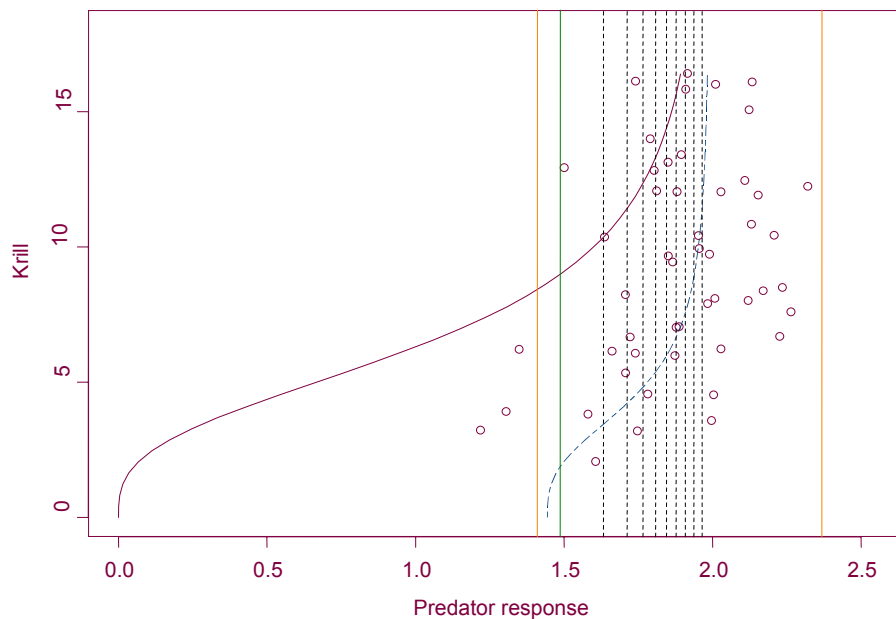


Figure 3: The inverted predator response curve to consider the estimation of krill availability from the predator response. Lines are as indicated in Figure 2. The vertical solid lines indicate from left to right – lower 0.025 anomaly, lower 0.1 anomaly and upper 0.975 anomaly as formulated for the predator response by WG-EMM in 1997.

CONCLUSIONS

19. This short note provides some possibilities for the future work of WG-EMM:

- (i) it is apparent that the current method for determining anomalies could be improved for some parameters based on appropriate predator response estimates;
- (ii) the ability to decide on krill availability will be contingent on the CV of the predator response in the upper part of the range of krill availability;
- (iii) it seems most likely that the asymptote of the predator response curve will be reasonably estimated while the lower tail may be difficult to estimate in short time series. This would favour an approach based on anomalies rather than estimation of krill availability;

- (iv) the lognormal errors in the krill estimates will cause some problems with this procedure and will need to be incorporated explicitly in the approach in the future.
20. Given the uncertainties surrounding these responses and the importance of identifying a critical level below which the predator response is likely to be reduced, it would seem reasonable to conclude that the lower percentile anomaly test should be a one-tailed test and probably at a higher percentile than the current 0.025.
21. The use of predator response curves provides an opportunity to base the anomaly criterion on biological rather than statistical parameters. It is a way of screening out the lower tail of predator responses in defining a more biologically oriented criterion.
22. Further simulation work is needed to determine the robustness of the method to the uncertainties in the approach described above. In that respect, simulations to identify the length of time series required to undertake this assessment would be very helpful.

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**PROPOSED REVISION OF *CEMP STANDARD METHODS*,
PART IV, SECTION 5**

PROPOSED REVISION OF *CEMP STANDARD METHODS*, PART IV, SECTION 5

OBSERVATION PROTOCOLS AND TECHNIQUES: PROTOCOLS FOR COLLECTING SAMPLES FOR TOXICOLOGICAL ANALYSES

The following procedure describes the methods for collecting and storing samples of animal tissues in the event that pollutants or toxic substances are suspected in species being monitored as part of CEMP.

Samples should be collected and analysed for organochlorine compounds such as polychlorinated biphenyls (PCBs), dichloro-diphenyl-trichloroethane (DDTs), lindane, polycyclic aromatic hydrocarbons (PAHs) and heavy metals (cadmium, mercury, lead, zinc and copper). It should also be appreciated that chemical content in seabirds may be related to diet and lifestyle and is naturally occurring.

It is recommended that all field teams conducting CEMP programs maintain stocks of sampling equipment at their monitoring site to allow adequate collection, storage and transport of samples for the following laboratory analyses.

The analyses of samples for contaminants involve sophisticated and expensive techniques and therefore require support from appropriate specialised centres.

SAMPLING GUIDELINES

Chlorinated Hydrocarbons

The body burden of chlorinated hydrocarbons can be evaluated from muscle and/or fatty tissue, skin biopsies, unhatched eggs, blood, preen gland oil and stomach contents. Collect a minimum of 2 g of tissue or skin and a few microlitres of preen gland oil. If the animal is dead, collect in addition liver, muscle and brain. Post-mortem sampling should be carried out on recently-dead individuals, with records of biometric parameters and times of death and sampling attached.

Heavy Metals

Ante-mortem collection of feathers, faeces and skin biopsies is suitable. Post-mortem sampling of recently-dead animals can also include liver and kidney.

Biochemicals

The modification of specific biochemical responses (i.e. enzymes and metabolites) may indicate the presence of pollutants in seabirds. These analyses can be correlated with those carried out on samples collected as described above. The following table summarises the biological samples suitable for specific biochemical tests.

Test	Sample
Porphyrin (COPRO-URO-PROTO)	Faeces, feathers, liver, blood (whole)
Mixed-function oxidases: Ethoxyresorufin-O-deethylase (EROD) Penthoxyresorufin-O-deethylase (PROD) Benzyloxyresorufin-O-deethylase (BROD)	Liver, skin biopsies
Benzopyrene-monoxygenase (BPMO) CYT-P450-reductase	
Esterases: Acetylcholinesterase (AChE) Butyrylcholinesterase (BChE)	Brain, blood (whole for mammals, and serum or plasma for birds and fish)

COLLECTION AND STORAGE OF SAMPLES

All samples should be collected into glass containers or tubes which can be sealed so they do not dehydrate in storage.

Samples for heavy metals and chlorinated hydrocarbon analyses should be stored as soon as possible at -20°C . Care should be taken to prevent contamination of samples – in the case of heavy metals, by metallic compounds in the sampling tubes (e.g. metal tops) and in the case of hydrocarbons, by plastics (e.g. plastic wrapping material).

Samples for biochemical analyses should be stored promptly in liquid nitrogen; it is very important for further successful laboratory analyses to freeze the samples immediately.

All samples should be labelled to provide details of sample, the identity of the individual animal and date of collection. It is important to ensure that tissue from the same animal may be matched in the laboratory. A detailed logbook should be maintained and forwarded with the samples.

**REPORT OF THE WORKING GROUP ON
FISH STOCK ASSESSMENT**
(Hobart, Australia, 13 to 23 October 2003)

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**REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT**
(Hobart, Australia, 13 to 23 October 2003)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 13 to 23 October 2003. Participants were welcomed by the Convener, Dr I. Everson (UK), and the Secretariat's Executive Secretary, Dr D. Miller.

1.2 Dr Everson advised the Working Group that Dr K. Shust (Russia) had been unable to attend the meeting due to poor health and WG-FSA wished him a speedy recovery.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 Dr Everson outlined the work program for the meeting. The following schedule and structure for the meeting had been agreed by the Scientific Committee in 2002 (SC-CAMLR-XXI, paragraph 13.9):

- (i) a reorganisation of the meeting format, so that information essential to the assessments is considered during days 1 and 2 of the meeting in order to allow assessments to be run and completed during the first week;
- (ii) a reorganisation of the meeting report, so that background information and advice on future work of WG-FSA is removed from the report and would not be translated. These would be disseminated as background papers to the Scientific Committee, reducing the size of the report of the Working Group and improving readability, access to information and advice necessary to the Scientific Committee;
- (iii) the development of species profiles for *Champsocephalus gunnari* and *Dissostichus eleginoides* – these reference documents contain species parameters for review by WG-FSA each year and updating as new information becomes available;
- (iv) development of an assessment manual to be reviewed and updated each year.

The Working Group agreed to work at the 2003 meeting according to this plan.

2.2 A number of subgroups was nominated last year to further the work of WG-FSA during the intersessional period (SC-CAMLR-XXI, Annex 5, paragraph 12.6), and reports had been submitted from the:

- Subgroup on Fisheries Acoustics (WG-FSA-SFA) (WG-FSA-03/14)
- Subgroup on Assessment Methods (WG-FSA-SAM) (WG-FSA-03/40)
- Subgroup on By-catch (WG-FSA-03/67).

2.3 Two of these subgroups (WG-FSA-SFA and WG-FSA-SAM) had met in the UK in August 2003, in association with the 2003 meeting of WG-EMM.

2.4 The agenda of the meeting was discussed and adopted with the following additional items:

- 4.3 ‘SSRU boundaries’
- 7.3 ‘Tagging programs’
- 12.4 ‘Long-term plans’.

Consequently, the existing subitems ‘Status of current assessment methods’ and ‘Identify gaps in the knowledge’ were renumbered as 4.4 and 7.4 respectively.

2.5 The Agenda is included in this report as Appendix A, the List of Participants as Appendix B and the List of Documents presented to the meeting as Appendix C.

2.6 The report was prepared by Dr D. Agnew (UK), Mr E. Appleyard (Secretariat), Mr B. Baker (Australia), Dr A. Constable (Australia), Prof. J. Croxall (UK), Dr M. Double (Australia), Dr E. Fanta (Brazil), Dr R. Gales (Australia), Dr S. Hanchet (New Zealand), Dr R. Holt (USA), Dr C. Jones (USA), Dr G. Kirkwood (UK), Dr K.-H. Kock (Germany), Dr E. Melvin (USA), Ms J. Molloy (New Zealand), Dr R. O’Driscoll (New Zealand), Dr G. Parkes (UK), Dr D. Ramm (Secretariat), Dr K. Reid (UK), Ms K. Rivera (USA), Dr G. Robertson (Australia), Dr E. Sabourenkov (Secretariat), Mr N. Smith (New Zealand), Dr B. Sullivan (UK), Ms E. van Wijk (Australia) and Dr S. Waugh (New Zealand).

REVIEW OF AVAILABLE INFORMATION

Data Requirements Specified in 2002

Development of the CCAMLR Database

3.1 Last year, WG-FSA reviewed the Secretariat’s development of a new database for survey data, and outlined further work for the 2002/03 intersessional period (SC-CAMLR-XXI, Annex 5, paragraphs 3.1 to 3.8; WG-FSA-02/10). The Secretariat’s tasks included distributing documents and specifications to Members to allow them to create software that exports data from their databases in the agreed CCAMLR format and developing a feedback mechanism for correcting errors in the database. WG-FSA also urged Members to consider the data requirements of the new CCAMLR survey database, ensure that all essential data are recorded and submitted to the Secretariat and provide updates and corrections to CCAMLR.

3.2 In 2002/03, the Secretariat completed the transfer of available survey data to the new database. Survey datasets residing in the new database are listed in WG-FSA-03/7, Appendix A. The amount and types of data contained in each dataset vary between surveys, and length frequencies and swept-area data were not provided in many of the data submitted prior to 1990.

3.3 In August 2003, the Secretariat advised all Members that the documentation and specifications for the new CCAMLR survey database and data exchange protocol was available, and that this information had been placed on the CCAMLR ftp site for viewing

and/or downloading. A copy of this documentation was also made available on the FSA server at the 2003 meeting. The Secretariat also reminded Members that WG-FSA had agreed that the data exchange protocol would be developed in liaison with nominated IT staff from each of the Member countries. Members were reminded of the need to consider the data requirements in the new CCAMLR survey database, and to ensure that all essential data are recorded and submitted to the Secretariat.

3.4 The Secretariat also developed a feedback mechanism for data owners to correct errors in the CCAMLR database. In August 2003, Members who had submitted survey data to CCAMLR were advised that a copy of their data had been placed in separate password-protected sections on the CCAMLR ftp site. Each section also contained a database application file to view the data in the CCAMLR format, and to generate data summaries for use in checking CCAMLR data against the owner's latest validated dataset. Data owners were asked to check the CCAMLR data on the ftp site against their latest, validated records, and to provide corrections to the Secretariat.

3.5 As part of the transition to the new database format, the Secretariat has also revised the database queries and FORTRAN program used to generate the weighted length-density data which are used in CMIX analyses. The revised routine provides greater flexibility in the selection of data (e.g. combining data from several surveys) and the definition of strata. The revision also provided an opportunity to validate the method used by the Secretariat.

Data Processing

3.6 Longlining for toothfish in Subarea 48.3 in 2002/03 was conducted over the entire season, ending on 31 August 2003. As a result, a large amount of data had only been submitted to the Secretariat in the weeks immediately prior to the meeting of WG-FSA. Nevertheless, these data had been processed and were available to the meeting. Most of the data processing was done by Mrs L. Millar (Data Entry Specialist) and the Working Group thanked her for entering the data in time for the meeting.

3.7 The Working Group noted that a number of datasets had been submitted after the deadlines agreed by the Commission (CCAMLR-XXII/BG/8). However, with the exception of fine-scale data from one vessel which fished in Subarea 88.1, all catch and effort reports and fine-scale data for the 2002/03 season had been submitted by the first day of the meeting. The remaining dataset was received during the meeting.

3.8 Mr Appleyard (Scientific Observer Data Analyst) reported on the status of observer logbook data and cruise reports submitted to the Secretariat. A total of 37 longline and 10 trawl cruises were conducted for finfish in the CCAMLR Convention Area during the 2002/03 season. With the exception of one cruise report from Subarea 48.3, all logbook data and reports had been submitted and processed by the Secretariat by the time of the meeting. The overdue report was received during the meeting.

3.9 International scientific observers also conducted six observation trips on board krill vessels fishing in Subarea 48.3. These data are expected to be submitted within one month of the observers returning to their home ports.

3.10 All logbooks and cruise reports for the 2002/03 season were submitted in electronic format. However, despite the 2002/03 season being the second season that the updated cruise report format had been available for use, most scientific observers in Subarea 48.3 had still submitted cruise reports using old formats. The Working Group noted that the current cruise report format has been available on the CCAMLR website for the past two seasons, and had been distributed to Members along with the updates to the *Scientific Observers Manual*.

Fisheries Information

Catch, Effort, Length and Age Data Reported to CCAMLR

3.11 Eight fisheries were conducted under the conservation measures in force in the 2002/03 season:

- trawl fishery for *Champscephalus gunnari* in Subarea 48.3;
- trawl fishery for *C. gunnari* in Division 58.5.2;
- longline and pot fishery for *Dissostichus eleginoides* in Subarea 48.3;
- trawl and longline fishery for *D. eleginoides* in Division 58.5.2;
- exploratory longline fishery for *Dissostichus* spp. in Division 58.4.2;
- exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1;
- exploratory longline fishery for *Dissostichus* spp. in Subarea 88.2;
- trawl fishery for *Euphausia superba* in Area 48.

3.12 In addition, four other fisheries were conducted in EEZs within the Convention Area in the 2002/03 season:

- longline fishery for *D. eleginoides* in Division 58.5.1 (French EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.6 (French EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.6 (South African EEZ);
- longline fishery for *D. eleginoides* in Subarea 58.7 (South African EEZ).

3.13 Catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in the 2002/03 fishing season are summarised in Table 3.1.

3.14 Catch, effort and length data were submitted for all fisheries managed under conservation measures, as well as most of the fisheries operating in EEZs.

3.15 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 for the 2001/02 and 2002/03 seasons, are summarised in Table 3.2.

Estimates of Catch and Effort from IUU Fishing

3.16 WG-FSA reviewed the information on IUU fishing which had been submitted to the Secretariat by 1 October 2003 (SCIC-03/5 Rev. 1). The deterministic method presently used by the Secretariat to estimate IUU fishing effort was the same method as the Working Group has used in previous years. This method used information on the number of vessels sighted

which is submitted by Members, and information on fishing trips and catch rates derived from CCAMLR data on licensed vessels. These estimates of IUU catch and effort in 2002/03 were then pro-rated to the end of the season (30 November 2003) (Table 3.3). WG-FSA also noted that new information submitted to the Secretariat had led to a revised estimate of IUU catch in Division 58.5.2 in the 2001/02 season from 2 500 tonnes to 3 489 tonnes of *Dissostichus* spp. (see SCIC-03/5 Rev. 1, Table 3).

3.17 Table 3.3 includes the estimated catch from IUU fishing in CCAMLR waters which was reported in SCIC-03/5 Rev. 1. The Working Group noted that the high level of IUU fishing and IUU catches had led to estimates of total removals of *Dissostichus* spp. in some areas inside the Convention Area (e.g. Division 58.5.2) which were in excess of the catch limit.

3.18 WG-FSA agreed that the method for estimating IUU catch and effort could be improved by taking explicit account of both 'seen' and 'unseen' IUU fishing using a simulation model to arrive at statistically rigorous estimates and confidence intervals of catches by IUU vessels. Such an approach was presented to WG-FSA last year (WG-FSA-02/4). Members are encouraged to review whether this method might be applied in other parts of the CCAMLR Convention Area.

3.19 WG-FSA noted that the new Joint Assessment Group (JAG) was to have met during the intersessional period to further develop methodology for estimating IUU fishing effort and catch (CCAMLR-XXI, paragraphs 8.10 to 8.14). Unfortunately, the first meeting of JAG had been scheduled immediately following WG-FSA-03 and, therefore, the advice and findings of JAG could not be considered by WG-FSA in 2003. The Working Group reiterated the importance of providing confirmed information on IUU fishing prior to its meetings (see also CCAMLR-XXI, paragraph 8.13).

Catch and Effort Data for Toothfish Fisheries in Waters adjacent to the Convention Area

3.20 WG-FSA noted that the catch of *Dissostichus* spp. outside the Convention Area in 2001/02, and reported in the CDS, was taken mostly in Area 41 (14 032 tonnes) and Area 51 (10 620 tonnes). However, in 2002/03 (to October 2003), most of the catch was reported from Area 41 (7 108 tonnes) and Area 87 (4 419 tonnes), and the catch reported from Areas 51 and 57 had contributed 24% of the total catch reported outside the Convention Area (down from 41% in 2001/02).

Scientific Observer Information

3.21 All information collected by scientific observers was summarised in WG-FSA-03/63 Rev. 1, 03/64 Rev. 1 and 03/65 Rev. 1. Reports and longline data were submitted by international and national observers from a total of 47 cruises in the Convention Area and one longline cruise in FAO Area 51. Species targeted were *Dissostichus* spp. and *C. gunnari*, on 37 cruises on longliners (28 vessels) and 10 on trawlers (5 vessels). Longline cruises were represented in Subareas 48.3, 58.6, 58.7, 88.1, 88.2 and Divisions 58.4.2 and 58.5.2, and trawlers in Subarea 48.3 and Division 58.5.2. Observers were deployed by eight Members:

Australia (8), Chile (1), France (1), New Zealand (2), South Africa (11), Spain (2), Ukraine (3) and the UK (19). Details are provided in WG-FSA-03/63 Rev. 1, Table 1 and 03/64 Rev. 1, Table 1.

3.22 In February 2003, updated versions of the observer logbook forms and cruise report format were placed on the CCAMLR website and distributed to all Members and technical coordinators (COMM CIRC 03/08). The Working Group noted that the updated logbook forms and cruise reports contained the additional data requirements identified by WG-FSA in 2002.

3.23 All logbooks had been submitted electronically in the updated CCAMLR format, however, some elements of the logbooks were not completed comprehensively.

3.24 The Working Group reiterated the advice of the Scientific Committee (SC-CAMLR-XXI, paragraph 2.3) that all technical coordinators ensure that only the current versions of cruise reports and logbook forms be used.

3.25 Biological data were collected by observers in accordance with research priorities identified by the Scientific Committee in previous years (weight-at-length, length frequency, maturity, otolith/scales, conversion factor, by-catch and incidental mortality).

3.26 The Working Group noted that for longliners, the main processing method for *D. eleginoides* was headed, gutted and tailed (HGT) with some observers also recording CF data for headed and gutted (HAG) product (WG-FSA-03/63 Rev. 1, Table 6). Observers reported a spread of conversion factors in the same fishing area and using the same processing method. For trawlers, the only processing method for *D. eleginoides* was HGT and for *C. gunnari* the only processing method was whole (WHO) (WG-FSA-03/64 Rev. 1, Table 3). The limited observer data show a small spread of conversion factors in the same fishing area and using the same processing method.

3.27 The Working Group encouraged Members to undertake additional analyses of conversion factor data to improve estimates of total removals from the population.

Research Surveys

Results

3.28 The USA conducted a bottom trawl survey of finfish in the South Shetland Islands (Subarea 48.1) during March 2003 (WG-FSA-03/38). Information on species and size composition, abundance, spatial distribution and dietary patterns were presented. The spatial distributions and standardised densities for demersal finfish species have remained relatively consistent compared with similar surveys conducted in March 1998 and 2001 in the same area. Estimates of total stock biomass for eight species of finfish calculated during each of the three surveys has fluctuated with no signal of substantial year classes or significant recruitment for any species. Standing stocks of *Gobionotothen gibberifrons* remain the largest relative to all other species, however there appears to be a decline in biomass. The authors concluded that the overall abundance of finfish in the South Shetland Islands has yet to reach a level at which commercial exploitation would be advisable.

3.29 Germany completed five bottom hauls north of Joinville–D’Urville Islands (Subarea 48.1) in February 2002 (WG-FSA-03/26). This area was a fishing ground in the 1970s and 1980s. The authors reviewed published and unpublished reports by several countries of historical fishing activities to provide a comprehensive review of fishing activities in that area. Fisheries and biological information were summarised for several species. Additional data would be welcomed by the authors to further investigate the fishery in this area.

3.30 Australia conducted a random stratified trawl survey of the Heard Island Plateau (Division 58.5.2) between 16 April and 10 May 2003. A preliminary assessment of yield of *C. gunnari* was undertaken using the standard CCAMLR methods. The 2003 estimate of abundance was approximately 20% of the 2002 estimate, a decline consistent with the passage of the strong 1997 cohort through the population and relatively weak recruitment in 1999 and 2000. The entry of an apparently stronger 1+-year-old cohort in the population in 2003 agrees with results based on a 2002 survey of the spawning grounds of *C. gunnari*.

3.31 Russia and Ukraine used data from a Soviet–Australian expedition in the Heard Island area conducted from May to August 1987 (WG-FSA-03/54) to investigate the assumption that *C. gunnari* occur only on the bottom during daylight hours and, therefore, there is no need to assess the pelagic component in making stock assessments. Results reported for the 1987 survey indicated icefish occurred in both bottom trawl and pelagic trawl catches. Young-of-the-year and juvenile fish were found mostly in the pelagic layer and adult fish were found mostly in the bottom trawl catches. The authors then cited results from other studies conducted on icefish at South Georgia which report the occurrence of *C. gunnari* in the pelagic zone during daytime. The authors concluded that icefish do occur in the pelagic zone during daylight and that assessments must take this component into consideration.

3.32 Russia compared icefish distribution and biomass assessments from data collected in surveys in the northwest shelf area of South Georgia in 2000 and 2002 (WG-FSA-03/55). In 2000, large icefish concentrations occurred in the northwest shelf area including aggregations in the water column, whereas in 2002 the presence of krill distributions near the bottom resulted in icefish remaining near the bottom even at night. The authors also found during the surveys, that fry and immature fish occurred in large numbers in the pelagic zone. Therefore, they concluded that the part of the stock permanently existing during the day in the pelagic zone is not taken into account by bottom net surveys and hence is not included in catch limit calculations. They believed that the use of nets and acoustic methods will enable a more appropriate assessment to be conducted.

3.33 New Zealand conducted a pilot study to determine the feasibility of using acoustic surveys for toothfish and rattail in the Ross Sea (WG-FSA-03/28). Data were collected continuously between 28 December 2002 and 21 February 2003 and then during line setting between 5 and 22 February 2003. Acoustic data were collected when setting longlines so acoustic recordings could be compared with longline catches. Because of problems associated with fishing in water over 1 000 m deep, especially if the bottom is rough or sloped, and in target differentiation between toothfish and rattails, the authors concluded, at this point, that it is not practical to estimate toothfish or rattail abundance in the Ross Sea using hull-mounted acoustic systems. The acoustic dead zone was large, meaning it was impossible to detect demersal species close to the bottom. Echo integration was unreliable because there was a very low signal-to-noise ratio deeper than 1 000 m. Echo counting

showed more promise, but only relatively strong targets well separated from the bottom could be enumerated. As toothfish do not have a swimbladder, their acoustic target strength may be too weak to allow them to be counted.

3.34 As part of its random stratified trawl survey for the Heard Island Plateau (Division 58.5.2) between 16 April and 10 May 2003, Australia assessed the abundance of juvenile *D. eleginoides*. It was noted that the area covered during the 2003 survey was substantially reduced from the area covered in previous surveys. The authors indicated that because of competing field operations, logistical constraints required a reduction in effort. Areas of historically low fish abundance were not covered, under the assumption that this represented a small proportion of the biomass. It was noted that biomass estimates were lower during 2003 than for previous years' efforts. The potential interaction of the reduction in survey effort and biomass estimates will be addressed when the Working Group calculates stock assessments using this data.

3.35 WG-FSA-03/12 utilised catch data from 13 surveys conducted by the UK, Germany and the USA, either individually or in close collaboration, at either South Georgia or Elephant Island between 1975 and 2003. *Notothenia rossii* were found at low abundance over most of the shelf on South Georgia, however much larger concentrations of fish were taken in a horseshoe-shaped underwater canyon (southeast of South Georgia). The concentration was fairly stable over time. Similar patterns of distribution and abundance were found at Elephant Island with *N. rossii* being spread over the shelf, again in low numbers, and large concentrations found in two limited areas on the shelf. The authors suggested that to provide more accurate estimates of the abundance and distribution of the species, the feasibility of using an acoustic survey combined with a number of identification hauls, should be investigated.

Acoustic Survey Workshop

3.36 Results of acoustic surveys for icefish were presented at last year's WG-FSA meeting (SC-CAMLR-XXI, Annex 5, paragraphs 5.96 to 5.101), however time constraints and the absence of experts in fisheries acoustics from many nations meant it was not possible to resolve some issues presented at the meeting. These issues were addressed by WG-FSA-SFA which met at the British Antarctic Survey, Cambridge, UK, from 18 to 22 August 2003 (WG-FSA-03/14). The terms of reference were to evaluate the application of acoustic methods in estimating biomass of exploited fish in the CCAMLR Convention Area and in particular to re-examine the acoustic data from the Russian and UK surveys. They were asked to resolve, if possible, issues identified at the WG-FSA meeting and to provide a robust estimate of biomass, confidence intervals and age composition. The WG-FSA-SFA meeting was convened by Drs M. Collins (UK) and P. Gasiukov (Russia).

3.37 Several potential sources of uncertainty in the acoustic estimates of *C. gunnari* biomass were identified. WG-FSA-SFA agreed that the four main sources of uncertainty were target strength, species and size composition, observation volume (e.g. dead zone, threshold values, ship's noise etc.) and areal availability (i.e. defining the boundaries of the area surveyed) (WG-FSA-03/14, paragraphs 4.1 to 4.3). Sources of uncertainty in *C. gunnari* acoustic biomass estimates, methods to combine acoustic and trawl estimates, and statistical treatment of acoustic data were discussed and presented in sections 4, 5 and 6 respectively of the report (WG-FSA-03/14).

3.38 Of these four sources of uncertainty, three (target strength, size and species composition and area backscattering coefficient) were selected as being the most important, and variability in estimates of the pelagic biomass of icefish resulting from these parameters was simulated (WG-FSA-03/14, paragraphs 6.23 to 6.28 and Tables 1 and 2). It was found that the main uncertainty in the biomass estimates is formed by uncertainty in density distribution and target strength. The influence of uncertainty in length composition in icefish in catches is less. Using the bootstrap method to calculate uncertainty in target strength results in a large range of biomass estimates.

3.39 With regard to species composition, WG-FSA-SFA noted that for the Russian survey virtually 100% of fish in the trawl catches in the southern region were *C. gunnari* and in the western region, 87% were *C. gunnari* with the remainder being *Pseudochaenichthys georgianus* and myctophids. It was noted that the co-occurrence of myctophids is difficult to assess with trawls that probably have low catchability for these fish. Since myctophids have much higher target strength than icefish of equal size, an underestimate of their co-occurrence from the net sampling would result in a significant overestimation of the icefish abundance. However, Dr Gasiukov noted that trawl samples were obtained using a midwater trawl RT/TM 70/300, equipped with small-meshed insert (mesh size 10 mm). In addition, it is likely that myctophids inhabit the upper water column and would not be found in the range surveyed by acoustic methods (8–58 m from the bottom). In view of this, he believed that it is unlikely that myctophids would be undersampled (WG-FSA-03/14, paragraph 6.21).

3.40 WG-FSA-SFA agreed that considerable progress had been made in addressing the uncertainty associated with acoustic estimates of *C. gunnari* in the pelagic zone. However, the subgroup was unable to reach a consensus as to whether the biomass estimates were sufficiently robust to be incorporated in the 2003 *C. gunnari* assessment for Subarea 48.3 (WG-FSA-03/14, paragraph 6.30).

3.41 WG-FSA-SFA provided the following advice to the Working Group regarding the use of acoustic methods (WG-FSA-03/14, paragraphs 9.1 to 9.8). It recommended that:

- (i) multiple-frequency acoustic methods be used to estimate the biomass of *C. gunnari* in the pelagic zone of Subarea 48.3 and other parts of the CCAMLR Convention Area, incorporating the following:
 - (a) pelagic trawl sampling of acoustic marks;
 - (b) in situ determination of target strength;
 - (c) compilation of a trawl-validated echogram library (for target and non-target species);
 - (d) if possible, synchronise bottom trawl and acoustic surveys (simultaneous surveys with two vessels or interchangeable bottom and pelagic trawls);
 - (e) calculate biomass and associated variance using acoustic data from each frequency;
- (ii) at the present time, acoustic data are not used to adjust the biomass estimates from bottom trawl catches in the bottom 8 m;

- (iii) a variety of methods (e.g. echoic chamber, physics-based and empirical models, in situ measurements of individuals and aggregations, and caged aggregations), be undertaken to reduce the uncertainty in estimates of target strength of *C. gunnari*, and to improve scattering models;
- (iv) experimental work be undertaken to determine frequency-dependent target strength of other abundant species in the CCAMLR Convention Area;
- (v) the efficiency of the dB-difference method of taxa delineation be evaluated in relation to the range-dependent signal-to-noise ratio;
- (vi) trawl selectivity and catchability be investigated as they impact on target strength determination, species delineation and observation volume;
- (vii) the stratification of Subarea 48.3 be reviewed for trawl and acoustic surveys to reduce the variance associated with biomass estimates and length-age structure;
- (viii) it meets well in advance of WG-FSA in 2004 to revise parameters and review new data from 2003/04 surveys.

3.42 WG-FSA greatly appreciated the efforts of the subgroup participants and especially thanked the Co-conveners, Drs Collins and Gasiukov. The Working Group endorsed the advice provide by WG-FSA-SFA above with respect to its application to Subarea 48.3. The Working Group noted in light of the results of WAMI, that these methods could be applied elsewhere once they have been refined. The Working Group also recommended that further work be undertaken on how to include acoustic estimates in yield assessments.

3.43 The Working Group noted that WG-FSA-SFA had agreed that icefish do inhabit pelagic zones in Subarea 48.3 which are not sampled by bottom trawls and that they recommended the use of acoustic methods to determine appropriate estimates of icefish biomass for Subarea 48.3 in the region 8–58 m above the bottom.

3.44 The Working Group noted the target strength calculations using the bootstrap method and the method by MacLennan and Menz (1996). Estimates of the lower one-tailed 95% confidence bound of the biomass, based on these two methods of estimating target strength were similar (WG-FSA-03/14, Tables 1 and 2), but the bootstrap method provided a slightly lower value. The Working Group agreed that using the lower estimate of biomass would be more conservative, and agreed to incorporate this value in this year's assessment of *C. gunnari* in Subarea 48.3.

3.45 The Working Group noted that the presence of myctophids in the survey region could result in an overestimation of icefish biomass but were reassured by discussions reflected in paragraph 3.39 regarding the catchability of myctophids in the nets used during the survey.

Future Surveys

3.46 The USA intends to conduct National Science Foundation funded research bottom trawling on board the RV *Nathaniel B. Palmer* from 16 May to 16 July 2004. The targeted areas include Shag Rocks and South Georgia (Subarea 48.3), the South Sandwich Islands

(Subarea 48.4) and Bouvet Island (Subarea 48.6). Trawling will also be conducted outside the CCAMLR Convention Area around the Falkland/Malvinas Islands, Burdwood Bank and Tristan da Cunha.

3.47 In January 2004, the UK will undertake a bottom trawl and acoustic survey at South Georgia and Shag Rocks (Subarea 48.3) on the FPRV *Dorada*. The cruise will determine the standing stock of *C. gunnari* and pre-recruit toothfish.

3.48 In March 2004, the UK will conduct a research cruise on the RRS *James Clark Ross* north of South Georgia and Shag Rocks (Subarea 48.3). The cruise will use acoustic and pelagic trawls to investigate the vertical distribution of myctophid fish and how their distribution effects their availability to predators.

3.49 New Zealand is proposing to carry out work in Subarea 88.1 from 25 January to 14 March 2004 using RV *Tangaroa* (WG-FSA-03/45). The voyage will include a hydrographic survey funded by Land Information New Zealand and a biodiversity survey funded by the Ministry of Fisheries as part of the BioRoss program. The biodiversity survey will sample deepwater invertebrates and fish communities in the northwestern Ross Sea (between Coulman Island and Cape Adare) and on seamounts around the Balleny Islands. Sampling will take place at depths from 50 to 800 m, using bottom trawls, benthic grabs and epibenthic sleds.

3.50 Australia will be conducting two surveys in the 2003/04 season. Both will be conducted from one of the two Australian-flagged trawlers working in the Heard Island and McDonald Islands (HIMI) area, most likely *Southern Champion*, and will follow a similar survey design as adopted in 2002.

3.51 The first survey will take place from December 2003 to January 2004 and will be conducted in conjunction with a marine biology and oceanographic research cruise in the HIMI area by *Aurora Australis*. As previously, a random stratified trawl survey will be conducted to assess the biomass and age structure of *C. gunnari* throughout its known distribution range within the region. The same survey with some additional strata will also be used to assess the abundance of *D. eleginoides* recruits, although because of time constraints some of the deeper water strata where the density of *D. eleginoides* is known to be low, will not be surveyed.

3.52 The second survey will take place during May–June 2004, during the same season that surveys in previous years have been undertaken. This survey will also assess abundance of icefish and toothfish recruits, and will include all strata.

PREPARATION FOR ASSESSMENTS

4.1 The Working Group noted the report of the first intersessional meeting of WG-FSA-SAM held from 12 to 15 August 2003 at Imperial College, London. The Working Group thanked Dr Kirkwood and the Marine Resources Assessment Group and the subgroup coordinator, Dr Constable, for such a successful meeting. The Working Group recalled its discussion last year on the work of this group including the primary questions to be considered (SC-CAMLR-XXI, Annex 5, paragraphs 9.1 to 9.11).

4.2 In reviewing the report, the Working Group noted the following outcomes of the subgroup meeting (WG-FSA-03/40 – paragraph references below in (i) to (xxxi) are from that report):

- (i) the need to provide full documentation and archives of assessments prepared each year based on the advice in paragraphs 2.1 to 2.6;
- (ii) the operational difficulty of the Secretariat in forecasting closures of small areas arises from a combination of the size of the catch limit, the number of vessels and catch rate per day in the area, and the length of the reporting period (paragraphs 2.7 and 2.8);
- (iii) the need to continue reviewing and evaluating methods for determining age composition from length-density data from surveys, including the use of CMIX or age-length keys as well as reviewing uncertainties in age determination, but in the interim to better use the diagnostic features of CMIX during mixture analyses at WG-FSA, including reviewing the diagnostic outputs from analyses used in current assessments (paragraphs 2.9 to 2.12);
- (iv) the development of detailed specifications of the GYM and adoption of updated GYM software and manual, which now includes the ability to undertake the short-term assessment of *C. gunnari*, and noting the need for WG-FSA to validate the use of the GYM in the mackerel icefish assessment rather than using the MathCad routine (paragraphs 2.13 and 2.14);
- (v) the development of a Java version of the GYM, translated from the specifications and code of the GYM with the exception of some routines from Numerical Recipes (paragraphs 2.15 and 2.16);
- (vi) the need to undertake 10 001 trials in the final assessments using the GYM (paragraph 2.17);
- (vii) development of methods to standardise CPUE time series, including the incorporation of random effects into Generalised Linear Mixed Models (GLMMs), and the recommendation to continue developing and evaluating approaches to standardise time series of CPUE (paragraphs 2.18 to 2.21 and 2.25);
- (viii) the need for WG-FSA to determine how it wishes to proceed with the standardisation of the CPUE series in Subarea 48.3 at its forthcoming meeting based on the advice of the subgroup in paragraphs 2.22 to 2.27;
- (ix) the discussion surrounding application of age-structured production models to Subarea 58.7 assessments of toothfish (paragraphs 2.28 to 2.32);
- (x) the consideration by the subgroup of estimating abundance of *C. gunnari* from trawl and acoustic surveys in Subarea 48.3, including recommendations to WG-FSA-SFA and to the Working Group on how to estimate abundance of *C. gunnari* from the Russian and UK surveys in 2002 at the forthcoming meeting of WG-FSA (paragraphs 2.33 to 2.49 and 5.7);

- (xi) the result that acoustics is unlikely to be a useful method for estimating abundance of *D. mawsoni* (paragraph 2.50);
- (xii) the need to consider at the forthcoming meeting of WG-FSA the application and implementation of mark–recapture programs for toothfish (paragraphs 2.51 and 2.52);
- (xiii) the recommendation to retain the research sets in exploratory toothfish longline fisheries and that the development of more detailed models of fleet dynamics would help to determine the future application of catch, effort and research data in the assessments of these fisheries (paragraphs 2.53 to 2.55);
- (xiv) the need to estimate natural mortality rates and growth rates of toothfish and to develop robust methods to do this (paragraphs 2.56 to 2.63);
- (xv) the discussion of plausible models of the population dynamics of toothfish that can be used to further develop the assessment process at the forthcoming meeting of WG-FSA and for formulating operating models to evaluate assessment methodologies such as that being developed for Subarea 58.7 (paragraphs 2.64 to 2.87);
- (xvi) the development of Fish Heaven as a spatially explicit operating population model that could be used to examine the efficacy of different management strategies (paragraphs 2.89 to 2.91);
- (xvii) the continuing development of the evaluation framework for evaluating the robustness of different assessment procedures, the encouragement of Members to evaluate and validate existing methods, and the need for further development and discussion of such frameworks in the coming year (paragraph 2.92);
- (xviii) the recommendations to WG-FSA on the assessments that could be undertaken this year, including the summary recommendations in Table 3.1 of the report (paragraphs 3.1 to 3.4 and 5.1);
- (xix) the recommendation to have a five-day meeting during the intersessional period in 2004, possibly immediately preceding the meeting of WG-EMM;
- (xx) the detailed identification of future work in paragraph 4.2;
- (xxi) the need for new software to be presented initially to the subgroup for evaluation in advance of WG-FSA, but recognising the need for a flexible approach such that new developments and their potential application at a meeting be considered early in a meeting of WG-FSA so that they can be included in assessments if they are not difficult to evaluate (paragraph 4.4);
- (xxii) the request for Secretariat support including to refine the archiving of assessments and software, the attendance of the Data Manager at future meetings of the subgroup, the circulation of papers via the website as well as

by compact disk on request, and for support in the last two days of the subgroup meeting to assist in report preparation, circulation of drafts and adoption (paragraphs 4.5 to 4.8);

- (xxiii) the recommendation that WG-FSA consider the long-term management objectives for *C. gunnari* and the application of decision rules, particularly as they relate to incorporating uncertainties in the assessment process (paragraph 5.2);
- (xxiv) the recommendation for WG-FSA to continue developing plausible models for the key species and for continuing the development of species profiles (paragraph 5.3);
- (xxv) the importance of ensuring the consistency in the population parameters used within assessments of individual species (paragraph 5.4);
- (xxvi) the request for feedback from the CCAMLR Otolith Network (CON) on its progress in resolving the uncertainties in age readings (paragraph 5.5);
- (xxvii) the request for WG-FSA to consider ways of maximising the statistical power of controlled experiments using spatial and temporal allocation of longline fishing effort to detect trends in CPUE as a means of monitoring changes in stock abundance (paragraph 5.6);
- (xxviii) the request of WG-FSA to seek assistance from WG-EMM in estimating the abundance of myctophids based on data from the CCAMLR-2000 Survey (paragraph 5.8);
- (xxix) the recommendation that WG-FSA should consider undertaking an analysis of CPUE data from the toothfish fishery in Subarea 48.3 (paragraphs 2.26 and 2.27) and should, where possible, undertake analyses of CPUE time trends in other fisheries and, in this regard, should request participants with specific expertise in GLM methods to meet early in the 2003 meeting to discuss potential approaches to the analysis of CPUE data (paragraph 5.9);
- (xxx) the recommendation for the Working Group to encourage and facilitate the coordination of work on tagging programs both within areas and across fishing fleets (paragraph 5.10);
- (xxxi) the request that WG-FSA consider its preferred mechanisms for the submission and validation of assessment software of potential benefit to the Working Group's activities, including the involvement of Secretariat staff, as necessary (paragraphs 4.4 and 5.11).

4.3 In preparation for the assessments this year, the Working Group agreed to the recommendations on assessments and passed these for consideration to the respective subgroups undertaking the assessments.

4.4 The Working Group noted the report of CON (WG-FSA-03/94) indicating the difficulties with estimating length-at-age based on otolith readings, including biases of two years or more, and errors in the estimation of age. It was also noted that length-at-age curves need to be validated by:

- (i) undertaking experiments to determine if growth rings are laid down annually by labelling toothfish with strontiumchloride (WG-FSA-03/70) or oxytetracycline (e.g. WG-FSA-03/80). Results using both methods have been encouraging;
- (ii) experiments comparing age data estimated by otolith readers with ages independently estimated using radiometric techniques (WG-FSA-03/94);
- (iii) using field methods to estimate growth rates directly, such as through mark–recapture programs (WG-FSA-03/90).

4.5 The Working Group noted that validation of the growth curve in Subarea 48.3 might be possible through the mark–recapture program. Such an effect will need to be considered when these data are analysed. The issue of uncertainties in growth parameters was further considered in the subgroups.

4.6 The Working Group undertook to compare results for *C. gunnari* short-term assessments arising from the use of MathCad and the GYM. It was noted in WG-FSA-03/32 that the results could be different from the GYM when the MathCad worksheet is used in the same way as for previous assessments. Dr Constable examined the two methods in detail. The results of yield estimates obtained from the GYM were validated by applying the designated fishing and natural mortalities to projections of the age structure in a spreadsheet showing that the output of the GYM was correct. The MathCad process was reviewed and showed that the process for scaling the numbers-at-age to the initial biomass estimate was potentially different to that used in the GYM. This difference arises because the scaling process in MathCad requires input of the lengths for each cohort observed in the survey data while the projections are undertaken using a von Bertalanffy growth curve. In the GYM, the scaling of abundance of the age structure to the biomass estimate occurs using the length-at-age at the time of the survey based on the length-at-age relationship used in the projection. As a result, the Working Group agreed that the GYM provides the same outputs as MathCad, but that attention would need to be given to ensuring the abundance of fish used in the projection reflect the abundance of fish-at-age in the stock at the time of the survey.

4.7 A number of issues concerning future assessment work were raised at this time. These were referred to Item 9.

4.8 The Working Group welcomed the considerable work undertaken in advance of the meeting through the two subgroups, WG-FSA-SAM and WG-FSA-SFA.

4.9 In order to facilitate the use of both CMIX and GYM, Dr Constable gave two presentations along with tutorial notes on both these packages. The Working Group thanked Dr Constable for preparing these materials and noted that the continued refinements to the GYM user interface are making this software much more easily accessible to members of the Working Group.

4.10 The Working Group noted that the GYM and the CMIX assessment software have been stable for many years and that the recent developments in the user interfaces of both

these programs have helped in the management of the input and output data and, as a result, they are becoming much more user-friendly. It was also noted that the wider use of the GYM has helped iron out any bugs in the user interface as well as providing the advice necessary for developing appropriate introductory and descriptive information in tutorials and manuals.

ASSESSMENTS AND MANAGEMENT ADVICE

New and Exploratory Fisheries

New and Exploratory Fisheries in 2002/03

5.1 Six conservation measures relating to eight exploratory fisheries were in force during 2002/03, but fishing only occurred in respect of three measures and four fisheries. Information on catches from active exploratory fisheries during 2002/03 is summarised in Table 3.1.

5.2 In most of the active exploratory fisheries, the numbers of days fished and the catches reported were relatively small. As was the case last year, the notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 41-09. A total of 1 792 tonnes of *Dissostichus* spp. was taken against a catch limit of 3 760 tonnes. During 2002/03, vessels from New Zealand, Russia and South Africa took 1 041, 663 and 142 tonnes of *Dissostichus* spp. respectively. Of the total catch, 229 tonnes were taken from the north of 65°S (SSRU 881A), and 1 563 tonnes were taken from the south of 65°S (mostly in SSRUs 881B and 881C). The 2002/03 season was severely restricted by icebergs and sea-ice. Although the Ross Sea Polynya was open, no fishing took place south of 72°30'S because of safety concerns, therefore little catch was taken from the southern SSRUs 881D and 881E.

5.3 Although the overall catch was about 50% of the catch limit for Subarea 88.1, catch limits in two fine-scale rectangles were exceeded by 3%, and the catch limit on SSRU 881C was exceeded by 106 tonnes (13%). It was noted that the catch limits were exceeded because of the high catch rates and the five-day reporting cycle (CCAMLR-XXII/BG/8). Dr Ramm reminded the Working Group that for each active fishery (e.g. longline fishery in Subarea 88.1 south of 65°S), the Secretariat reported regularly (e.g. every five days) to Members engaged in that fishery and provided an up-to-date total catch of the target species by fine-scale rectangle, SSRU and for the fishery as a whole. However, the Secretariat only forecast closure dates for the fishery as a whole, and did not attempt to forecast closures in fine-scale rectangles or SSRUs.

5.4 The exploratory fishery in Subarea 88.2 was undertaken by one New Zealand vessel which caught 106 tonnes of *D. mawsoni* against a catch limit of 350 tonnes. Fishing was carried out only in SSRU 882E, to the east of the Ross Sea.

5.5 The exploratory fishery in Division 58.4.2 was undertaken by one Australian-flagged vessel which caught 117 tonnes of *D. mawsoni* against a catch limit of 500 tonnes. Fishing was carried out in three SSRUs.

5.6 The catches of by-catch species in all the exploratory longline fisheries for *Dissostichus* spp. fell within the catch limits set in Conservation Measure 41-09. It was noted that overall by-catch was similar between each of the high-Antarctic fisheries, although there was considerable variation between SSRUs (see also Agenda Item 5.4).

5.7 Data collected by New Zealand vessels from the exploratory longline fishery in Subareas 88.1 and 88.2 during the last five seasons were described and analysed in detail in WG-FSA-03/44 and related papers. Data collected from the Australian exploratory longline fishery in Division 58.4.2 in the 2002/03 season were described and analysed in detail in WG-FSA-03/68. The Working Group welcomed these papers in providing very useful summaries of the data gathered from these exploratory longline fisheries.

5.8 The Working Group noted that four Members were in breach of Conservation Measure 41-01. Notification by Members not intending to enter a fishery was only received from Japan in respect of five areas and New Zealand in respect of one area.

5.9 As part of Conservation Measure 41-01 all vessels are required to carry out a research plan which includes completing a minimum number of research sets on entering an SSRU. Of the 10 vessels fishing in the new and exploratory fisheries, only one Russian vessel failed to complete its quota of research sets. The Working Group welcomed the results of the research activities of the other vessels, which in some cases had completed more than their required 20 research sets per SSRU.

New and Exploratory Fisheries Notified for 2003/04

5.10 A summary of new and exploratory fisheries notifications for 2003/04 is given in SC-CAMLR-XXII/BG/5 Rev. 1 (Table 5.1). There was a total of 31 notifications made by 14 Members. The numbers of vessels for the notifications for exploratory fisheries for *Dissostichus* spp. in 2003/04 are shown, grouped by subarea or division, in Table 5.2. Four notifications were incomplete or not submitted by the deadline. Conservation measures in force for those areas for the 2002/03 season are provided in Table 5.2.

5.11 As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions (see Table 5.2). While this is of potential concern, the Working Group also noted that the experience of previous years indicated that a number of these may not be activated.

5.12 The Working Group noted that there were a number of notifications for Subareas 48.1, 48.2, 58.6, 58.7 (outside EEZs) and Division 58.4.4 where directed fishing on *Dissostichus* spp. is prohibited. The Working Group noted the conservation measures indicated that these will remain closed to the toothfish fishery until a survey has been completed, the results analysed, and the fishery is reopened on the advice of the Scientific Committee to the Commission.

5.13 Other notifications were for fishing in Division 58.4.1 and Subarea 88.3, which were closed to fishing in the 2002/03 season. The Working Group noted that neither area has defined SSRU boundaries or catch limits. There were also notifications for the assessed fisheries in Subarea 48.3 and Division 58.5.2.

5.14 The Working Group requested clarification on its role in assessing notifications with regard to closed areas and those that were incomplete and those that were submitted late. It also requested direction on how to proceed with assessing all-encompassing notifications as opposed to assessing notifications which follow strictly the requirements of the conservation measures.

5.15 In reviewing the notifications, the Working Group observed that there had been an improvement in specifying intended catches. Most countries reported catches separately for each subarea or division. The exception was Namibia, which notified for several areas without specifying separate catch limits. While this inconsistency continues, the task of assessing the likely effects of multiple exploratory fisheries in an area is made much more difficult. The Working Group emphasised that intended catch levels should be governed by what is required for economic viability and by operational and data acquisition considerations, as specified in Conservation Measure 21-02.

5.16 The Working Group expressed concern that the notification by Namibia to fish 5 000 tonnes of *Dissostichus* spp. in Division 58.4.1 in the 2003/04 season far exceeded the current catch limit of 500 tonnes for this division.

5.17 There have been a very large number of notifications for fishing in Subareas 88.1 (13 notifications for up to 32 vessels), 88.2S (eight notifications for up to 22 vessels) and Subareas 48.6 and 88.2N and Divisions 58.4.2, 58.4.3a and 58.4.3b (each for up to 15 vessels). Depending on the size of the precautionary catch limits, this implies that if all vessels operated simultaneously, the available catch per vessel could be lower than that required for economic viability, especially for those vessels operating in high latitudes where fishing imposes considerable operational difficulties.

5.18 It is likely that there will be additional administrative problems in determining closure dates for fishing in fine-scale rectangles and SSRUs when many vessels are fishing simultaneously in a subarea or division (see paragraph 5.3).

5.19 There were also two notifications for exploratory trawl fisheries. An Australian notification was for a trawl fishery for *Dissostichus* spp. and *Macrourus* spp. in Divisions 58.4.3a and 58.4.3b. A Russian notification was for a mixed trawl fishery targeting *Chaenodraco wilsoni*, *Trematomus eulepidotus*, *Lepidonotothen kempfi* and *Pleuragramma antarcticum* and several other Nototheniidae in Division 58.4.2.

5.20 With regard to advice on precautionary catch limits for stocks likely to be subject to new or exploratory fisheries in 2002/03, the Working Group agreed that this would only be possible this year for *Dissostichus* spp. in Subareas 88.1 and 88.2, and for *Macrourus* spp. in Divisions 58.4.3a and 58.4.3b.

Small-scale Research Unit Boundaries

5.21 The Working Group recalled its advice from last year to investigate more appropriate SSRU boundaries for Subarea 88.1 during the intersessional period (SC-CAMLR-XXI, Annex 5, paragraphs 5.27 to 5.31). Work on the revision of the boundaries was carried out by New Zealand and reported in WG-FSA-03/29.

5.22 In determining appropriate SSRU boundaries, the physical and geographical features of the subarea including the bathymetry, location of the fishery, the distribution and abundance of the target and by-catch species (rattails and skates), and the impact of sea-ice on fishing practices were examined. The paper recommended that the northern SSRU boundary at 65°S remain in place because it separated the mixed *Dissostichus* spp. fishery in the north from the *D. mawsoni* fishery to the south. It recommended a second boundary at 70°S to separate the middle region of the subarea comprising scattered banks, seamounts and ridges from the southern region comprising the Ross Sea shelf and slope. A third natural boundary was at 76°S, which separated the Ross Sea shelf from the shelf edge and slope. The Ross Sea shelf contains mainly subadult and small adult *D. mawsoni* (80 to 110 cm), and has a very low by-catch of skates and rattails. The shelf edge and slope has a wide range of *D. mawsoni* sizes and the highest by-catch rates of skates and rattails. Because much of the fishery effort and catch of toothfish has come from this region, the paper recommended it be divided at 180° longitude.

5.23 The Working Group welcomed the intention to base SSRU boundaries on ecological principles. It noted that the SSRUs in Subarea 88.1 are amongst the largest in CCAMLR, and that further division of these SSRUs would bring them more into line with the size of SSRUs in other areas. It also considered that smaller SSRUs have a greater likelihood of having homogeneous stock characteristics and as such could be used to derive information on stock status and demography including movements from both commercial and research operations. Smaller SSRUs would also give a wider range of research and management options. There may also be advantage to constraining the fishing to a smaller number of SSRUs in the early stages of the fishery to help facilitate assessment procedures that could be applied more broadly. This is because it would help provide the necessary spatial contract to determine the response of the stock to fishing.

5.24 In addition to the factors considered in WG-FSA-03/29, the Working Group further examined the bathymetry and the distribution of catches of *Dissostichus* spp. since the start of the exploratory fishery in 1998. It identified 12 areas most of which were subdivisions of the areas proposed in WG-FSA-03/29. The Working Group agreed that the new SSRUs better captured the irregular shapes of the bathymetric features and fishing grounds encountered in the subarea, and resulted in SSRUs more similar in size to those in other CCAMLR areas. The resulting 12 new SSRUs are shown in Figure 5.1.

5.25 The Working Group recognised that it is becoming extremely hard to manage the closure of fine-scale rectangles in this subarea because of the increase in the number of vessels and Members operating there. The Working Group believed that increasing the numbers of SSRUs, whilst at the same time removing catch limits on fine-scale rectangles, will overcome much of the current problems with area closures. This is because it will drastically reduce the number of subdivisions (fine-scale rectangles) that the Secretariat has to manage, whilst at the same time increasing the catch limit in each new subdivision (SSRU). At present some of the proposed SSRUs will likely have catch limits that are equal to or less than the current 100 tonne fine-scale rectangle limit and would therefore also face the same reporting issues as highlighted for fine-scale rectangles. This will mean that catch limits will be approached more slowly and be easier to manage. Other options for better managing catch limits in SSRUs include reducing the amount of effort in SSRUs, more regular reporting of catches and forecasting closures of SSRUs. (At present forecasting is only carried out for larger subareas and divisions.)

5.26 The intention then would be to have SSRUs that are biologically meaningful but also more manageable. The proposed change is also more consistent with the approach in other new and exploratory fisheries, such as Divisions 58.4.2 and 58.4.3.

5.27 The Working Group emphasised that the new SSRUs were in many cases around features that could be more easily identified as natural divisions amongst spatial areas of the stock. It also noted that with smaller areas there was more opportunity for focusing research opportunities and that stock characteristics would be more likely to be homogeneous.

5.28 The Working Group discussed the application of this approach to other new and exploratory fisheries in the CCAMLR Convention Area. Although some limited catch and distributional data were available for Subarea 88.2 and Division 58.4.2, the data were too sparse to revise SSRU boundaries in these areas. The Working Group recommended that the SSRU boundaries for these and other areas be reviewed when more data were available, but consistency could be applied across subareas and divisions for which little information is available.

5.29 The Working Group also noted that there were notifications for exploratory longline fisheries in Division 58.4.1 and Subarea 88.3. This is the first notification to fish in Division 58.4.1 and there are no existing SSRU boundaries for either area. The Working Group recommended that SSRU boundaries be no larger than 10° of longitude to be consistent with SSRU boundaries in other high-latitude subareas and divisions.

Approaches to Setting Catch Limits for Subarea 88.1

5.30 Totals of 1 740 tonnes of *D. mawsoni* and 51 tonnes of *D. eleginoides* were caught during 2002/03. This exploratory fishery has now been in operation for the past six seasons (WG-FSA-03/44). During that time, the total catches have been 41 tonnes in 1998, 296 tonnes in 1999, 745 tonnes in 2000, 659 tonnes in 2001, 1 333 tonnes in 2002 and 1 791 tonnes in 2003.

5.31 The exploratory fishery has seen a widespread distribution of effort. However, in the 2002/03 season the fishery was severely restricted by icebergs and sea-ice and no fishing was possible south of 72°30'S, so little catch was taken from the southern SSRUs 881D and 881E. New grounds were found to the north and at least a further 57 new fine-scale rectangles were fished during the season – mainly in the north of SSRUs 881B and 881C (WG-FSA-03/44).

5.32 For the last three years the Working Group has used the approach for calculating precautionary catch limits for *Dissostichus* spp. for Subarea 88.1 outlined in SC-CAMLR-XIX, Annex 5, paragraphs 4.20 to 4.33. This approach is based on analogy with *D. eleginoides* in Subarea 48.3, and is scaled by the estimates of mean recruitment in that population, and as such cannot be considered an independent assessment. Last year the Working Group agreed not to update the CPUE series used in the assessment. However, it considered that revision of the assessment might be appropriate with better information on fishing selectivity, other biological parameters and area boundaries.

5.33 No new estimates of fishing selectivity or other biological parameters are available for Subarea 88.1, but there has been a change in the estimates of mean recruitment of *D. eleginoides* in Subarea 48.3 (paragraphs 5.116 to 5.125), and there has also been a revision of the Subarea 88.1 boundaries (paragraphs 5.21 to 5.29).

5.34 The Working Group therefore agreed it was necessary to update the assessment of yield for Subarea 88.1. Because the parameters used to estimate γ for each area had remained unchanged, the only requirement was to estimate the pre-exploitation precautionary yield for Subarea 48.3 using the three estimates of mean recruitment. The corresponding estimates of yield for the whole of Subarea 88.1 were 13 882, 10 814 and 6 163 tonnes.

5.35 The Working Group agreed that the revised estimates of yield should be treated with caution and noted that various discount factors had been applied previously to the results of assessments using this approach. It also noted that the current catch limit was 3 760 tonnes. A standardised CPUE analysis of the three main fishing grounds showed no trend over time (WG-FSA-03/43), so there is no evidence that the fishery has caused a significant reduction in the population under the current level of catches.

Allocation of Catch Limits to SSRUs

5.36 The Working Group recalled that in recent years a common catch limit had applied to each of the four southern SSRUs in Subarea 88.1. However, the proposed SSRUs have quite different sizes, fishable seabed area and fish density. The Working Group therefore agreed that catch limits should be calculated separately for each SSRU and reflect the fishable seabed area and fish density from that SSRU.

5.37 The fishable seabed areas were calculated as the seabed area in the 600 to 1 800 m depth range. Bathymetric data provided by New Zealand vessels were input into a GIS system to determine polygons of fished area, and applying a bathymetric grid using Lambert azimuthal equal-area projection, to calculate the amount of seabed area over which adult *Dissostichus* spp. are likely to be located. The fish density was calculated as the mean CPUE (total catch of *Dissostichus* spp. divided by total effort) in each new SSRU over the history of the fishery.

5.38 The mean CPUE and seabed area as a proportion of the total are given for each new SSRU in Table 5.3. These proportions could be used to apportion the total catch limit between the SSRUs. This could be based on CPUE, seabed area, or a combination of the two.

5.39 The Working Group noted that given recent overall catch limits in Subarea 88.1, such an approach could lead to very small catch limits in some SSRUs. This could occur, for example, where no fishing had been carried out, where CPUE had been low, and/or fishable seabed area is small. A low catch limit, combined with the requirement to complete 20 research sets, would mean that these SSRUs would be unlikely to be fished.

5.40 The Working Group recommended that a consistent approach should be taken for high-latitude fisheries in general with regard to specifying requirements in SSRUs.

Precautionary Catch Limits for Subarea 88.2

5.41 An exploratory fishery has now been carried out in Subarea 88.2 for the last two seasons with reported catches of 41 tonnes in 2001/02 in SSRU 882A and 106 tonnes in 2002/03 from SSRU 882E.

5.42 No new estimates of fishing selectivity or other biological parameters are available for Subarea 88.2, but there has been a reduction in the estimates of mean recruitment of *D. eleginoides* in Subarea 48.3 (paragraphs 5.116 to 5.125).

5.43 The Working Group therefore agreed it was necessary to update the assessment of yield for SSRU 882A in Subarea 88.2 which was carried out last year. Because the parameters used to estimate γ for each area had remained unchanged, the only requirement was to use the estimate of the pre-exploitation precautionary yield for Subarea 48.3 using the three estimates of mean recruitment. The corresponding estimates of yield for Subarea 88.2 were 602, 469 and 267 tonnes.

Progress towards Assessments of New and Exploratory Fisheries

5.44 The current method of estimating yields of *Dissostichus* spp. in Subarea 88.1 and other new and exploratory fisheries is based on analogy with *D. eleginoides* in Subarea 48.3. At last year's meeting the Working Group considered that the development of stand-alone methods to monitor abundance and estimate precautionary yields in Subarea 88.1 (which are independent of Subarea 48.3) was a high priority.

5.45 Given the increased level of catches in Subarea 88.1, and the large number of notifications for the 2003/04 season, the Working Group reiterated the urgent need to develop a means for estimating abundance and carrying out an assessment of this stock. Several papers from New Zealand which were discussed at WG-FSA-SAM and WG-FSA examined possible methods of monitoring abundance in Subarea 88.1.

5.46 The feasibility of using acoustics data obtained from using hull-mounted transducers was examined during the 2003 season (WG-FSA-03/28), but the authors concluded it was unlikely to provide estimates of standing stock adequate for estimating yield. A standardised CPUE analysis of the main grounds in Subarea 88.1 has shown no trends, but it is unknown if it is monitoring abundance (WG-FSA-03/43). Preliminary results of a simulation study of *D. mawsoni* in the Ross Sea presented at WG-FSA-SAM were inconclusive and the authors noted that there were practical difficulties in setting research lines in similar places each year in the Ross Sea due to the highly variable ice conditions between years (WG-FSA-SAM-03/11). The results of a tagging feasibility study were summarised in WG-FSA-SAM-03/10. The authors concluded that if the main assumptions of the Jolly-Seber estimator are met, then annual tagging of fish in the Ross Sea might provide estimates of annual recruitment, survivorship and abundance.

5.47 The Working Group thanked New Zealand for the work that had gone into the examination of alternative approaches for monitoring abundance during the intersessional period. It also considered various other options for monitoring abundance in Subarea 88.1. It noted that the division of the subarea into a number of smaller management units (SSRUs), may provide other research and assessment options. The Working Group identified three

techniques that could be used to try and monitor abundance: concentrating effort in small areas over time to determine stock characteristics, depletion experiments, tagging programs and bottom trawl surveys of juvenile grounds.

5.48 Concentrating effort over a longer period could help identify what can reasonably be construed on stock status. Alternatively, a depletion experiment is a deliberate attempt to increase fishing effort in a small area for a shorter period and to see whether the decline in fish abundance can be measured through commercial catch and effort data. Small-scale depletion experiments were attempted for *D. eleginoides* during the early 1990s (Parkes et al., 1996). Up to 10 lines were set within a localised area with a diameter of 10 n miles consecutively for a period of up to three days. Trends in CPUE for *D. eleginoides* varied considerably both within and between experiments. When all experiments were considered together there had been no significant decline in abundance. A similar experimental approach was used to try to detect changes in crab abundance in Subarea 48.3 (SC-CAMLR-XX), and was also unsuccessful. However, the Working Group considered that depletion experiments might work over a larger spatial and temporal scale. For example, an experimental study could be set up for a period of three years. Fishing effort could be directed to an SSRU (or part thereof) at a level high enough to cause an expected and observable decline in fish abundance. This could be achieved within the precautionary framework by temporarily closing or reducing catch limits in other SSRUs such that the total catch limit for the subarea was not exceeded.

5.49 There would be some direct financial cost of carrying out a depletion experiment to fishers because they would be restricted in their fishing operations and would have reduced CPUE for a short period if the experiment was successful. Environmental safeguards could be put in place so that fishing would stop in a season if the CPUE declined below a threshold during the experiment. If the experiment was successful then estimates of toothfish abundance for that area could be obtained by the end of the specified period. This would then provide information to guide the evaluation of approaches to developing the fishery in the whole subarea. The proposed depletion experiment could also provide estimates of biomass and yield for the main by-catch species (rattails and Rajids). Potential problems include the variability of sea-ice between years, which means that the area used for the depletion experiments would need to be carefully chosen. Another potential problem is emigration and immigration from the area of the depletion experiment both within and between years.

5.50 A number of tagging studies has been carried out in CCAMLR waters (see also Appendix D). These results clearly indicate that both species of toothfish survive the tagging event and have provided important information on movement and growth of toothfish. Furthermore, the recapture rate around Macquarie Island was high enough to provide a precise estimate of stock size (Tuck et al., 2003).

5.51 A tagging study could be initiated with the intention of estimating stock size in Subarea 88.1. A simulation study was carried out to determine how many years it would take to obtain a precise estimate of annual recruitment and survivorship over a range of initial stock sizes using a Jolly–Seber estimator (WG-FSA-SAM-03/10). The results suggested that for a range of initial stock sizes of 2 to 20 million recruits, and at a release rate of 3 500 tags per year, it would take 12 years to obtain a precise estimate of survivorship. (Note that because the tagging experiment has already been running for three years, with almost 2 000 tagged fish released already, a precise result would be obtained in nine years.) After this time the risk of failure to detect a stock decline rate of 0.05 or greater was less than 5%

over all initial stock size assumptions. The simulations have not yet been carried out, but clearly a more concentrated tagging effort with a faster rate of release of tagged fish would provide an answer in a shorter time period.

5.52 Clearly the main benefit of the program will be to provide an absolute biomass estimate of the stock. Other benefits will include improved understanding of stock structure and interrelationships with other areas. The cost of the tagging study could be borne by the fishery, and would clearly increase as the number of tagged fish increased. In the 2002/03 season, New Zealand vessels were required to tag one toothfish per tonne of fish caught. Thus the tagging was funded by the fishers in proportion to fishing success. At an average weight of 20 kg per fish this equates to an estimated loss equivalent to the fishing time needed to obtain about 2% of the catch. There are a number of assumptions that have to be met to achieve an unbiased estimate using tag-recapture experiments. It would be necessary to quantify initial mortality, tag loss and tag detection rates, as these can lead to bias in the abundance estimate (WG-FSA-SAM-03/10). There could also be problems caused by mixing assumptions, and also by emigration and immigration. However, some of these can be addressed as the tagging program develops and through further simulation studies (Appendix D, paragraph 8).

5.53 Bottom trawl surveys are the main method currently used by CCAMLR to estimate toothfish abundance. They can often be used to monitor several species at the same time and estimates of pre-recruit fish can be projected through the GYM to estimate long-term precautionary yields. A survey of toothfish juveniles (<60 cm) in the Ross Sea region could provide estimates of recruitments and be used to estimate precautionary yields. However, there are several issues associated with carrying out trawl surveys for juveniles in the Ross Sea as discussed below.

5.54 The location of *D. mawsoni* juveniles in Subarea 88.1 is largely unknown (WG-FSA-SAM-03/11). In other areas, including Subareas 48.1, 48.2 and Division 58.4.2, juvenile toothfish are typically found in shallow waters (<500 m). Small numbers of 4- and 5-year-old fish were caught in the exploratory longline fishery close to the Balleny Islands in 1998, but this has a very small shelf area. The main area of shallow shelf, where juveniles are expected to be found, is in the southern Ross Sea from 72°S to 77°S. However, in some years this area is completely closed by ice. For example, in the 2002/03 season no fishing was possible south of 72°30'S.

5.55 Other factors such as bottom topography and glacial debris mean that trawling could be operationally difficult in the area. The area in the depth intervals of 0 to 600 m is estimated to be 320 000 km². (Comparable areas around South Georgia and HIMI are 45 000 and 60 000 km² respectively.) Given the large area it would probably be necessary to conduct a multinational trawl survey of the area. A multinational survey was successfully applied to estimate krill biomass in 2000. The cost of such a survey would be considerable and may take several years to organise. The benefit would be that if successful, a preliminary assessment could be carried out once the results were obtained. The survey would also provide biomass estimates for other species occupying the shelf area, and may also lead to a better understanding of the biology and ecology of the region. However, it should be noted that the survey would need to be repeated at regular intervals to provide a robust estimate of mean recruitment.

5.56 A preliminary cost–benefit analysis of the various approaches is summarised in Table 5.4. All approaches have implicit assumptions and have problems and costs associated with them. However, the Working Group recommended that consideration be given to urgently progress one or more of these approaches.

5.57 The Working Group also noted that none of these options are mutually exclusive. For example, a depletion experiment combined with a tagging study could provide a powerful tool. Also there could be a phased approach to the estimation of abundance. In the first phase, a tagging program in each SSRU could be made part of the conservation measure to start introducing tags into the population. In later phases, a carefully planned short-term depletion experiment or planning for a trawl survey could be carried out, perhaps combined with an intensive tagging program.

Comments on Research Plans

5.58 In each of the exploratory fishery notifications, the research plans proposed at least met the minimum requirements specified in Conservation Measure 41-01 and in some aspects exceeded them.

5.59 The Working Group acknowledged the value of the research components of exploratory fisheries in the past and previous seasons, noting in particular the extent to which it has been possible to make progress towards a precautionary assessment of Subareas 88.1 and 88.2.

5.60 The Working Group did not have time to thoroughly review the research plan and data collection plans specified in Conservation Measure 41-01 during the meeting, but recommended that they be reviewed intersessionally. However, it did discuss the possibility of the inclusion of a tagging requirement into the research plan for the new and exploratory fishery in Subareas 88.1 and 88.2.

5.61 Dr Constable noted that the tag–recapture experiment at Macquarie Island had led to an assessment of this stock (Tuck et al., 2003). He noted that an evaluation of the approach had led to good management of that particular fishery. He also added that tagging would be a good safeguard – even if superseded at a later date by another method.

5.62 Dr Hanchet noted that both WG-FSA and the Scientific Committee had strongly encouraged continuation of the tag–recapture experiments in Subarea 88.1 last year (SC-CAMLR-XXI, paragraph 4.114 and Annex 5, paragraph 5.56). He further noted that although three countries had fished in Subarea 88.1 during the 2002/03 season, only New Zealand had made a significant commitment to tagging. New Zealand vessels tagged almost 1 000 fish during the course of the season, making a total of 2 000 fish tagged in the subarea to date.

5.63 The Working Group endorsed the inclusion of tagging as a requirement in the research plans for the Subarea 88.1 fishery for the 2003/04 season. Further details on tagging protocols are provided in Agenda Item 7.4 (paragraphs 7.11 to 7.18 and Appendix D).

Advice to the Scientific Committee

5.64 This section summarises advice derived from consideration of topics related to directed fishing. Complementary advice on new and exploratory fisheries in respect of issues of seabird by-catch are discussed in paragraphs 6.206 to 6.218 and summarised in paragraph 6.275.

5.65 Six conservation measures relating to eight exploratory fisheries were in force during 2002/03, but fishing only occurred in respect of three of these. In most of the active exploratory fisheries, the numbers of days fished and the catches reported were small. The notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 41-09. During 2002/03 vessels from New Zealand, Russia and South Africa took 1 792 tonnes of *Dissostichus* spp.

5.66 The overall catch in Subarea 88.1 was about 50% of the catch limit (paragraph 5.3).

5.67 Catch limits in two fine-scale rectangles were exceeded by 3%, and one SSRU by 13%. This is because forecasting of closure in fine-scale rectangles and SSRUs is currently not made (paragraph 5.3).

5.68 Conservation Measure 41-01 requires Members who have made a notification of a desire to participate in an exploratory fishery but no longer wish so to do should notify the Secretariat. Such notifications had been received from Japan and New Zealand. Four Members had failed to make such notifications (paragraph 5.8).

5.69 Nine of the 10 vessels that fished in exploratory fisheries under Conservation Measure 41-01 completed the required quota of research sets (paragraph 5.9). The Working Group strongly urged all Members to complete their research set requirements as this provides background estimates and overall CPUE in those areas as a safeguard monitoring tool.

5.70 Thirty-one notifications of new or exploratory fisheries were made by 14 Members for 2003/04 (Table 5.1). Four notifications were incomplete or not submitted by the deadline. There were multiple notifications of exploratory fisheries for *Dissostichus* spp. for most subareas or divisions (Table 5.2). While this is of potential concern, the Working Group also noted that the experience of previous years suggested that many of these might not be activated.

5.71 The Working Group found difficulties in giving this very large number of notifications due time for a thorough consideration. There were several notifications for Subareas 48.1, 48.2, 58.6, 58.7 and Division 58.4.4, which are closed until a research survey has been carried out. There were notifications for Division 58.4.1 and Subarea 88.3, which were closed in the 2002/03 season and also notifications for the assessed fisheries in Subarea 48.3 and Division 58.5.2.

5.72 The Working Group would like clarification on its role in assessing notifications with regard to closed areas and those that were incomplete and those that were submitted late. It would also like direction on how to proceed with assessing all-encompassing notifications as opposed to assessing notifications which follow strictly the requirements of Conservation Measure 41-01.

5.73 The Working Group expressed concern at the notification by Namibia to fish 5 000 tonnes of *Dissostichus* spp. in Division 58.4.1 in the 2003/04 season in terms of the current catch limit of 500 tonnes for this division.

5.74 There have been a very large number of notifications for Subareas 88.1 (13 notifications for up to 32 vessels), 88.2S (eight notifications for up to 22 vessels) and for Subareas 48.6 and 88.2N and Divisions 58.4.2, 58.4.3a, 58.4.3b (each for up to 15 vessels). The Working Group noted that in the light of the catch limit the catch per vessel is likely to be uneconomically low (paragraph 5.17).

5.75 There are additional administrative problems in managing conservation measure provisions for fishing in fine-scale rectangles and SSRUs when many vessels are fishing simultaneously in a subarea or division (paragraph 5.18).

5.76 With regard to provision of advice on precautionary catch limits for stocks likely to be subject to new or exploratory fisheries in 2002/03, the Working Group agreed that this would only be possible this year for *Dissostichus* spp. in Subareas 88.1 and 88.2, and for *Macrourus* spp. in Divisions 58.4.3a and 58.4.3b. For all the other subareas and divisions for which notifications have been made, the Working Group is unable to provide any new advice on precautionary catch limits.

5.77 The Working Group noted the large size of the existing SSRUS in Subarea 88.1, and the operational difficulties experienced by the Secretariat (and Members) in managing the fine-scale rectangles. The Working Group has proposed a reorganisation within Subarea 88.1 into 12 SSRUs, whilst at the same time removing the fine-scale rectangle catch limits (paragraphs 5.24 to 5.27).

5.78 These new SSRUs are more ecologically meaningful and in general will be easier to manage than fine-scale rectangles. Other options for better managing catch limits in SSRUs include reducing the amount of effort in SSRUs, more regular reporting of catches and forecasting closures of SSRUs. (At present forecasting is only carried out for larger subareas and divisions.)

5.79 The Working Group further recommended that SSRU catch limits in Subarea 88.1 are made proportional to the estimated fishable seabed area and mean fish density (mean CPUE) (Table 5.3).

5.80 Because the Subarea 88.1 assessment is directly linked to the recruitment estimates for Subarea 48.3, and these recruitment estimates had been revised, the Working Group agreed to repeat last year's Subarea 88.1 assessment using the new estimate of recruitment (paragraphs 5.116 to 5.125). The estimated yields for Subarea 88.1 were 13 880, 10 810 and 6 160 tonnes. The Working Group reiterated its advice from last year that these revised estimates of yield be treated with caution.

5.81 Because the Subarea 88.2 assessment is directly linked to the recruitment estimates for Subarea 48.3, and these recruitment estimates had been revised, the Working Group agreed to repeat last year's Subarea 88.2 assessment using the new estimates of recruitment (paragraphs 5.116 to 5.125). The estimated yields for Subarea 88.2 were 602, 469 and 267 tonnes. The Working Group reiterated its advice from last year that these revised estimates of yield be treated with caution.

5.82 The Working Group recommended that a consistent approach should be taken for high-latitude fisheries with regard to the size of SSRU boundaries and precautionary catch limits. Where no data were available for identification of more appropriate SSRU boundaries, then it is recommended they be evenly spaced at intervals of 10° of longitude.

5.83 The current method of estimating yields of *Dissostichus* spp. in Subarea 88.1 and other new and exploratory fisheries is based on analogy with *D. eleginoides* in Subarea 48.3. At last year's meeting the Working Group considered that the development of stand-alone methods to monitor abundance and estimate precautionary yields in Subarea 88.1 (which are independent of Subarea 48.3) was a high priority. Given the increased level of catches in Subarea 88.1, and the large number of notifications for the 2003/04 fishing year, the Working Group reiterated the urgent need to develop a means for estimating abundance and carrying out an assessment of this stock.

5.84 The Working Group considered several different options for estimating abundance in Subarea 88.1. These methods could replace the use of fine-scale rectangles in generating useful scientific data. It identified three approaches that it considered to hold the most promise in providing abundance estimates that could be used for stock assessment: tag-recapture experiments, depletion experiments and juvenile trawl surveys. A provisional cost-benefit analysis of these three approaches was carried out and is given in Table 5.4. All three approaches have implicit assumptions and have problems and costs associated with them. However, the Working Group recommended that consideration be given to try and progress an approach.

5.85 In that regard, the Working Group noted that a tag-recapture experiment at Macquarie Island had led to an assessment of this stock (Tuck et al., 2003) and good management of that fishery. It was also noted that both WG-FSA and the Scientific Committee had strongly encouraged continuation of the tag-recapture experiments in Subarea 88.1 last year (SC-CAMLR-XXI, paragraph 4.114 and Annex 5, paragraph 5.56). It was further noted that although three countries had fished in Subareas 88.1 and 88.2 during the 2002/03 season, only New Zealand had made a significant commitment to tagging, and had succeeded in tagging almost 1 000 fish during the course of the season.

5.86 The Working Group recommended the inclusion of tagging as a requirement in the research plans for the Subarea 88.1 fishery for the 2003/04 season. Further details on tagging protocols are provided in Agenda Item 7.4.

5.87 An assessment of *Macrourus* spp. was carried out for Divisions 58.4.3a and 58.4.3b (see paragraph 5.251). The Working Group recommended a catch limit of 159 tonnes for Division 58.4.3a and of 26 tonnes in Division 58.4.3b. The Working Group noted that the notification for the catch of *Macrourus* spp. in 2003/04 is for a larger overall total catch (CCAMLR-XXII/25).

Assessed Fisheries

Dissostichus eleginoides South Georgia (Subarea 48.3)

Trends in Fishing Vulnerability

5.88 As was done at the 2002 meeting, annual estimates of vulnerabilities-at-age for the longline fishery in Subarea 48.3 were calculated using the method described in WG-FSA-02/64. This method takes specific account of the tendency for the size of fish taken in the longline fishery to be positively correlated with depth fished, so that shifts in effort distribution by depth between years will result in different fishing pressures being placed on fish in different length (or age) classes.

5.89 The method first estimates vulnerabilities-at-length using estimates of length densities by depth zone and region around South Georgia and Shag Rocks obtained from observer data. These are then converted to vulnerabilities-at-age using the growth curve estimated for Subarea 48.3. The analyses this year incorporated revised data for 2002 and all available data for 2003.

5.90 As was the case last year, the annual estimated vulnerabilities-at-age fell into two distinct patterns: a 'shallow' fishing pattern and a 'deep' fishing pattern. For both patterns, the most heavily fished depth zones in each year were those around 1 200 m, but in the 'shallow' fishing years (1998–2000 and 2003), there was a distinct subsidiary mode in effort distribution by depth around 400–500 m, while this was less distinct in years with a 'deep' fishing pattern (1997, 2001–2002). The patterns of effort distribution are shown in Figure 5.2.

5.91 The resulting annual estimated schedules of vulnerability-by-age are shown in Figure 5.3 and Table 5.5.

5.92 Assessment trials conducted last year demonstrated that the precautionary catch limits calculated for the 'shallow' fishing pattern are lower than those for the 'deep' fishing pattern (SC-CAMLR-XXI, Annex 5, paragraph 5.75). This is consistent with the fact that shallow-water fishing takes more smaller fish (per tonne of catch) than does deep-water fishing. Shallow-water fishing will therefore also take more immature fish than deep-water fishing.

5.93 Using observer data from 1999 to 2003, the proportions of immature fish (stage I on the maturity scale) by depth zone were estimated and these are illustrated in Figure 5.4. This figure illustrates that in the shallowest depth zone (200–400 m), the proportion of immature fish in the catch exceeded 50%. This proportion drops steadily with increasing depth, until it levels off at depths greater than 800 m to around 20–30%. The Working Group noted that the proportion of immature fish at depths greater than 800 m was higher than previously expected.

5.94 Clearly, if it were possible to direct fishing away from the shallower depth zones, then the proportion of immature fish in the catch (and the numbers of fish caught per tonne of catch limit) might be reduced. Figure 5.5 illustrates the proportion of the catch limit biomass taken by depth zone between 1999 and 2003, showing that approximately 5–10% of the catch limit is taken in the 200–400 m depth zone, and 15–30% in the 200–600 m depth zones.

5.95 The Working Group agreed that some restriction of fishing in shallower waters might be useful, but it also noted that the proportion of immature fish in waters deeper than 600 m was higher than expected. Further studies of the possible effects of such restrictions were encouraged.

CPUE Standardisation

5.96 Haul-by-haul longline catch and effort data for Subarea 48.3 (fine-scale data) for the 1985/86 to 2002/03 fishing seasons were examined. The Working Group also considered the information contained in WG-FSA-03/98, noting that the CPUE data referred to therein were included in the longline catch and effort dataset.

5.97 At its intersessional meeting, WG-FSA-SAM had discussed appropriate methods to be used for CPUE standardisation of longline CPUE data for *D. eleginoides* (WG-FSA-03/40). In the context of these discussions, two sets of alternatives were identified for consideration in the 2003 assessment of *D. eleginoides* in Subarea 48.3:

- (i) whether the standard GLM method used for previous assessments should continue to be used, or whether the GLMM method presented by Dr S. Candy (Australia) (WG-FSA-SAM-03/12) should be used;
- (ii) whether the complete time series (1985/86 to 2002/03) should be used, or whether only the later section of the time series (1995/96 to 2002/03) should be used.

5.98 In raising the possibility of only using the later section of the CPUE time series, WG-FSA-SAM had noted the past and current difficulties with estimating the standardised CPUE series for Subarea 48.3, and the desirability of using CPUE data that were reliable and internally consistent. It recognised, however, that the possibility of using only the shortened CPUE time series was based on the expectation that to do so would not substantially alter the outcome of the assessments.

5.99 WG-FSA-03/96 explored the effects of using the two different standardisation methods and the two alternative time series on the data used in the 2002 assessment. It concluded that truncation of the standardised series used in the 2002 assessment (which was calculated using the standard GLM approach) would result in only a slight modification of the predicted median escapements and probabilities of depletion if the shorter time series started in 1995/96. The consequences would be different if the shorter series started in a later season. However, analysis of the truncated series using the GLMM method would have much more pronounced consequences, predicting a considerable increase in levels of median escapement and decreased probabilities of depletion. When the full series was used, the estimates of median escapement and probability of depletion were similar for both the GLM and GLMM approaches for the current time series and assessment.

5.100 Discussing these findings, the Working Group agreed that despite the uncertainties in interpretation of the full time series, there still remained an advantage in retaining the full series in its analyses. It also agreed that it had insufficient knowledge of the properties of the GLMM approach to decide at this meeting to adopt it in favour of the GLM approach for

assessments at this meeting. Accordingly, WG-FSA agreed that for the 2003 assessment, it would standardise CPUE by applying the GLM approach to the full CPUE time series, as it had done in previous assessments.

5.101 The Working Group recommended, however, that the issues of which standardisation method should be applied and the uncertainties in interpretation of the full time series, including how uncertainties in the series may be incorporated in the assessment (e.g. as in WG-FSA-03/96), should be further studied intersessionally. In particular, further evaluation of the sensitivity of alternative standardisation methods to assumptions under different CPUE scenarios would be of benefit.

5.102 Details of the CPUE standardisation using the GLM approach can be found in SC-CAMLR-XXII/BG/27, paragraphs 5.2.1 to 5.2.4 and Table 5.6 of this report.

5.103 The standardised time series of CPUEs in kg/hook is plotted in Figure 5.6. The standardisation is with respect to Chilean vessels fishing at depths of 1 000 to 1 500 m. Adjusted standardised catch rates have fluctuated around a relatively constant level between 1986/87 and 1994/95. The adjusted standardised catch rates declined substantially between 1994/95 and 1996/97. Since then, catch rates have been stable from 1997/98 to 2002/03.

Estimates of Recruitment

5.104 Estimates of numbers of recruits at age 4 are calculated by applying the CMIX program to length-density data (numbers/km² for each length class) from each survey haul, weighted by the seabed areas of the three depth strata (50–150 m, 150–250 m and 250–500 m) at South Georgia and Shag Rocks (see SC-CAMLR-XXI, Annex 5, paragraph 5.60). The Working Group reviewed all the previous CMIX analyses of recruitment in detail at its 2000 meeting (SC-CAMLR-XIX, Annex 5, paragraphs 4.130 to 4.142).

5.105 In the 2002 assessment, new data were available from the 2002 UK survey of South Georgia and Shag Rocks, and these were used last year to update the recruitment series for Subarea 48.3. The estimates of age-4 recruitment in 2000/01, 2001/02 and 2002/03 resulting from the 2002 survey data were high relative to previous years, especially in 2002/03, and this led to a notable increase in the precautionary catch limit for 2003 over that which applied in 2002.

5.106 No recruitment survey was carried out in 2003, but in view of the concern expressed last year (SC-CAMLR-XXI, Annex 5, paragraphs 5.68 to 5.71), the Working Group specifically re-examined the recruitment estimates obtained from the 2002 survey. Comparison of biomass estimates calculated from TRAWLCI and from CMIX total densities revealed a large discrepancy, with the CMIX estimate being considerably larger. Further investigation revealed that there had been an error in the extractions of length-density data at the 2002 meeting, with hauls with zero catches of *D. eleginoides* having been inadvertently omitted. This error substantially inflated the recruitment estimates that were obtained. Revised estimates of recruitment calculated using the revised 2002 length-density dataset are shown in Table 5.7, along with the previous estimates.

5.107 Similar biomass comparisons were made for all the remaining available UK survey datasets (see SC-CAMLR-XXII/BG/27, Figure 5.2.8). Only for the 1990 UK survey was a

further discrepancy revealed in earlier CMIX analyses, which produced a considerably higher biomass estimate (around 28 000 tonnes) than the TRAWLCI analysis (around 10 000 tonnes). For this survey, no problems were identified with the data extractions, however the original and revised CMIX analyses were inconsistent, with the revised analyses suggesting considerably lower densities. The underlying reasons for this inconsistency are unclear.

5.108 The Working Group strongly recommended that for all future data extractions for estimating recruitment, the comparison of biomass estimated from CMIX total densities and TRAWLCI should be carried out routinely. It also recommended that equivalent validation tests should be devised, clearly documented and carried out routinely for all data extractions used in assessments.

5.109 The new time series of recruitment estimates after correcting those for the 1990 and 2002 surveys are shown in Table 5.7. The combined effects of the two corrections lead to a much lower mean annual recruitment than had been estimated previously (Figure 5.7). It was noted that consistent biomass estimates from CMIX and TRAWLCI by no means ensured that the corresponding recruitment estimates were free from error, as there are a number of other data manipulation, analysis and interpretation steps before and after the data extraction and CMIX analysis. They still could be biased either upwards or downwards as a result of different types of errors. There was no opportunity during the meeting to review these other steps.

5.110 Separately from these checks, Drs C. Davies (Australia) and Gasiukov had been asked to review each of the earlier CMIX analyses used to calculate estimates of recruitment. This request derived from the recommendation of WG-FSA-SAM that greater use of the diagnostic capabilities of the CMIX program would assist in the fitting and interpretation of outputs. Their detailed report is included in SC-CAMLR-XXII/BG/27. The principal findings were that there appeared to be some inconsistencies between the mean lengths of the identified cohorts and those expected from the von Bertalanffy growth curve estimated for Subarea 48.3. There also appeared to be some inconsistency between years in the assignment of ages to population components.

5.111 In view of the identified uncertainties in previous data extractions and possible inconsistencies in the interpretation of the CMIX analyses, the Working Group agreed that it should attempt to redo the CMIX analyses using data newly-extracted from the database held by the Secretariat.

5.112 The results of these analyses, which were carried out by Drs Collins and Davies, are also given in SC-CAMLR-XXII/BG/27. The Working Group agreed that the results obtained represented a more consistent and improved analysis given the short time available and thanked them for their work. However, while every attempt had been made during these analyses to make full use of the CMIX diagnostics and to follow a consistent approach to the analysis throughout, it had not been possible in the time available to conduct as thorough an analysis as would be desirable. The following concerns were noted:

- (i) in a number of cases, there was a larger than desirable difference between observed and expected densities in the CMIX fits;
- (ii) for some analyses, there was evidence of a lack of fit for some important population components;

- (iii) it had been necessary to adjust growth parameters from those previously estimated for Subarea 48.3 and used elsewhere in the assessment;
- (iv) there remain unexplained differences between the new and previous data extractions for some Argentinian surveys;
- (v) there remained some uncertainty in the identification and assignment of ages in the CMIX components.

5.113 There was no more time available after review of these results for further CMIX runs to be carried out to attempt to address these issues. As uncertainties still remained in the new recruitment estimates, and since major discrepancies had been identified in the recruitment series used in the 2002 assessment, it was agreed that these estimates should not be used in assessment trials at this meeting. Rather, it was agreed that these revised analyses and the problems that were still left unresolved highlighted the need for a thorough review of the recruitment estimation process.

5.114 Accordingly, the Working Group agreed that there was an urgent need to review and evaluate the entire process of estimating *D. eleginoides* recruitment from trawl surveys for use in assessments, including a variety of general analysis and interpretation issues. Points to be considered in this evaluation should include, but not be restricted to, the following:

- (i) the reading of ages, the estimation of growth curves and how age information should be incorporated into the CMIX analyses. In particular, account needs to be taken in the estimation of recruitment of the potential errors and uncertainties in the age information and assignment of ages to mixture components;
- (ii) which age groups should be included in the estimation of recruitment, bearing in mind the extent to which they are fully selected in the survey hauls and possibly higher natural mortality in younger age groups;
- (iii) taking account of possible variations in catchability between surveys;
- (iv) the need for a clear set of decision rules to guide those attempting CMIX analyses;
- (v) evaluation of survey design and interannual variation in catchability of age classes for estimation of recruitment series for *D. eleginoides*.

5.115 The Working Group agreed that the conduct of this work should be given high priority by WG-FSA-SAM at its intersessional meeting in 2004. However, it also noted that for this evaluation to be completed before the next WG-FSA meeting, it was essential that considerable preparatory work be completed before the WG-FSA-SAM meeting.

Assessment

5.116 The Working Group conducted assessments incorporating the following changes from the assessment conducted in 2002:

- (i) the revised estimates of total removals for *D. eleginoides* in Subarea 48.3 (Table 5.8);
- (ii) the revised selectivity-at-age schedules (Table 5.5);
- (iii) the updated standardised CPUE series (Table 5.6);
- (iv) revised series of estimates of recruitments (Table 5.7).

5.117 Input parameters for the GYM assessment runs are given in Table 5.9.

5.118 The incorporation of new series of total removals, standardised CPUEs and selectivities-at-age are expected to result in relatively little change from the previous year's assessment. However, the effects of using the different recruitment series were expected to be more substantial. In order to demonstrate these influences, the Working Group first carried out three assessment trials:

- (i) using the new series of total removals, standardised CPUEs and selectivities-at-age, but using the series of estimated recruitments calculated using the estimates of survey densities-at-age as agreed in 2002. This run was included purely as a baseline to facilitate comparisons with the results of using the old 2002 recruitment series;
- (ii) as for (i), but estimating the recruitments using the revised densities-at-age for the 2002 survey;
- (iii) as for (i), but estimating the recruitments using the revised densities-at-age for the 1990 and 2002 surveys.

5.119 The precautionary catch limit resulting from use of the 2002 recruitment series was 7 813 tonnes, a similar level to that estimated last year, as expected. When the revised estimates of length densities for the 2002 survey were used, the precautionary catch limit was reduced to 5 524 tonnes. When the revised estimates for both the 1990 and 2002 surveys were used, the precautionary catch limit was reduced further to 1 979 tonnes. Historical and projected trajectories for the latter two assessment trials are shown in Figures 5.8 and 5.9.

5.120 As noted earlier, the Working Group had agreed after much discussion that it would not be appropriate to carry out an additional assessment trial using the new estimates of densities-at-age from the CMIX analyses carried out during the meeting, given the uncertainties that remained in them. The corollary of this decision, however, is that at this meeting WG-FSA does not have a recruitment series for Subarea 48.3 in which it has sufficient confidence on which to base an agreed assessment of *D. eleginoides* stocks in Subarea 48.3.

5.121 At the time of adopting the report, Dr Collins advised the Working Group that he had discovered a mistake had been made in his revised CMIX analysis of the 1990 UK survey data (see paragraph 5.107). This discovery had been made when a new comparison was made of biomasses estimated from the revised CMIX analysis and from the TRAWLCI analysis of the original survey data. This time, the biomass based on the revised CMIX analysis biomass (around 6 500 tonnes) was considerably lower than the TRAWLCI biomass estimate (around

10 000 tonnes), indicating that the revised CMIX densities were now too low. There was no time available to allow further revision or review of the CMIX analyses or to carry out further GYM trials.

Management Advice

5.122 Given the uncertainties in the estimated recruitment series, the Working Group is unable to recommend a specific catch limit for *D. eleginoides* for the 2003/04 fishing season. In view of the effects of corrections to the problems identified with the recruitment series used in the 2002 assessment, the Working Group recommended that whatever catch limit the Commission should adopt for *D. eleginoides* for the 2003/04 fishing season should be substantially less than that which applied in 2002/03 (7 810 tonnes).

5.123 The Working Group emphasised that it has recommended a high-priority program of work for the intersessional period to fully review and revise the recruitment series for Subarea 48.3 as part of a broader review of methods of estimating recruitment from trawl survey data, coordinated by WG-FSA-SAM. This program aims to review and evaluate existing and alternative methods for estimating recruitment. By its 2004 meeting, a consistent and reliable recruitment series will be available for assessing the *D. eleginoides* stock in Subarea 48.3. The Working Group noted that, because the catch limits it attempts to calculate for *D. eleginoides* are precautionary long-term catch limits for a long-lived species, a failure to reliably estimate a precautionary yield in a single year would be less serious than would be the case for a fishery subject to annual assessments of optimised yield. Following the determination of a revised recruitment series for Subarea 48.3 next year, it will become apparent whether or not previous catches have been above those that would have been calculated historically as precautionary yields using that recruitment series. If previous catches have been above precautionary yield levels, then this will be taken into account when calculating subsequent precautionary yields.

5.124 The remaining provisions of Conservation Measure 41-02 should be carried forward for the 2003/04 season.

5.125 Any catch of *D. eleginoides* taken in other fisheries in Subarea 48.3 should be counted against the catch limit determined by the Commission.

Dissostichus eleginoides Kerguelen Islands (Division 58.5.1)

Standardisation of CPUE

5.126 Haul-by-haul catch and effort data for the French longline fishery inside the French EEZ in Division 58.5.1 (fine-scale data) for the 1999/2000 to 2002/03 fishing seasons were examined. These data had been kindly provided by Prof. G. Duhamel (France). GLMMs and Linear Mixed Models (LMMs) as described in WG-FSA-SAM-03/12 and WG-FSA-03/34 were used to investigate trends in CPUE (kg/hook), average weight of caught fish (kg) and fishing depth (m). Details of the statistical analyses carried out are given in SC-CAMLR-XXII/BG/27, paragraphs 5.2.21 to 5.2.26.

5.127 Figure 5.10 shows the standardised CPUE series for 1999/2000 to 2002/03, along with estimated total removals for the same period. Figure 5.11 shows the corresponding series of standardised average weights in the catch.

5.128 These analyses show a general decreasing trend in the standardised CPUE with two steps (i.e. 1999–2000 and 2002–2003). The decrease in the standardised average weight probably indicates that the older age classes are becoming less numerous in the exploited stock.

Management Advice

5.129 Given the dramatic increase in total removals from 2000 onwards and the corresponding decline in standardised CPUE, the Working Group agreed that it is imperative that steps be taken to substantially reduce total removals from 2003 levels.

Dissostichus eleginoides Heard Island and McDonald Islands (Division 58.5.2)

5.130 The catch of *D. eleginoides* for the trawl fishery in the 2001/02 CCAMLR fishing season was 2 756 tonnes (catch limit = 2 815 tonnes, Conservation Measure 222/XX).

5.131 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2002/03 season was 2 879 tonnes (Conservation Measure 41-08) for the period from 1 December 2002 to 30 November 2003. The catch reported for this division at the time of the 2003 WG-FSA meeting was 2 130 tonnes.

Determination of Long-term Annual Yields using the GYM

5.132 SC-CAMLR-XXI, Annex 5, paragraphs 5.85 to 5.94 described the assessment of long-term annual yield for *D. eleginoides* in Division 58.5.2 used at the 2002 meeting. The same methodology was applied for the assessment at this meeting.

5.133 There were no updates to population parameters from last year used in the analysis of long-term annual yield. The input parameters used in the assessment are included in Table 5.10.

5.134 WG-FSA-03/33 provided information and analysis of a random stratified trawl survey of *D. eleginoides* in Division 58.5.2 carried out by Australia during 2003. The paper included estimates of abundance in 2003, CMIX analyses to determine cohort densities, and a comparison of the length distribution of catches from the first longline operation in Division 58.5.2 with commercial trawl catches. The results presented in WG-FSA-03/33 were used as a basis to revise the input of estimated cohort strengths for inclusion in the GYM (Table 5.11). WG-FSA-03/33 also provided a preliminary assessment of long-term annual yield for *D. eleginoides* in Division 58.5.2. The Working Group made several modifications to this preliminary analysis.

5.135 The Working Group agreed that recruitment data from two trawl surveys (1992 and 2000 in Table 5.11) should be excluded from the GYM. The 1992 survey was excluded because it did not sample below 500 m and the Working Group felt that it did not adequately cover the depth distribution of fish in the age range 3 to 8 years (see WG-FSA-96/38). The 2000 survey was also excluded because of Working Group concerns about the sampling design. The 2000 survey specifically targeted *C. gunnari*, and did not sample strata where *D. eleginoides* were known to occur in high densities. Thus, it is likely this survey underestimated the density of some cohorts.

5.136 For the base-case assessment, the Working Group agreed to include survey estimates of cohorts from ages 3 to 7. As in previous assessments, the Working Group considered that fish younger than age 3 were not adequately sampled by the trawl survey. Cohorts older than age 6 may be underestimated due to fishing on these cohorts. However, the process of mixture analysis can result in incorrectly assigning cohorts at older ages and inclusion of age-7 fish would potentially mitigate this possibility. Age-7 fish were not included in the 2003 survey as they were not detected in the mixture analysis. The Working Group further agreed to include the estimate of the age-8 cohort from the 1999 survey. The 1999 survey targeted *D. eleginoides*, included intensive sampling in areas where fish ages 5 and above were known to occur, and provided the only estimate of recruitment for this cohort. Estimates of recruitments based on a mean natural mortality rate of 0.165 year^{-1} are provided in Table 5.12.

5.137 Estimates of total removals for Division 58.5.2, based on updates of reported catches and new estimates of IUU (Table 3.2), are provided in Table 5.13, which also details the computed size/age vulnerabilities.

Assessment

5.138 The Working Group agreed that the base case, with the updated total removals and recruitment estimates, provided the most suitable inputs to the GYM for *D. eleginoides* in Division 58.5.2. The decision rule concerning escapement was binding in this assessment. The yield at which there was median escapement of 50% of the median pre-exploitation spawning biomass level over 35 years was 2 873 tonnes.

5.139 Three sensitivity analyses were undertaken. The first two sensitivities examined the influence of excluding trawl survey estimates of older age groups from the GYM. In the first case, only the age-8 cohort from the 1999 survey was excluded. This would result in a decrease in long-term precautionary yield (50% escapement decision rule triggered) to 2 748 tonnes (Table 5.14). The second sensitivity used only ages 3 to 6 from the 1990, 1993, 1999, 2001, 2002 and 2003 trawl surveys. This sensitivity would result in a more substantial decrease in the long-term precautionary yield to 2 150 tonnes (Table 5.14), with the decision rule triggered by the probability of depletion below 20% of pre-exploitation median spawning biomass. The decrease in yield from this sensitivity was due to the absence of recruitment estimates for the 1986, 1994 and 1995 age-4 cohorts which were estimated as relatively strong at ages 7 and 8 in the 1990 and 1999 trawl surveys (see Table 5.12).

5.140 The third sensitivity trial investigated the influence of the fishing vulnerability curves (see Table 5.13). The base-case assessment was based on trawl estimates of vulnerability, where vulnerability declines at older ages. Because of the incidence of IUU longline fishing

in Division 58.5.2 and the recent introduction of a legal longline fishery, the Working Group considered the possibility that fish remain fully selected once they are vulnerable to the fishery ('flat-topped' vulnerability). This sensitivity trial would result in a substantially higher level of long-term yield of 3 731 tonnes, based on the 50% escapement decision rule trigger (Table 5.14). The primary reason for this was that the flat-topped vulnerability would allow more of the catch (biomass) to be taken from larger fish, reducing the fishing mortality on young fish.

Management Advice

5.141 The Working Group recommended that the catch limit for Division 58.5.2 in the 2003/04 season be revised to 2 873 tonnes, representing the long-term annual yield estimate from the GYM. The remaining provisions of Conservation Measure 41-08 should be carried forward for the 2003/04 season.

5.142 The Working Group noted that the recruitment series for *D. eleginoides* in Division 58.5.2 is dependent on the design of trawl surveys and the methods used to estimate recruitment. It recommended that estimates of recruitment are reviewed before the 2004 WG-FSA-SAM meeting, consistent with recommendations for Subarea 48.3 and other fisheries.

5.143 The Working Group also noted that tagging experiments (WG-FSA-03/72) and genetic studies (WG-FSA-03/66) have indicated that some subadult *D. eleginoides* from Heard and McDonald Islands in Division 58.5.2 migrate to Kerguelen and Crozet Islands in Division 58.5.1. The Working Group noted that movement of subadult or adult fish among areas could have significant implications for management of fisheries in both areas. As the current assessment process is based on projections of cohorts through the fishery, based on estimates of local recruitment from survey data in the areas, it is not likely to be affected provided all catches taken from these cohorts are accounted for. However, significant connectivity between statistical areas, as a result of dispersal of eggs and/or larvae or movement of post-settlement toothfish, would mean that impacts of fishing on the spawning stock in one area will potentially impact on recruitment in other areas. The Working Group agreed that implications of these preliminary findings warranted further consideration.

Champsocephalus gunnari South Georgia (Subarea 48.3)

Commercial Fishery

5.144 The commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) was open from 01 December 2002 to 30 November 2003. The catch limit agreed by the Commission for this period was 2 181 tonnes (Conservation Measure 42-01). This conservation measure included several other conditions applicable to this fishery. These included restricting the total catch of *C. gunnari* taken in the period between 1 March and 31 May to 545 tonnes to reduce possible targeting of spawning concentrations. Further provisions were made to include per-haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish, data reporting on a haul-by-haul basis, and the presence of a scientific observer on every vessel. Overall by-catch limits covering all fishing activities in Subarea 48.3 also applied (Conservation Measure 33-01).

5.145 As of 7 October 2003, three vessels had participated in the 2002/03 commercial fishery. All fishing took place between 18 December and 26 February with a total catch of 2 155 tonnes. Twenty-six tonnes of the catch limit remain and the fishing season will remain open until 30 November 2003.

Surveys

5.146 No new stock abundance surveys were undertaken in the 2002/03 season in Subarea 48.3. Data from two surveys in January/February 2002, one by Russia (*Atlantida*) and one by the UK (*Dorada*), were analysed at last year's meeting (SC-CAMLR-XXI, Annex 5, paragraphs 5.95 to 5.101 and Table 5.16). The estimate of abundance in 2002 had been calculated from a combined dataset, with the UK haul-by-haul data multiplied by a factor of 1.241 to account for differences in catchability between the two trawls (SC-CAMLR-XXI, Annex 5, paragraphs 5.103 and 5.104). This approach was consistent with that adopted by the Working Group in 2000 and 2001.

5.147 At its workshop in August 2003, WG-FSA-SAM considered the application of such a scaling factor and agreed that one difficulty with this approach is that it does not take account of the possibility of a threshold abundance (swept-area density) being required for a bias to be present between the UK and Russian trawl gear (WG-FSA-03/40, paragraph 2.39).

5.148 Both last year's meeting of the Working Group and the intersessional meeting of WG-FSA-SAM considered the use of acoustic data collected during both surveys for estimating the abundance of fish in the layer above the bottom trawl (WG-FSA-03/40, paragraphs 2.33 to 2.49). At last year's meeting, WG-FSA identified several areas of uncertainty, including the target strength of icefish. There was insufficient time at that meeting to resolve these issues. The acoustic estimates were therefore not used in the 2002 assessment.

5.149 In August 2003, WG-FSA-SAM considered several ways in which acoustic estimates could be used to estimate the abundance of icefish, in combination with the bottom trawl data (WG-FSA-03/40, paragraphs 2.43 to 2.49).

5.150 WG-FSA-SFA subsequently considered in detail the specific details of the Russian acoustic data from the *Atlantida* survey at its workshop in August 2003 (WG-FSA-03/14).

5.151 WG-FSA-SFA agreed to restrict the estimation of acoustic biomass to the pelagic layer above the level of the bottom trawl (8–58 m above the seabed). The assessment of uncertainty in the estimate was initially restricted to the estimates of target strength, species composition, and acoustic sampling variance. The workshop had agreed that the total measurement uncertainty arising from each of these sources needed to be studied and quantified before the acoustic estimates of *C. gunnari* biomass could be used (WG-FSA-03/14, paragraph 5.4).

5.152 Information concerning these sources of uncertainty was added to the report of WG-FSA-SFA (WG-FSA-03/14) during the post-meeting adoption of the report by correspondence. WG-FSA considered this information and agreed that it addressed the

concerns of the WG-FSA-SFA to the extent that it would be possible to use the acoustic estimate at this year's meeting in the assessment of *C. gunnari* in Subarea 48.3 (paragraphs 3.36 to 3.45).

Assessment at this Year's Meeting

5.153 The Working Group agreed to use a combined estimate of abundance from the Russian acoustic survey and the combined UK and Russian bottom trawl surveys (calculated last year, SC-CAMLR-XXI, Annex 5, paragraph 5.104) as the starting point for a short-term projection starting in 2001/02 and ending in 2003/04 (SC-CAMLR-XXII/BG/27, paragraphs 5.2.27 to 5.2.35).

5.154 The GYM, used routinely for the assessment of long-term yield of other species in the CCAMLR Convention Area, is now capable of being configured to perform the short-term projection used for *C. gunnari* in Subarea 48.3 and Division 58.5.2 (WG-FSA-03/40, paragraph 2.13). Some differences had been noted between the results of the short-term projection in the GYM with those obtained previously using the MathCad procedure (WG-FSA-03/32). These differences and the reasons for them are discussed in paragraph 4.6. The Working Group agreed to use the GYM to implement the short-term assessment at this year's meeting.

5.155 The Working Group discussed whether the estimate of biomass in age 1 in 2001/02 (the 2000/01 cohort) should be included in the projection. In the past, this age group has been excluded because it is considered to be poorly represented in bottom trawl samples compared to older age classes, due to the more pelagic distribution of young fish (WG-FSA-02/54 and 02/55). This age group may be much better estimated by the acoustic survey and concurrent pelagic trawls. The Working Group noted that these fish would recruit fully to the fishery in 2003/04 as age 3, and would therefore correctly represent part of the commercial catch.

5.156 The Working Group was concerned about the uncertainties involved in projecting the 2000/01 cohort over two years. The Working Group recalled previous discussions of the possibility that natural mortality on young fish might be higher than for older age classes, due to higher predation by predators feeding in the water column (WG-FSA-01/71; SC-CAMLR-XX, Annex 5, Appendix D, paragraphs 5.8 to 5.11). No estimate of how high this level of *M* might be was available at this year's meeting. However, information provided by WG-FSA-03/74 suggested that it could be high. The paper described the consumption of considerable amounts of young icefish by gentoo penguins and Antarctic fur seals, with estimated consumption often exceeding the biomass estimated from bottom trawl surveys. However, the authors of WG-FSA-03/74 also noted that the majority of the foraging dives of Antarctic fur seal are within the top 50 m (Boyd et al., 1994), well above the layer sampled by the bottom trawl.

5.157 In this context the Working Group noted that the estimate of *M* for *C. gunnari* in Subarea 48.3 (0.71) is already high compared to other Antarctic fish species and also much higher than the value used for this species in Division 58.5.2 (0.4).

5.158 The length frequency of the commercial catch in 2002/03 (Figure 5.12) indicates that age-class-2 fish were not subjected to substantial fishing mortality in 2002/03. Almost all of

the catch was greater than 25 cm in length. The mean length of age-2 fish is approximately 24 cm. The low occurrence of age-2 fish in the catch is likely to be due to the existing minimum size limit (24 cm) in Conservation Measure 42-01, paragraph 4.

5.159 Taking these issues into account, the Working Group agreed to undertake two short-term projections, one including age-1 fish in the initial biomass, and one excluding these fish. A single level of *M* was used for both of these projections.

5.160 The analysis comprised the following steps:

- (i) The one-sided lower 95% confidence bound of the total biomass of *C. gunnari* from the *Atlantida* acoustic survey in February 2002 for the area above the level of the bottom trawl (8–58 m off the bottom) was calculated based on information provided by Dr Gasiukov. The resulting biomass across all age classes was 12 353 tonnes.
- (ii) The acoustic biomass estimate was added to the combined biomass estimate from the UK and Russian bottom trawl surveys in 2002, calculated at last year's meeting (SC-CAMLR-XXI, Annex 5, Table 5.19, last column). The total biomass in 2001/02, including the pelagic component, was 35 059 tonnes (12 353 + 22 706).
- (iii) The Working Group noted that at last year's meeting the lower 95% confidence bound of the biomass estimate was calculated using a bootstrap procedure that included all fish caught during the survey. However, this biomass estimate was used to scale the age distribution of fish numbers age 2+. This biomass estimate should therefore have been reduced to take account of the omission of the age-1 fish from the projection. This error was corrected at this year's meeting. The resulting biomass of age 2+ estimated from the combined bottom trawl surveys was 22 393 tonnes, a 1.4% reduction compared to the value in Table 5.19 of last year's report.
- (iv) The age distribution of the pelagic biomass component was calculated by analysing catch-weighted length frequencies (numbers of fish) from concurrent pelagic tows (WG-FSA-02/44) using the CMIX program. Haul-by-haul length frequencies from pelagic tows were weighted by catch/distance towed (nominal trawl width constant across hauls). The results of the CMIX analysis are presented in Figure 5.13. The Working Group noted an almost 16% difference between the observed and expected densities from the CMIX analysis. The plot of the expected mixtures indicates that this discrepancy is in component-1 (age-1) fish. Accordingly, the density of component-1 was adjusted to take account of the discrepancy. This increased the density from 3 835 to 4 860 (units are relative numbers per area).
- (v) The distribution of numbers-at-age resulting from the CMIX analysis was converted to a distribution of biomass-at-age by converting the mean length-at-age from the CMIX analysis to mean weight-at-age using a length–weight relationship calculated from more than 5 000 weight measurements collected during UK trawl surveys in 2002 and 2003 (the UK survey in 2003 was not a biomass survey, but did provide biological data for *C. gunnari*). The length–weight plot is presented in Figure 5.14.

- (vi) Length densities from the combined 2002 bottom trawl survey data analysed at last year's meeting were reanalysed using CMIX at this year's meeting, in order to obtain an estimate of the relative abundance of the 1 year olds in the bottom trawl estimates. This component of the population was not previously included in the analysis. Inclusion of the 1-year-old fish allowed both the adjustment of the bottom trawl biomass estimate to exclude 1 year olds (see paragraph 5.183), and also the inclusion of 1 year olds (both from the acoustic and the bottom trawl estimates) in the initial population structure. The results of the CMIX analysis are presented in Figure 5.15.
- (vii) The resulting estimate of total biomass of age-2+ fish in 2001/02 was 29 694 tonnes, comprising 22 393 tonnes from the bottom trawl survey and 7 301 tonnes from the acoustic survey.

5.161 The results of the CMIX analysis in Figures 5.13 and 5.15 confirm the findings of WG-FSA in 2002. As at last year's meeting, the CMIX analysis indicated that no 4-year-old fish were detected by the Russian and UK surveys in 2002. This was true also for the analysis of the length frequencies from the pelagic hauls.

5.162 Of the commercial catch of 2 656 tonnes in Subarea 48.3 in 2002, 471 tonnes were taken in February after the assumed time of application of the joint surveys (30 January). This catch value was included in the projection along with the catch of 2 155 tonnes taken during the 2002/03 season.

5.163 The resulting data inputs into the two short-term projections, comprising a biomass estimate, distribution of numbers-at-age, an estimate of M , a selection function, von Bertalanffy growth parameters, mean lengths-at-age, a weight-length relationship and known catches since the time of the biomass estimate implemented using the GYM, are provided in Tables 5.15 and 5.16.

5.164 Short-term assessments were run using two representations of growth: (i) using von Bertalanffy growth parameters and (ii) using fixed mean lengths-at-age from the CMIX analysis of bottom trawl data for ages 2, 3, 5 and 6. Mean length was taken directly from the von Bertalanffy curve for ages 1 and 4. The results of the projections were very similar due to good correspondence between the mean lengths from the CMIX analyses and the length-at-age estimated by the growth curve. The mean lengths-at-age were considered to provide the most realistic representation of growth for the short-term projections.

5.165 The Working Group considered the results of the two short-term projections (Table 5.17). The projection of age-2+ fish from 2001/02 gives a projected yield of 2 205 tonnes in the 2003/04 season. The projection of age-1+ fish from 2001/02 gives a projected yield of 3 570 tonnes in the 2003/04 season.

5.166 The Working Group welcomed the developments in the assessment of icefish at this year's meeting. For the first time, the Working Group had been able to provide an estimate of the biomass and age structure of fish in the water column above the layer sampled by bottom trawls, which have been the only means of estimating biomass in the past. By combining this estimate with the estimate derived from bottom trawl surveys, the Working Group has provided a more representative estimate of the biomass in Subarea 48.3 than previously

available. The Working Group noted, however, that the acoustic estimate covered only the layer from 8 to 58 m above the bottom, and that *C. gunnari* also occur in layers above this level.

5.167 As with the estimates from bottom trawl surveys, the Working Group noted the substantial uncertainties associated with the estimate of biomass from the acoustic survey. These uncertainties had been discussed in detail by the meetings of WG-FSA-SAM and WG-FSA-SFA in the intersessional period.

5.168 The Working Group recalled that the short-term projection and its associated catch-control rule was developed to assess a catch level such that fishing should not, without any substantial risk (no more than 5% probability), reduce the spawning stock biomass to below 75% of the level that would occur in the absence of fishing within the two years following an abundance biomass estimate provided by a survey. To achieve this, the one-sided lower 95% confidence bound of the biomass estimate is used as the starting point for the projection. In incorporating the acoustic biomass in the abundance estimate, the Working Group used the lower of two estimates of the one-sided lower 95% confidence bound of the biomass (paragraph 3.44).

5.169 The Working Group agreed that the estimate of biomass from the acoustic survey should be included in the projection for the estimation of yield in 2003/04. However, the Working Group could not agree whether the catch limit for 2003/04 should be based on the projection that incorporates age-1 fish in the 2001/02 biomass estimate, or the projection that excludes those fish.

5.170 Several members of the Working Group considered that WG-FSA-SFA's failure to reach consensus as to whether acoustic biomass estimates should be used in the assessment of *C. gunnari* warranted taking a precautionary approach to using this information to set catch levels in Subarea 48.3. While these members agreed that there was sufficient evidence to include acoustic biomass estimates for *C. gunnari* in the assessment process, they recommended using the projection of age-2+ fish only. They felt the dynamics of *C. gunnari* in the pelagic zone were poorly understood; specifically:

- (i) there are considerable uncertainties as to the effects of vertical migratory patterns (including effects of seasonality, as well as migration of older age classes);
- (ii) the potential for age-specific mortality rates, in particular for age-1 fish due to predator-prey interactions are not accounted for in the assessment;
- (iii) there are uncertainties in size composition of *C. gunnari* in acoustic estimates of biomass.

5.171 Because there was no opportunity to adequately address these issues during the WG-FSA-SFA and WG-FSA-SAM meetings, and in view of the importance of taking a precautionary approach to management of this fishery, these members recommended that age-1 fish be excluded from the projection used for the assessment of yield.

5.172 Other members considered that, in view of the conservative nature of the short-term projection method, the precautionary catch limit for 2002/03 should be based on the projection including the age-1 fish. Specifically, they noted that:

- (i) the concerns expressed at the meeting of WG-FSA-SFA have been considered, and the Working Group used the lower of two estimates of biomass resulting from the methods of estimating target strength, species identification and length composition used by WG-FSA-SFA;
- (ii) the method of estimating biomass from the acoustic data also incorporates uncertainty in species identification, length composition and density variability;
- (iii) the projection uses the one-sided lower 95% confidence bounds of the biomass estimates;
- (iv) the estimate of biomass in the layer above the bottom trawl covers the range from 8 to 58 m above the bottom and there is likely to be additional biomass of *C. gunnari* in layers above this level;
- (v) the value of M used in the projection is high compared to other Antarctic species, and the stock of *C. gunnari* in Division 58.5.2;
- (vi) the combination of points (ii), (iii) and (iv) above leads to a conservative catch limit, consistent with a precautionary approach;
- (vii) the status of the stock will be assessed by a survey in the forthcoming season (paragraph 3.47).

5.173 The Working Group agreed that the uncertainties in the assessment of the yield of *C. gunnari*, and their potential effects on management of the fishery in the short and long term, should be more fully addressed in the intersessional period as part of the development and evaluation of a management procedure for *C. gunnari* (see SC-CAMLR-XX, Annex 5, Appendix D, paragraph 9.1(vi)).

Management Advice

5.174 The Working Group prepared two assessments of the precautionary catch limit for *C. gunnari* in 2003/04. The projection of age-1+ fish from 2001/02 gives a projected yield of 3 570 tonnes in the 2003/04 season. The projection of age-2+ fish from 2001/02 gives a projected yield of 2 205 tonnes in the 2003/04 season. The Working Group was unable to reach agreement about which of these two catch limits should be recommended (paragraphs 5.169 to 5.172).

5.175 The Working Group had no information from which to consider or revise its advice of 2001 in respect of the current seasonal limitation in Conservation Measure 42-01. It therefore recommended that these aspects of the conservation measure should remain unchanged.

5.176 The Working Group recommended the continuation of other aspects of Conservation Measure 42-01, with the exception of the possible consideration of whether bottom trawl gear might be permitted under appropriate conditions (SC-CAMLR-XXI, paragraphs 5.46 to 5.50).

Champscephalus gunnari Kerguelen Islands (Division 58.5.1)

5.177 The last commercial catches of icefish in Division 58.5.1 were taken in the 1995/96 season. A survey was undertaken in 2001/02 (WG-FSA-02/65). Current information is that the biomass of *C. gunnari* in the survey area has remained at low levels since 1996/97. With no recent information on the status of the stock, it is expected that the fishery for *C. gunnari* within the French EEZ of Division 58.5.1 will remain closed in the 2003/04 season and will remain closed until information on stock status is obtained from a survey.

Champscephalus gunnari in Division 58.5.2

Commercial Catch

5.178 The commercial fishery for *C. gunnari* around Heard Island (Division 58.5.2) in the 2002/03 season is open from 1 December 2002 to 30 November 2003. The catch limit agreed by the Commission for this period was 2 980 tonnes to be taken on the Heard Island Plateau only (Conservation Measure 42-02). This conservation measure included several other conditions applied to this fishery, including per-haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish, data reporting on a haul-by-haul basis, and the presence of a scientific observer on every vessel. Overall by-catch limits covering all fishing activities in Division 58.5.2 also applied (Conservation Measure 33-02).

5.179 The commercial catch in the 2002/03 fishing season up to 3 October 2003 was 2 343 tonnes. This catch was taken during fishing operations that started in February 2003 and ended in May 2003. The fishery will remain open until 30 November 2003 or until the catch limit is reached, whichever is sooner. This fishery was based on strong 4- and 5-year-old cohorts detected as 3 and 4 year olds in the June 2002 survey.

Surveys

5.180 A survey was conducted on the Heard Island Plateau and Shell Bank in May 2003 to assess the abundance and size structure of the *C. gunnari* populations. The results of this survey are reported in WG-FSA-03/32. This survey used the same methodology that has been applied since 1997 and was conducted after the commercial fishing in 2002/03 had concluded. The abundance estimated from the survey was about 20% of that in the previous three years and the population was composed principally of 2- and 4-year-old fish. This is consistent with expected natural and fishing mortality of the 4- and 5-year-old fish and the recruitment of a fairly weak 2-year-old cohort. No *C. gunnari* were caught on Shell Bank. The biomass estimate for this stratum was zero.

Assessment at this Year's Meeting

5.181 Following some difficulties in the interpretation of length densities of *C. gunnari* in Division 58.5.2 at last year's meeting, WG-FSA requested that 'intersessional work should be conducted to reconcile differences between mean lengths from the mixture analysis and mean lengths-at-age from the growth curve' (SC-CAMLR-XXI, Annex 5, paragraph 5.118).

WG-FSA-03/32 contained an analysis that clarifies the age composition of the stock and the expected lengths-at-age for each cohort. The paper proposes an adjustment in the t_0 parameter of the von Bertalanffy growth model in order to align the growth curve with the estimated lengths from CMIX analysis of length distributions sampled at the time of the survey. Using the adjusted t_0 provided better fit to the observed mean length, although the estimated density of the 2+ cohort was smaller than the observed density. The Working Group agreed to use the adjusted growth curve for the short-term projection at this year's meeting.

5.182 As with the assessment of *C. gunnari* in Subarea 48.3, the short-term projection was run using the GYM (paragraph 4.6). Data inputs for the projection are provided in Table 5.18. With a fishing mortality of 0.1439 for 2003/04 and 2004/05 the catch limit satisfying the agreed criteria is 507 tonnes over two years. This is made up of 292 tonnes in the first year (2003/04) and 215 tonnes in the second year (2004/05). The decrease in the yield estimate from the 2002/03 season is mostly due to the decrease in the initial biomass estimate used for the projection. The estimate of the one-sided lower 95% confidence bound of biomass was 20 510 tonnes in 2001/02. This fell to 2 322 tonnes in 2002/03 arising from the results of the 2002/03 survey.

5.183 The results of the survey presented in WG-FSA-03/32 suggested that a potentially strong cohort of 1 year olds will grow to legal size as 2 year olds towards the end of the 2003/04 season. However, the Working Group noted that this cohort was not reliably assessed by the bottom trawl survey for reasons similar to those described in SC-CAMLR-XX, Annex 5, Appendix D, paragraph 7.17. This cohort will not be able to be assessed during the forthcoming season. WG-FSA-03/32 suggested a number of alternatives to reduce the fishing mortality on this unassessed cohort during the forthcoming season:

- (i) delaying the start of the fishing season until the cohort has been assessed;
- (ii) increasing the minimum legal size so as to avoid exploiting the cohort until the 2004/05 season by retaining 240 mm as the minimum in the early part of the season and then increasing the minimum size to 280 mm in August 2004 (see paragraph 5.184);
- (iii) shortening the fishing season to avoid such exploitation but to not alter the catch.

5.184 Table 5.19 provides a summary of the cohorts currently observed in the population and their expected modal sizes at the times of the surveys as well as at the beginning of the 2003/04 and 2004/05 seasons. It was noted that the 2001 cohort will grow to 240 mm mean length by May 2004. These fish are expected to reach 280 mm mean length by the end of the 2003/04 season. Increasing the size limit to 280 mm in May 2004 would provide some protection for this cohort in the forthcoming season. The Working Group noted that this information would need to be considered when choosing between the options in paragraph 5.183.

Management Advice

5.185 The Working Group agreed that the total catch limit should be revised to 292 tonnes for the period from 1 December 2003 to 30 November 2004.

5.186 The remaining provisions of Conservation Measure 42-02 should be carried forward to the 2003/04 season.

5.187 It is recommended that a measure be included to protect young unassessed cohorts from being exploited later in the season as they grow to sizes larger than the current minimum size limit. Options for such measures are provided in paragraph 5.183.

5.188 The Scientific Committee may wish to consider ways of providing for stable catches from one year to another given the large fluctuations in the abundance of this species.

Other Fisheries

Dissostichus eleginoides Crozet Islands (inside French EEZ) (Subarea 58.6)

Standardisation of CPUE

5.189 Haul-by-haul catch and effort data for the French longline fishery (inside the French EEZ) in Subarea 58.6 (fine-scale data) for the 1999/2000 to 2002/03 fishing seasons were examined. These data had been kindly provided by Prof. Duhamel. GLMMs and LMMs, as described in WG-FSA-SAM-03/12 and WG-FSA-03/34, were used to investigate trends in CPUE (kg/hook), average weight of caught fish (kg) and fishing depth (m). Details of the statistical analyses carried out are given in SC-CAMLR-XXII/BG/27, paragraphs 5.3.1 to 5.3.7.

5.190 Figure 5.16 shows the standardised CPUE series for the period 1999/2000 to 2002/03, along with total removals. Figure 5.17 shows the time series of standardised average weights in the catch for the same period.

5.191 These analyses show a major decrease in the standardised CPUE from 2000 to 2003. The lower 1999 CPUE estimate probably reflects the adaptation to fishing in the Crozet area. The substantial decrease in the standardised average weight from 2000 probably indicates that the older age classes are becoming less numerous in the exploited stock.

5.192 Even with the relatively low level of total removals from 1998 onwards, the CPUE estimates decreased sharply between 2000 and 2003. There are two possible causes for this decrease in CPUE: (i) overexploitation of the stock due in particular to the high total removals in 1996 and 1997; and/or (ii) a possible cumulative effect of depredation on the line by killer whales. Killer whales are very abundant in the Crozet Islands area and have recently adapted to the presence of longlines as a source of opportunistic food. This last hypothesised effect on longline CPUE will be studied intersessionally by Prof. Duhamel and Dr Candy.

Management Advice

5.193 Given the dramatic decline in CPUE since 2000 even under the relatively low levels of total removals, it is imperative that future total removals should be reduced until further analyses indicate the cause of the CPUE decline and steps can be taken to conserve the stock adequately.

Dissostichus eleginoides in Subarea 58.7

Prince Edward Islands EEZ

5.194 WG-FSA-03/97 presented a further updated assessment of the *D. eleginoides* population in the South African EEZ around the Prince Edward Islands. A previously updated assessment from that presented last year (WG-FSA-02/76) had been discussed by WG-FSA-SAM.

5.195 Despite model refinements, WG-FSA-03/97 reported that the CPUE data and catch-at-length data remain sharply inconsistent within the modelling framework considered. The former suggested the population to be heavily depleted, whereas the latter suggested quite the reverse. Based on a cautious interpretation of projections over the wide range of current stock status that can be argued from these analyses, the authors suggested that annual catch levels should not exceed a few hundred tonnes.

5.196 The Working Group agreed that it would be useful to re-examine the standardisation of the available CPUE for this region, to see if this might help resolve the difficulties that had been encountered. This was carried out by Dr Candy, with details given in SC-CAMLR-XXII/BG/27, paragraphs 5.3.8 to 5.3.10.

Standardisation of CPUE

5.197 Haul-by-haul catch and effort data for the South African EEZ around the Prince Edward Islands in Subarea 58.7 (fine-scale data) for the 1996/97 to 2001/02 fishing seasons were examined. GLMMs and LMMs, as described in WG-FSA-SAM-03/12 and WG-FSA-03/34, were used to investigate trends in CPUE (kg/hook). One difference to the standardisation method described in WG-FSA-03/34 was that the series was scaled by dividing each season's CPUE estimate by the average over all seasons as in WG-FSA-03/97.

5.198 Figure 5.18 shows the standardised CPUE series for the period, along with the estimated total removals. Figure 5.19 shows a comparison of three estimated CPUE time series: (i) the series estimated at WG-FSA-03 using the methods described in WG-FSA-03/34, (ii) the series given in WG-FSA-02/76, and (iii) the series given in WG-FSA-03/97.

5.199 Even with the relatively low level of total removals from 1998 onwards, the standardised CPUE estimates remained at low levels relative to those for 1996 and 1997. This was possibly due to the high total removals in 1996 and 1997.

Assessment

5.200 The Working Group agreed that the revised standardised CPUE series represented an improvement to the series presented in WG-FSA-03/97. However, the overall trend over time still remains similar to that found in WG-FSA-03/97, indicating when taken by itself that the population has been substantially reduced. As the revision to the standardised CPUE series does not affect the catch-at-length data, the fundamental contradiction discussed in WG-FSA-03/97 still remains.

Management Advice

5.201 Taking a precautionary evaluation of the available data, the Working Group suggested that the annual allowable catch in the Prince Edward Islands EEZ should not exceed 300 tonnes, subject to target levels of recovery that might be adopted by the Commission.

Outside Prince Edward Islands EEZ

Management Advice

5.202 The Working Group recommended that the prohibition of directed fishing in Subarea 58.7 outside EEZs (Conservation Measure 32-12) should continue.

Notothenia rossii (Area 48)

5.203 *N. rossii* was the first target species of the fishery in the Southern Ocean. The species had been heavily fished at the end of the 1960s/beginning of the 1970s. The closure of the fishery for this species was one of the first conservation measures CCAMLR adopted in 1985 (Conservation Measures 32-04 to 32-06).

5.204 Fish biomass within a CCAMLR subarea or part of a subarea is commonly estimated by targeting a number of species including *N. rossii* at the same time. However, *N. rossii* shows a highly skewed spatial distribution of abundance; hauls with large catches tend to occur in small areas that are consistent between years while hauls taken over the remaining area of distribution typically contain few fish. Skewed distributions of catches lead to large confidence intervals, and can undermine the assumption of the normal distribution of estimates, even when large sampling effort is applied (Jones et al., 1995). It was for this reason that CCAMLR was unable to provide adequate biomass estimates for *N. rossii* and follow the potential recovery of the stocks properly in the almost 20 years that the fishery was closed.

5.205 In order to provide more accurate biomass estimates of the species in the future, WG-FSA-03/12, based on analyses of research surveys between 1975 and 2003 (paragraph 3.35), suggested that it should be investigated if *N. rossii* may be estimated by

- stratifying on the consistent areas of high density;
- increasing the sampling effort that can be applied by acoustic methods as indicated by preliminary Russian investigations conducted in the late 1970s. These need to be combined with an adequate number of identification hauls.

5.206 With respect to the calculation of biomass of *N. rossii* from historic surveys, maximum likelihood methods based on empirically observed distributions may provide biomass estimates with smaller confidence intervals as an alternative to the method commonly used by CCAMLR to calculate mean biomass and corresponding confidence intervals (Pennington, 1983).

South Shetland Islands – Antarctic Peninsula (Subarea 48.1)

5.207 CCAMLR closed the fishery in this subarea after the 1989/90 season (Conservation Measure 32-02). The US AMLR Program and the German Antarctic Marine Living Resources Program (G.AMLR) conducted bottom trawl surveys of Elephant Island and the (lower) South Shetland Islands (Subarea 48.1) during the 1996, 1998, 2001, 2002 and 2003 austral summers. Information on species and size composition, abundance, spatial distribution and dietary patterns from the most recent survey in 2003 was presented in WG-FSA-03/38. Estimates of total stock biomass from these surveys were computed for eight species: *C. gunnari*, *Chaenocephalus aceratus*, *Chionodraco rastrospinosus*, *G. gibberifrons*, *Lepidonotothen larseni*, *L. squamifrons*, *Notothenia coriiceps* and *N. rossii*. The standing stock for most species has fluctuated, with no signal of substantial year classes or significant recruitment for any species. Standing stock of *G. gibberifrons* remained the largest relative to all other species. However, there appears to be a decline in biomass of this species with few recruits having entered the adult part of the stock since 1996 (see paragraph 3.28).

5.208 The former fishing ground off Joinville–D’Urville Islands at the tip of the Antarctic Peninsula was revisited in 2002. This area had been fished extensively for *C. wilsoni* in certain years from the late 1970s through to the second half of the 1980s. Other species which were known to occur in the catches in some numbers were *C. rastrospinosus* and *G. gibberifrons*. The catch history of the area, however, was poorly understood and commercial catches have been reported to CCAMLR only twice by Poland and the former German Democratic Republic in 1978/79 and 1979/80. Occasional visits by the Polish research vessel *Profesor Siedlecki* in the 1980s did not provide further insight into the status of the most abundant stocks. WG-FSA-03/26 reviewed what was known on the biology of stocks in the Joinville–D’Urville Islands region and their exploitation in the 13 years since they had been subject to fishing. Despite considerable new biological information on the target species of the fishery, the scarcity of data for assessment purposes did not allow CCAMLR to assess the status of stocks (see paragraph 3.29).

South Orkney Islands (Subarea 48.2)

5.209 The subarea was closed by CCAMLR for finfishing after the 1989/90 season (Conservation Measure 32-02). No new information was provided in 2002/03 with respect to the state of the stocks. The most recent information available to WG-FSA is from a bottom trawl survey undertaken by the USA in March–April 1999.

South Sandwich Islands (Subarea 48.4) and Bouvet Island (Subarea 48.6)

5.210 Both subareas exhibit a rather limited shelf area surrounding the islands. They have not been subject to commercial fishing activities with the exception of one exploratory longline cruise around the South Sandwich Islands in 1993 (Ashford et al., 1994). Following results from this cruise, CCAMLR had set a catch limit of 28 tonnes of *Dissostichus* spp. for this subarea (Conservation Measure 41-03).

5.211 No new information has been provided on fish stocks in the South Sandwich Islands since 1993. New information is likely to be forthcoming in 2004 when the US 'Icefish' cruise will be visiting the South Sandwich Islands in austral winter. A total of 30 hauls is planned to be conducted by bottom trawl haul.

5.212 No new information has been provided on fish stocks around Bouvet Island since France conducted some research hauls with a small-sized trawl around the island in 1980 (Duhamel, 1987) and the former German Democratic Republic conducted a survey with a commercially-sized bottom trawl around the island in 1980/81 (Gubsch and Hoffmann, 1981). No data had been submitted since then to enable CCAMLR to set catch limits for fish stocks around the island. New information is likely to be forthcoming in 2004 when the US 'Icefish' cruise will be visiting Bouvet Island. A total of 30 hauls is planned to be conducted by bottom trawl haul.

Electrona carlsbergi (Subarea 48.3)

5.213 The state of the stock was last assessed in 1994. A precautionary catch limit has been set at 109 000 tonnes by CCAMLR since then, including provisions for the catch of this species at Shag Rocks, the by-catch of notothenioids in this fishery, and data reporting and research (Conservation Measure 43-01). The initial assessment in 1994 was undertaken with considerable uncertainty regarding the input parameters. Members are encouraged to provide information to refine this assessment.

5.214 More data on *E. carlsbergi* and other myctophids may become available from the CCAMLR-2000 Survey. It is still unclear to the Working Group, however, to what extent data collected during a survey targeting krill could be used to estimate myctophid biomass in the area quantitatively.

Stone crabs (*Paralomis* spp.) (Subarea 48.3)

5.215 Stone crabs are subject to Conservation Measures 52-01 and 52-02 regulating the fishery and experimental harvest of crabs. They were not exploited in the 2002/03 season. WG-FSA-03/76 described results obtained during January 2000 using a baited video camera system that was deployed 15 times at depths of 719–1 518 m around South Georgia. Four species of lithodid crab (*Paralomis formosa*, *P. spinosissima*, *Lithodes* spp. and *Neolithodes diomedae*) were attracted to the baits of which *P. formosa* was the most abundant. The abundance of *P. formosa* was estimated using arrival rate at baits, predictions of odour plume size and observations of walking speed. Numbers of crabs increased rapidly following bait emplacement, with total numbers observed in the 4.9 m² field of view exceeding 50 within 200 minutes on three occasions. The density of crabs, estimated from the increase in crab numbers per unit area of odour plume, averaged 8 313 individuals km⁻² (range 1 100–25 600). Density was not significantly correlated with depth, temperature or current speed and variability was attributed to substrate form.

5.216 WG-FSA-03/77 demonstrated the utility of baited camera systems to estimate the abundance of scavenging lithodid crabs in deep water around South Georgia (Subarea 48.3). Crabs accumulate at bait over time and the area from which they are attracted (the odour

plume) is estimated from the current speed, diffusion coefficients and crab walking speed. The Working Group recommended that the method of estimating density be reviewed by WG-FSA-SAM if it is proposed to be used as a basis for assessments.

5.217 No proposal for the harvest of crabs has yet been received by CCAMLR for the 2003/04 season.

5.218 The Working Group noted that since Conservation Measure 52-02 was first formulated there has been an attempt by Watters (1997) to use the data derived from Conservation Measure 52-02 to estimate stock size. There have also been analyses of species composition, distribution and demography (Purves et al., 2003) which used data collected under Conservation Measure 52-02, and, as in WG-FSA-03/77, suggestions of new methods of estimation of biomass. It would therefore be appropriate to revisit the plan in Conservation Measure 52-02 to assess the extent to which its objectives have been met, or in what way it might be modified so as to provide information likely to lead to an assessment. The Working Group encouraged Members to submit proposals for alternative ways of managing and collecting data from the fishery, which would be evaluated by the Working Group.

Martialia hyadesi (Subarea 48.3)

5.219 The exploratory fishery on *M. hyadesi* was subject to Conservation Measure 61-01. No new information on the species was available. No new request has been submitted to CCAMLR to continue exploratory fishing on this species in 2003/04.

Management Advice

Notothenia rossii

5.220 The Working Group recommended that further investigations be undertaken in the future in order to provide more accurate biomass estimates of *N. rossii* (see paragraph 5.205).

Elephant Island, Lower South Shetland Islands and Antarctic Peninsula (Subarea 48.1)

5.221 The Working Group agreed with the conclusions of WG-FSA-03/38 that the overall abundance of finfish in the South Shetland Islands has yet to reach a level at which commercial exploitation would be sustainable. The Working Group therefore recommended that the existing Conservation Measures 32-02 and 32-04 on the prohibition of finfishing in Subarea 48.1 remain in force.

South Orkney Islands (Subarea 48.2)

5.222 No new information on the state of fish stocks around the islands has been made available. The Working Group therefore recommended that existing Conservation Measures 32-03 and 32-05 on the prohibition of finfishing in Subarea 48.2 remain in force.

South Sandwich Islands (Subarea 48.4)

5.223 No new information on the state of fish stocks around the islands has been made available. The Working Group therefore recommended that the existing Conservation Measure 41-03 for *D. eleginoides* in Subarea 48.4 remains in force.

Electrona carlsbergi (Subarea 48.3)

5.224 Due to the uncertainty surrounding input data to the original assessment, the Working Group recommended that the fishery be closed. It should only be reopened after a new survey on this species is conducted and the results have been evaluated by CCAMLR.

Stone Crabs

5.225 The Working Group recommended that existing Conservation Measures 52-01 and 52-02 on stone crabs should remain in force.

Martialia hyadesi

5.226 The Working Group recommended that the existing Conservation Measure 61-01 should remain in force.

By-catch

5.227 The long-term status of by-catch taxa has been identified as an issue for urgent attention by the Scientific Committee (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.153). The key issues that need to be addressed are:

- assessments of the status of by-catch taxa (particularly rajids and macrourids)
- assessments of the expected impact of fisheries on by-catch species
- consideration of mitigation measures.

5.228 WG-FSA-03/67 is the report of the intersessional subgroup on by-catch which lists the work plan and a summary of completed work.

5.229 WG-FSA-03/71 summarised current approaches to by-catch management and activities across non-target taxa and examines the range of protection afforded to by-catch

taxa (seabirds, marine mammals, elasmobranchs, bony fish and benthic invertebrates). This paper suggested that a consistent, integrated approach to by-catch be taken across all taxa. Such an approach would identify and prioritise the areas that need to be addressed based on a preliminary evaluation of risks.

5.230 The Working Group noted that by-catch measures aim to minimise by-catch with three main steps to this end – avoidance, mitigation and, lastly, the assessment of yield for finfish if mortality is not preventable. There was a general view that approaches to by-catch would benefit from consistency for the different by-catch taxa and, where possible, consistency in approaches across fisheries. The Working Group noted that an integrated approach to scientific work and evaluation of by-catch issues could help bring appropriate expertise together in developing strategies to minimise by-catch. For example, the Working Group agreed that a risk assessment for skates and rays might be undertaken in a similar way to the assessments of seabirds, consistent with the developing global attention given to elasmobranch by-catch issues.

5.231 The Working Group recommended that, at the next meeting of WG-FSA, time be allocated to discussing issues of potential mutual interest and importance to WG-FSA and WG-IMAF. Such issues should include:

- (i) estimation of by-catch levels and rates;
- (ii) assessment of risk, both in terms of geographical areas and population demography;
- (iii) mitigation measures;
- (iv) scientific observer duties.

5.232 WG-FSA-03/15 summarised the toothfish, skate and longline by-catch survey undertaken in early 2003 in Subarea 48.3. The survey aim was to provide information on the biology and ecology of species and did not result in quantitative data that could be used to estimate standing stock. Additionally, the tagging program for rajids and an underwater video system for studying behaviour of deep-sea species is described. Further information on skate captures and tagging is presented in WG-FSA-03/59.

Assessment of the Status of By-catch Species or Groups

5.233 The priority by-catch taxa for which assessments of status are required are the macrourids and rajids (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.154).

Rajidae

5.234 Insufficient biological information was available for rajids and as such no assessments were undertaken.

Macrourus spp.

5.235 Updated biological data were available for *Macrourus whitsoni* in Subarea 88.1 (WG-FSA-03/44) and *M. holotrachys* in Subarea 48.3 (WG-FSA-03/16).

5.236 Precautionary pre-exploitation harvest levels (γ) were calculated for *M. whitsoni* in Subarea 88.1, *M. carinatus* in Division 58.5.2, *M. holotrachys* in Subarea 48.3 and *Macrourus* spp. in Division 58.4.3 using the GYM. The parameter and simulation characteristics used to compute γ for the four macrourid stocks are presented in Table 5.20. Following the recommendation of the Scientific Committee (SC-CAMLR-XXI, Annex 5, paragraph 5.162), trials were also carried out to investigate the sensitivity of γ to variations in M and other model parameters.

5.237 Additional information on the input parameters used in the assessments is contained in SC-CAMLR-XXII/BG/27.

5.238 The decision rule used to assess γ was that the median escapement of the spawning stock at the end of (n) years of exploitation is 50% of the pre-exploitation spawning stock biomass, and that the probability of depletion below 20% of the median pre-exploitation spawning biomass is no greater than 0.1 over (n) years. The period of stock projection (n) was determined by the estimated longevity and was set to be equal or greater than the generation time of the species (i.e. $n = 55$ for *M. whitsoni* in Subarea 88.1 and *Macrourus* spp. in Division 58.4.3; $n = 35$ for *M. carinatus* in Division 58.5.2 and *M. holotrachys* in Subarea 48.3). In 2002, the period of stock projection was 20 years for all *Macrourus* assessments (SC-CAMLR-XXI, Annex 5, paragraph 5.157).

5.239 Where an estimate of B_0 was available, the long-term precautionary yield was estimated using the formula: $\text{Yield} = \gamma B_0$.

M. whitsoni in Subarea 88.1

5.240 Parameters for *M. whitsoni* in Subarea 88.1 were based on biological data collected by observers on New Zealand exploratory longline vessels in the Ross Sea. Biological parameters were recalculated in 2003 to be expressed in terms of pre-anal length (WG-FSA-03/44) (Table 5.20). Additional information on the derivation of the input parameters is presented in SC-CAMLR-XXII/BG/27.

5.241 The best estimate of γ for *M. whitsoni* in Subarea 88.1 was 0.01439. This resulted in a median escapement of 0.78 and probability of depletion of 0.10 over 55 years. The estimate of γ from this year's assessment was much lower than the previous estimate of 0.02165 for Subarea 88.1 from 2002. The reduction in γ this year was due to the extension of the period of stock projection from 20 to 55 years (Table 5.21). The conversion of biological parameters from total length to pre-anal length had little effect on estimates of γ (Table 5.21).

5.242 Estimates were sensitive to the range of M and the coefficient of variation (CV) of B_0 . The estimate of γ was 0.01404 using a range of M of 0.05–0.12 and a CV of $B_0 = 1.184$, while

a low M (0.02–0.09) resulted in an estimate of γ of 0.01126 and a high M (0.08–0.15) resulted in a γ of 0.01690 (Table 5.21). Trials with the CV of $B_0 = 0.5$ gave a γ of 0.01814, while a CV of $B_0 = 2.0$ gave a γ of 0.01325.

5.243 Estimating a precautionary yield for *M. whitsoni* in Subarea 88.1 using γ requires an estimate of B_0 for the population. The feasibility of using acoustics to provide estimates of standing stock of *M. whitsoni* was assessed in WG-FSA-03/28. At present it is not practical to estimate abundance of *M. whitsoni* using acoustic methods. There are currently no estimates of B_0 in Subarea 88.1 or adjacent areas. Therefore the Working Group was not in a position to compute a precautionary yield.

M. carinatus in Division 58.5.2

5.244 Parameters for *M. carinatus* in Division 58.5.2 were based on biological data presented in WG-FSA-02/48. Input parameters were identical to those used last year with the exception of the von Bertalanffy parameters which were revised in van Wijk et al. (2003) (Table 5.20).

5.245 The estimate of γ calculated in 2002 for *M. carinatus* in Division 58.5.2 (using a stock projection of 20 years and the von Bertalanffy growth parameters from WG-FSA-02/48) was 0.03226. This resulted in a median escapement of 0.51 and probability of depletion of 0.10.

5.246 The best estimate of γ for *M. carinatus* in Division 58.5.2 was 0.02511 (Table 5.22). This resulted in a median escapement of 0.59 and probability of depletion of 0.10 over 55 years.

5.247 The estimate of γ from this year's assessment was much lower than the 2002 estimate and is due to the extension of the period of stock projection from 20 to 35 years (Table 5.22). Revising the growth parameters resulted in very little change in the estimated γ (Table 5.22).

5.248 Estimates of γ were sensitive to estimates of natural mortality and the CV on the estimate of initial biomass (B_0). Increasing natural mortality from a range of 0.09–0.17 to 0.12–0.20 increased the estimate of γ to 0.02728, while a low M (0.05–0.13) resulted in an estimate of γ of 0.02169. Increasing the CV of B_0 to 1 resulted in a decrease in the estimated γ to 0.02014 (Table 5.22).

5.249 An estimate of B_0 for *M. carinatus* in Division 58.5.2 was derived using the mean density estimate of *Macrourus* spp. obtained from a research trawl survey of BANZARE Bank, the southernmost part of the Kerguelen Plateau (van Wijk et al., 2000), pro-rated to the area of seabed in the same depth range (600–1 500 m) in Division 58.5.2. This gave a mean biomass for Division 58.5.2 of 14 402 tonnes. Applying $\gamma = 0.02511$ gives an estimate of yield for *M. carinatus* in Division 58.5.2 of 360 tonnes.

Macrourus spp. in Division 58.4.3

5.250 Australia has notified its intention to conduct an exploratory trawl fishery for *Macrourus* spp. in Division 58.4.3 in the 2003/04 fishing season. It is likely the catch will

include both *M. whitsoni* and *M. carinatus*. No biological data were available for either species in Division 58.4.3, thus the assessment was based on biological parameters for *M. whitsoni* in Subarea 88.1 and a fishing selectivity for *M. carinatus* in Division 58.5.2. This set of biological parameters was chosen because *M. whitsoni* is thought to be more vulnerable to exploitation than *M. carinatus* based on estimates of γ in other areas. The fishing selectivity for *M. whitsoni* in Subarea 88.1 is derived from longline data, thus the estimated fishing selectivity for *M. carinatus* in the trawl fishery in Division 58.5.2 was used in the assessment (Table 5.20).

5.251 The best estimate of γ for *Macrourus* spp. in Division 58.4.3 was 0.01654. This resulted in a median escapement of 0.61 and probability of depletion of 0.10 over 55 years (Table 5.23).

5.252 An estimate of B_0 for *Macrourus* spp. in Division 58.4.3b was available from a research trawl survey of BANZARE Bank. The mean biomass calculated from the survey was 9 639 tonnes. Applying $\gamma = 0.01654$ gives a mean estimate of yield for *Macrourus* spp. in Division 58.4.3b of 159 tonnes. Pro-rating the mean density from the survey to the area of seabed in Division 58.4.3a results in a mean biomass of 1 594 tonnes. Applying $\gamma = 0.01654$ gives a mean estimate of yield for *Macrourus* spp. in Division 58.4.3a of 26 tonnes.

M. holotrachys in Subarea 48.3

5.253 Parameters for *M. holotrachys* in Subarea 48.3 were based on biological data presented in WG-FSA-02/26, Morley and Belchier (2002) and WG-FSA-03/16. The biological parameters in WG-FSA-03/16 were expressed in terms of pre-anal length (Table 5.20). Parameters from 2002 documents presented in total lengths were recalculated in terms of pre-anal length during the meeting to provide a consistent set of data.

5.254 The estimate of γ for *M. holotrachys* in Subarea 48.3 was 0.02197. This resulted in a median escapement of 0.70 and probability of depletion of 0.10 over 55 years (Table 5.24).

5.255 Estimates of γ for *M. holotrachys* in Subarea 48.3 were sensitive to estimates of the CV on the estimate of initial biomass (B_0) (Table 5.24).

5.256 Estimating a precautionary yield for *M. holotrachys* in Subarea 48.3 using γ requires an estimate of B_0 for the population. There are currently no estimates of B_0 in Subarea 48.3 or adjacent areas. Therefore the Working Group was not in a position to compute a precautionary yield.

Management Advice

5.257 The estimates of γ calculated for all three *Macrourus* species indicate that they have relatively low productivity and thus may be vulnerable to overexploitation.

5.258 The Working Group recommended that the estimate of precautionary yield for *M. carinatus* in Division 58.5.2 (360 tonnes) be considered as the precautionary by-catch limit.

5.259 The Working Group recommended that the estimate of precautionary yield for *Macrourus* spp. in Division 58.4.3a (26 tonnes) and in Division 58.4.3b (159 tonnes) be considered as the precautionary catch limit (paragraph 5.87).

5.260 The Working Group agreed that the application of by-catch limits is to provide adequate protection for by-catch species, with the understanding that the fishery takes steps to reduce and minimise by-catch rates (paragraph 5.230). It was also agreed that these by-catch limits, with their attendant uncertainties, should not be used as a reflection of a long-term sustainable yield. In that context, sustained by-catch at these levels over a number of years would require a revised assessment.

5.261 The Working Group noted that no estimates of B_0 were available for *Macrourus* spp. in Subareas 48.3 or 88.1 and as such, no estimate of precautionary yield could be calculated. Further, the Working Group noted that an estimate of B_0 was unlikely to be forthcoming in the next few years.

5.262 The Working Group recommended that future work include research towards generating population parameters and estimates of standing stock for macrourids and rajids. This will become more urgent with an increasing number of years of an active fishery.

5.263 In the absence of assessments for by-catch species, the Working Group recommended that precautionary measures that place upper limits on by-catch and reduce the potential for localised depletion be adopted.

5.264 The Working Group also suggested that the development of avoidance and mitigation measures for by-catch species be given high priority.

5.265 The Working Group recommended that, at the next meeting of WG-FSA, time be allocated to discussing issues of potential mutual interest and importance to WG-FSA and WG-IMAF. Such issues should include:

- (i) estimation of by-catch levels and rates;
- (ii) assessment of risk, both in terms of geographical areas and population demography;
- (iii) mitigation measures;
- (iv) scientific observer duties.

Assessment of the Expected Impact of Target Fisheries on By-catch

Estimated Total Removals

5.266 In order to adequately assess the impact of fisheries on by-catch it is necessary to have accurate information on the total removals of by-catch taxa at a fishery level (SC-CAMLR-XXI, paragraph 5.170).

5.267 At WG-FSA 2002, estimates of total retained/discarded by-catch removals were calculated from observer data for the first time. Unfortunately an estimate could not be made for all areas due to a lack of data on the proportion of longline sets observed for by-catch. No data was available on the estimated fish by-catch cut or lost from longlines, at a fishery level.

5.268 The Scientific Committee strongly emphasised the need for accurate reporting of by-catch data (SC-CAMLR-XXI, Annex 5, paragraphs 5.184 and 5.185). Specifically, observers should record the proportion of hauls/sets observed for both retained/discarded by-catch and cut-off/lost by-catch. In addition, observers should record fish that are cut or lost from longlines (paragraphs 10.13 to 10.15).

5.269 The observers' logbooks and forms were revised to improve by-catch data collection and distributed by the Secretariat to technical coordinators in February 2003. An analysis of observer reports from the 2002/03 season indicates most were submitted to the Secretariat on old forms. Although the new forms were not generally used, some Members have collected the data required to calculate total removals using their own databases. It was possible to calculate estimates of retained/discarded by-catch from observer data in all fisheries, with the exception of Subarea 58.6 and Division 58.5.1. The by-catch of fish cut from longlines could be estimated in Subarea 48.3 and Division 58.5.2. The Working Group requested that Members collecting data in a non-standard format work with the Secretariat intersessionally to ensure that all by-catch data is adequately transferred to the CCAMLR database (see section 10).

Estimated Retained/Discarded Catch

5.270 Estimates of total removals of retained/discarded by-catch by fishery for the 2002/03 fishing season are presented in Table 5.25. Estimates derived from fine-scale and observer data were similar, however as observer data could not be scaled for Division 58.5.1 or Subarea 58.6, fine-scale data is presented in Table 5.25. By-catch of rajids and macrourids as a percentage of target catch varies from <1 to 26%.

5.271 WG-FSA-03/73 reviewed fish and invertebrate by-catch by fishing season and ground in the *D. eleginoides* and *C. gunnari* trawl fisheries in Division 58.5.2. The total by-catch represents less than 1 and 2% respectively, of the total catch weight in each fishery. The total by-catch in the longline fishery represents 8% of the total catch weight. The elasmobranch by-catch in the trawl fisheries comprised *Somniosus antarcticus* with a mean of eight sharks caught per year and *Lamna nasus* with a mean catch of seven sharks per year. WG-FSA-03/69 summarised a risk assessment for *S. antarcticus* in Division 58.5.2 and concluded that at present catch rates, fishing was unlikely to have a negative impact on stocks.

5.272 WG-FSA-03/44 gave an overview of by-catch in the *D. mawsoni* fishery in Subareas 88.1 and 88.2. The main by-catch species is *M. whitsoni* which accounts for 7% of the total catch in 2003. The percentage rattail catch has varied from <1 to 27% between years and SSRUs. The rajid by-catch comprises two species, *Amblyraja georgiana* and *Bathyraja eatonii*, and was less than 1% of the total catch. The percentage catch of rajids between SSRUs and years has ranged from 0 to 15%. Other by-catch taxa each contributed less than 1% to the total catch.

Estimated Cut-off Catch

5.273 Estimates of total mortality for fish cut from longlines in Subarea 48.3 and Division 58.5.2 are presented in Table 5.26. Minimum and maximum estimates of by-catch are calculated assuming all fish survive or die respectively.

5.274 The total mortality arising from the by-catch of skates and rays in the longline fishery in Subarea 48.3 was estimated in WG-FSA-03/58. This paper applied the depth-stratified mortality rates estimated from the ray survivorship experiment described in WG-FSA-03/57 to estimate the total number of rays cut off lines. For each of three fishing-depth bands (0–1 200 m, 1 200–1 500 m, 1 500–2 000 m) observer tally data were used to estimate the total number of rays that were cut off lines, and the survivorship estimated by WG-FSA-03/57 (98%, 56% and 24% respectively) was applied to these numbers to arrive at an estimate of total mortality. Finally, the estimate of retained/discarded skates and rays from fine-scale data was added to arrive at an estimate of overall mortality in the 2002/03 fishing season of 67 tonnes.

5.275 The Working Group welcomed this new work and recommended that further experiments on survivorship be undertaken. It was noted, however, that few rays had been obtained from water shallower than 1 100 m, and that therefore the model estimates of survivorship in shallower waters were less supported by data than the estimates from deeper water. Accordingly, the estimated deaths were revised for the shallow water stratum by applying the survivorship (78.5%) observed by the experiment in water between 1 100 and 1 300 m (Figure 5.20).

5.276 Overall, 54 rays had survived in the experiment, and 41 had died (WG-FSA-03/57)¹. The Working Group recognised that the results of the experiment indicated differences in survivorship with depth, with increasing survivorship expected for rays caught in shallower water. However, the uncertainty in the estimates of survivorship at different depths had not been fully explored. The Working Group agreed to use the estimate derived from the assessment of depth-related survivorship using the data for 1 100–2 000 m (85 tonnes, Table 5.26, Agnew method) but recommended that approaches for estimating survivorship from such data and for estimating the total mortality of skates and rays be reviewed by WG-FSA-SAM.

5.277 The Working Group also noted that survivorship of skates and rays cut off longlines would be influenced by many post-release factors, including increased vulnerability to predation, physiological effects of pressure changes and the potential for subsequent disease/infection in injured skates. Estimates of survivorship from experiments would also be affected by factors such as the period of observation, the capture position on the longline and soak time. The Working Group encouraged Members to undertake survivorship experiments in future. Experiments that address survivorship of rajids caught in shallow water and experiments that extend the observation period would be particularly useful.

5.278 WG-FSA-03/73 provided estimates of the rays cut from longlines in the toothfish fishery in Division 58.5.2. The methodology was similar to that used for Subarea 48.3, i.e. observer tally data were used to estimate cut-off rays, and retained/discarded catches were added to achieve a total ray catch. All discarded rays, including those cut off the line, were assumed to die.

¹ Numbers surviving 12 hours in the experimental tank.

5.279 The Working Group noted that using observer tally data was essential to obtain good estimates of the numbers of rays cut or knocked off hooks. No information on the number of rays cut off longlines was available for any other fishing area.

Estimates of By-catch by Vessel

5.280 The Working Group analysed by-catch by vessel from observer data in an effort to relate by-catch to various factors, including fishing method, fishing depth, bait type and height of hooks above the sea floor. Understanding why some vessels catch more or less by-catch may yield information that could be used to develop mitigation and avoidance measures for by-catch.

5.281 Unfortunately incomplete observer by-catch data, inconsistency in the way by-catch is reported and confounding factors in fishing methods (such as setting longlines across slopes) resulted in difficulties in satisfactorily interpreting the results. The Working Group suggested that an analysis of non-target fish by-catch by vessel could be undertaken intersessionally by the by-catch subgroup using fine-scale data.

Comparison of By-catch Datasets

5.282 By-catch data is reported to CCAMLR in four different forms, STATLANT data (reported by Flag State at the end of the season), fine-scale data (haul-by-haul), catch and effort data (reported by vessel in 5-day, 10-day or monthly periods) and observer data. A comparison of the first three datasets was made to give an indication of the adequacy of reporting by-catch via the different methods.

5.283 The by-catch data from the STATLANT, catch and effort and fine-scale datasets was extracted by the Secretariat by fishery from the 1997 to 2003 fishing seasons. The Working Group tabulated the results (SC-CAMLR-XXII/BG/27, Tables 5.4.1 to 5.4.8) and noted that, in general:

- STATLANT data underestimates by-catch;
- fine-scale and catch and effort estimates were generally similar although data quality was inconsistent and varied by year and area;
- fine-scale data (haul-by-haul) is the most comprehensive of the three datasets for by-catch.

5.284 Difficulties were experienced in extracting and analysing observer data. In general, the quality of observer data for by-catch was variable. The most common recurring problems were:

- the use of outdated forms and cruise report formats. This results in specifically requested information not being collected, i.e. numbers of rajids that are cut from longlines;

- incomplete fields: if key data fields are not completed then certain calculations cannot be undertaken (e.g. if the percentage of hauls/sets observed is not recorded then estimates of total removals cannot be scaled up to fishery level);
- incorrect data entry (i.e. typographical errors and inconsistent entry of units);
- incorrect codes being used, this ranges from the use of incorrect fate and species codes (using Member-specific codes when CCAMLR/FAO species codes are provided) to incorrect data recording codes. It is possible that species may be caught that are not listed in the codes provided, technical coordinators have been asked to supply the Secretariat with the species name and a valid code will be sent to them.

Management Advice

5.285 The Working Group strongly reiterated the need for accurate reporting of by-catch in all data formats.

5.286 The Working Group specifically requested that observers record the proportion of hauls/sets observed for both retained/discarded by-catch and cut-off/lost by-catch. In addition, observers should record fish that are cut or lost from longlines (paragraphs 10.13 to 10.15).

5.287 The Working Group recommended that the data requirements for fish and invertebrate by-catch and the priority of tasks for observers in collecting this information be reviewed intersessionally by the by-catch subgroup (paragraphs 5.231 and 5.296).

5.288 The Working Group noted that IUU fishing is also likely to result in mortality of by-catch species. Therefore the estimates of total removals presented here should be treated as minimum estimates.

Consideration of Mitigation Measures

5.289 At WG-FSA 2002, the Working Group recommended that wherever possible during longlining operations (SC-CAMLR-XXI, Annex 5, paragraph 5.195):

- live rajids should be cut from the line whilst still in the water to increase the chances of survivorship;
- vessels should be encouraged to develop methods to minimise rajid by-catch.

5.290 Additionally, the Working Group noted that information was required on (SC-CAMLR-XXI, Annex 5, paragraph 5.195):

- the vulnerability of rajids to capture
- methods for adequately assessing survivorship of animals released
- methods for handling rajids that maximise survivorship

- methods for adequately documenting the biological characteristics, including size, of rajids hooked but not landed.

5.291 The Working Group noted that there was some degree of conflict in the above advice with one recommending that all rajids be cut from the line in order to increase survivorship and the other requiring some retention of rajids in order to collect biological information.

5.292 The Working Group recognised that while it was important to minimise by-catch wherever possible, it was also necessary to obtain some data for use in assessing the status of rajids. A possible solution would be for observers to retain rajids that would normally be cut from the longline during some of the biological sampling periods in order to obtain an unbiased sample from which biological data could be collected.

5.293 The Working Group noted that in some areas by-catch rates were highly correlated with geographical location. It encouraged fishers to develop strategies that avoid localities with high by-catch wherever possible.

5.294 The Working Group noted paragraph 5.50 of SC-CAMLR-XXI which concluded that it would be appropriate to review relevant conservation measures and to develop advice on the use of bottom trawl gear, taking into account issues relating to the by-catch of seabirds and non-target fish species, and potential damage to benthos. It also noted comments in paragraphs 6.214 to 6.243.

5.295 The Working Group noted that it had been unable to review the use of bottom trawl gear in Subarea 48.3 in relation to the effects of such gear on non-target fish and benthos (SC-CAMLR-XXI, paragraphs 5.46 to 5.50) due to a lack of relevant information and time. However, it noted that Conservation Measure 33-01 already limits the level of by-catch of demersal fish species in Subarea 48.3. Nevertheless, the Working Group recommended these issues be examined for all CCAMLR fishing areas in a wider context, both intersessionally and at WG-FSA. Members are requested to submit relevant data and information to WG-FSA intersessionally.

5.296 The Working Group also recommended that:

- (i) when mitigation measures in relation to vessel hauling and setting activities are considered and developed, these should avoid or minimise potential operational conflict with existing mitigation measures for seabird by-catch;
- (ii) the duties of scientific observers should be reviewed to ensure appropriate balance between tasks relating to targeted fish species, non-targeted fish species and seabirds and marine mammals and benthos.

Management Advice

5.297 The Working Group recommended that vessels be advised that, where possible, they should cut all rajids from their lines whilst still in the water, except on the request of the observer during the observer's biological sampling period.

5.298 The Working Group requested that Members and observers, where feasible, provide a report to the Secretariat on methods or strategies of fishing that minimise non-target fish by-catch.

Regulatory Framework

5.299 The Working Group reviewed the fishery plans updated to the present season by the Secretariat. It noted that references to fishery-related research need to be included, as does a clear link to the requirements of Conservation Measure 21-02 in the case of exploratory fisheries.

5.300 The Working Group noted the need to evaluate the value of data collection and research requirements arising from observer programs and for exploratory fisheries. It also noted the recommendation of WG-FSA-SAM to retain research sets in exploratory longline fisheries until such time as these evaluations have been undertaken (paragraph 4.2(xiii)). Ideally, this review should be done after data have been collected for a number of fishing seasons and the extent to which the utility of the data arising from these fisheries can be evaluated. It also needs to include a review of how much progress can be made towards assessment of the fishery's potential yield, the impacts on dependent and related species and the future data requirements that would assist in progressing assessments, as required by paragraphs 1(ii)(a, b) of Conservation Measure 21-02. Following this review, the Working Group would recommend any necessary changes to the data collection and research plans so that the requirements of Conservation Measure 21-02 can be met.

5.301 The Working Group identified that the exploratory fishery for toothfish in Subareas 88.1 and 88.2, and the experimental harvest regime for the crab fishery in Subarea 48.3 could now be reviewed in this light, although there was not enough time to undertake a review at this year's meeting.

5.302 CCAMLR-XXII/52 outlined a potential approach, which would be implemented by SCIC, for developing a comprehensive assessment of compliance of fishing vessels with conservation measures.

5.303 The Working Group welcomed this initiative, which should result in a more rigorous assessment of compliance with all conservation measures than is currently undertaken. It recalled that it had made comments on the issue of possible trade-offs between compliance measures, the importance of minimum standards of compliance and the difficulty of comparing compliance measures with different aims and objectives in paragraphs 6.58 to 6.65.

5.304 It was noted that the comprehensive compliance assessment would require consistent data to be collected from the fishery by observers and other sources. It would be important, therefore, to ensure that conservation measures were constructed to be as amenable to objective quantitative monitoring as possible. It would also be important to ensure that other observer tasks, or the position of scientific observers on vessels, were not compromised.

5.305 One of the objectives of a compliance score would be to incentivise vessels to increase their compliance performance. It was suggested that it would be useful to provide additional incentives, and rewards, to vessels undertaking research.

5.306 It was pointed out that it would be difficult, on presently available information, to comment on priorities and weighting for compliance issues. Often WG-FSA advice is presented as a package, rather than alternative weighted priorities. However, the proposed procedure of communication between SCIC, the Scientific Committee, WG-FSA and presumably JAG, should be appropriate for exploring these issues.

Evaluation of the Threats Arising from IUU Activities

5.307 Table 3.2 indicates that there may have been a slight reduction in the total catch of IUU fish in the Convention Area in the 2002/03 fishing season. The Working Group emphasised that the catch (10 070 tonnes) remained much higher than was sustainable given our current understanding of toothfish populations in the Convention Area. In that light, the Working Group recalled its discussion and recommendations to the Scientific Committee last year (SC-CAMLR-XXI, Annex 5, paragraphs 5.215 to 5.227).

5.308 Although Table 3.2 suggests that the CDS-estimated high-seas catch outside the Convention Area was lower in 2002/03 than it was in 2001/02, it was pointed out that delays in reporting, and the fact that the fishing season was not finished, meant that the high-seas catch estimate was incomplete. For comparison, the estimate of 2001/02 high-seas catch made at the 2002 meeting of WG-FSA was 14 659 tonnes (SC-CAMLR-XXI, Annex 5, Table 5.30), later revised to 21 289 tonnes (Table 3.2). The Working Group has considered previously that some of these data may represent IUU catches from the Convention Area, misreported as coming from high seas outside the Convention Area.

5.309 The Working Group particularly noted the utility of the CDS data in tracking trends in catches of toothfish, and urged JAG to incorporate other data, such as trade data, as a check on the amount of toothfish that is currently being traded with catch documents.

5.310 The Working Group noted that there has been an increase over the last three years in high-seas catch coming from Area 47 (76 tonnes in 2000/01, 655 tonnes in 2001/02 and 2 852 tonnes so far in 2002/03). The Working Group noted that the estimate of seabed area for this statistical area is small, about one-third of that in Area 51 (SC-CAMLR-XXI, Annex 5, Table 5.32). As indicated last year for Areas 51 and 57, this rate of catch from only small areas is unlikely to be sustainable. Dr E. Balguerías (Spain) informed the Working Group that a Spanish vessel had been fishing in this area with a scientific observer on board, and he would endeavour to provide information on this cruise at the next meeting of WG-FSA.

5.311 Catches in Areas 51 and 57 were slightly lower in 2002/03 than in the 2001/02 fishing season, but this might be because of the incomplete data reporting. The Working Group reiterated its advice of last year that these high catches are unlikely to be sustainable, and may include significant amounts of misreporting from within the Convention Area (SC-CAMLR-XXI, Annex 5, paragraphs 5.210 to 5.213). It noted that Russian scientists had offered to provide detailed bathymetric data from Area 51 which would allow a better estimate of seabed area to be made (SC-CAMLR-XXI, paragraph 4.36; CCAMLR-XXI, paragraph 8.7). Unfortunately these data were not submitted in time to be considered by the Working Group, but could be analysed in time for next year's meeting. In the interim of such a review, it was agreed that the best evidence available on seabed areas in the region remains the estimates provided by the Secretariat in SC-CAMLR-XXI, Table 5.30.

5.312 The Working Group drew the attention of the Scientific Committee to the analyses last year of the prospects for the legal catches with continued high levels of IUU fishing (SC-CAMLR-XXI, Annex 5, Figure 5.8) and the assessments of time series of CPUE compared with total removals in Division 58.5.1 and Subareas 58.6 and 58.7 (SC-CAMLR-XXII/BG/27, paragraphs 5.3.1 to 5.3.10).

INCIDENTAL MORTALITY OF MAMMALS AND SEABIRDS ARISING FROM FISHING

Intersessional Work of Ad Hoc WG-IMAF

6.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMAF according to the agreed plan of intersessional activities for 2002/03 (SC-CAMLR-XXI, Annex 5, Appendix D). The report contained records of all activities planned and results of their completion and is available on the IMAF page of the CCAMLR website.

6.2 The Working Group thanked the Science Officer for his work on the coordination of IMAF activities and the technical coordinators for their extensive support. It also thanked the Scientific Observer Data Analyst for his work on the processing and analysis of data submitted to the Secretariat by international and national observers during the course of the 2002/03 fishing season.

6.3 The Working Group concluded that most tasks planned for 2002/03 had been successfully implemented. 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 2003/04, compiled by the Convener and Science Officer, be appended to its report (Appendix E).

6.4 The membership of ad hoc WG-IMAF was reviewed. The Working Group noted with regret that Ms T. Hewitt (Australia) had resigned from the group due to her changed commitments. The Working Group especially welcomed Dr Agnew, Mr J. Arata (Chile), Drs Double, Melvin, T. Micol (France), Sullivan and Waugh who attended the meeting for the first time. The Working Group continued to appreciate Mr M. McNeill's (New Zealand) expert advice on operational aspects of fishing and encouraged analogous input from other Members. Members were asked to review their representation on WG-IMAF intersessionally, to suggest additional members and to facilitate the attendance of their representatives at the meetings.

Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area

6.5 Data were available from 37 longline cruises conducted within the Convention Area during the 2002/03 season (details in WG-FSA-03/63 Rev. 1).

6.6 The Working Group noted that the proportion of hooks observed was similar to last year for Subareas 48.3 (25% (range 17–63) compared with 22% (range 19–31)), 58.6 and 58.7 (45% (range 36–50) compared with 37% (range 9–59)) and 88.1 and 88.2 (52% (range 35–62)

compared with 42% (range 40–45)), but with generally greater consistency across vessels. Only for four cruises (*Isla Alegranza* (17%), *Isla Santa Clara* (19%), *Ibsa Quinto* (19%) and *Shinsei Maru No. 3* (19%)) was the proportion of hooks observed lower than 20%.

6.7 As usual, the total observed seabird catch rate was calculated using the total number of hooks observed and the total seabird mortality observed (Table 6.1). The estimated total catch of seabirds by vessel was calculated using each vessel's observed catch rate multiplied by the total number of hooks set.

Subarea 48.3

6.8 The total estimated seabird mortality was eight birds (Tables 6.1 and 6.2) compared with 27 birds last year and 30 the year before (Table 6.3). The overall catch rate was 0.0003 birds/thousand hooks compared to 0.0015 for the previous year (Table 6.3). Of the two birds observed killed (both at night), one was a grey-headed albatross and one a Cape petrel (Table 6.4).

6.9 This is the lowest seabird mortality rate and total yet recorded in this subarea, a notable achievement, especially given the recent increase in fishing effort (from 17 to c. 25 million hooks over the last two years).

South African EEZs in Subareas 58.6 and 58.7

6.10 The total estimated seabird mortality was seven birds (Tables 6.2 and 6.3) compared with no bird mortalities last year (Table 6.3). The overall catch rate was 0.003 birds/thousand hooks compared to zero for the previous year (Table 6.3). Of the two birds observed killed (both at night), one was a white-chinned petrel and one a grey petrel (Table 6.4).

6.11 The maintenance of low levels of seabird by-catch rates and totals was encouraging, particularly compared to levels from 1997 to 2000, but it was observed that fishing effort has decreased markedly (from 6–8 million hooks in 1999–2001 to 1.3–1.6 million hooks in 2002 and 2003).

Subareas 88.1 and 88.2

6.12 No incidental mortality of seabirds was observed in fishing operations, despite a significant increase in fishing effort compared with previous years. This was the seventh successive year of zero seabird by-catch in the fishery in Subarea 88.1 and the second such year for Subarea 88.2.

Division 58.4.2

6.13 This was the first year that longline fishing had been conducted in Division 58.4.2. No incidental mortalities of seabirds were observed in fishing operations.

Division 58.5.2

6.14 This was the first year that longline fishing had been conducted in Division 58.5.2. No incidental mortalities of seabirds were observed in fishing operations.

6.15 Overall, the Working Group noted that in respect of data for regulated longline fishing reported to CCAMLR, the estimated total of 15 birds killed in 2003 is the lowest ever recorded and negligible in respect of impact on the seabird populations concerned. Everyone involved in conducting and managing the fishing operations should be thanked for their efforts.

French EEZs in Subarea 58.6 and Division 58.5.1

6.16 Data received intersessionally for 1999/2000 and 2000/01 (SC-CAMLR-XXI, Annex 5, paragraph 6.15) were in the process of evaluation, but had not been submitted in CCAMLR forms and formats. Results for the 1999 and 2000 seasons, involving mortality of 8 491 white-chinned petrels, had been reported previously to CCAMLR (SC-CAMLR-XX, paragraph 4.32).

6.17 The Secretariat reported that no data had been received for the 2002/03 season, nor had data been received for the 2001/02 season.

6.18 The Working Group greatly regretted the continuing failure of France to provide data, including in appropriate forms and formats, despite repeated requests (e.g. SC-CAMLR-XX, paragraph 4.33) and despite assurances given last year (SC-CAMLR-XXI, paragraph 5.5; CCAMLR-XXI, paragraph 6.10).

6.19 Dr Micol reported that France continued to have problems with the by-catch of seabirds, chiefly white-chinned petrels, in the fisheries within its EEZs in the Convention Area. Between September 2001 and August 2002, 12 057 birds (94% white-chinned petrels) had been killed during setting of 19 million hooks, at a rate of 0.635 birds/thousand hooks. In the fishing year commencing September 2002, 13 784 birds (93% white-chinned petrels) had been killed during setting of 30 million hooks, at a rate of 0.456 birds/thousand hooks, a significantly lower rate than in the previous year. Mortality levels were highest in February, particularly during full moon.

6.20 Dr Micol reported that the French authorities were extremely concerned at this situation and are actively working in several areas to address the problem:

- (i) Autoline vessels (currently six in this fishery) are only allowed to set at night, with minimum lighting, no offal discharge during setting, and line weights of 8 kg every 500 m generally and 8 kg every 250 m during the January–April chick-rearing period of white-chinned petrels; at least one streamer line is used.
- (ii) Spanish system vessels (currently one in the fishery) must comply with the provisions of Conservation Measure 25-02, including prohibition of offal discharge during setting. By-catch rates are currently lower for the Spanish

system vessel (0.275 birds/thousand hooks, based on 413 hooks observed) than for the autoline vessels (0.684 birds/thousand hooks, based on 12 595 hooks observed).

- (iii) Seasonal closures are being considered, especially during October and February–March, when white-chinned petrels are at greatest risk; this year longline fishing around Kerguelen will be prohibited to all vessels for one month during the above periods.
- (iv) The more drastic approach of closing the longline fishing grounds during the whole of the breeding season of white-chinned petrels (i.e. as in Subarea 48.3) had been considered. However this would have at least two undesirable effects. Firstly, fishing in winter would coincide with the breeding season of grey petrels (*Procellaria cinerea*), equally vulnerable to being killed on longlines but with much smaller populations than white-chinned petrels. Secondly, extensive restriction of the fishing season would compromise many of the activities in these areas designed to combat the high potential levels of IUU fishing, which potentially kills large numbers of seabirds.
- (v) Observers are required on all longline fishing vessels. Reporting of seabird by-catch rates is required at daily intervals; vessels with high by-catch rates receive formal warnings and may be subject to a 100 n mile move-on requirement.
- (vi) In addition, the catch limit for the current year is divided into two parts, with 20% being reserved for those vessels which have demonstrated the best performance, in terms of compliance with fishing regulations and with environmental practices (e.g. low seabird by-catch rates).
- (vii) Research is under way to investigate gear and fishing practices which might help to reduce or solve the problem. These approaches include: use of integrated line weighting for autoliners; line colour (currently seabird by-catch rates are significantly higher on black, compared with white, lines); trials of pot fishing; use of artificial baits, ultrasonic and water cannon scaring devices.
- (viii) Comprehensive analyses of the by-catch data in relation to time of year, environmental conditions etc. has been commissioned from Dr H. Weimerskirch's (France) research group.

6.21 The Working Group welcomed this report from Dr Micol. It noted that:

- (i) the high seabird by-catch rates reflect the difficulties of achieving appropriate mitigation for longline fishing in areas surrounding major seabird breeding colonies (at Crozet and Kerguelen Islands) during their main breeding season;
- (ii) the reported by-catch rates are likely to be conservative estimates due to the nature of the observer operation (single observer, daily bird totals derived from assembling the accumulated by-catch rather than from direct observation during setting);

- (iii) the line weighting for autoliners will be inadequate to achieve appropriate sink rates, based on detailed experiments elsewhere in the Convention Area.

6.22 The Working Group noted its serious concern at the level of seabird by-catch reported for the French EEZs (25 841 birds killed between September 2001 and August 2003) and further noted that:

- (i) the rates of seabird by-catch (0.635 and 0.456 birds/thousand hooks for 2001 and 2002 respectively) greatly exceed those for any other fishery within the Convention Area;
- (ii) there is an apparent trend of substantial increases in fishing effort (from 19 million hooks to 30 million hooks over the last two years) in an area with known high levels of seabird by-catch;
- (iii) the level of by-catch reported is likely to be unsustainable for the major populations being affected (white-chinned and grey petrels);
- (iv) there are no recent published population estimates, nor monitoring studies, nor indication of population trends for either white-chinned petrels or grey petrels in the region;
- (v) the high level of seabird by-catch associated with autoline fishing in the French EEZs in 2001 and 2002 might indicate that if the autoliners recently purchased by France are operating in this fishery, their design did not incorporate those features desirable for reducing seabird by-catch (see SC-CAMLR-XXI, Annex 5, paragraph 6.84). The Working Group repeated the request for further information from France in relation to the design and operation of the recently purchased longline fishing vessels.

6.23 The Working Group noted that the experience of the group and, in particular, those members with experience inside and outside the Convention Area (especially in the New Zealand region where white-chinned petrels are abundant) would be very relevant in helping French scientists and managers to address this very serious situation (see also SC-CAMLR-XXI, paragraph 5.6). The Working Group also noted that better knowledge of how the recent reductions in by-catch in the South African EEZs in Subareas 58.6 and 58.7 had been achieved would be very instructive.

6.24 The Working Group recommended that:

- (i) by-catch data for the 2002 and 2003 seasons be submitted to the Secretariat as soon as possible, using CCAMLR data reporting forms and formats. These data would be analysed by the Scientific Observer Data Analyst in the usual way and made available on the IMAF section of the CCAMLR website for evaluation by the Working Group;
- (ii) the results of the analyses by Dr Weimerskirch's research group be submitted to CCAMLR as soon as possible. This would be placed on the IMAF webpage for evaluation and discussion. The Working Group recollected the value of the

analyses undertaken by South African scientists in investigating the influences of a variety of factors on seabird by-catch rates in Subareas 58.6 and 58.7 (WG-FSA-98/42, 99/42 Rev. 1 and 00/30);

- (iii) an ad hoc subgroup be established to collaborate with French scientists, managers and fishers, in order to provide advice on the most practical and effective ways of addressing the seabird by-catch problems in the French EEZs.

6.25 The Working Group emphasised the potential benefits of the collaborative development of a program of testing and evaluation of existing and potential mitigation measures. An appropriate program would simultaneously reduce local by-catch rates and provide urgently needed data to enable improved conservation measures to be developed for the Convention Area as a whole and with important implications for by-catch management in areas adjacent to the Convention Area.

Recommendations to Reduce Seabird By-catch in the French EEZs in Subarea 58.6 and Division 58.5.1 in 2003/04

6.26 In light of the high seabird mortality levels in the French EEZs in Subarea 58.6 and Division 58.5.1, Working Group members from New Zealand, Australia and France met to discuss the best ways of achieving the desired conservation outcomes. Three approaches were proposed: the immediate implementation of mitigation measures thought to be effective in reducing mortality; the joint preparation of a trial designed to demonstrate the effectiveness of certain measures as seabird deterrent; and fisher exchanges between France and New Zealand.

6.27 In addition to strict compliance with the requirements of Conservation Measure 25-02, it was considered that additional mitigation measures would be required in the French EEZs in Subarea 58.6 and Division 58.5.1 to reduce the very high levels of seabird mortality in these areas. The additional measures include specified line weighting for autoline vessels, deployment of two streamer lines (as indicated in the recommended revision to Conservation Measure 25-02), use of a bird-scaring gas cannon and modification to offal discharge practices.

Mitigation Measures

6.28 The line-weighting regime should ensure that longlines sink at ≥ 0.25 m/s which, in combination with a single streamer line, has been highly effective in reducing mortality of white-chinned petrels in New Zealand (WG-FSA-03/23). This sink rate can be achieved by compliance with the line sink rate requirements of Conservation Measure 24-02 (attachment to longlines of 5 kg weights at 50–60 m intervals) or use of longlines with 50 g/m of integrated weight (IW). It was stressed that line weights spaced at greater than 50–60 m intervals would not substantially increase sink rates. Of the two available line-weighting regimes, IW is preferred by fishers in New Zealand because of its constant sink profile, ease of handling and use, and the potential to enhance catch rates of fish (ling).

6.29 Paired streamer lines should be used on all line sets. Offal should be discharged only once each day, either when steaming on the fishing grounds or when line hauling. Given the need to reduce seabird mortality levels as a matter of urgency, the latter measure – which is different to the advice currently given in Conservation Measure 25-02 – is included as an attempt to minimise the number of seabirds following vessels during line hauling, which may result in fewer birds around vessels during line-setting operations. A single discrete dumping of offal each day may reduce the number of birds around vessels when line-setting operations commence. It was also recommended that vessels be equipped with a bird-scaring gas cannon (of the type used in vineyards) as an additional deterrent (the cannon deters birds from the area immediately behind the vessel, thus causing birds to dive on lines further behind vessels where longlines are deeper and more difficult to reach).

6.30 The Working Group endorsed these recommendations and urged the appropriate French authorities to implement them as a matter of priority.

Mitigation Trial

6.31 To reduce seabird mortality in the French EEZs in Subarea 58.6 and Division 58.5.1 it was proposed to conduct a mitigation trial in the 2003/04 season. The purpose of the trial in this area is to determine the effectiveness of methods shown to be effective in reducing seabird mortality in the New Zealand ling fishery. The trial would measure the effects of mitigation methods on both seabird by-catch and a target fish catch. The trial will contribute to the development of a collaborative relationship with industry in tackling the seabird by-catch problem and will produce information of relevance to the fisheries in question as well as to other fisheries in the Convention Area. The details of the trials would be developed by members of WG-IMAF as soon as possible intersessionally.

Fisher Exchange

6.32 The Working Group believed the most effective way to improve the experience of French longline fishers in practical and effective mitigation measures was for a New Zealand fisher to visit Reunion Island as soon as possible. At a later date it would be productive for French fishers to visit New Zealand and experience at first hand the operation of mitigation measures proven to be effective against white-chinned petrels.

6.33 Overall, the Working Group noted that while it strongly supported the immediate implementation of conservation measures as specified in paragraphs 6.27 and 6.28, it reiterated its earlier advice (SC-CAMLR-XX, paragraph 4.33) that the most effective measure to minimise seabird by-catch would be to restrict longline fishing to the months of May to August inclusive, outside the breeding season of white-chinned petrels.

Implementation of Conservation Measures 24-02 and 25-02

6.34 Data from observer reports relating to compliance with these conservation measures in 2002/03 were provided in WG-FSA-03/63 Rev. 1 and 03/65 Rev. 1 and are summarised in Tables 6.5 and 6.6 and Figure 6.1. Comparison with similar data from previous years is provided in Table 6.6.

Streamer Lines

6.35 Compliance with streamer line design and deployment has once again improved with observers reporting full compliance on 34 of 37 cruises (92%). This compares to 86% compliance last year. The three vessels that did not fully comply failed on attachment height (*Ibsa Quinto* and *Isla Alegranza*), length of streamer line and streamer length (*Lodeynoye*) and spacing of streamers (*Isla Alegranza*) (Table 6.5).

6.36 All vessels fishing in Subareas 58.6, 58.7, 88.1 and 88.2 and Division 58.5.2 used streamer lines on all sets. In Subarea 48.3, nine vessels undertook sets without using a streamer line. Of these, three vessels undertook more than five sets without streamer lines (*In Sung No. 66* – 8 sets (5%), *Isla Alegranza* – 45 sets (31 %) and *Shinsei Maru No. 3* – 24 sets (20%)) (Table 6.1 and WG-FSA-03/63 Rev. 1). In Division 58.4.2, the *Eldfisk* undertook nine sets (6%) without a streamer line.

Offal Discharge

6.37 Observer reports indicated compliance with the requirement to hold offal on board or to discharge on the opposite side to where the line was hauled on all vessels except the *South Princess* in Subareas 58.6 and 58.7 (Table 6.1). According to the logbook, this vessel discharged offal on the same side as hauling for 99% of its hauls. The cruise report also indicated that offal was discharged during 1.8% of sets. While fishing in Subareas 88.1 and 88.2, the *South Princess* discharged offal during one set.

6.38 In Subarea 48.3, four vessels were observed discharging offal during setting: both cruises of the *Argos Helena* (3% each cruise); the *Tierra del Fuego* (3%); and the *Isla Sofia* and *Jacqueline* both discarded offal on one occasion.

6.39 Issues relating to quantification and reduction of discards of hooks in offal are summarised in paragraphs 10.4 to 10.6.

Night Setting

6.40 Compliance with night setting has remained high this year in all subareas where this requirement applies. In Subareas 48.3, 58.6 and 58.7, 98% of sets occurred at night. Only one vessel (*Magallanes III* in Subarea 48.3) undertook a substantial number of day sets (37 sets, 18% according to logbook data). However, the report of the scientific observer indicated that all sets took place between dusk and dawn.

6.41 In Subareas 88.1, 88.2 and Division 58.4.2 vessels fished under Conservation Measure 24-02, which contained exemptions to night setting south of 60°S for vessels which demonstrated a consistent minimum line sink rate of 0.3 m/s (see paragraph 6.44).

Line Weighting – Spanish System

6.42 This is the third year that vessels using the Spanish longline system have operated with the alternative line-weighting regimes of either 8.5 kg weights spaced at no more than 40 m or 6 kg at no more than 20 m (Conservation Measure 25-02). This year there was 100% compliance with this measure in Subareas 48.3, which is a substantial improvement from last year when 66% of vessels complied. In earlier years (between 1997/98 and 1999/2000), when the conservation measure required 6 kg every 20 m, the highest compliance was 5%. In Subareas 88.1 and 88.2 there was full compliance with line weighting.

6.43 In Subareas 58.6 and 58.7 the *Koryo Maru No. 11* only used 6 kg every 40 m, thus failing to comply with the line-weighting regime in Conservation Measure 25-02.

Line Weighting – Autoline System

6.44 In Subareas 88.1, 88.2 and Division 58.4.2 vessels fishing south of 60°S in daylight were required to use line weights to achieve a consistent minimum line sink rate of 0.3 m/s (Conservation Measure 24-02). The Working Group noted that all vessels complied with this measure. The sink rates are provided in WG-FSA-03/65 Rev. 1, Table 5.

General

6.45 The Working Group noted that if compliance with Conservation Measure 25-02 is interpreted strictly (i.e. 100% in all elements of the conservation measure), 14 of the 29 vessels (48%) fully complied with all measures at all times throughout the Convention Area (Table 6.7). This compares with 3 of 21 vessels last year (14%). The Working Group noted that a group of vessels failed to fully comply by small margins (Table 6.7). The Working Group once again emphasised that the specifications in the conservation measure are minimum standards; it recommended that vessels should be advised to exceed these minimum standards to prevent compliance failure.

Fishing Season

6.46 In 2000 the Scientific Committee advised the Commission that once full compliance with Conservation Measure 29/XIX (now Conservation Measure 25-02) was achieved, together with negligible levels of seabird by-catch, any relaxation of closed seasons should proceed in a stepwise fashion and the results of this be carefully monitored and reported (SC-CAMLR-XIX, paragraph 4.42).

6.47 In 2002 WG-FSA considered three options for season extensions:

- (i) An extension of the season for two weeks in September once there was full compliance with Conservation Measure 29/XIX (25-02), and subject to a limit of three birds per vessel, assuming fishing effort was maintained at current levels. Vessels would be required to carry two observers, so that the limit could be monitored accurately, and either two streamer lines or a single streamer line with a boom and bridle system would be required.
- (ii) An extension of the season for the last two weeks in April once there was full compliance with Conservation Measure 29/XIX (25-02), and subject to a limit of three birds per vessel, assuming fishing effort was maintained at current levels. Vessels would be required to carry two observers, so that the limit could be monitored accurately, and either two streamer lines or a single streamer line with a boom and bridle system would be required.
- (iii) In the forthcoming season to allow only vessels in Subarea 48.3 that were adjudged to have complied fully with Conservation Measure 29/XIX (25-02) in 2001/02 to fish during the last two weeks of April to enable a preliminary assessment of the seabird by-catch during this period. As part of the access arrangement during this period, the vessel would be required to collect data to allow a more reliable assessment of the risk to seabirds during this period. This would include collection of data on the sink rate of longlines, and observation of seabird behaviour around the vessel. A limit of three birds would be applied to the vessel; two observers would be required so that the limit could be monitored accurately; two streamer lines or a single streamer line with a boom and bridle system would be required.

6.48 In 2002 the Scientific Committee advised the Commission that option (i) – an extension of the fishing season for two weeks in September once there was full compliance with Conservation Measure 29/XIX (25-02) and subject to a limit of three birds per vessel – was the preferable option in light of the lower potential risk to seabirds.

6.49 In 2002 the Commission endorsed the conclusion of SCOI (CCAMLR-XXI, Annex 5, paragraph 3.22) that only one vessel was judged to have fully complied with Conservation Measure 29/XIX (25-02) in the longline fishery in Subarea 48.3 in 2002. The Commission agreed that trials to assess the feasibility of a step-by-step extension of the fishing season could commence during the last two weeks of April 2003 using this one vessel.

6.50 The vessel (*Argos Helena*) that fully complied with Conservation Measure 29/XIX (25-02) in Subarea 48.3 in 2002 took up the option of commencing fishing during the last two weeks of April 2003. The vessel commenced fishing on 15 April 2003. On 20 April 2003 it killed three seabirds (two white-chinned petrels and one black-browed albatross). Because of the three-seabird limit placed on the vessel, all fishing ceased until the regular fishing season commenced on 1 May 2003.

6.51 The cruise report stated that five seabirds were caught during the trip, and of these three were dead. It is unclear from the information provided whether all of these birds were caught during the season extension, and the observer interpreted the limit only to relate to dead birds, or whether the live birds were caught after 1 May 2003. This illustrates two points: firstly the importance of the Working Group's note last year (SC-CAMLR-XXI, Annex 5, paragraph 6.176) that it is necessary to define precisely what is meant by birds 'caught'; and secondly the need for observers to complete logbooks fully at all times.

6.52 On the basis of the experience of the *Argos Helena*, and new information from the French EEZ during the 2001 and 2002 seasons (see paragraphs 6.19 to 6.21), the Working Group reiterated its advice from last year that current mitigation measures are unlikely adequately to mitigate capture of white-chinned petrels during the summer season in high-risk areas.

6.53 In light of this, the Working Group felt unable to support consideration of the two options that include fishing in April (options (ii) and (iii)). Where a trial season extension is under consideration, the Working Group still recommended September as an option for any vessel that has achieved full compliance with Conservation Measure 25-02, and noted that this was endorsed as the preferred option by the Scientific Committee last year (SC-CAMLR-XXI, paragraph 11.7).

6.54 Should an extension of the season occur in September and any seabird limit imposed on vessels be reached, this may indicate that Conservation Measure 25-02 is not adequate to allow an extension of the fishing season. Equally, if vessels do not reach the seabird limit, a review of the mitigation measures would be necessary to determine whether they used more than the minimum standards specified in Conservation Measure 25-02. Under either scenario, the Scientific Committee may need to review its earlier advice to the Commission (SC-CAMLR-XIX, paragraph 4.42) that once compliance with this conservation measure is achieved, relaxation of closed seasons should be considered.

Compliance with Conservation Measure 25-03

Net Monitoring Cables

6.55 The Working Group noted that observers were reporting the presence of cables associated with side-mounted net monitoring devices on trawl vessels in the Convention Area (WG-FSA-03/65 Rev. 1), which could be interpreted as representing a contravention of Conservation Measure 25-03.

6.56 The Working Group believed that cables linked to side-mounted devices may pose no threat to seabirds. The Working Group recommended that observers be provided with illustrations that highlight the difference between cables linked to side-mounted net monitoring devices and trawl third-wire style net monitoring cables. As it is, third-wire style net monitoring cables that have been shown to kill seabirds, the Working Group recommended that observers be asked to report only on the latter with respect to Conservation Measure 25-03. However, reports of any seabird interactions with cables linked to side-mounted net monitoring devices should be included in the observer report.

Offal Discharge

6.57 Two trawl vessels fishing in Subarea 48.3 were observed discarding offal during net shooting and hauling, the *Sil* (5 shots and 5 hauls) and the *In Sung Ho* (5 shots).

Assessment of Compliance of Fishing Vessels with Conservation Measures

6.58 The Working Group considered CCAMLR-XXII/52 which suggested a potential approach, to be implemented by SCIC, towards developing a new system for undertaking assessment of compliance of fishing vessels with conservation measures.

6.59 The paper indicated some deficiencies of the current system, notably that it does not differentiate between minor and substantive infringements, and that compliance assessment is not comprehensive across all relevant conservation measures.

6.60 The paper proposed a method for ranking compliance of vessels based on combining assessments for all relevant conservation measures, so that each vessel is assigned a total compliance score.

6.61 Currently, WG-IMAF interprets the minimum acceptable standard for compliance with conservation measures to be 100%. The Working Group expressed concern that the proposed compliance score approach could result in a lowering of the acceptable standard of compliance. Acceptance of less than 100% compliance with measures would effectively provide a disincentive to fishers to make efforts to achieve the prescribed standards. The Working Group has repeatedly stressed that many conservation measures (or elements thereof) are only minimum standards and that vessels should strive to exceed these standards both to prevent compliance failure (see paragraph 6.45) and to achieve the best standards of conservation and management.

6.62 The Working Group noted that the proposed method of deriving a total compliance score depended on weighting elements of conservation measures. This implies that the contribution each conservation measure makes towards achieving the Commission's objectives is known, and that this knowledge exists for the elements within each conservation measure. Because this is not usually the case, making such an assessment would be very subjective. In addition, combining all conservation measures to derive a total score would be of limited utility because each is designed to address different conservation and management objectives.

6.63 The Working Group was also concerned that if a threshold total compliance score was less than 100%, this could result in fishers trading off between conservation measures with different weightings to achieve the threshold score. In addition, the method proposed does not address the problem of distinguishing between non-compliant vessels that fail by a small amount and those failing by a large margin.

6.64 More generally, the Working Group was unclear how the total compliance score would be interpreted or used. This is important, if the method is to be properly assessed and compared with other potential approaches.

6.65 The Working Group noted that the implications of a review of methods of assessing compliance were much more extensive than simply developing a new approach. Any new system would require a comprehensive evaluation of the contents of all conservation measures, of the instructions to observers and inspectors, of the nature, scope and content of the reporting mechanisms and of the details of the data validation, analysis and assessment

protocols. It was particularly important to ensure that any new and improved system is based on data which are collected and reported in as accurate, unambiguous and consistent a fashion as possible.

Research into and Experiences with Longline Mitigation Measures

General

6.66 The Working Group reviewed the video ‘Off the Hook’ (WG-FSA-03/19) – an educational video on seabird avoidance for Alaska longline fisheries and noted that video is a powerful medium to convey both the need for seabird conservation and seabird mitigation techniques to fishers. Video should be considered as an alternative or additional medium when updating the CCAMLR publication *Fish the Sea Not the Sky*.

6.67 WG-FSA-03/20 described approaches that combine fisher innovation and stakeholder cooperation with scientific data gathering to find solutions to seabird mortality in two US fisheries. The Working Group noted that this model could have useful application in relation to the French fisheries in Division 58.5.1 and Subarea 58.6.

6.68 A poster developed cooperatively by the National Audubon Society, the Hawaii Longline Association and BirdLife South Africa describing methods to handle birds caught live on longline hooks had been contributed to the IMAF page on the CCAMLR website. It was noted that while the methods might be useful in some fisheries, they would be less practical in others. It was agreed that the Secretariat obtain permission for Members to reproduce the poster for their own use.

6.69 To investigate the potential for using the rate of foraging attempts by black-browed albatrosses during longline setting operations as an index of their level of mortality, over a seven-month period in 2001/02, observers on board *D. eleginoides* longliners in the waters around the Falkland/Malvinas Islands collected data on black-browed albatross foraging behaviour (WG-FSA-03/91). A complex of environmental and operational variables was identified as significantly affecting the level of black-browed albatross mortality.

6.70 To reduce the environmental variation and to analyse a dataset with a higher level of mortality, a data subset (33-day period) was modelled. This identified a range of environmental and operational variables, including the rate of foraging attempts (in combination, explaining 55% of the variation). This was the first attempt to investigate the relationship in the southern hemisphere, and it suggests that without targeted experimental work to further investigate the relationship, caution should be exercised using the rate of foraging attempts of black-browed albatrosses as an index of their level of mortality.

6.71 Dr Fanta reported that experiments carried out on the oceanographic vessel *Soloncy Moura* of the Brazilian Institute for the Environment (IBAMA) found that blue-dyed bait and streamer lines significantly reduced the capture of albatrosses and petrels in the pelagic longline fishery. She was encouraged to submit the results of this research to the Working Group.

6.72 Experiences, relevant to mitigation of longline seabird by-catch, in respect of use of moonpools and video monitoring are reported in paragraphs 10.17 and 10.19 to 10.22.

Dyed Bait and Stealth Gear

6.73 The Working Group noted that Japanese scientists have conducted valuable research on the efficacy of blue-dyed bait as a mitigation strategy and encouraged Japan to submit the results of that work to the Working Group. It was further noted that Mustad is producing a blue, artificial bait (Nor Bait) for use in seabird by-catch mitigation in demersal longline fisheries. Results of recent trials of blue-dyed bait in Hawaii were inconclusive (WG-FSA-03/36).

6.74 The Working Group noted Dr Micol's report (paragraph 6.19) of higher rates of seabird by-catch when black hooklines were used on autoliners compared to white hooklines; this is contrary to the notion that less visible line or stealth fishing gear is likely to reduce seabird by-catch.

Line Weighting

6.75 WG-FSA-03/23 reported the results of an IW longline trial in the New Zealand ling longline fishery in November 2002. The trial ran for 16 days and involved the setting of 340 000 hooks. Up to 1 400 white-chinned petrels per day were in the vicinity of the vessel during the trial. A streamer line was used as a constant during the trial. Unweighted (UW) lines sinking at 0.1 m/s caught a total of 81 white-chinned petrels and one sooty shearwater, while IW lines sinking at 0.25 m/s caught only one white-chinned petrel. The trial is being repeated in October/November 2003 to increase the sample size, to examine interannual variation in effectiveness of IW gear as seabird deterrent and to trial additional mitigation treatments. Trials were also conducted on IW longlines in the New Zealand ling fishery in the winter of 2003 examining effects of IW longlines on the capture of target and non-target fish species. The Working Group noted that a proposal to run a similar trial on the effects of IW longlines (cf. UW lines) on toothfish CPUE in Subareas 88.1 and 88.2 in the 2003/04 season is pending (WG-FSA-03/17). The Working Group noted that once the current IW trial in New Zealand (measuring effects on seabird by-catch) and the trial proposed for Subareas 88.1/88.2 (measuring effects on target fish species) have been completed, there will be enough experimental evidence available on the performance of IW gear to warrant modification of Conservation Measure 25-02 to accommodate line-weighting provisions for autoline vessels. It is intended that the recommended changes to this conservation measure regarding line weighting for autoline vessels will be submitted to CCAMLR in 2004.

6.76 WG-FSA-03/81 reported the results of a trial conducted in 2003 to: (i) determine the sink rate of Spanish system hooklines with time-depth recorders; and (ii) interpret post hoc the seabird mortality estimates for the three line-weighting regimes in the trial by Agnew et al. (2000). The latter point was important given the low white-chinned petrel mortality recorded for autoline longlines sinking at 0.25 m/s referred to in WG-FSA-03/23 and because of the absence of line sink rate data for the Spanish system line-weighting regime required in Conservation Measure 25-02 (8.5 kg/40 m). Longlines carrying 4.25 kg/40 m, 8.5 kg/40 m and 12.75 kg/40 m sank to 20 m depth at 0.4 m/s, 0.54 m/s and 0.68 m/s respectively. These estimates are greater than the 0.25 m/s rate (with a single streamer line) shown to be successful against white-chinned petrels in New Zealand. Assuming the lines sank at similar

speeds in the trial by Agnew et al. (2000), which also employed a single streamer line, the faster sinking Spanish system line caught white-chinned petrels at a higher rate than the slower sinking autoline line.

6.77 The Working Group noted that two observers had used time-depth recorders to measure the sink rates of Spanish system longlines in Subarea 48.3 in the 2002/03 fishing season. Average sink rates using a weighting regime of 8.5 kg at 40 m were recorded as 0.55 m/s (*Argos Helena*) and 0.45 m/s (*Koryo Maru No. 11*), similar to the results reported in WG-FSA-03/81.

6.78 The Working Group observed that reasons for this may be the faster setting speed of Spanish system vessels, which reduces the degree of coverage of hooklines beneath the aerial section of streamer lines or that streamer lines were not deployed in a comparable fashion. It noted that the distance astern at which the hookline reaches a specific depth integrates vessel speed and sink rate into a performance measure; this approach may be preferred to using sink rate specifications alone.

6.79 WG-FSA-03/62 reported a comparison between bottle tests and time-depth recorders (latest model: Wildlife Computers Mark 9) in measuring the sink rates of longlines in accordance with Conservation Measure 24-02. The paper highlighted some inconsistencies in measurements with the bottle test when used on UW longlines in certain weather conditions and cautioned that in high winds and seas, care must be taken in measuring UW longline sink rates with the bottle method. The Working Group noted that the bottle test was designed for hooklines with added weight and performs more reliably in this case (see WG-FSA-01/46).

6.80 Further studies on autoline and Spanish system vessels are necessary to fully understand the role of line sink rates in reducing seabird mortality by both types of fishing methods.

Underwater and Side Setting

6.81 Underwater setting chutes of two lengths (9 m and 6.5 m) and a new approach to seabird mitigation – side setting – were trialled in Hawaiian pelagic longline fisheries (WG-FSA-03/36). Side setting involved deploying snoods near the bow while using a device to restrict seabird access. Results suggest that side setting might be a useful mitigation measure, but results were inconclusive due to operational problems with the underwater setting chutes and the limited scale of the trials.

6.82 It was noted that side setting is being experimented with in demersal fisheries by one vessel in New Zealand. Several vessels side-set in Alaska with mixed performance in respect of seabird by-catch.

Streamer Lines

6.83 WG-FSA-03/18 presented a leaflet describing streamer line performance, material standards and aspects of streamer line rigging in Alaskan longline fisheries. It was suggested

that a similar leaflet describing the concepts and goals of streamer line deployment would be a useful supplement in explaining to fishers the streamer line requirements in Conservation Measure 25-02.

6.84 WG-FSA-03/22 reviewed literature on the effectiveness of single and paired (or multiple) streamer lines and the existing CCAMLR streamer line performance and material standards. It proposed specific options for revisions of the streamer line requirement, and therefore served as a basis for Working Group discussion on revision of streamer line requirements for conservation measures. Although streamer lines are a key element to longline seabird by-catch mitigation worldwide, little research to determine their optimal design (materials and configuration) has been attempted. WG-FSA-03/22 introduced information on the dive rates of white-chinned petrels on IW-50 hooklines set with single and paired streamer lines with an aerial extent of 60 m and for UW lines set with a single streamer line. White-chinned petrel dives peaked at a distance of 70 m astern of the vessel in all cases. In contrast to single streamer lines, dives on the hookline were virtually eliminated to 50 m astern when two streamer lines were deployed; however a definitive comparison was not possible because an acoustic cannon was fired randomly while the paired streamer lines were deployed. Specific research based on quantifiable measures of seabird behaviour (attacks and dives on baits) of white-chinned petrels, grey petrels, black-browed albatrosses and flesh-footed shearwaters was strongly recommended. The Working Group concurred that research on streamer line design and configuration is a high priority for all longline fisheries.

6.85 WG-FSA-03/22 proposed modifications to the CCAMLR streamer line requirements based on available information. Although it is likely that research will demonstrate that paired or multiple streamer lines are significantly more effective than single streamer lines at reducing the incidental mortality of all seabirds, this has not been tested scientifically for Southern Ocean seabirds. WG-FSA-03/22 also proposed two options as a starting point for discussion and action by WG-IMAF: (i) require that a minimum of two streamer lines be deployed during line setting in Convention Area waters based on the best available information; or (ii) maintain the status quo (require a single streamer line be deployed). In either case, explicit streamer line performance standards were strongly recommended. These included requiring an aerial extent of 80–100 m, and specifying the streamer line placement relative to the hookline and prevailing wind. Changes to required streamer line materials and configurations are also recommended.

Proposed Integrated Line-Weighting Trial in Subareas 88.1 and 88.2

6.86 WG-FSA-03/17 requested permission to conduct a line-weighting trial in Subareas 88.1 and 88.2 in the 2003/04 season. The trial will require the relaxation of Conservation Measure 41-09, which requires that vessels set longlines at ≥ 0.3 m/s, and Conservation Measure 24-02 with respect to line sink rate monitoring and Conservation Measure 25-02 with respect to daytime setting. The trial is an important stage in a work plan under way since June 2002 designed to examine the effectiveness of IW (fast sinking) longlines in reducing seabird by-catch. The work plan also examines the effectiveness of IW lines in catching target and non-target fish species. Hitherto trials have been conducted in the New Zealand ling longline fishery against white-chinned petrels, which is the commonest seabird species taken on longlines in Convention Area waters. The trial in New Zealand has

also examined the effects of IW longlines on catch rates of ling and non-target fishes so the implications to both seabird conservation and fishing efficiency of IW longlines are understood.

6.87 The proposed trial in Subareas 88.1 and 88.2 will address the effects of IW longlines on catch rates of toothfish and non-target fish species. The trial will require the deployment of pairs of lines, consisting of one UW (normal) longline and one IW longline. Lines will be allowed to sink at their natural rates, which will be 0.1 m/s for UW and 0.25 m/s for IW. IW lines, which will reach fishing depth much sooner than UW lines, have the potential to catch more toothfish. Setting lines in pairs is fundamental to the trial as it will minimise the number of confounding effects. Since the trial will require exemption from Conservation Measures 24-02, 25-02 and 41-09, and fishing will occur at all stages of the day/night cycle, alternative mitigation measures will be necessary to minimise seabird mortality during the trial. These measures have been outlined in WG-FSA-03/17. It is expected that seabird mortality will not occur during the trial.

6.88 The results of the trial will be important in developing recommendations for line-weighting provisions for autoline vessels in Conservation Measure 25-02 next year, and will aid in efforts to achieve swift uptake by autoline vessels of IW longlines both inside and outside the Convention Area. The trial could also have implications for fishing efficiency and stock assessment, particularly if it is demonstrated that IW lines affect the catch rates of toothfish and non-target fish species.

6.89 The Working Group fully supported the proposal and recommended that exemptions from the relevant elements of Conservation Measures 24-02, 25-02 and 41-09 be allowed. It commended the approach taken to understanding the effects of the use of IW longlines in relation to both seabird by-catch and fishing efficiency, and requested that the results be reported in full to the Working Group next year.

Research into and Experiences with Trawl Mitigation Measures

6.90 This topic is discussed, in relation to experiences in the Convention Area, in paragraphs 6.237 to 6.245 and SC-CAMLR-XXII/BG/28.

Revision of Conservation Measure 25-02 (previously 29/XIX)

6.91 The Working Group concluded in 2002 that several elements of Conservation Measure 25-02, including line-weighting specifications for autoliners, streamer line requirements and removing hooks from discards and offal should be reviewed and revised if appropriate (SC-CAMLR-XXI, Annex 5, paragraph 6.82). This year the Working Group reviewed the entire conservation measure and developed proposed changes based on tabled papers and other available information.

General

6.92 The Working Group recommended that the term ‘baited hooks’ be replaced with the term ‘hooklines’ (defined as the groundline or mainline to which the baited hooks are attached by snoods) throughout the conservation measure to better reflect the nature of the gear and operation of demersal fisheries.

Autoline Line Weighting

6.93 The Working Group noted that information on the performance of IW lines required to propose changes to the conservation measure is incomplete. Results of trials in the New Zealand ling fishery and possibly other fisheries will be available in 2004 and should provide a basis for prescribing weighting regimes and/or performance standards for the sinking of autoline hooklines within this conservation measure. The Working Group concluded that autoline weighting requirements should be defined when more complete information is available in 2004.

6.94 The Working Group noted, however, that in the circumstances currently prevailing in the French EEZs in Subarea 58.6 and Division 58.5.1 (paragraphs 6.19 to 6.25), it was appropriate and necessary immediately to implement conservation measures including a recommended mandatory line-weighting specification based on existing experiences (paragraph 6.28). This recommendation (IW line of a minimum of 50 g/m or attachment of 5 kg weights at 50–60 m intervals) is included in the proposed revision to Conservation Measure 25-02 as an advisory specification.

Thawed Bait

6.95 The mandatory use of thawed bait in demersal longline fisheries in the Convention Area was discussed. Working Group members noted that with the requirement for Spanish longline vessels to weight lines as described in Conservation Measure 25-02, frozen baits did not affect line sink rate and were therefore of minimal conservation benefit.

6.96 For autoline vessels, the longline is negatively buoyant and the size and nature of cut baits are such that the use of frozen or semifrozen bait does not slow line sink rate. Therefore, the requirement to use only thawed bait provides minimal conservation benefit.

6.97 For autoline vessels fishing under Conservation Measure 24-02, with the requirement to meet a minimum longline sink rate, the mandatory requirement to use thawed bait is of minimal conservation benefit.

6.98 Given the generally high level of compliance with line weighting on Spanish longline vessels, the 100% compliance with line-weighting requirements under Conservation Measure 24-02 and the current knowledge of the autoline fishing method, the Working Group recommended that the element of the conservation measure relating to thawed bait was no longer relevant and should be deleted.

Haul Seabird Deterrent

6.99 The Working Group noted that experiences by Australian fishers last season in two longline fisheries (Divisions 58.4.2 and 58.5.2) identified a potential issue with seabird by-catch when hauling longlines. During two cruises large numbers of giant petrels and Cape petrels regularly attended the vessels. While no birds were caught during line setting in this fishery, no doubt due to strict adherence to line-weighting requirements, eight birds were caught during haul operations. The problem may have been exacerbated by the requirement that both vessels retained all offal during fishing operations, making the haul area the only source of food from the vessel. The Working Group agreed that the offal retention policy was to be encouraged, and reviewed ways of minimising by-catch around the haul site.

6.100 In Division 58.5.2, one vessel, the *Janas*, was able to minimise interactions by using a haul seabird deterrent, which discouraged birds from accessing baits when hauling. In Division 58.4.2, the *Eldfisk* reported successfully limiting seabird interactions at the haul using a fire hose aimed into the water near where the line was hauled; no birds were caught while hauling. In Subarea 48.3, the *Koryo Maru No. 11* deployed a buoy suspended from a 4 m boom 2 m aft of the hauling bay on most (66%) hauls – no birds were taken during hauling. In Subarea 88.1, the *Volna* deployed a form of haul seabird deterrent; no birds were taken during hauling. The Working Group noted that seabird by-catch around the haul was a problem in other Convention Area fisheries, particularly in areas assessed by the group as having an average to high or high levels of risk. It therefore recommended that Conservation Measure 25-02 include provision for use of a haul seabird deterrent while hauling longlines in these fisheries. The haul deterrent should be configured such that it incorporates considerations for other non-target by-catch (e.g. cutting elasmobranchs from the line).

Streamer Line

6.101 The Working Group noted that the streamer line requirements prescribed in Conservation Measure 25-02 were based on observations in pelagic fisheries and have remained virtually unchanged for 13 years. Taking particular note of the recommendations in WG-FSA-03/22 (see paragraphs 6.84 and 6.85), the Working Group agreed that the aerial extent of a streamer line and its placement relative to prevailing winds over the hookline are critical to the performance of a streamer line. The streamer line specification in Conservation Measure 25-02 could be improved by addressing these two aspects of streamer line performance. Therefore, the Working Group recommended that the conservation measure encourage vessels to optimise the aerial extent of streamer lines and to deploy streamer lines in such a way that the aerial extent prevents bird attacks on the hookline as far astern of the vessel as possible, even in crosswinds. Although the Working Group had recommended that information be gathered through observers on the effect of aerial coverage of streamer lines on their effectiveness as a seabird deterrent in 2002 (SC-CAMLR-XXI, Annex 5, paragraph 6.74), such data were not collected and therefore information on the aerial extent of streamer lines used in Convention Area waters is not available. The Working Group strongly recommended that these data be collected in the forthcoming season, and provided suggestions as to how this might be done (paragraphs 10.26 and 10.27).

6.102 The height at which the streamer line is attached to the vessel, the tension created by the object towed, the weight of the streamer line materials and vessel speed govern the aerial extent achieved by a streamer line. Because data on the aerial extent of streamer lines were

not available, the Working Group found it difficult to prescribe a minimum aerial extent in the conservation measure at this time. Recognising that the height of the attachment point is both a critical component of aerial extent and a measurable requirement that can be altered with minimal effort and expense by vessel operators, the Working Group recommended that the current requirement of a 4.5 m attachment point be increased to 7 m, in preference to requiring an explicit aerial extent.

6.103 Noting that streamer lines are least effective in crosswinds, the Working Group recommended that the conservation measure require that the streamer line attachment point be on the windward side of the hookline and, to the extent possible, that the required towed object be maintained directly astern of the windward vessel attachment point. These requirements would lead to the streamer line being positioned above the hookline in crosswinds, maximising the effectiveness of streamer lines in conditions that are known to make streamer lines least effective.

6.104 The Working Group noted that the current requirement that the streamer line be 3 mm in diameter is unnecessary and recommended it be deleted. Further, it noted that fishers should have the ability to choose a line diameter that is most appropriate to their vessels. The possibility that the 150 m length requirement be changed was discussed; however no data were available to recommend an alternative length.

6.105 The Working Group noted that data on the optimal spacing and materials for streamers are also not available due to the lack of research in this area. The Working Group recommended that the existing 5 m spacing be retained in the conservation measure and that this spacing be described as a maximum in order to allow vessels to experiment with shorter streamer intervals as appropriate. The Working Group noted that the number of streamers currently required (five) would be insufficient in almost all circumstances and that this situation would be further exacerbated as fishers optimise the aerial extent of streamer lines. Given these observations, the Working Group recommended that streamers be attached throughout the aerial extent of the line, beginning at 5 m from the stern of the vessel, to maximise the effectiveness of the aerial extent of the streamer line. Increasing the height of the attachment point to the vessel and encouraging optimising the aerial extent of the streamer line makes existing streamer length requirements inappropriate. The Working Group recommended revision to reflect that each streamer should extend to the water as measured in the absence of wind and swell, and that an appropriate range of streamer line lengths be specified.

6.106 The Working Group also recommended that the swivel requirements be modified to reflect the intent of these requirements – i.e. that streamers do not become twisted around the streamer line or with each other and to allow individual vessels to determine the best method to achieve that intent.

6.107 The Working Group noted that limited information was available on the conservation benefits of two streamer lines compared to a single line with regard to Southern Ocean seabird species. The Working Group recommended that the use of two streamer lines – attached so that when deployed they are on either side of the hookline – be encouraged but not mandatory in the conservation measure, due to the lack of definitive evidence at this time.

Fish Hook Removal

6.108 The Working Group noted that full compliance with the existing requirement for fish hooks to be removed from offal and fish heads prior to discharge, was difficult to achieve or measure. It recommended that the existing advice be revised to include a requirement that a system be implemented by the vessel to remove fish hooks from offal and fish heads prior to discharge. This recommendation would allow the intent of the existing requirement to be achieved while making compliance assessment feasible.

6.109 Taking account of the foregoing information and suggestions, the Working Group prepared a draft revision of Conservation Measure 25-02, which is attached as Appendix F.

Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

6.110 As no information is available on seabird by-catch rates from the unregulated fishery, estimates of the incidental mortality of seabirds during IUU fishing within the Convention Area present a number of difficulties, requiring various assumptions to be made.

6.111 In previous years the Working Group has prepared estimates using both the average catch rate for all cruises from the appropriate period of the regulated fishery in a particular area and the highest catch rate for any cruise in the regulated fishery for that period. Justification for using the worst catch rate from the regulated fishery is that unregulated vessels accept no obligation to use any of the mitigation measures prescribed in CCAMLR conservation measures. Therefore catch rates, on average, are likely to be considerably higher than in the regulated fishery. The method used is described in full in SC-CAMLR-XXII/BG/19.

6.112 Last year a new method for estimating unregulated catch of fish and birds in Subarea 48.3 was presented (WG-FSA-02/4 and 02/5). The estimate of bird by-catch rate was made by bootstrapping the observed catch rates from fishing operations in 1996/97. The fleet in Subarea 48.3 in 1996/97 implemented relatively few mitigation measures and has been considered to provide the best estimate the Working Group has of likely rates in the unregulated fishery in this subarea. A problem with this analysis is that one vessel, the *Isla Isabel*, had a bird by-catch rate an order of magnitude greater than other vessels fishing that year (summer rate: 11.641 birds/thousand hooks compared to an average of 0.792 birds/thousand hooks for the other vessels).

6.113 WG-FSA-02/4 and 02/5 addressed this problem by running two simulations, one with and one without the *Isla Isabel* data. Following comments by the Working Group last year (SC-CAMLR-XXI, Annex 5, paragraphs 6.90 to 6.92), WG-FSA-03/56 repeated the analysis using *Isla Isabel* data weighted by the number of hooks observed on each cruise.

6.114 The Working Group agreed to apply the method developed in WG-FSA-02/4 and 02/5 to the relevant information for other statistical areas, using particularly the data presented in Table 31 of WG-FSA-98 (SC-CAMLR-XVII, Annex 5) for the by-catch rates of birds in the 1996/97 fishing season in Subarea 58.7. These data were previously used to calculate the unregulated fishery by-catch rates in Subareas 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2 (SC-CAMLR-XVII, Annex 5, paragraph 7.75). These data have also been used to represent

the bird by-catch data appropriate to Division 58.4.4 and Subarea 88.1, adjusted downwards by 40% to reflect the lower seabird vulnerability in this division and subarea (SC-CAMLR-XVIII, Annex 5, paragraph 7.62).

6.115 One of the problems with the bootstrapping method is that there are rather few data from which to bootstrap. A decision was therefore made to use, as bootstrap data for Subareas 58.6 and 58.7 etc., the individual cruise data in WG-FSA-98, Table 31 (SC-CAMLR-XVIII, Annex 5) where the number of observed hooks was not null. For Subarea 48.3, the data used were the individual cruise data presented in Table 1 of WG-FSA-03/56. Data were separated into summer (October–March) and winter (April–September) periods². The resulting median and 95% confidence intervals for seabird by-catch rates for the unregulated fishery are given below.

Subarea/Division	Season	Lower 95%	Median	Upper 95%
48.3	Summer	0.39	0.741	11.641
	Winter	0	0	0.99
58.6, 58.7, 58.5.1, 58.5.2	Summer	0.45	0.55	1.45
	Winter	0.01	0.01	0.07
58.4.4, 88.1	Summer	0.27	0.33	0.87
	Winter	0.006	0.006	0.042

6.116 The Working Group agreed that these values should be used to estimate seabird by-catch in IUU *Dissostichus* spp. fisheries in the Convention Area in 2003. It was also agreed that these values should be applied to the toothfish removals data used to generate similar estimates for previous years.

6.117 It was noted that in addition to the change to seabird by-catch estimates resulting from using the new seabird by-catch rates, the review by the Secretariat and WG-FSA of data on IUU removals of *Dissostichus* spp. resulted in several changes to historical data on total removals. These changes have been incorporated into the reanalysis of the historical data. For last year (2002), the only change in the data on removals relates to Division 58.5.2.

6.118 The estimates of potential unregulated seabird by-catch in the Convention Area in 2002/03 and comparison with estimates for previous years are provided in detail in SC-CAMLR-XXII/BG/19.

6.119 The overall estimated total for the whole Convention Area in 2002/03 indicates a potential seabird by-catch in the unregulated fishery of 17 585 (95% confidence interval range of 14 412 to 46 954) seabirds. The values for this and previous years are summarised in respect of different parts of the Convention Area in Table 6.8.

6.120 The Working Group indicated that it would appreciate further investigation of the representation of features of these data. As an illustrative example, Figure 6.2 was prepared,

² With the exception of the *Garoya* cruise in Subarea 58.7, which took place from 5 April to 10 May 1997, but had a very high by-catch rate of 1.88 birds/thousand hooks, which probably more appropriately reflects a summer rate.

which shows median interquartile and range values for the complete data from 1996 to 2003 for the relevant subareas and divisions of the Convention Area. The advice of the Scientific Committee was sought on the preferred presentation of these data.

6.121 In comparison with estimates for previous years, calculated in identical fashion, the value for 2003 is the lowest reported since estimates started in 1996. Although seabird by-catch values for 1998 to 2000 are not dissimilar to 2003, the 2003 value is only about 70% of the values for 2001 and 2002 (SC-CAMLR-XXII/BG/19). This presumably reflects a commensurate reduction in toothfish removals or changes in the areas from where IUU fishing occurs.

6.122 Based on the data since 1996 (SC-CAMLR-XXII/BG/19), an estimated total of 187 155 (95% confidence interval range of 152 381 to 546 567) seabirds have been killed by these vessels. Of these:

- (i) 41 897 (95% confidence interval range of 33 904 to 132 011) were albatrosses, including individuals of four species listed as globally threatened using the IUCN threat classification criteria (BirdLife International, 2000);
- (ii) 7 417 (95% confidence interval range of 6 059 to 20 742) were giant petrels, including one globally threatened species;
- (iii) 116 130 (95% confidence interval range of 95 728 to 335 932) were white-chinned petrels, a globally threatened species.

6.123 The Working Group noted that changes to the methodology used to estimate the by-catch of seabirds in unregulated fisheries meant that values estimated this year are approximately half those in previous reports, including last year in SC-CAMLR-XXI/BG/23. However, it was noted that the median value used for IUU fisheries in Subarea 58.6 and Division 58.5.1 (and adjacent areas) of 0.55 birds/thousand hooks is similar to – or even lower than – the values in regulated fisheries in these areas in recent years: 0.456 birds/thousand hooks in 2002, 0.635 birds/thousand hooks in 2001, 2.937 birds/thousand hooks in 2000 and 0.736 birds/thousand hooks in 1999.

6.124 The Working Group requested that seabird by-catch rates used to characterise IUU fishing be reviewed next year to ensure that appropriately consistent relationships to values reported for regulated fisheries are maintained.

6.125 As in previous years, it was emphasised that these values are very rough estimates (with potentially large errors). The present estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution.

6.126 Nevertheless, even taking this into account, the Working Group endorsed its conclusions of recent years that:

- (i) the levels of loss of seabirds from the populations of these species and species groups are still broadly consistent with such data as exist on the population trends of these taxa, including deterioration in conservation status as measured through the IUCN criteria;

- (ii) such levels of mortality continue to be unsustainable for the populations of albatrosses and giant and white-chinned petrels breeding in the Convention Area.

6.127 Many albatross and petrel species are facing potential extinction as a result of longline fishing. The Working Group again urgently requested the Commission to continue to take action to prevent further seabird mortality by unregulated vessels in the forthcoming fishing season.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

6.128 The Working Group considered papers reporting on seabird mortality from fisheries conducted outside the CCAMLR Convention Area but which affected birds that breed within it.

6.129 WG-FSA-03/47 and 03/52 reported, respectively, on New Zealand and Australian research relevant to seabirds vulnerable to fisheries mortality. None of the papers referenced deals specifically with birds that breed in the Convention Area, and which may be affected by fisheries mortality outside the area, though fisheries effects on populations breeding elsewhere are covered in some studies.

6.130 Mr Arata reported that Uruguayan scientists had recently collected seabird by-catch data from their EEZ. This had indicated high rates of seabird mortality, including of birds potentially from the Convention Area. Uruguay was encouraged to submit a report for consideration at the next meeting of the Working Group.

6.131 No reports on seabird mortality in regions adjacent to the Convention Area were received from any country. Members were reminded of the standing request for submission of such data.

6.132 WG-FSA-03/09 reported on the level of dietary dependence of black-browed albatrosses on fisheries offal in the Chilean region. The study showed that 69–89% of diet mass, depending on the year, was composed of fishery discards. Prey species identified in the diet showed that these were most likely mainly to come from Chilean national fisheries, mainly for hoki, southern blue whiting and golden kingclip, corroborated by satellite-tracking information reported last year (SC-CAMLR-XXI, Annex 5, paragraphs 6.120 and 6.121). Of particular relevance to the conservation measures was the identification of longline hooks in three diet samples from Diego Ramírez Islands, Chile.

Research into the Status and Distribution of Seabirds

6.133 Following last year's renewed request for information summarising national research on seabirds (albatrosses and *Macronectes* and *Procellaria* petrels) vulnerable to longline fisheries interactions, papers were presented by New Zealand (WG-FSA-03/47), Australia (WG-FSA-03/52) and the USA (WG-FSA-03/93). Reference to research on albatrosses by Chile is included in WG-FSA-03/10 and 03/11, and research by the UK and South Africa in

WG-FSA-03/37. Further reference to relevant research by South Africa is included in WG-EMM-03/8, 03/11 and 03/41. Some details of research by France are included in WG-EMM-03/32 and 03/41. Of countries known to be conducting relevant research, no specific reports were received from Argentina and the UK.

6.134 Previously the research summary by the USA included details of current research into methods to monitor and mitigate seabird by-catch, which was welcomed by the Working Group as a valuable contribution to its work. Consequently all Members were requested to include details of mitigation research in their annual research summaries to update the Working Group on the current status of relevant mitigation research programs (SC-CAMLR-XXI, Annex 5, paragraph 6.111). As the USA was again the only Member to provide this information, the Working Group reiterated the request for inclusion of mitigation research in national research reports.

6.135 In order to compare assessments of levels of fishing effort and seabird by-catch with seabird population dynamics and foraging ranges, Members have been requested to provide any new or outstanding details of seabird population and foraging studies. As only New Zealand and Australia provided this information (WG-FSA-03/47 and 03/52), the review of the level of information available for each population that was previously forecast (SC-CAMLR-XXI, Annex 5, paragraph 6.113) remains outstanding.

6.136 Information on population dynamics and foraging studies provided to date has been summarised into SC-CAMLR-XXII/BG/18, which updates SC-CAMLR-XXI/BG/22. All Members were again requested to provide more comprehensive national research reports so that appropriate assessments can be undertaken.

6.137 The Working Group recommended that in order to streamline and achieve more complete and representative reporting for the 2004 meeting, reporting formats would be reviewed and that the Secretariat would forward a reminder to all members of WG-IMAF to submit reports during the intersessional period.

6.138 The most recent assessments of the global conservation status of albatrosses, giant petrels and *Procellaria* petrels are reflected in SC-CAMLR-XXII/BG/18. This summary reflects the revised status of six species of albatrosses whose threatened status has been upgraded according to IUCN Red List categories (WG-FSA-03/101). Of these six species, four have been identified as being at risk to fisheries-related mortality in the Convention Area, and longline fishing has been identified as the prime factor responsible for greatly increasing their risk of extinction.

6.139 Black-browed albatross, listed as Near Threatened in 2000, and Vulnerable in 2002, was upgraded to Endangered, with new census information from the Falkland/Malvinas Islands showing that the species is likely to decline by over 50% over three generations (65 years) (WG-FSA-03/101). Black-browed albatrosses breed at 12 sites, with most birds occurring at the Falkland/Malvinas Islands, South Georgia and Chile. Numbers at the Falkland/Malvinas Islands, with 60% of the world's population, have declined at most breeding sites, with sharp decreases at the two major colonies. Monitored populations at South Georgia also continue to decline.

6.140 Information in WG-FSA-03/101 reported that the decline of black-browed albatrosses may be attributable to increased longline fishing effort and/or the development of new longline fisheries over much of the Patagonian shelf, around South Georgia, off the southern

African coast, and in the Southern Ocean. Black-browed albatrosses are one of the most frequently killed species in many longline fisheries, and they are also killed in substantial numbers in many trawl fisheries.

6.141 Atlantic yellow-nosed albatross has been upgraded from Near Threatened in 2000 to Endangered in 2003 due to population declines recorded in long-term study colonies on Gough and Tristan da Cunha Islands, indicating a 58% reduction over three generations (71 years) (WG-FSA-03/37). If threats do not abate, population models suggest that the species may need to be classified as Critically Endangered, the final category before becoming Extinct.

6.142 The status of Indian yellow-nosed albatross, listed as Vulnerable in 2000, has also been upgraded to Endangered on the basis of an estimated overall decline of 63% over three generations (71 years), based on data from the stronghold of the population on Amsterdam Island. This decline, reported in WG-FSA-03/101, is the result of high adult mortality and poor recruitment apparently owing to interactions with fisheries and disease (WG-EMM-03/32). During the breeding season, Indian yellow-nosed albatrosses have been taken by longliners fishing for *D. eleginoides* in the vicinity of the Prince Edward Islands.

6.143 Sooty albatross has been upgraded from Vulnerable to Endangered on the basis of an estimated 75% decline over three generations (90 years), potentially as a result of interactions with fisheries (WG-FSA-03/101). The change in status was based on trends recorded at three sites. In the southeast Atlantic Ocean sector, the Gough Island population appears to have decreased by about 50% over 28 years. In the western Indian Ocean sector the Marion Island population declined by 25% between 1990 and 1998, and on Possession Island (Crozet) the population declined by 58% between 1980 and 1995. If these trends are found to be consistent at further sites, the species may qualify as Critically Endangered.

6.144 In recent years 20 species of albatrosses and petrels have been identified as being at risk from longline fisheries in the Convention Area. The current status of these species, as reflected in SC-CAMLR-XXII/BG/18 which updates SC-CAMLR-XXI/BG/22, is listed below.

Critically Endangered	Endangered	Vulnerable	Near Threatened
Amsterdam albatross	Northern royal albatross	Wandering albatross	White-capped albatross
Chatham albatross	Sooty albatross	Antipodean albatross	Light-mantled albatross
	Black-browed albatross	Southern royal albatross	Northern giant petrel
	Atlantic yellow-nosed albatross	Grey-headed albatross	Grey petrel
	Indian yellow-nosed albatross	Campbell albatross	
		Salvin's albatross	
		Buller's albatross	
		Southern giant petrel	
		White-chinned petrel	

6.145 The Working Group noted with serious concern the increasing number of albatross and petrel species that were becoming more immediately threatened with extinction, as reported by WG-FSA-03/101, largely as a result of fisheries interactions. Croxall and Gales (1998) noted that, based on 1997 information, albatrosses had the highest proportion of threatened species in any bird family that has more than a single species. The recent changes in threatened species status in the family makes the situation for albatrosses increasingly serious.

6.146 In order to monitor these threatened species, and more effectively mitigate the threats they face, the Working Group encouraged Members to support: censuses and monitoring at key breeding sites; continuation of existing long-term population studies; determination of foraging distribution for populations where this is not known; evaluation of all significant influences on survival, including enhanced monitoring of seabird by-catch; and promotion of adoption of best-practice mitigation measures in longline and trawl fisheries within the species' ranges.

6.147 Prof. Croxall reported that the BirdLife International Seabird Conservation Programme has now developed a GIS database for the archiving and analysis of satellite and geolocation tracking data for albatrosses and petrels (see SC-CAMLR-XXI, Annex 5, paragraph 6.159(iii)). A workshop to achieve this was held at Gordons Bay, South Africa, from 1 to 5 September 2003 and a report will be available to CCAMLR in the forthcoming intersessional period. Of potential interest to CCAMLR will be new data on the density distribution of foraging by albatrosses and petrels, including in relation to FAO statistical areas, to the boundaries of RFMOs and to the distribution of effort in longline fisheries.

6.148 Information on a previously undescribed population of black-browed albatrosses at Evangelistas Islets, Straits of Magellan, Chile, was reported in WG-FSA-03/10. The population was censused from aerial photographs taken in October 2002 which yielded a population estimate of 4 670 breeding pairs. This new record raises to four the number of islands in Chile where black-browed albatrosses breed.

6.149 In order to update information on the status of black-browed and grey-headed albatrosses breeding in Chile, censuses were conducted during October 2001 (Diego de Almagro) and October 2002 (Evangelistas, Ildefonso and Diego Ramírez) at all known breeding locations (WG-FSA-03/11). Population sizes were determined using boat-based, aerial and ground-based photography and ground counts. Black-browed albatrosses occur at all four locations, whilst grey-headed albatrosses, with the exception of eight pairs observed at Ildefonso, are confined to Diego Ramírez. Total estimated population sizes for the four known breeding locations in Chile are 123 000 pairs (20% of global population) of black-browed albatrosses and 16 400 pairs (20% of global population) of grey-headed albatrosses. Based on this new information, Chile is now recognised as holding the second-largest population of black-browed albatrosses in the world.

6.150 While estimates of the black-browed and grey-headed albatrosses have been obtained for Diego Ramírez and Ildefonso on a few occasions previously (summarised in WG-FSA-03/11), lack of information of methods and inconsistencies in timing of census precluded any conclusion regarding population trends. Integration and comparison of a range of survey techniques in this study have yielded valuable methodological insights into surveying remote and relatively inaccessible albatross colonies.

6.151 Population dynamics and trends of Atlantic yellow-nosed albatross was described with respect to the effects of mortality from longline fisheries operating in the South Atlantic (WG-FSA-03/37). Population demographic data collected from Gough Island and Tristan da Cunha showed that the number of breeding birds was strongly correlated between the two islands, with both colonies declining at 1.2% per annum. Using a range of measured demographic parameters, modelling predicts annual rates of decrease of 1.5 to 2.8% on Gough Island and 5.5% on Tristan da Cunha. Comparison with congeners suggests that the observed and predicted decreases are most likely to be caused by low adult and immature survival rates.

6.152 The population trends of surface-nesting seabirds at Marion Island measured between the 1990s and 2002/03 showed different trends, but for the majority of species, numbers decreased (WG-EMM-03/08). For the species at risk from fisheries interactions in the Convention Area, decreases in numbers of sooty albatrosses, light-mantled albatrosses, southern giant petrels and possibly northern giant petrels are suggested to have resulted from mortality of birds in longline fisheries. Populations of wandering and grey-headed albatrosses at Marion Island have fluctuated during the period, increasing in 2000/01 and 2001/02 before decreasing to low levels in 2002/03. The Working Group welcomed the synthesis of this long-term and multi-species population data and encouraged the continued collection of population data of species being influenced by both environmental (climate change) and anthropogenic (fisheries mortality) influences.

6.153 The Prince Edward Islands support substantial proportions of the global populations of a number of surface nesting seabirds. Populations of most of these have decreased at the islands since the 1980s and 12 of the 16 species are regarded as regionally or internationally threatened. The main cause of population decrease for the albatrosses and giant petrels is thought to be by-catch mortality in longline fisheries. The Working Group supported the recommendation in WG-EMM-03/14 that a combination of research, monitoring and legislation will help conserve the surface-nesting seabirds of the Prince Edward Islands into the 21st century.

6.154 WG-EMM-03/32 reported that two pathogenic diseases (avian cholera and *Erysipelas* bacteria) have been identified in yellow-nosed albatrosses at Amsterdam Island and are suspected (but not confirmed) to be present in Amsterdam and sooty albatrosses (WG-EMM-03/32). The avian cholera infection may have been influenced by the increase in temperature in the Indian Ocean during the 1970s but more likely resulted from contamination by poultry introduced to Amsterdam Island in the 1960s.

6.155 The diseases identified are suggested to result in elevated chick mortality, and possibly death of infected adults (WG-EMM-03/32). The most threatened albatross species, the Amsterdam albatross, already classified as Critically Endangered, has been reduced to 20 pairs breeding annually and increased chick mortality will further jeopardise the survival of this species. The Working Group noted the importance of surveillance of disease and other factors that can influence survival of threatened species, but was cautious about the interpretation of the level of significance of disease in influencing population trends, given the limited data (small sample size) presented, especially for adult birds, and the isolation of the diseases only in Indian yellow-nosed albatrosses.

6.156 Although the world's oceans have been warming in recent decades, the impact on the biota is poorly understood because of the paucity of long-term datasets on marine organisms. WG-EMM-03/53 reported that climatic changes in the southern Indian Ocean over the last 50 years were particularly important in the sub-Antarctic sector. During that period, with a time lag of two to nine years, the population size of most seals and seabirds monitored on several breeding sites has decreased severely, whilst two species have increased at the same time (king penguin and Amsterdam (sub-Antarctic) fur seal). The Working Group recognised the importance of the long-term monitoring studies of population size, complemented by demographic parameters, in the Southern Ocean that can provide valuable signals to changes occurring in the marine environment. The results of these studies show that climate change and ocean warming can have important effects on the biotic components of marine ecosystems.

6.157 WG-FSA-03/82 reviewed progress in the development of genetic tests to validate the identity of albatross species killed by fishing activities. Simple, widely applicable tests now exist for all albatross species except those which distinguish the following species pairs: Antipodean and Gibson's albatrosses (*Diomedea antipodensi* and *D. gibsoni*); northern and southern royal albatrosses (*D. epomophora* and *D. sanfordi*); southern and northern Buller's albatrosses (*Thalassarche bulleri* and *T. platei*).

6.158 The Working Group recognised that although genetic techniques can identify the population-origin of albatrosses, population-origin is not synonymous with island-origin due to the extent of inter-island movement of some albatrosses (e.g. WG-EMM-03/41). This does not diminish the importance of retaining by-catch specimens and the Working Group reiterated the requirement that Members retain specimens whenever possible and report annually the extent and location of their seabird by-catch collections.

6.159 WG-EMM-03/41 reported the exchange of wandering albatrosses between the Crozet Islands and the Prince Edward Islands (1 068 km apart). Adults and fledgling albatrosses have been banded at these locations since 1960 and 1976 respectively. Since banding commenced, 61 birds have been recorded in both locations and 18 fledglings banded in the Crozet Islands have subsequently bred at the Prince Edward Islands. The Working Group agreed that the wandering albatrosses of these two island groups form a metapopulation and should be treated as a single conservation unit.

6.160 Prof. Croxall reported that Dr P. Ryan (South Africa) is currently examining the use of genetic techniques to identify the island-origin of white-chinned petrels, including birds killed by fishing activities. Preliminary trials indicate that these genetic techniques may also be directly applicable to *Macronectes* species.

International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing

Second International Fishers' Forum (IFF2)

6.161 The Western Pacific Regional Fishery Management Council hosted the Second International Fishers' Forum (IFF2) in Honolulu, Hawaii, USA, from 19 to 22 November 2002 (WG-FSA-03/25). In November 2000, New Zealand hosted the First International Fishers' Forum (IFF1) which focused on methods to solve the incidental catch of seabirds by longline fishing gear. IFF2 built on the efforts made by the participants at IFF1, and also included discussions on sea turtle biology and behaviour, and on reducing and minimising the harmful effects of interactions between sea turtles and longline gear. The Commission noted its support of this international initiative (CCAMLR-XXI, paragraph 6.11(iv)).

6.162 A total of 236 participants from 28 countries attended IFF2. Individuals from 13 of the 24 CCAMLR Members were in attendance. Issues were discussed and perspectives exchanged through plenary and breakout sessions. Sessions included: seabird mitigation and research; turtle mitigation and research; data collection; education/communication; obstacles, lessons learnt and ways forward; international agreements and national approaches; and fishers' incentives.

6.163 IFF2 concluded with a resolution by participants which included further encouragement to the FAO, relevant regional fisheries management organisations and national agencies to collaborate in the implementation and monitoring of the IPOA to reduce incidental catches of seabirds in longline fisheries.

6.164 The Western Pacific Regional Fishery Management Council has produced an Executive Summary of IFF2, available at www.wpcouncil.org/iff2/WPR%20Fishery_rev21802.pdf. The full text of the IFF2 resolution is included therein.

6.165 The Working Group was encouraged by the continued participation of multiple stakeholders in international fora such as this. It encouraged CCAMLR Members that have not yet hosted an IFF to consider hosting the next meeting in the near future.

6.166 Given the seabird by-catch issues in trawl fisheries that the Working Group has been addressing in recent years, it urged the host of IFF3 to consider including a session on this topic.

Agreement on the Conservation of Albatrosses and Petrels (ACAP)

6.167 Since 1999, parties to CMS have been pursuing the development of ACAP (WG-FSA-03/53). CCAMLR has indicated its support of this international initiative (CCAMLR-XXI, paragraph 6.11(iv)). To date, ACAP has nine signatories (Australia, Brazil, Chile, Ecuador, France, New Zealand, Peru, Spain and the UK) and four (Australia, New Zealand, Ecuador, and Spain) of the necessary five ratifications required for entry into force.

6.168 It is anticipated that the remaining ratification required for ACAP to enter into force will occur within the next few months and that the first meeting of the parties will be held early in 2004. Both the UK and South Africa have confirmed their intention to ratify shortly.

6.169 Australia, in its role as Interim Secretariat, has established a website for ACAP with the aim of keeping all Range States and interested organisations informed of current progress with ACAP and related issues. Further information can be obtained at: www.deh.gov.au/coasts/species/seabirds.

6.170 The Working Group recognised the importance of the proposed conservation actions of ACAP and is hopeful that the first meeting of the Parties will occur prior to the next Working Group meeting. The Working Group encouraged:

- (i) Members of CCAMLR to ratify ACAP and to support the active participation of scientists and fishers concerned with and working on the conservation of albatrosses and petrels;
- (ii) support for the attendance and representation of CCAMLR at the next ACAP meeting.

FAO's International Plan of Action for Reducing Incidental Catch
of Seabirds in Longline Fisheries (IPOA-Seabirds)

6.171 The Working Group noted the Commission's continued request to Members to develop and implement national plans in support of the FAO IPOA-Seabirds (CCAMLR-XXI, paragraph 6.11(v)).

6.172 Last year the Commission endorsed the Scientific Committee's advice to renew attempts to obtain progress reports on the development and implementation of FAO NPOA-Seabirds from Members, especially Argentina, Brazil, Chile, European Community, France (in respect of overseas territories) and Uruguay, with responsibilities for areas adjacent to the Convention Area or conducting fisheries in these areas (CCAMLR-XXI, paragraph 6.11(v)).

6.173 The 25th session of the FAO's COFI met from 24 to 28 February 2003, in Rome, Italy. FAO requested Member States to complete questionnaires on its implementation of the Code of Conduct for Responsible Fisheries and the IPOAs. These self-assessments are compiled into a single report and submitted to COFI. Of the 68 FAO Members reporting longline fisheries, only three reported they had developed NPOAs (Brazil, Egypt and the USA) and three reported partially complete NPOAs (European Community, Spain and Sweden).

6.174 The Working Group noted the following new information regarding the status of development of NPOA-Seabirds:

- (i) New Zealand released a draft NPOA and will finalise the plan in November 2003 (WG-FSA-03/41). The NPOA addresses seabird by-catch in the longline and trawl fisheries primarily, and proposes a mix of voluntary Codes of Practice developed for each fishery, economic incentives, regulations and penalties for irresponsible fishing practices. The codes will specify fishing practices, maximum by-catch limits, and methods to monitor compliance, education and public awareness. Mandatory measures would be used if necessary. The New Zealand draft NPOA is available at www.doc.govt.nz.
- (ii) Australia's NPOA will build on and extend the Threat Abatement Plan that is currently being implemented to reduce seabird by-catch (WG-FSA-03/51). Once the Assessment Report on seabird interactions with longline fisheries is finished, the NPOA can be completed. It is expected that the NPOA will be completed by mid-2004 and submitted to FAO's 26th Session of COFI in 2005. The Draft Assessment Report is available at www.affa.gov.au.
- (iii) Dr Fanta reported that Brazil produced a draft NPOA in April 2003. The draft was prepared for the Brazilian Institute of the Environment by the Albatross Institute, a non-governmental organisation. The draft NPOA will be finalised through a consultative process including scientists, representatives of the Ministry of the Environment, the Secretary of Fisheries and Aquaculture of the Presidency of the Republic, the Ministry of Foreign Affairs, fishers and fishing company owners. Dr Fanta has been invited to provide information on measures taken in CCAMLR longline fisheries to avoid the incidental catch of seabirds. This plan will be presented at a BirdLife International/FAO workshop in Chile in December 2003.

- (iv) Dr Sullivan reported that the Falkland/Malvinas Islands Plan of Action is in the advanced stages of industry consultation; it is intended to commence the process of formal adoption early in 2004. The intent of the FAO IPOA-Seabirds was interpreted to put in place management strategies to achieve a reduction in fisheries-related seabird mortality in general. Therefore, given the high level of trawl-related mortality in Falkland/Malvinas Islands waters, a draft plan has also been developed for the squid and finfish trawl fisheries. There are currently insufficient data to conduct an assessment of the large *Illex argentinus* jigging fleet, so an Assessment Directive has been drafted to collect the data necessary to conduct an assessment (as detailed in IPOA-Seabirds) within four years of the adoption of the plans.
- (v) South Africa distributed a draft NPOA in November 2002. The Working Group requested information on learning when the NPOA may be finalised.
- (vi) Apart from the reports from New Zealand and Australia (WG-FSA-03/41 and 03/51), the CCAMLR Secretariat received no other updates on NPOA development.

6.175 The Scientific Committee had noted slow progress to develop and implement NPOAs (SC-CAMLR-XXI, paragraph 5.35). The Working Group continued to highlight the need for nations and fishing entities to develop effective NPOAs for fisheries that interact with seabirds from the Convention Area.

6.176 The Working Group was encouraged to learn that FAO will jointly host with BirdLife International a South American workshop on the conservation of albatrosses and petrels in Chile in December 2003. Invited participants will include government, fishing industry, and environmental organisation representatives from Argentina, Chile, Peru, Ecuador and Uruguay. The Working Group is hopeful that this effort by FAO and BirdLife International will hasten the development and implementation of NPOAs in key areas and improve the progress seen to date in completed and effective NPOAs. It encouraged the convening of similar workshops in other key areas and for distant water fleets.

RFMOs, Tuna Commissions and International Governmental Organisations

6.177 The Working Group recollected its earlier advice, endorsed by the Commission, that the greatest threats confronting the conservation at sea of albatrosses and petrels breeding in the Convention Area are the levels of mortality likely to be associated with IUU longline fishing inside the Convention Area and with longline fishing for species other than *Dissostichus* in areas adjacent to the Convention Area (CCAMLR-XX, paragraph 6.33). CCAMLR has been making particular efforts to collaborate with relevant RFMOs to address these problems, but with limited success in 2002.

6.178 The situation from last year has not improved, when the Commission noted that intersessional contact with RFMOs with competences in areas adjacent to the Convention Area regarding the issue of incidental mortality of seabirds had been limited and unsatisfactory (CCAMLR-XXI, paragraph 6.16). It requested that Members, who are also

members of other RFMOs, ensure that the issue of seabird by-catch is included on the agendas of appropriate meetings of all relevant RFMOs (SC-CAMLR-XXI, paragraphs 5.30 to 5.34).

6.179 The CCAMLR Observer to CCSBT (Australia) provided a report from the November 2001 meeting of CCSBT-ERSWG (SC-CAMLR-XXII/BG/21). The Working Group noted that CCSBT has required the mandatory use of one streamer line on member country vessels targeting southern bluefin tuna. Aside from this, it appears that minimal activities have occurred to develop a comprehensive seabird by-catch reduction program.

6.180 In the ERSWG report, Japan noted the comments made at CCAMLR in regard to the incomplete coverage and lack of clarity of its NPOA and reported that the comments would be considered by its NPOA review committee. Japan indicated that it would report to CCAMLR on the outcome. The CCAMLR Secretariat has not yet received such comments from Japan.

6.181 The Working Group was encouraged that ICCAT adopted a Resolution on Incidental Mortality of Seabirds (Res. 02-14) at its 2002 annual meeting. The resolution urges Parties to inform ICCAT's Standing Committee on Research and Statistics (SCRS) of the status of their NPOA-Seabirds and to implement such plans, where appropriate. Furthermore, the resolution encourages Parties to collect and provide to SCRS all available information on interactions with seabirds, including incidental catches in all fisheries under the purview of ICCAT.

6.182 Ms Rivera reported that the USA has included seabird by-catch information from its Atlantic pelagic longline fishery in its national report to ICCAT this year as well as the information requested on its NPOA-Seabirds implementation.

6.183 The Working Group encouraged other CCAMLR Members that are also members of ICCAT to comply similarly with ICCAT's Resolution 02-14. The Working Group noted with concern that the final version of Resolution 02-14 did not specify any time frame for the execution of the tasks.

6.184 As a result of an examination last year of fisheries data provided by IOTC, the Working Group noted that pelagic longline effort by Japan and Taiwan in the Indian Ocean south of 40°S overlaps with the foraging distribution of several albatross species that breed in the Convention Area (SC-CAMLR-XXI, Annex 5, paragraph 6.146).

6.185 Thus, the CCAMLR Secretariat sent a request in November 2002, via the IOTC Secretariat, to delegations at the annual IOTC meeting who represented countries which are also CCAMLR Members. The request was to ensure that the issue of seabird by-catch be included for consideration by IOTC. No response to this has been received to date.

6.186 Dr Kirkwood noted that the Scientific Committee of IOTC had recently established a working party to assess by-catch of non-target species. However, its main initial focus would be on shark by-catch in tropical longline fisheries, from which interactions with seabirds had not been reported.

6.187 The Working Group welcomed this information, but noted that it would appreciate the opportunity for seabird by-catch experts contributing to its work to assess interactions

between seabirds potentially originating from the Convention Area and longline fisheries (especially for swordfish and albacore) in the southern part of the IOTC area and to propose any mitigation measures that might be deemed appropriate.

6.188 IATTC has measures in place calling for the reduction of non-target catches which are not landed. IATTC indicated last year that its purse-seine fishery observer program has never documented seabird by-catch and that its longline fishery has no observer program (SC-CAMLR-XXI, Annex 5, paragraphs 6.147 and 6.148).

6.189 For a second year, the USA has provided seabird by-catch information from its west coast pelagic longline fishery for tuna and swordfish, a fishery that occurs within the IATTC Convention Area (SC-CAMLR-XXI, Annex 5, paragraph 6.148; WG-FSA-03/39). Information from both years indicated that the seabird species incidentally caught in this pelagic longline fishery are not species that breed in the CCAMLR Convention Area. The Working Group appreciated this information and requested that, in the future, if fishery changes occur and the observer program documents by-catch of seabirds from the CCAMLR Convention Area, that such information be provided to WG-IMAF.

6.190 Mr Smith informed the Working Group that the recent Chairman's report from the 5th Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific (WCPFC) (available at www.ocean-affairs.com) stated that the Convention is highly likely to enter into force by the middle of 2004. The Working Group suggested that CCAMLR could provide an assessment of the potential risk to CCAMLR Convention Area seabirds by vessels fishing in the WCPFC area.

6.191 The Working Group noted that following its recommendation to the Scientific Committee last year, the Commission requested Members who are also members of and observers to relevant RFMOs to: (i) ensure that the issue of seabird by-catch is included on the agendas of appropriate meetings of all relevant RFMOs; (ii) continue reporting on activities relating to seabird by-catch; and (iii) press for inclusion of this topic on RFMO agendas (CCAMLR-XXI, paragraph 6.16; SC-CAMLR-XXI, paragraphs 5.30 to 5.34; SC-CAMLR-XXI, Annex 5, paragraph 6.154). The Working Group noted that CCAMLR has nominated observers to participate intersessionally at the meetings of ICCAT, IATTC and CCSBT. A reminder was also sent by the Secretariat, via the IOTC Secretariat, to delegations of those CCAMLR Members who are also members of IOTC. By the time of WG-FSA, no reports from CCAMLR observers at these meetings had been made available. The Working Group recommended that further actions on cooperation with RFMOs be developed by the Scientific Committee after considering reports from CCAMLR observers.

6.192 The Working Group was disappointed to learn that a joint Chile/USA seabird by-catch proposal submitted to the APEC Fisheries Working Group in 2003 was not approved. It appears that due to lack of available APEC funds, the proposal was not forwarded for consideration. The Working Group commended the proposers on their collaborative and cooperative efforts and encouraged renewed attempts to seek support for this seabird by-catch initiative.

Other International Organisations and Initiatives,
including Non-governmental Organisations

6.193 The formation of Southern Seabird Solutions was first reported to the Working Group last year (SC-CAMLR-XXI, Annex 5, paragraph 6.156). A status report on Southern Seabird Solutions was received (WG-FSA-03/31) detailing some of its activities, such as: fostering exchange of crew and technologies between fleets in different countries; hosting national and regional fishers forums to enable fishers from different fleets to exchange ideas and information; developing and testing new mitigation technologies; establishing similar groups to Southern Seabird Solutions in other countries; and producing various outreach materials to build awareness of the issue and solutions.

6.194 Southern Seabird Solutions is holding its annual conference in Auckland, New Zealand, in November 2003. The Working Group again commended the work of Southern Seabird Solutions as it recognises the value of this group in aiding the reduction of seabird by-catch of birds breeding in the Convention Area. The Working Group encouraged active participation in Southern Seabird Solutions by CCAMLR Members.

6.195 Prof. Croxall reported that the BirdLife International Seabird Conservation Programme has several ongoing activities of note that relate to albatrosses and petrels that breed in the Convention Area:

- (i) a seabird mitigation guide available (in Spanish) for fishers using the Spanish longline system;
- (ii) a fishers' competition with substantial prize money for the best seabird avoidance device;
- (iii) co-hosting with FAO a technical workshop for South America in Chile in December 2003;
- (iv) hosting with Asian partners a technical workshop for Asian nations, particularly distant water fleets, in Taiwan in January 2004;
- (v) comprehensive activity reports from BirdLife International partners in the USA (National Audubon Society) and Spain (SEO/BirdLife).

6.196 The Working Group commended BirdLife International for these numerous activities and is encouraged by continued work to address the critical areas of South American fisheries and the distant-water fleets of Asian nations, both of which relate to the foraging distributions of albatrosses and petrels breeding in the Convention Area.

6.197 The Third International Conference on Albatrosses and Petrels will be held in Montevideo, Uruguay, from 23 to 27 August 2004. The Working Group encouraged the active participation of CCAMLR Members in this important meeting which will directly address the conservation of albatross and petrel species breeding in the Convention Area. Information on the conference is available at www.iapc2004.com.

National Initiatives

6.198 The USA reported on a seabird identification guide that is used by observers in its Alaskan groundfish fisheries to accurately identify the seabird species that are incidentally caught in fishing gear (WG-FSA-03/24). The guide is comprised of photo accounts of dead birds and uses a simple identification scheme.

6.199 The Working Group reviewed this approach to seabird identification by fishery observers. Features of this guide are worth future consideration if the Commission decides to revise its own 'live bird' guide for species occurring in the Convention Area. In the interim, the Working Group encouraged CCAMLR Members to work with its observer programs to acquire the imagery that could be used in such training tools.

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

Assessment of Risk in CCAMLR Subareas and Divisions

6.200 As in previous years, the Working Group assessed the numerous proposals for new fisheries and the potential for these new and exploratory fisheries to lead to substantial increases in seabird incidental mortality.

6.201 In order to address these concerns, the Working Group reviewed its assessments for relevant subareas and divisions of the Convention Area in relation to:

- (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.

6.202 Comprehensive assessments on the potential risk of interaction between seabirds and longline fisheries for all statistical areas in the Convention Area are carried out each year and have been combined into a background document for use by the Scientific Committee and Commission last year (this was SC-CAMLR-XXI/BG/21).

6.203 This year new data on at-sea distribution of light-mantled albatross from satellite-tracking studies was provided in WG-FSA-03/52. This information was used to update the assessment of potential risk of interaction between seabirds and longline fisheries for Division 58.4.1. Also incorporated were minor changes to correct errors and inconsistencies identified during the review of the assessments, and to clarify the Working Group's advice last year with respect to high-latitude subareas and divisions in the Convention Area where exemptions from seasonal restrictions may apply subject to the application of conservation measures similar to Conservation Measure 24-02. The revised assessments incorporating new information made available at the meeting (with changes/additions underlined) have been issued as SC-CAMLR-XXII/BG/17.

New and Exploratory Longline Fisheries Operational in 2002/03

6.204 Of the 21 proposals last year for new and exploratory longline fisheries in 10 subareas and divisions, only five were actually undertaken: by Australia in Division 58.4.2; by New Zealand, Russia and South Africa in Subarea 88.1; and by New Zealand in Subarea 88.2.

6.205 No seabird by-catch was reported to have been observed in any of these fisheries. Clearly the strict adherence in Subareas 88.1 and 88.2 and Division 58.4.2 to the specific requirements set out in Conservation Measure 24-02 with respect to line-weighting regimes, combined with fishing in an area of average-to-low and average risk, has proven successful in achieving zero incidental by-catch of seabirds.

New and Exploratory Longline Fisheries Proposed for 2003/04

6.206 Twenty-nine applications for new and exploratory longline fisheries, submitted by 14 countries, were received by CCAMLR in 2003. The areas for which these proposals were received were:

Subarea 48.1	Argentina
Subarea 48.2	Argentina
Subarea 48.3	Namibia
Subarea 48.6	Argentina, Japan, Namibia, New Zealand, South Africa, Spain
Division 58.4.1	Argentina, Australia, Namibia, USA
Division 58.4.2	Argentina, Australia, Namibia, Russia, Ukraine, USA
Division 58.4.3a	Argentina, Australia, Namibia, Russia, Ukraine, USA
Division 58.4.3b	Argentina, Australia, Namibia, Russia, Ukraine, USA
Division 58.4.4	Argentina, Namibia
Division 58.5.1	Argentina, Namibia
Division 58.5.2	Argentina, Namibia, USA
Subarea 58.6	Argentina, South Africa
Subarea 58.7	Argentina, Namibia
Subarea 88.1	Argentina, Japan, Republic of Korea, Namibia, New Zealand, Norway, Russia, South Africa, Spain, UK, Ukraine, Uruguay, USA
Subarea 88.2	Argentina, Republic of Korea, Namibia, New Zealand, Norway, Russia, South Africa, Ukraine
Subarea 88.3	Argentina.

6.207 All the areas listed above were assessed in relation to the risk of seabird incidental mortality according to the approach and criteria set out in SC-CAMLR-XXII/BG/17. A summary of risk level, risk assessment, IMAF recommendations relating to fishing season and any inconsistencies between these and the proposals for new and exploratory longline fisheries in 2003, is set out in Table 6.9. The only changes to advice in relation to levels of risk of seabird by-catch for any part of the Convention Area were for Division 58.4.1 (from level 3 to level 2) and Division 58.4.2 (from level 2 to level 3).

The only obvious inconsistencies needing resolution (highlighted in Table 6.9) are:

- All Namibian proposals contain inconsistencies with respect to their stated intentions to comply with recommended seabird by-catch mitigation measures, particularly compliance with Conservation Measure 25-02, and in respect of fishing seasons.
- The Korean proposals for Subareas 88.1 and 88.2 contain insufficient detail to assess the intended level of compliance with seabird by-catch mitigation measures.
- The Norwegian proposal indicates intention to use only one observer in Subareas 88.1 and 88.2, inconsistent with the provisions of Conservation Measures 41-09 and 41-10.
- The need for confirmation by Ukraine that its proposal for Divisions 58.4.3a and 58.4.3b is to fish in a season from 1 to 30 May 2004. This confirmation was received during the WG-FSA meeting.
- The Argentinian proposal for Division 58.5.1 and Subareas 58.6 and 58.7 indicates intention to fish outside the recommended fishing season for these statistical areas.
- If Working Group advice is followed, Conservation Measure 24-02 will need to be amended to permit exemptions from the requirement to set longlines at night, prescribed in paragraph 3 of Conservation Measure 25-02, for Subareas 48.1, 48.2, 48.4, 48.5 and 48.6 north of 60°S, and Divisions 58.4.1, 58.4.3a and 58.4.3b.

6.208 In previous years, fishing proposals in exploratory fisheries in Subareas 48.6 (south of 60°S), 88.1 and 88.2 and Division 58.4.2 have obtained an exemption from the requirement of Conservation Measure 29/XIX (25-02) to set longlines at night. These areas had been assessed by the Working Group as having an average to low risk (risk levels 1, 2 or 3) of seabird incidental mortality. Exemptions were given providing that vessels complied fully with measures specified in Conservation Measure 24-02, designed to ensure that a line sink rate of at least 0.3 m/s was achieved during daytime fishing operations.

6.209 To date all vessels fishing in exploratory fisheries in these areas have achieved this sink rate and have experienced zero seabird mortalities. The Working Group believed that this result could be attributed largely to strict adherence to this requirement, although there is a need to exercise caution in this interpretation because seabird abundance and risk of incidental mortality is average-to-low (risk level 2) in the higher latitudes of Subareas 88.1 and 88.2.

6.210 Last year the Working Group indicated that this proven protocol could be extended to other vessels fishing experimentally in similar average- to low-risk areas (risk levels 1, 2 or 3) within the Convention Area (SC-CAMLR-XXI, Annex 5, paragraph 6.173). However, the Working Group advised that to extend this requirement to higher-risk areas, such as Subarea 58.6, would be premature.

6.211 Setting of longlines within the Convention Area during daylight hours using currently approved fishing gear still represents a risk for seabirds, even in areas of average risk. In all instances where the provisions of Conservation Measure 24-02 are applied, there remains the need for continued review of performance with respect to incidental mortality of seabirds

during fishing operations. The Working Group recommended that any vessel operating under the provisions of this conservation measure, and which catches a total of three (3) seabirds shall revert to night setting in accordance with Conservation Measure 25-02. Similar provisions were specified for the 2002/03 season in Conservation Measures 41-04, 41-05, 41-09 and 41-10.

6.212 With respect to the prescription of a seabird by-catch level, the Working Group noted that there is still no definition of the status of birds ‘caught’ (SC-CAMLR-XXI, paragraph 5.39(iii) and Annex 5, paragraph 6.176).

6.213 The Working Group recalled that last year it had noted that it was necessary to define precisely what is meant by the number of birds caught and to take account of this in any review of the seabird by-catch limit. To do this it was necessary to make appropriate provision in the *Scientific Observers Manual* logbook data recording and reporting forms, and instructions to scientific observers, for distinguishing birds landed alive but with potentially fatal injuries from those released alive with no or minor injury (SC-CAMLR-XXI, Annex 5, paragraphs 6.207 and 10.22 to 10.23; SC-CAMLR-XXI, paragraph 5.45(iii)).

6.214 This year the Working Group proposed a working definition of birds caught such that any bird ‘caught’ by the fishery should be recorded in one of the following three categories:

1. Dead not landed on board – those birds observed to be killed by direct interaction with fishing gear but not landed on the fishing vessel.
2. Dead landed on board – those birds landed on the vessel that are dead (i.e. show no muscle movement or corneal reflex).
3. Alive landed on board –
 - (a) injured
 - (b) released uninjured.

6.215 For those birds in the third category (alive landed on board) a bird should be recorded as injured (3a) if it has any of the following pathologies: fracture of a wing bone, a leg bone or beak, more than two primary feathers on either wing that have broken feather shafts, substantial damage to the patagial tendon (indicated by a drooping wing or the inability to fly upon release), an open wound (other than superficial injuries in which there is no subcutaneous muscle damage), waterlogged or hydrocarbon soiled plumage, or any bird released with a hook in situ.

6.216 The Working Group recognised that whilst it may be possible to release some injured birds, the long-term survival of these individuals is likely to be substantially reduced. Therefore, birds in category 3a should be considered as being dead.

6.217 In the assessment of seabird by-catch, the number of birds caught by a fishery should be defined as the sum of categories 1, 2, and 3a.

6.218 It was noted that the level of observation necessary for monitoring seabird by-catch may need further review. The Working Group reiterated its advice that higher levels of observer coverage may be necessary in some circumstances (SC-CAMLR-XXI, Annex 5, paragraph 6.178).

Other Incidental Mortality

Interactions involving Marine Mammals with Longline Fishing Operations

6.219 One southern elephant seal was reported to have drowned after becoming entangled in the mainline of the *In Sung No. 66* fishing in Subarea 48.3. The observer was informed of this but did not witness the event (WG-FSA-03/63 Rev. 1). Three southern elephant seals were entangled and drowned in the mainline of the *Janas* while fishing in Division 58.5.2 (WG-FSA-03/63 Rev. 1).

6.220 In relation to interactions between cetaceans and longline fishing, especially involving loss of fish or interruption to fishing activities (see SC-CAMLR-XXI, Annex 5, paragraph 6.180), WG-FSA-03/27 summarised data from longliners in Subarea 48.3 between 2000 and 2002. This indicated that sperm whales were recorded during 24% of hauling operations and killer whales, the second most abundant cetacean species, were recorded during 5% of hauls. Catch rates were significantly lower when killer whales were present (0.15 kg/hook; 21.5 fish/thousand hooks), when compared to hauls with no cetaceans present (0.29 kg/hook; 48.5 fish/thousand hooks). The same trend was, however, not observed for catch rates when sperm whales were present during hauling (0.32 kg/hook; 51.9 fish/thousand hooks). Sperm whales were likely attracted to areas with high catch rates, but in areas with lower catch rates indications are that depredation by sperm whales can lead to a drop-off in catches. The authors suggested that further investigations are needed to determine the extent of longline–cetacean interactions, to address the problems of longline–cetacean depredation, to standardise observer protocols to ensure the collection of valuable data, and to assess and implement mitigation strategies under controlled experimental conditions.

6.221 WG-FSA-03/95 used observer data from Chilean waters adjacent to the Convention Area to quantify the level of sperm and killer whale interactions with demersal longliners. Based on the frequency of toothfish lips and heads hauled, the authors estimated that around 3% of toothfish are taken from the line by sperm and killer whales. The authors also suggested that sperm whales that congregate around toothfish longliners may be susceptible to an increased level of attack by killer whales, although the magnitude of this problem has not been quantified.

6.222 Dr Micol reported that the documented decline in the number of killer whales in Subarea 58.6 was considered, at least in part, to be a result of the use of firearms and explosive deterrents by IUU longline vessels.

6.223 Scientific observers in Subarea 48.3 reported that both Antarctic fur seals and leopard seals were observed removing toothfish from lines at the surface, including a single leopard seal that had a longline hook in its lip.

Interactions involving Marine Mammals and Seabirds with Trawl and Pot Fishing Operations

Pot Fishing

6.224 There were no reports of pot fishing within the Convention Area in 2003.

Krill Trawl Fishing

6.225 The level of observer coverage achieved on krill trawlers in Subarea 48.3 was 66%, however, all scientific observers were still at sea at the time of the meeting, and therefore no cruise reports were available to the Working Group for consideration.

6.226 It was noted that in its Report of Members' Activities (posted on the CCAMLR website) Poland indicated that in the krill fishery in Area 48, between 13 March and 26 August 2003, 73 Antarctic fur seals were caught by the Polish vessel *Acamar*, of which 26 were killed and 47 released alive.

6.227 The Working Group noted that this level of Antarctic fur seal mortality associated with krill fishing was considerably higher than any previous report.

6.228 In the absence of reports from scientific observers, the Working Group was unable to investigate the circumstances further. It noted that reports from UK scientific observers on vessels from Japan, Republic of Korea, Ukraine and the USA would be available for consideration at its next meeting.

6.229 The Report of Members' Activities by Japan indicated that in the krill fishery in Area 48 in 2003 a total of nine seals had been caught and released alive.

6.230 The Working Group suggested that vessel operators and researchers with relevant experience should collaborate in the development and implementation of methods either to exclude seals from nets or to release captured seals in a manner that minimises handling and injury. Details of any devices used to release fur seals by vessels fishing for krill would be particularly relevant. Experience from analogous fisheries in Australia and New Zealand might also be useful.

6.231 The Working Group noted that it would be valuable to be able to consider data on incidental mortality associated with krill fishing during the WG-FSA meeting, where experts in by-catch mitigation are present. It requested the Scientific Committee to address how best to arrange appropriate reporting from the krill fishery to facilitate this.

Finfish Trawl Fishing

6.232 Based on data from scientific observer logbooks and cruise reports from the trawl fishery in Division 58.5.2, a total of 15 incidents of seabird entanglement was recorded, of which six (2 white-chinned petrels, 2 black-browed albatrosses and 2 Cape petrels) were fatal (WG-FSA-03/64 Rev. 1). Full details of vessel-specific seabird by-catch over the last five years are provided in Table 6.10.

6.233 Based on data from scientific observer logbooks and cruise reports from the *C. gunnari* trawl fishery in Subarea 48.3, a total of 43 incidents of seabird entanglement was recorded. Of these, 36 were fatal and seven resulted in birds being released alive, although two birds released alive had sustained major injuries. The bird mortalities consisted of white-chinned petrels (78%), black-browed albatrosses (19%) and grey-headed albatrosses (3%). In addition, a single black-browed albatross mortality was recorded after the bird collided with a trawl warp cable during daylight hours (WG-FSA-03/64 Rev. 1).

6.234 The Working Group noted that the number of seabirds killed in this fishery has reduced from 93 in 2001 (SC-CAMLR-XX, Annex 5, paragraph 8.5) to 73 in 2002 (SC-CAMLR-XXI, Annex 5, paragraph 6.188) to 36 in 2003, which might suggest that mitigation measures are resulting in some reduction in mortality.

6.235 However, it was noted that when the seabird mortality is expressed in terms of relevant fishing effort (e.g. number of hauls), the by-catch rates (birds per haul) are 0.25 (2001), 0.15 (2002) and 0.20 (2003), providing limited evidence of any reduction in seabird by-catch rate.

6.236 The Working Group noted that while the level of seabird mortality in the *C. gunnari* trawl fishery in Subarea 48.3 in 2003 has reduced by 58% since 2001, the level of seabird mortality in this fishery is still substantially greater than that in the regulated longline fishery in the same subarea.

6.237 Last year it was indicated that seabird mortality in the *C. gunnari* trawl fishery in Subarea 48.3 arose as birds dived into and became entangled in the large mesh in the wings of the net during shooting and hauling (SC-CAMLR-XXI, Annex 5, paragraph 6.198). In order to better understand the process by which the birds become entangled, a typical sequence of activities and the state of the trawl is provided in SC-CAMLR-XXII/BG/28 (previously WG-FSA-03/79 Appendix 1). However, it should be noted that there may be differences in gear characteristics and operation between vessels participating in this fishery.

6.238 This year no vessel reached the precautionary by-catch limit of 20 birds adopted in 2002 and retained in 2003 (Conservation Measure 42-01, paragraph 8), although both the *Betanzos* and *Sil* approached the level, with 16 recorded mortalities each. In the case of the *Sil*, 15 of these occurred in a single shot. This occurred when, with the net partially in the water, shooting was interrupted for several minutes to change the batteries on the acoustic net sounder. The Working Group emphasised the importance of conducting all maintenance measures with the net on board and making all practicable efforts to reduce the time that the net is on or near the sea surface during shooting and hauling.

6.239 WG-FSA-03/79 provided an analysis of by-catch data and the efficacy of the mitigation measures used to reduce net entanglements in the *C. gunnari* trawl fishery in Subarea 48.3 in 2002/03. It reported 32 seabird entanglements during hauling and 18 during shooting, that significantly more entanglements were recorded during daytime than night-time, but that no significant difference was identified between daytime and night-time hauls. Most birds were caught in meshes of diameter 160–200 mm. Although the analysis failed to identify mitigation measures that significantly reduced mortality, several methods appeared to be effective, including use of streamer lines, offal discharge practice and gear operating procedures.

6.240 The Working Group considered that the use of streamer lines during hauling, removing fish from the net while the net remains on the deck prior to shooting (i.e. net cleaning) and the addition of weights attached to the codend to increase the sink rate and reduce the time that nets remain on or close to the sea surface, warrant further experimental development.

6.241 The use of bottom trawls is currently prohibited in Subarea 48.3 (Conservation Measure 42-01). Last year the Working Group indicated that the use of bottom trawl gear, fished off the bottom (i.e. adapted to do so), might be permitted under appropriate conditions (SC-CAMLR-XXI, Annex 5, paragraph 6.202).

6.242 Dr Agnew informed the Working Group that vessel operators involved in the fishery have enquired about the potential for vessels to use demersal trawling gear during daylight hours, reverting to pelagic gear for operations conducted in darkness. It has been suggested by operators that this may reduce seabird by-catch as the demersal gear is heavier, has a smaller mesh at the mouth and is present at the surface for a much shorter period of time than the pelagic/midwater trawl gear.

6.243 The Working Group considered that this recommendation should be assessed in relation to potential damage that may be caused to benthic communities by heavy demersal gear set on the seabed and also to possibly higher levels of by-catch of non-target fish species. Without the implementation of factory discharge management prescriptions this might lead to increased levels of discards and offal discharge and alter seabird interactions with fishing gear, particularly trawl warp cables (see paragraph 6.249).

6.244 The Working Group agreed that in order to take account of the new information on potential mitigation measures obtained from scientific observers in this fishery in 2002/03, modification should be made to Conservation Measure 25-03 (see paragraph 6.252).

6.245 The Working Group noted that fishers in the *C. gunnari* trawl fishery in Subarea 48.3 were currently experimenting with several innovative mitigation measures and should be encouraged to continue this practice; the level and detail of reporting in observer reports should also be maintained.

6.246 The Working Group recalled that as the existing interim seabird by-catch limit was on a per-vessel basis, and there was no limit on the number of vessels operating in this fishery, there existed the potential for a substantial increase in seabird by-catch.

6.247 The seabird by-catch limit agreed by the Commission in 2001 of 20 birds per vessel was intended as an interim measure in this fishery (CCAMLR-XX, paragraph 6.39). The Working Group suggested that the interim per-vessel seabird by-catch limit might be reviewed given the lack of substantial reduction in the catch rate of birds as a result of mitigation measures put in place in the fishery in 2002 and 2003.

6.248 WG-FSA-03/92 presented data on seabird mortality in the demersal finfish trawl fishery in the waters around the Falkland/Malvinas Islands in 2002/03, when 1 529 (CV 0.15) seabirds (1 411 black-browed albatrosses and 98 southern giant petrels) were killed in the fishery. The Working Group noted that this mortality estimate is considered conservative as it was based solely on birds or parts of birds that were hauled aboard and did not account for birds dislodged from the cable prior to or during hauling.

6.249 WG-FSA-03/92 highlighted the causes of the contrasting nature of seabird by-catch in demersal trawl fisheries. The demersal fishery in the Falkland/Malvinas Islands produces a higher level of factory discharge, attracting a greater density of birds to the vessel over a longer period of time, compared to the pelagic *C. gunnari* fishery in Subarea 48.3, in which the target species is processed whole and vessels produce relatively little discharge.

6.250 The Working Group agreed that, given the scale of the problem in the waters around the Falkland/Malvinas Islands and the size of the factory trawling fleets in the adjacent waters of Chile and Argentina, this cause of mortality may represent a significant threat to seabirds generally and also to those species from the Convention Area that forage seasonally in these regions.

Revision of Conservation Measure 25-03

6.251 The Working Group reviewed the current provisions of Conservation Measure 25-03 in the light of the new information available (paragraphs 6.237 to 6.244).

6.252 The following additions (new paragraphs) to the conservation measure were proposed:

- (i) New paragraph 4. Nets should be cleaned prior to shooting to remove items that might attract birds.
- (ii) New paragraph 5. Vessels should adopt shooting and hauling procedures that minimise the time that the net is lying on the surface of the water with the meshes slack. Net maintenance should, to the extent possible, not be carried out with the net in the water.
- (iii) New paragraph 6. Vessels should be encouraged to develop gear configurations that will minimise the chance of birds encountering the parts of the net to which they are most vulnerable. This could include increasing the weighting or decreasing the buoyancy of the net so that it sinks faster, or placing coloured streamers or other devices over particular areas of the net where the mesh sizes create a particular danger to birds.

Other Business

Revision of *Fish the Sea Not the Sky*

6.253 The Secretariat advised the Working Group that it continues to receive periodical requests for copies of the booklet *Fish the Sea Not the Sky*. A number of copies are still available in French, Russian and Spanish, but not in English.

6.254 The Working Group noted that it had recommended a number of changes to mitigation measures which would require revision of Conservation Measure 25-02 on which the booklet is based. Therefore, the booklet would require revision should it be published again. Production of the revised booklet in all official languages of CCAMLR would require substantial funds.

6.255 The Working Group also noted the existence of a range of educational material recently published by other international and national organisations on the reduction of seabird by-catch. It therefore decided that rather than revise *Fish the Sea Not the Sky*, alternative means of publicising CCAMLR measures should be investigated (e.g. video, posters, flyers). Consequently, the Working Group requested the Secretariat to estimate indicative costs for the production of a poster and flyer and report this to the Scientific Committee.

Advice to the Scientific Committee

General

6.256 The plan of intersessional work (Appendix E) summarises requests to Members and others for information of relevance to the work of the Working Group (paragraphs 6.1 to 6.3). Members are particularly invited to review the membership of the Working Group, to suggest additional members and to facilitate attendance of their representatives at meetings (paragraph 6.4).

Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area in 2003

- 6.257 (i) For Subarea 48.3 the total estimated seabird by-catch in 2003 was only eight birds at a rate of 0.0003 birds/thousand hooks, even lower than the values of the last three years (paragraphs 6.8 and 6.9).
- (ii) Within the South African EEZs in Subareas 58.6 and 58.7, the total estimated seabird by-catch was seven birds at a rate of 0.003 birds/thousand hooks, maintaining the substantial reduction from the situation two years ago (paragraphs 6.10 and 6.11). The causes of this marked improvement are unknown, although fishing effort was still reduced (paragraph 6.11).
- (iii) No incidental mortality of seabirds was observed in Subareas 88.1 (for the seventh successive year) and 88.2 (for the second successive year), nor in Divisions 58.4.2 and 58.5.2 (paragraphs 6.12 to 6.14), presumably due to strict compliance with conservation measures.
- (iv) These totals represent the lowest estimated seabird by-catch in regulated longline fisheries yet reported for these parts of the Convention Area; thanks were proposed to all responsible (paragraph 6.15).
- 6.258 (i) No data from longline fishing in French EEZs in Subarea 58.6 and Division 58.5.1 had been received for 2003, nor, as requested last year, for 2002 (paragraphs 6.16 to 6.18). However, it was reported that France continued to have problems with the by-catch of seabirds, chiefly white-chinned petrels, in the fisheries within its EEZs in the Convention Area. Between September 2001 and August 2002, 12 057 birds (94% white-chinned petrels) had been killed during setting of 19 million hooks, at a rate of 0.635 birds/thousand hooks. In the fishing year commencing September 2002, 13 784 birds (93% white-chinned petrels) had been killed during setting of 30 million hooks, at a rate of 0.456 birds/thousand hooks (paragraph 6.19).
- (ii) Current attempts by France to address this problem were summarised (paragraph 6.20), together with comments by the Working Group (paragraph 6.21).

6.259 Rates and levels of seabird by-catch in the French EEZs represent a very serious situation, likely unsustainable for the major populations being affected (paragraph 6.22). It is recommended that:

- (i) all current and outstanding data be submitted to CCAMLR as soon as possible for analysis and evaluation in conjunction with any similar analyses by French scientists (paragraph 6.24);
- (ii) longline fisheries in the French EEZs be managed in strict compliance with Conservation Measure 25-02, together with additional mitigation, as specified in paragraphs 6.28 to 6.30, in respect of line weighting for autoliners, streamer line design and deployment, offal discharge and use of scaring cannons;
- (iii) trials of existing methods successful in New Zealand at mitigating against by-catch of white-chinned petrels are conducted in the area (paragraph 6.31);
- (iv) exchange of fishers takes place between New Zealand and France (paragraph 6.32);
- (v) despite strong support for these measures, the Working Group reiterated earlier advice that closing the longline fishery in these areas from September to April inclusive would represent the most effective means of by-catch reduction (paragraph 6.33).

Implementation of Conservation Measures 24-02, 25-02 and 25-03

6.260 Reported compliance with these conservation measures this year, compared to last year, was substantially improved in all subareas and divisions and was again complete in Subareas 88.1 and 88.2:

- (i) Streamer lines – compliance with streamer line design was 92% compared with 86% and 66% in the last two years (paragraph 6.35). In Subareas 58.6, 58.7, 88.1 and 88.2, all vessels used streamer lines on all sets; in Subarea 48.3, 16 of 19 vessels did so (paragraph 6.36).
- (ii) Offal discharge – all vessels except *South Princess* (Subareas 58.6 and 58.7) complied with the requirement either to hold offal on board, or to discharge on the opposite side to where the line was hauled. Only one vessel (*South Princess*) was observed to discharge offal during setting (paragraph 6.37).
- (iii) Night setting – in Subarea 48.3 compliance was 98%, compared to 99% and 95% in the last two seasons; in Subareas 58.6 and 58.7 it was 98%, compared with 78% and 99% in the last two years (paragraph 6.40).
- (iv) Line weighting (Spanish system) – in Subarea 48.3 appropriate weighting was used in 100% of cruises compared with 63% and 66% in the last two years (paragraph 6.42); in Subareas 58.6 and 58.7 the only vessel using this method (*Koryo Maru No. 11*) failed to comply (paragraph 6.43).

- (v) Line weighting (autoline system) – the requirement to achieve a line sink rate of 0.3 m/s when fishing in daylight in Subareas 88.1, 88.2 (south of 65°S) and Division 58.4.2 was met by all vessels (paragraph 6.44).

6.261 In relation to overall compliance with Conservation Measure 25-02, 14 of the 29 vessels (48%), including eight of 19 in Subarea 48.3, fully complied with all measures at all times throughout the Convention Area (paragraph 6.45, Table 6.7). This compares with 3 of 21 vessels last year (14%). A group of vessels failed to fully comply by small margins (Table 6.7) and it was re-emphasised that the specifications in the conservation measure are minimum standards and that vessels should be advised to exceed these minimum standards to prevent compliance failure (paragraph 6.45).

6.262 In respect of reports relating to compliance with Conservation Measure 25-03, records of offal discharge (paragraphs 6.38 and 6.57) and possible misinterpretation relating to cables associated with monitoring devices (paragraphs 6.55 and 6.56) were noted.

6.263 A response to proposals to SCIC for a new system of assessing compliance of fishing vessels with conservation measures is provided in paragraphs 6.58 to 6.65.

Fishing Seasons

6.264 On the basis of the data for the 20002/03 fishing season in Subarea 48.3, seabird by-catch levels were very low (negligible in terms of the population dynamics of the species concerned), for the fourth successive season. Full compliance with Conservation Measure 25-02 was achieved by eight vessels in Subarea 48.3 (Table 6.7). A review of advice and decisions relating to fishing seasons for Subarea 48.3 last year, and revised advice for the current year (that any extension to the fishing season in 2003/04 should occur only in September, and only for vessels in full compliance in 2002/03) is provided in paragraphs 6.47 to 6.54.

Research into and Experiences with Longline Mitigating Measures

6.265 An extensive review of current initiatives, especially in relation to practices in the Convention Area and to the specification of Conservation Measure 25-02, is provided in paragraphs 6.66 to 6.108. Of particular note are:

- (i) the successful outcome of trials of IW longlines, whereby in New Zealand waters by-catch on IW lines and control lines were 1 and 81 white-chinned petrels respectively (paragraph 6.75);
- (ii) strong support for a trial of IW lines in Subareas 88.1 and 88.2 in 2003/04, together with exemptions from appropriate conservation measures, in order to develop recommendations for autoline weighting as part of Conservation Measure 25-02 (paragraphs 6.86 to 6.89);
- (iii) that trials on Spanish system longlines demonstrated that the weighting regime of 8.5 kg at 40 m specified in Conservation Measure 25-02 produced line sink rates of about 0.5 m/s (paragraph 6.76);

- (iv) a comprehensive review of streamer line design and operation (paragraphs 6.83 to 6.85).

6.266 Taking account of all the information and data presented, a revision of Conservation Measure 25-02 is proposed, the rationale for which is described in paragraphs 6.92 to 6.108; a draft revised conservation measure is attached as Appendix F.

Assessment of Incidental Mortality of Seabirds during IUU Longline Fishing in the Convention Area

- 6.267 (i) The method proposed last year for improving the calculation of estimates of seabird by-catch associated with IUU fishing for toothfish was implemented this year for all parts of the Convention Area where IUU by-catch had been reported (paragraphs 6.112 to 6.114; full details are in SC-CAMLR-XXII/BG/19); estimated median and 95% confidence interval values for seabird by-catch associated with IUU fishing are summarised in paragraph 6.115.
- (ii) A similar approach was applied to the historical data on toothfish removals taking account of information incorporated at the start of this year's meeting.
- (iii) Results for the current and previous years are summarised in Table 6.8, values being about one half of those derived from using the previous method (paragraph 6.123). However, by-catch rates associated with IUU fishing being used for subareas and divisions in the Indian Ocean were lower than many of the rates reported in regulated fisheries in this area in the last four years. A review of seabird by-catch rates used to characterise IUU longline fisheries was requested (paragraphs 6.123 and 6.124).
- (iv) Advice was requested on some issues relating to the presentation and interpretation of these results (paragraph 6.120).
- (v) For 2003, overall estimated potential values, at 17 585 (range 14 412–46 954) seabirds killed are about 70% of equivalent values for 2001 and 2002 and the lowest value since these estimates commenced in 1996 (paragraph 6.119). Since 1996, an estimated potential total of 187 155 (range 152 381–546 567) seabirds, comprising 41 897 (range 33 904–132 011) albatrosses, 7 417 (range 6 059–20 742) giant petrels and 116 130 (range 95 728–335 932) white-chinned petrels, have been killed in IUU longline fisheries in the Convention Area (paragraph 6.122). A subdivision of these totals by area is provided in Table 6.8.
- (vi) Such levels of mortality remain entirely unsustainable for the populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area (paragraph 6.126), many of which are declining at rates where extinction is possible.
- (vii) The Commission should continue to take stringent measures to combat IUU fishing in the Convention Area (paragraph 6.127).

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

6.268 No new data were reported this year; Members were asked to respond next year to this standing request for information on Convention Area seabirds killed in nearby areas.

Research into the Status and Distribution of Seabirds at Risk

6.269 Submitted data on:

- (i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrels vulnerable to interactions with longline fisheries;
- (ii) the foraging ranges of populations of these species adequate to assess overlap with areas used by longline fisheries;

are still insufficient for a comprehensive review of these topics. All Members are requested to submit relevant data to next year's meeting (paragraphs 6.133 to 6.137).

6.270 Such new data as were provided this year (notably in paragraphs 6.148 to 6.156) have been incorporated into SC-CAMLR-XXII/BG/18, together with the latest reassessment by IUCN/BirdLife International of the conservation status of albatrosses (with six species moving to categories of higher extinction risk), this being summarised in paragraph 6.144.

6.271 Members are again requested to provide information on the extent and location of their seabird by-catch collections to facilitate the development of collaborative research to investigate the origins of birds killed (paragraph 6.158).

International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing

6.272 Information was reported on recent and new international initiatives under the auspices of:

- (i) IFF2 – meeting in Hawaii, USA, 19 to 22 November 2002, including a request for CCAMLR Members to consider hosting IFF3 (paragraphs 6.161 to 6.166);
- (ii) ACAP – potential entry into force during 2004 and support for attendance and representation by CCAMLR (paragraphs 6.167 to 6.170);
- (iii) FAO NPOA-Seabirds – noting some progress in development of plans (especially by New Zealand, Australia, Brazil, Falklands/Malvinas and South Africa) but very limited progress in implementation (paragraphs 6.171 to 6.176).

6.273 Recollecting that the greatest threats confronting the conservation at sea of albatrosses and petrels breeding in the Convention Area are the levels of mortality likely to be associated with IUU longline fishing inside the Convention Area and with longline fishing for species

other than *Dissostichus* in areas adjacent to the Convention Area (CCAMLR-XX, paragraph 6.33), outcomes of CCAMLR's efforts this year to collaborate with all relevant RFMOs to address these problems (paragraphs 6.177 to 6.192) include:

- (i) CCSBT – report from the November 2001 meeting of the ERSWG was received, including the intention of Japan to respond to comments by CCAMLR on its NPOA (paragraphs 6.179 and 6.180);
- (ii) ICCAT – adopted a resolution on incidental mortality of seabirds at its November 2002 meeting; however concern was expressed that collecting and reporting data on incidental mortality had no specified timeframe for implementation (paragraphs 6.181 to 6.183);
- (iii) IOTC – no formal response yet to CCAMLR's request but a working party on by-catch has been established to which input from CCAMLR in respect of potential by-catch of Convention Area seabirds is recommended (paragraphs 6.184 to 6.187);
- (iv) IATTC – no observer programs in areas where Convention Area birds are likely to be caught (paragraphs 6.188 and 6.189);
- (v) WCPFC – likely to enter into force in 2004; CCAMLR should offer to provide assessments of the potential risk to CCAMLR Convention Area seabirds by vessels fishing in the WCPFC area (paragraph 6.190);
- (vi) reaffirmation of the desire to organise effective communication and representation of CCAMLR interests at meetings of relevant RFMOs, particularly via appropriate briefing for Members acting as CCAMLR observers (paragraph 6.191).

6.274 Recent initiatives addressing by-catch issues of albatrosses and petrels breeding in the Convention Area by New Zealand, USA and BirdLife International were commended (paragraphs 6.193 to 6.199).

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

- 6.275 (i) Of the 21 exploratory longline fisheries approved for 2002/03, only five, in Subareas 88.1 and 88.2 and Division 58.4.2, were operational; no seabird by-catch was reported in any of these fisheries (paragraphs 6.204 and 6.205).
- (ii) The assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised and provided as advice to the Scientific Committee and Commission in SC-CAMLR-XXII/BG/17 (paragraphs 6.201 to 6.203). The only changes to advice in relation to levels of risk of seabird by-catch for any part of the Convention Area were for Divisions 58.4.1 and 58.4.2 (paragraph 6.207).

However, the potential for exemptions for daylight setting in areas of lower risk to seabirds has been clarified and incorporated into the advice (paragraphs 6.208 to 6.211).

- (iii) The 29 proposals by 14 Members for new and exploratory longline fisheries in 15 subareas/divisions of the Convention Area in 2003/04 were addressed, in relation to advice in SC-CAMLR-XXII/BG/17 and Table 6.9 (paragraphs 6.206 and 6.207).
- (iv) The only potential problems apparently needing resolving in respect of issues relating to incidental mortality of seabirds (Table 6.9 and paragraph 6.207) are:
 - (a) inconsistencies in all Namibian proposals with respect to its intention to comply with recommended seabird by-catch mitigation measures, particularly Conservation Measure 25-02, and in respect of fishing seasons;
 - (b) insufficient detail in the Korean proposals for Subareas 88.1 and 88.2 to assess intended compliance with seabird by-catch mitigation measures;
 - (c) the intention in the Norwegian proposal to use only one observer in Subareas 88.1 and 88.2;
 - (d) the intention in the Argentinian proposal for Division 58.5.1 and Subareas 58.6 and 58.7 to fish outside the recommended fishing season.
- (v) In respect of requests to fish during daytime, Conservation Measure 24-02 might need to be amended to permit exemptions from the requirement to set longlines at night, as prescribed in paragraph 3 of Conservation Measure 25-02, for Subareas 48.1, 48.2, 48.4, 48.5 and 48.6 north of 60°S, and Divisions 58.4.1, 58.4.3a and 58.4.3b.
- (vi) Potential definitions of the nature and status of birds caught, in relation to the limits on seabird by-catch are provided (paragraph 6.212).
- (vii) There may be a need to review appropriate levels of observation to detect accurately low levels of bird by-catch (paragraph 6.218).

Other Incidental Mortality

- 6.276 (i) In the Convention Area in 2003, one southern elephant seal was reported killed in the longline fishery in Subarea 48.3; three southern elephant seals were reported killed by a longline vessel in Division 58.5.2 (paragraph 6.219).
- (ii) Interactions between cetaceans and longline fishing, including quantitative estimates of toothfish removals from fishing lines, were provided for Subarea 48.3 and for Chilean waters (paragraphs 6.220 and 6.221).

6.277 One krill trawl fishing vessel in Area 48 caught 73 Antarctic fur seals of which 26 were killed; as observer reports are unavailable until the close of the krill fishing season,

further information is lacking. The Scientific Committee was requested to address how best to arrange appropriate reporting of incidental mortality from the krill fishery for consideration at WG-FSA (paragraphs 6.226 to 6.231).

- 6.278 (i) In the trawl fishery for *C. gunnari*/*D. eleginoides* in Division 58.5.2, 15 seabirds were entangled of which six were killed (paragraph 6.232).
- (ii) In the *C. gunnari* trawl fishery in Subarea 48.3, 43 seabirds were entangled, at least 36 fatally (paragraph 6.233).
- (iii) Though levels of seabird by-catch mortality in the trawl fishery in Subarea 48.3 have reduced from 93 in 2001 to 73 in 2002 to 36 in 2003, corresponding by-catch rates of 0.25, 0.15 and 0.20 birds per haul, show no clear trend (paragraphs 6.234 and 6.235 and Table 6.10).

6.279 The Working Group noted new data and information relating to by-catch mitigation in the *C. gunnari* trawl fishery (paragraphs 6.237 to 6.240) and recommended that:

- (i) data continue to be collected to improve mitigating measures for the *C. gunnari* trawl fisheries in Subarea 48.3;
- (ii) Conservation Measure 25-03 should be revised to take account of additional mitigation provisions deriving from recent experiences (paragraphs 6.244, 6.251 and 6.252);
- (iii) review of the current interim seabird by-catch limit for this fishery might be appropriate (paragraphs 6.246 and 6.247);
- (iv) review of measures relating to bottom trawl gear may still be appropriate (paragraphs 6.241 to 6.243).

6.280 Rather than revise *Fish the Sea Not the Sky*, now that the English version is out of print, the Working Group recommended that it might be replaced by appropriate poster material and requested estimated costs for this (paragraphs 6.253 to 6.255).

BIOLOGY, ECOLOGY AND DEMOGRAPHY OF TARGET AND BY-CATCH SPECIES

Information Available to the Meeting

7.1 In addition to information which was pertinent to the assessment of stocks and which had been dealt with in sections 5.1 to 5.4, a large number of papers contained substantial biological information on target and non-target species which was not directly relevant to the assessments. This information, however, helped considerably in further improving our biological understanding of these species. These papers have been listed in the following:

- (i) information on fishing grounds and their fish stocks with the exception of the Ross Sea (WG-FSA-03/13, 03/26, 03/38, 03/89);

- (ii) by-catch species (skates, macrourids) (WG-FSA-03/15, 03/16, 03/42, 03/57, 03/59, 03/61, 03/69, 03/71, 03/73);
- (iii) *D. eleginoides* (WG-FSA-03/48, 03/66, 03/70, 03/72, 03/73, 03/80, 03/83, 03/85, 03/86 Rev. 1, 03/87, 03/88, 03/90, 03/94, 03/96, 03/99);
- (iv) *D. mawsoni* (WG-FSA-03/30, 03/44, 03/46, 03/49);
- (v) *C. gunnari* (WG-FSA-03/54, 03/55, 03/60, 03/61, 03/74, 03/75 Rev. 1);
- (vi) stone crabs (WG-FSA-03/76, 03/77).

7.2 Summaries of each of these papers are provided in SC-CAMLR-XXII/BG/26.

Stock Identity and Molecular Markers

7.3 The Working Group discussed WG-FSA-03/66, 03/72, 03/83, 03/84, 03/86 Rev. 1 and 03/88 with respect to the population structure of *D. eleginoides* in the Southern Ocean, both between ocean basins and within an ocean basin, and the impact advection may have on the downstream drift of adult and early life history stages and possible upstream movements of larger juvenile fish.

7.4 Populations of toothfish from south of the Sub-Antarctic Front (Orsi et al., 1995), appear to be different in various respects (e.g. otolith trace element signatures, age-length parameters) from those living around the Falkland/Malvinas Islands and off Chile. South of the Sub-Antarctic Front, genetic differences were found between some samples taken from different ocean basins, but not all, and similarities in age-at-length have been found between samples from different ocean basins. It was noted, however, that this could be explained by spatial characteristics of growth other than by movements. No measurements of interchange have so far been made.

7.5 The question of how many stocks of *D. eleginoides* there are and their connection remains to be resolved. Investigations in the Indian Ocean based on genetic studies suggest that early life stages of *D. eleginoides* may drift with the eastward moving west wind drift from spawning grounds, such as Crozet and Kerguelen to Heard Islands. If early life stages have drifted from areas as far west as the Prince Edward Islands in substantial numbers to the east, this larval drift would have been substantially diminished after the adult stock at the Prince Edward Islands had been reduced to less than 10% of its initial size in the seasons following 1996.

7.6 At Heard Island, larger juvenile *D. eleginoides* have been tagged and found to move in a northeastward direction from Heard Island to Kerguelen and Crozet Islands. This movement may be supported by an northeastward flowing current at 2 000 m depth near Kerguelen. However, it is yet unknown to what extent fish move over oceanic areas east-northeastward and to what extent interchange between areas does occur.

7.7 Fish occurring at Heard, Kerguelen, Crozet and Prince Edward Islands are treated as being separate populations. Movements of fish from Heard Island to as far as Crozet Island may indicate that fish in the Indian Ocean form one population, or a metapopulation with

sufficient interchange between areas to warrant consideration for future management. While the current assessments are based on estimates of local recruitment, and therefore will not be affected by estimates of the status of the spawning stock, this issue requires further consideration in terms of the management and stock structure of toothfish stocks.

7.8 Several papers pointed at the importance of hydrographic structure in accounting for differences and similarities between populations of *D. eleginoides* and identifying different pathways for transportation of life stages in the northern part of the Southern Ocean. It was suggested that a workshop be held in 2004 which could help to resolve some of these issues. A number of Members supported the notion of holding this workshop. However, they cautioned that, given the workload of WG-FSA for 2004 already, it may be more appropriate to postpone the workshop by 12 months. This would enable a larger number of members to participate in and contribute to the workshop.

7.9 Dr Fanta reported on progress made on evolutionary and molecular biology of Antarctic organisms.

- (i) The SCAR Life Sciences Group on Evolutionary Biology of Antarctic Organisms held a workshop on Evolutionary Adaptation of Antarctic Marine Organisms in Siena, Italy, where new findings on some molecular biology aspects of the adaptation to the polar environment and its relation to biodiversity were discussed. The presentations will be published in a special issue of *Antarctic Science* in 2004.
- (ii) A workshop was held in Cambridge, UK, in February 2003, to establish the terms of reference of an integrated SCAR-LSSSG program, congregating the interests of the actual programs RiSCC, EVOLANTA and EASIZ. The draft of the program 'Evolution and biodiversity in Antarctica: the response of life to change (EBA)' (www.nioo.knaw.nl/projects/scarlsssg/) will be presented to the next SCAR meeting in July 2004 in Bremen, Germany.
- (iii) There will be a symposium on 'Genomics and gene function in polar fishes' organised by the American Fisheries Society – Physiology Section, in Manaus, Brazil, in August 2004 (www.fishbiologycongress.org/).
- (iv) The National Academy of Sciences in the USA has published 'Frontiers in Polar Biology in the Genomic Era' details being found at http://www.nap.edu/catalog/10623.html?onpi_topnews_020703.
- (v) The EVOLANTA webpage is under construction and aims to be a tool to congregate information on groups interested in and/or carrying out research on evolution, adaptation, gene flow, molecular genetics, biodiversity in Antarctic organisms, and favours multilateral and international collaboration. It will be linked to the SCAR and the CCAMLR websites to facilitate communication among scientists and improve the awareness of the needs of both organisations.

Species Profiles

7.10 The mackerel icefish species profile (WG-FSA-03/4) had been revised by Dr Everson for WG-EMM-03. He agreed to undertake further revision of the paper and also of the toothfish profile (WG-FSA-02/8), as well as a new profile for by-catch species, in time for WG-FSA-04.

Tagging

7.11 An ad hoc tagging subgroup met during the WG-FSA meeting to discuss the results of various tagging papers on toothfish and skates that had been presented at WG-FSA and WG-FSA-SAM. The discussions of this subgroup are summarised as Appendix D.

Advice to the Scientific Committee

7.12 The Working Group recommended that tagging of toothfish be a requirement of the research plan for the conservation measure in Subareas 88.1 and 88.2, and noted that this could be usefully extended to include all new and exploratory toothfish fisheries.

7.13 The Working Group considered that at the very least a tagging study would provide valuable data on growth, behaviour, movement rates and stock structure in Subareas 88.1 and 88.2, and could also provide an approach to estimating absolute abundance (paragraphs 5.50 to 5.52).

7.14 The Working Group noted the success obtained by New Zealand which had requested that their fishers tag toothfish at the rate of one toothfish per tonne of toothfish caught during the 2002/03 season (WG-FSA-SAM-03/09). The Working Group agreed that each vessel entering a new and exploratory fishery should tag one toothfish per tonne, with a maximum of 500 fish per vessel.

7.15 The Working Group noted that there may be costs associated with research plans in some SSRUs where the fishing grounds are only small. The requirement for tagging may also have a cost in lost revenue. The Working Group also noted the Commission's desire to ensure that the cost of research and assessments is commensurate with the value of the fishery, and noted that it would be beneficial to review this matter in the future.

7.16 In addressing potential biases in the use of tag-recapture experiments, the Working Group recommended that a number of assumptions of the model be evaluated using simulation studies in the intersessional period (Appendix D, paragraph 8).

7.17 The Working Group agreed to adopt the protocol for tagging toothfish in Subareas 88.1 and 88.2 (WG-FSA-03/95), whilst noting that it would be revised slightly to incorporate any changes agreed in Appendix D, paragraph 13, and that the protocol would have some implications for the work of observers during the fishery.

7.18 It was agreed that the exchange of ideas and work on tagging should continue during the intersessional period. Mr Smith, Mr R. Williams (Australia) and Dr M. Belchier (UK)

would act as co-conveners of the tagging subgroup with Mr Smith leading the group over the next 12 months. The Working Group noted that the establishment of a tagging subgroup may have financial implications for the 2004 CCAMLR budget.

Baited Camera Systems

7.19 A method using baited camera systems was employed to investigate the abundance of toothfish (WG-FSA-03/76 and references therein) using either the arrival rate or the first arrival time at the bait. However the toothfish do not remain at the bait long, and so the total number attracted cannot be calculated and first arrival time difficult to ascertain. Furthermore, there is clear evidence from video footage that the toothfish behaviour is influenced by the lighting regime (see section 4 and paragraph 5.216).

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

Champscephalus gunnari

8.1 Following a request last year (SC-CAMLR-XXI, paragraph 8.3), WG-EMM-03/42 described several potential indices, in particular standing stock, condition and diet of *C. gunnari* that may have some application to the work of CEMP. WG-EMM encouraged further work, particularly comparison with other CEMP and non-CEMP indices that reflect krill availability over similar temporal and spatial scales, that might allow these indices to be incorporated into ecosystem assessments (Annex 4, paragraph 4.88 and Appendix D, paragraph 100).

8.2 The Working Group noted that in addition to the potential utility of *C. gunnari* as an indicator of the krill-based ecosystem, there was other time-series information on cohort strength and recruitment, natural mortality, length-at-age of the 1+ and 2+ age classes and gonad maturity that might provide information on *C. gunnari* of value to the work of WG-FSA.

8.3 The Working Group encouraged Members to consider the mechanism by which information on *C. gunnari* might be incorporated into multi-species models and encouraged participation in the 'Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management' to be convened by Dr Constable at the 2004 meeting of WG-EMM (Annex 4, paragraphs 6.13 to 6.24).

8.4 Of specific relevance in this context, WG-FSA-03/74 presented data on the frequency and size composition of *C. gunnari* in the diet of Antarctic fur seals and gentoo penguins at South Georgia from 1991 to 2002. The following key points were noted in discussion:

- A recruitment index based on the contribution by mass of the 1+ age class in the diet of gentoo penguins indicated a higher degree of variability in recruitment than considered previously.

- Estimates of consumption of *C. gunnari* by Antarctic fur seals and gentoo penguins (c. 138 000 tonnes per annum) exceeded standing stock estimates (17–67 000 tonnes) over the period of the study.
- A deterministic population model of *C. gunnari* from 1991 to 2002, using a variable mortality rate scaled by the inverse of krill abundance, matched the fluctuations in *C. gunnari* shown by trawl surveys.
- The authors of WG-FSA-03/74 suggested that changes in the South Georgia ecosystem over the past two decades may have increased the level of predator consumption of *C. gunnari* and may provide a potential ecosystem-based explanation for the apparent lack of a recovery of this species to its pre-exploitation population size.

8.5 The Working Group agreed that this contained important information on interactions between *C. gunnari* and upper-trophic level predators and that further work was encouraged to develop methods to incorporate these data into assessment procedures, and then to incorporate this data into ecosystem models involving *C. gunnari*.

Antarctic Shags

8.6 Arising from discussion at WG-EMM (Annex 4, paragraph 4.96) the potential applicability and utility of data from the diet of Antarctic shags for monitoring fish populations in the work of WG-FSA were outlined in WG-FSA-03/21. The Antarctic shag is an opportunistic piscivorous feeder and time series of the fish composition in its diet has the potential to prove useful in monitoring the recovery of depleted fish populations such as *N. rossii* and *G. gibberifrons*.

8.7 The Working Group recognised that these time-series data could provide useful information to its work and encouraged the authors of WG-FSA-03/21 to liaise with the Secretariat to submit historical data from their monitoring program. The Working Group endorsed the recommendation of WG-EMM (Annex 4, paragraph 4.94) that future studies of the composition of the fish diet of Antarctic shags should follow the same method for the collection and reporting of data and encouraged other Members to undertake such studies and report the results to CCAMLR.

Interaction between WG-FSA and WG-EMM

8.8 There are a number of synergies between the work of both WG-EMM and WG-FSA, in particular with regard to the use of the GYM in the assessment of krill and finfish fisheries and time series of recruitment and abundance of several finfish species derived in WG-FSA that might be analysed in an analogous way to the time-series analysis conducted by WG-EMM.

8.9 The Working Group noted that in the report of its meeting in 2003, WG-EMM had asked the Scientific Committee to provide advice on how the ecological relationships and

trophic interactions involving non-krill-centric components of the Southern Ocean, including exploited stocks of finfish, should be included in the work of both WG-EMM and WG-FSA (Annex 4, paragraph 4.92).

8.10 Dr Constable informed the Working Group that the interaction of oceanographic and biological processes was an important component of the preparation for the ‘Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management’ in which the interaction of ice and oceanographic processes might be related to indices of recruitment and abundance of icefish and toothfish.

8.11 The Working Group encouraged Members to be involved in this workshop to help in the development of plausible operating models for the dynamics of icefish and toothfish.

8.12 The Working Group suggested that, depending on the advice of the Scientific Committee to the request from WG-EMM (Annex 4, paragraph 4.92), that the outcome of the ‘Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management’ would provide a good opportunity to review the most appropriate mechanism by which to optimise the work of the Scientific Committee’s working groups.

Advice to the Scientific Committee

8.13 The Working Group encouraged future work to develop methods to incorporate data on interactions between *C. gunnari* and upper-trophic level predators into assessment procedures and into ecosystem models involving *C. gunnari*.

8.14 Time-series data of fish composition in the diet of Antarctic shags has the potential to provide useful information to the work of WG-FSA, and Members are encouraged to liaise with the Secretariat on the submission of such time series collected following the methods developed by the authors of WG-FSA-03/21.

8.15 There are a number of synergies between the work of both WG-EMM and WG-FSA and, depending on the advice of the Scientific Committee to the request from WG-EMM (Annex 4, paragraph 4.92), the outcome of the ‘Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management’ would provide a good opportunity to review the most appropriate mechanism by which to optimise the work of the Scientific Committee’s working groups.

FUTURE ASSESSMENTS

9.1 The Working Group recalled its discussion last year and its endorsement of a work program on future assessments (SC-CAMLR-XXI, Annex 5, paragraphs 9.1 to 9.10), as well as the recommendations for future work at the recent meeting of WG-FSA-SAM (paragraph 4.2).

9.2 In light of the discussions at this meeting, the Working Group noted that future assessment work needed to include the recommendations of WG-FSA-SAM (paragraph 4.2) and that account needed to be given to:

- (i) procedures, including documentation of the manner in which elements of the assessment process are undertaken;
- (ii) methodologies, including the field and laboratory methods for acquiring data used in the assessments, including, inter alia, survey methods, observer requirements and age determination;
- (iii) statistics, including the estimation of parameters;
- (iv) assessments, including estimates of yield, evaluation of the robustness of management procedures and the development of plausible models for underpinning assessments and evaluations.

9.3 In light of these points, the Working Group agreed that priorities need to be set on work that helps deliver robust assessments taking account of uncertainties in different elements of the assessment process. It also noted that precise estimates of different parameters may not necessarily be required before assessments can be satisfactorily undertaken.

9.4 The Working Group agreed to outline the priority work in developing assessments of yield and management procedures for finfish.

Dissostichus eleginoides

9.5 The Working Group noted that the assessment process for *D. eleginoides* currently involves the following analyses:

- (i) estimating abundance of juvenile fish from data acquired from trawl surveys;
- (ii) estimating biological parameters from data acquired from survey and fisheries data;
- (iii) estimating length-at-age based on otolith readings of age;
- (iv) estimating vulnerabilities of fish to the fishery based on:
 - (a) fisheries CPUE and length data for Subarea 48.3;
 - (b) survey and fisheries length and age data for Division 58.5.2;
- (v) estimating abundance of cohorts from survey data by disaggregating length-density data from surveys into age composition using CMIX;
- (vi) standardising CPUE from the fisheries in Subareas 48.3, 58.6, 58.7 and Divisions 58.5.1 and 58.5.2;
- (vii) assessment of long-term annual yield based on long-term decision rules for the stock using the GYM software:
 - (a) integration of standardised CPUE into assessments of Subarea 48.3
 - (b) no integration of CPUE data into assessments of Division 58.5.2
 - (c) no assessments undertaken for other areas.

9.6 The Working Group noted:

- (i) an assessment procedure for Subarea 58.7 is being developed based on age-structured production models and CPUE time series;
- (ii) the process for estimating *D. eleginoides* recruitment from trawl surveys for use in assessments, as described in detail in paragraph 5.114, needs to be evaluated, including the methods for estimating age composition (paragraph 4.2);
- (iii) a review of the data extraction and analysis procedures and methodologies used in the estimation of the recruitment series in Subarea 48.3 is needed (paragraph 5.123);
- (iv) a method needs to be developed for incorporating, where estimated, the catchability of a survey into the estimation of abundance of juvenile cohorts during the assessment procedure;
- (v) methods for estimating growth parameters need to be reviewed in light of uncertainties in the estimation of age;
- (vi) development should continue on methods for standardising CPUE time series and for investigating how such data could be incorporated into assessments, including taking account of uncertainty in the time series (paragraph 4.2);
- (vii) the need to estimate natural mortality rates and growth rates of toothfish and to develop robust methods to do this (paragraph 4.2), noting that such methodologies might be useful in a number of steps in the assessment;
- (viii) the need to include a capacity in the GYM for having multiple fisheries in an assessment;
- (ix) further development of plausible models of the population dynamics of toothfish, including metapopulation models, to further develop the assessment process and for formulating operating models to evaluate assessment methodologies and management procedures that can account for potentially multiple fisheries operating on a single stock (paragraph 4.2).

Dissostichus mawsoni

9.7 The Working Group noted that this species is subject to exploratory fisheries, for which advice has been given on the following matters:

- (i) an approximate estimate of yield by analogy with *D. eleginoides* in Subarea 48.3 based on biological parameters of *D. mawsoni* in the Ross Sea;
- (ii) a standardised time series of CPUE;
- (iii) the size and location of SSRUs to facilitate the acquisition of information for assisting with assessments;

- (iv) the establishment of research programs in addition to the research plan associated with existing conservation measures, including the development of mark–recapture programs and the further acquisition of biological data;

9.8 The Working Group noted the following work is still required:

- (i) an assessment of yield derived from stock and biological parameters in the Ross Sea;
- (ii) an assessment of stock abundance (in whole or in part);
- (iii) further development and review of the use of mark–recapture programs in the assessment of toothfish needs to be undertaken (paragraph 4.2);
- (iv) further evaluation of the application of catch, effort and research data in the assessments of these fisheries (paragraphs 4.2);
- (v) further examination of ways of spatial and temporal allocation of longline fishing effort to maximise the information gained from trends in CPUE and characteristics of the stock as a means of monitoring changes in stock abundance and developing an assessment of yield (paragraph 4.2).

Champscephalus gunnari

9.9 The Working Group noted that the assessment process for *C. gunnari* currently involves the following analyses:

- (i) estimating abundance of the stock
 - (a) using bottom trawl surveys and acoustic surveys in Subarea 48.3
 - (b) using bottom trawl surveys in Division 58.5.2;
- (ii) estimating biological parameters from data acquired from survey and fisheries data;
- (iii) estimating length-at-age based on the progression of cohorts;
- (iv) estimating vulnerabilities of fish to the fishery based on differences in length composition between research and commercial data;
- (v) estimating abundance of cohorts from survey data by disaggregating length-density data from surveys into age composition using CMIX;
- (vi) assessment of short-term annual yield based on short-term decision rules for the stock using the GYM software.

9.10 The Working Group noted the following work is still required:

- (i) further development of methods to estimate the abundance of *C. gunnari* using acoustics and that the manner in which these are incorporated into assessments need to be evaluated;
- (ii) consideration of the long-term management objectives for *C. gunnari* and the application of long-term decision rules, particularly as they relate to incorporating uncertainties in the assessment process (paragraph 4.2);
- (iii) consideration of the existing decision rule for the short-term assessments, such as the confidence bound on the biomass estimate and the escapement of the cohorts following fishing, to identify whether any part of the decision rule could be made less stringent while still ensuring a high probability of maintaining productivity of the stock and its predators;
- (iv) review the potential for age-specific mortality (paragraph 5.170);
- (v) consideration of medium-term assessment methods such as those used in ICES that endeavour to account for the probability of recruitment success in subsequent years (paragraph 4.2).

Other Species

9.11 The Working Group noted that in the absence of new estimates of stock abundance, work to refine assessments of other species is not warranted.

9.12 The Working Group also noted that estimating total removals and survivorship of by-catch species, particularly skates and rays, remains an important task in future assessments.

General

9.13 The Working Group noted the advances being made in developing an evaluation framework and encouraged Members to provide evaluation and validation of methods to WG-FSA-SAM for review. It noted the recommendations from WG-FSA-SAM this year that:

- (i) the continuing development of the evaluation framework for evaluating the robustness of different assessment procedures, the encouragement of Members to evaluate and validate existing methods, and the need for further development and discussion of such frameworks in the coming year (paragraph 4.2);
- (ii) the need for new software to be presented initially to the subgroup for evaluation in advance of WG-FSA, but recognising the need for a flexible approach such that new developments and their potential application at a meeting be considered early in a meeting of WG-FSA so that they can be included in assessments if they are not difficult to evaluate (paragraph 4.2);

- (iii) the need to evaluate the sensitivity of assessments to inconsistencies in population parameters used within assessments of individual species (paragraph 4.2).

9.14 The Working Group noted that further enhancements of the GYM could be made to help in assessments when more knowledge is available, such as the inclusion of length composition data from fisheries to help weight the trials from the assessments in a similar manner to the application of the standardised CPUE.

9.15 The Working Group requested that the Secretariat investigate the acquisition of AD Model Builder for use by the Working Group and provide a report to the Working Group on the cost and how Members would be able to access this software.

9.16 The Working Group noted the desirability of standardising the format of reporting assessments in order to minimise the report language in future.

9.17 The Working Group noted the continuing improvement to the user interface of the GYM. This has allowed assessments to be performed on toothfish, icefish and other species by many of the participants at WG-FSA. The improved interface and manuals have been an important contribution to broadening the involvement and understanding of the assessment process, facilitating the review of each assessment by other participants.

9.18 In the interests of continuing this development and the review of its assessment tools, the Working Group requested that the Data Manager supervise an independent external review of the GYM software and manual according to the following:

- (i) a revised manual and software be provided before the end of the year taking account of the assessment work at WG-FSA this year and comments from Members in the coming month on the interface and documentation;
- (ii) suggestions for appropriate independent experts and organisations be obtained from members of WG-FSA, which would then be approached to participate in the review;
- (iii) a report on the outcomes of the review be provided to WG-FSA-SAM in time for consideration at the 2004 meeting so that the subgroup can provide advice to WG-FSA on these outcomes next year.

The amount of anticipated funds required to conduct the external review is unknown, however, experience relative to obtaining invited experts to WG-EMM indicates that the cost could be approximately US\$3 000.

9.19 The Working Group noted that the user interface of the GYM has been updated a number of times in recent years. It agreed that the stable GYM package used in the review above would form the basis of assessments next year as the GYM is now able to be used in all current assessments. The implementation of newer versions would need to be accepted by the Working Group prior to assessments each year.

Preparations for 2004

9.20 The Working Group agreed that the following tasks need to be undertaken as a matter of urgency and requested the Secretariat to coordinate these:

- (i) the development of validation tests for database extractions and other routines, including documentation (paragraph 5.108);
- (ii) the development of a version of CMIX that is compatible with Microsoft Windows XP.

9.21 The Working Group noted that WG-FSA-SAM has made considerable advances in facilitating the work of WG-FSA and agreed that this subgroup should continue to meet intersessionally, provided a host can be found, to ensure adequate preparations for assessments are made prior to each meeting of WG-FSA. It agreed that:

- (i) subgroup meetings should ideally be held just prior to meetings of WG-EMM to provide for integration with that working group;
- (ii) each subgroup meeting should be held for five days;
- (iii) the attendance of the Data Manager for the entire meeting be requested;
- (iv) Secretariat support for the last two days of these meetings be requested.

9.22 The Working Group agreed that the priority work for the next WG-FSA-SAM meeting would include:

- (i) the review and evaluation of methods to estimate abundance of recruits in toothfish assessments;
- (ii) the methods for standardising CPUE and the application of CPUE in assessments of toothfish;
- (iii) the methods by which information derived from exploratory fisheries, including mark-recapture data, could lead to assessments;
- (iv) examination of long-term management procedures for *C. gunnari*, including decision rules;
- (v) the methods for integrating acoustic and trawl survey data into assessments of abundance of *C. gunnari*;
- (vi) the methods for estimating mortality of skates and rays and for estimating total removals of skates and rays from by-catch and observer data.

9.23 The Working Group noted that substantial work will be required in advance of the subgroup meeting if progress on these issues is to be made at the meeting. As such, the Working Group requested Members to coordinate work early in the coming year so that developments and results can be circulated amongst the subgroup in advance of the meeting.

9.24 The Working Group agreed that the agenda of the next subgroup meeting would be determined on the basis of submissions and that its work would primarily consist of:

- (i) developing the assessment timetable for WG-FSA in 2004;
- (ii) reviewing submissions on approaches to assessments as discussed above and providing direction and recommendations on their implementation or future work to the Working Group.

9.25 The Working Group thanked Dr Constable for his coordination of the subgroup to date and noted that a replacement coordinator will be required in the near future.

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

Summary of Information Extracted from Observer Reports and/or provided by Technical Coordinators

10.1 A summary of information extracted from scientific observer reports was presented in WG-FSA-03/63 Rev. 1, 03/64 Rev. 1 and 03/65 Rev. 1 (paragraph 3.21).

10.2 The Working Group noted that the quality and quantity of observer data collected continued to improve and that the observer data was integral to the ongoing work of WG-FSA. The Working Group commended all the observers that worked in the CCAMLR Convention Area in 2002/03 for their excellent work.

Implementation of the Observer Program

Nautical Twilight

10.3 Unlike in 2002 (SC-CAMLR-XXI, Annex 5, paragraph 10.3), no difficulties with determining nautical twilight were reported this year. Observers in high-latitude fisheries reported that the algorithm provided to calculate area-specific, day-by-day, degree-by-degree nautical twilight tables was particularly valuable. The Working Group encouraged the continued provision of the algorithm to all observers, especially in high-latitude areas.

Hooks in Offal

10.4 Last year the Working Group asked that more information be collected to quantify the number of hooks discharged in fish heads as part of the offal discarding process (SC-CAMLR-XXI, Annex 5, paragraph 6.68). No new information was provided with which to assess the actual numbers of hooks discarded in fish heads. However, based on the observer information, 71.9% of longline vessels did not discharge hooks in fish heads (Table 10.1). The determination of whether hooks were discharged by vessels that do not have the means to retain offal on board was based on subjective judgement by observers.

10.5 The Working Group recognised that acquiring data to quantify the numbers of hooks discharged in fish heads and offal was difficult, however, the low proportion of vessels apparently discharging hooks was encouraging.

10.6 In order to further reduce the number of hooks discharged in fish heads and offal, the Working Group recommended that for vessels where there is not a requirement to retain offal on board the vessel, a system should be implemented to remove hooks from fish heads and offal prior to discharge and that observers should record whether or not such a system was operational.

Observer Workload and Safety

10.7 The Working Group considered the following comments made in observer cruise reports:

- (i) the amount of data that can be accurately and safely collected by observers has reached its maximum;
- (ii) where there was a requirement for night setting in the regulated longline fishery, the difficulties of identification of the species and number of birds made during darkness meant that such observations were of limited value;
- (iii) recording of meteorological data, which provide a snapshot of weather conditions that may change rapidly during the course of operations, were considered to be of little utility;
- (iv) the reporting of sightings of other fishing vessels, other than those that were unidentifiable or suspected IUU vessels, were data that could be obtained more consistently from other sources.

10.8 The Working Group recommended that the recording of meteorological data (other than on those occasions where extreme meteorological conditions caused fishing to stop) be simplified where possible, observations of birds and marine mammals during night setting be discontinued and that the recording of vessel sightings other than for unidentified and suspected IUU vessels should not be a requirement of observers.

10.9 The Working Group noted several comments in observer cruise reports relating to working conditions on board vessels in high-latitude fisheries. Observers noted that in these fisheries the vessels are often operating in moderate sea-ice and that these conditions present a range of challenges not faced in Convention Area fisheries to the north (based on the experience of those observers in other CCAMLR fisheries).

10.10 Based on observer comments, and noting also the comments of CCAMLR-XXI (paragraph 11.56) the Working Group suggested that the Scientific Committee consider observer safety in high-latitude fisheries, in particular the appropriateness of vessels fishing in high latitudes that are not purpose-built or appropriately modified for working in sea-ice.

10.11 The Working Group noted that the prioritisation of observer tasks needed careful consideration and involves determination of the practicality of alternative data collection

methods and determining the data that are essential for the work of WG-FSA. The Working Group requested WG-FSA-SAM to consider the data that are essential for stock assessment purposes to help in prioritising observer workload.

Monitoring of Skate and Ray By-catch

10.12 A paper describing a maturity-staging guide for observers and its implementation in Subarea 88.1 was reported in WG-FSA-03/42. The staging guide is considered the best available for skates at this time and should be incorporated into the *Scientific Observers Manual* to improve biological data collection for skates.

10.13 In response to a request from the Scientific Committee (SC-CAMLR-XXI, paragraph 5.78), a trial form was prepared by the Secretariat to provide information on the species of skates and rays caught, the discard method and likely survivorship of each animal. The fields were:

- Haul number
- Species
- Method of discard
 - D:** Landed, then discarded (including from the factory)
 - C:** Cut off the line (snood and hook remaining)
 - S:** Shaken off / removal by gaff
 - L:** Lost at the surface / dropped off
 - U:** Unknown method of discard
- Released
 - A:** Alive / likely to survive
 - I:** Injured / unlikely to survive
 - K:** Dead
- Total length (to the nearest cm).

10.14 The form was trialled on a single vessel (*Isla Sofia*) in Subarea 48.3 and the following feedback was provided by the scientific observer:

- (i) monitoring the method of discard during hook/line observations was straightforward;
- (ii) the assessment of survival based on observation was considered unreliable because scientific observers are already fully occupied observing target and by-catch species as well as seabird and marine mammal interactions and were unable to determine the fate of individual skates and rays;
- (iii) determining the body length was impractical particularly for small individuals especially where the whole animal was not above the waterline.

10.15 The Working Group accepted that much of the information that had been sought was relatively subjective and recommended that the observer logbook be updated with the following clarifications of the data required:

- (i) skates that are landed³ should be assigned a *method/fate* code of R for those fish landed and retained on board or D for those fish landed and subsequently discarded;
- (ii) skates that are released prior to landing should be assigned a *method/fate* code of C, S or L;
- (iii) all skates that are released prior to landing should also be assigned a *condition* code (A, I or K) in addition to a fate code (C, S or L);
- (iv) those fish that are released alive with jaws and mouthparts removed or with gaff wounds (other than in the outer parts of the wing) should be recorded in *condition* code I;
- (v) the definition of the codes above is:

a.	method/fate code	
	landed ³ animals	R: retained D: discarded
	released animals	C: cut off S: shaken off/gaffed off L: lost at surface/dropped off
b.	condition code for released animals	
		A: alive/likely to survive I: injured according to paragraph (iv) above K: dead

Experience with Moonpools

10.16 The Working Group reiterated the importance of completing the 2003 skate/ray recording forms (paragraphs 5.285 and. 5.286).

10.17 The Working Group in 2002 highlighted the potential benefits of longline vessels with moonpools for hauling (SC-CAMLR-XXI, Annex 5, paragraph 6.84). Two longline cruises were observed this year where the vessel had a built-in moonpool, a first in the Convention Area. The observer generally confirmed the predicted benefits and made the following comments: birds were unable to attempt to attack the longline during hauling; giant petrel (*Macronectes* spp.) numbers about the vessel appeared lower than normal; fish loss, for *Dissostichus* spp. and for dead by-catch, was minimal as fish would stay within the moonpool allowing easy recovery by crew; released skates were able to make their own way out of the moonpool; species that swam into the moonpool of their own accord and could not find their way out could be scooped out of the moonpool with a dip net and released overboard at sea level through an external hatch; tagging of fish was relatively easy and minimised physical

³ Brought on board the deck of the vessel.

stress on the fish; crew and observers were not subject to the usual cold and hazardous external working conditions with the hauling station internal to the vessel; the hauling area and all catch on the line could be clearly viewed and was well lit at all times; downward-facing video cameras at the base of the moonpool allowed prior warning of catch arriving at the hauling station with benefits for fish tagging, skate release and the removal of weights from the longline; and line hauling was not affected by sea-ice, reducing the loss of fish from the line and the cutting off of fishing gear by sea-ice.

Deck Lighting

10.18 Limited information on deck lighting had been reported and technical coordinators were requested to ensure that this part of the observer form was completed. In particular, details of the specific efforts made to minimise deck lighting, how often these activities occurred in relation to the total observed fishing effort and an assessment of their likely effectiveness would be useful to the work of ad hoc WG-IMAF.

Video Monitoring

10.19 There have been no reports on the use of video monitoring systems to complement observer coverage in the Convention Area since WG-FSA-02. A paper describing the use of video monitoring systems outside the Convention Area was considered by the Working Group (WG-FSA-03/100).

10.20 In reviewing WG-FSA-03/100 and its application to the Convention Area, the Working Group noted that video monitoring systems may complement observer coverage but are unlikely to replace scientific observers. The Working Group also highlighted several issues that need further consideration and resolution, including:

- (i) logistical constraints with respect to deployment – as many vessels are in the Convention Area for a part of the year the equipment would need to be installed/removed pre and post-fishery, often in remote ports;
- (ii) equipment maintenance – cameras and data storage hardware need regular maintenance;
- (iii) data review and auditing – although the video will automatically capture relevant data and analytical tools may sort and collate data to some extent, analysis of the collected data would still be required, as would audit of the collated data;
- (iv) accurate specimen identification – although video images may be able to separate some taxa to the species level, for many seabirds in particular, specimens would still need to be retained and returned ashore for accurate identification.

10.21 The Working Group noted that in the medium term there was considerable potential for deployment of video monitoring technology with respect to monitoring the implementation of the technical elements of various conservation measures, such as whether or not a streamer line was in use, the measurement of streamer line performance (e.g. aerial

coverage) and incidental catch limits. The technology would also be useful for observers at sea for managing requirements to be in two places at once (for example, recording by-catch electronically whilst undertaking sampling in the factory, with delayed viewing of video to record by-catch data).

10.22 The Working Group was informed that further trials to develop video monitoring systems will be undertaken during the intersessional period by New Zealand and the USA and requested these Members to report the results to the Working Group. It also encouraged the trialling of video monitoring systems in parallel to the Scheme of International Scientific Observation in the Convention Area.

Definition of Dead Seabirds

10.23 The Working Group agreed to the proposed definition of alive/dead provided in paragraphs 6.212 to 6.217. It was noted that technical language used in the definition would need to be incorporated into the observer logbook, together with appropriate definitions and diagrams.

Species Identification Sheets

10.24 The Working Group noted that observers reported more data than previously on invertebrate by-catch this year. In several instances scientific observers had requested improved identification guides to further facilitate this work.

10.25 The Working Group noted requests from observers for a wider range of species identification sheets, in particular for less common fishes and invertebrates, and agreed that the Species Identification Sheets should be updated with new information and expanded; further updates will be coordinated intersessionally by Dr Collins. Observers also requested colour photographs be incorporated into the species guides wherever possible. The Working Group noted that it is planned that digital images will be put on disc to form a comprehensive electronic field guide. Technical coordinators were encouraged to print colour copies of the guide for observers.

Aerial Extent of Streamer Lines

10.26 The Working Group noted the advice of ad hoc WG-IMAF that Conservation Measure 25-02 might be revised in 2004 in respect of the streamer line element, if data were available on the optimal aerial coverage of streamer lines behind the vessel. The Working Group recommended that indicative values of aerial coverage be collected by observers (paragraph 6.101).

10.27 The Working Group agreed that the aerial extent of the streamer line should be recorded as the distance from the attachment point of the streamer line above the stern of the vessel (or the point at which the streamer line passes the stern where the point of attachment is forward of the stern of the vessel) to the point where the streamer line first touches the water. To measure the aerial extent at sea, markers that can be clearly seen from the stern of the

vessel should be incorporated into the streamer line such that they delineate distance along the streamer line (this can be streamers if their spacing is known and fixed, or other markings). These markings should then be used during all daylight sets, in areas where they are allowed, to conduct repeat measurements in order to provide an averaged estimate of the aerial extent of the streamer line for each observed set. In areas where daylight sets are prohibited, repeat measurements should be made during daylight hours at normal longline setting speed on a voyage commencing and at other appropriate times when the vessel is not fishing, such as when moving between fishing grounds.

Sub-sampling Methods for Observers

10.28 Observers provided no commentary on the sub-sampling methods recommended for trialling in SC-CAMLR-XXI, Annex 5, paragraphs 10.11 to 10.15. Limited input was received by the intersessional subgroup from technical coordinators.

10.29 The intersessional subgroup on longline sub-sampling methods for observers had identified four key targets for the observer sub-sampling methodology:

- (i) the method must be robust for estimating length-at-age, vital rates and other important parameters for assessment and population studies, and should also provide for estimation of any potential biases;
- (ii) the method must be able to meet minimum sample sizes required for biological studies;
- (iii) the method must be developed taking into account the variation between the autoline and Spanish longline methods, with a separate method detailed for each gear type;
- (iv) the method must be easy for observers to implement.

10.30 The subgroup noted that the data required to define such a method are not currently available, in particular:

- (i) the number of hooks hauled during each fish sub-sampling session
- (ii) the location on the line of the portion of the line sub-sampled.

The Working Group recommended that observers collect the required additional data so that a more robust sub-sampling methodology could be developed during the intersessional period.

10.31 The Working Group also recommended that the system of sampling a fixed number of fish per fishing event be reviewed during the intersessional period as it may result in inconsistent use of sampling units. WG-FSA-03/85 noted that because of these inconsistencies, sub-samples are being taken with unequal inclusion probabilities between sub-sampling sessions. This can result in biases in estimates of population vital rates and mixing proportions.

10.32 WG-FSA-03/85 also noted that it does not particularly matter if an observer does not start sampling at exactly the selected point on the longline, but that sampling should be started as close as feasible based on the system used by the vessel to monitor how much of the incoming line has been hauled.

10.33 The Working Group also recommended that observer experience with the methods detailed in SC-CAMLR-XXI, Annex 5, paragraph 10.14 and WG-FSA-03/85, and any other sub-sampling methods, be reported in observer cruise reports.

Depredation

10.34 WG-FSA 03/27 and 03/95 described scientific observer data on interactions involving killer whales and sperm whales with longline fishing operations in Subarea 48.3 and on the Patagonian shelf in southern Chile. The quantification of the impact of these cetaceans on the fishery is problematic, especially in the case of sperm whales where there were no direct observations of removal of fish from lines. Analysis from Subarea 48.3 indicated that the CPUE (fish/thousand hooks) for hauls with no cetaceans present was reduced by almost half when killer whales were present, however, when sperm whales were present the CPUE was actually increased. Despite this apparent increase in fishing efficiency, reports from scientific observers indicated that the presence of sperm whales that appeared to be a major influence in fishing operations with vessels cutting/buoys off lines and moving to a new area when whales were present.

10.35 Observers also reported depredation by Antarctic fur seals and leopard seals in Subarea 48.3, Antarctic fur seals in Division 58.5.2 and colossal squid (*Mesonychoteuthis hamiltoni*) in Subarea 88.1.

Conversion Factors

10.36 Conversion factor data for *Dissostichus* spp. were not collected from all trawlers (WG-FSA-03/64 Rev. 1) and highly variable quantities were collected from longline vessels (WG-FSA-03/63 Rev. 1). Despite the request for a more detailed description of processing cuts last year (SC-CAMLR-XXI, Annex 5, paragraph 3.36), few observers provided detailed descriptions and diagrams of the cuts used on vessels. The Working Group noted that these data were important for future work on conversion factors.

10.37 A significant decline in the condition of *D. mawsoni* in Subarea 88.1 was again observed leading up to the spawning season in May. Previously this has only been documented in Subarea 88.1 and the Working Group encouraged observers to look out for this phenomenon in other fisheries for *Dissostichus* spp.

Information Relevant to SCIC

10.38 Observer information on the monitoring of the implementation of conservation measures is contained in two sources:

- (i) Secretariat papers WG-FSA-03/63 Rev. 1, 03/64 Rev. 1 and, in particular, 03/65 Rev. 1;
- (ii) discussions of ad hoc WG-IMAF, in particular paragraphs 6.34 to 6.57 and 6.260.

10.39 The Working Group also noted that the information and advice in CCAMLR-XXII/BG/8, SC-CAMLR-XXII/BG/1 and paragraphs 3.7, 3.16 to 3.20, 5.8, 5.9 and 5.67 to 5.69 were relevant to SCIC.

Advice to the Scientific Committee

10.40 Additions and modifications to the *Scientific Observers Manual* logbook data recording and reporting sheets, and instructions to scientific observers and technical coordinators, should be made in respect of:

- (i) provision of the algorithm for calculation of the times of nautical dawn and dusk (paragraph 10.3);
- (ii) collecting and reporting additional data on systems implemented on fishing vessels to remove hooks from discarded fish heads and offal (paragraph 10.6);
- (iii) removal of meteorological observation requirements from the observer work program (paragraph 10.8);
- (iv) discontinuation of regular standardised observations of birds and marine mammals during night setting (paragraph 10.8);
- (v) discontinuation of the recording of vessel sightings other than for unidentified and suspected IUU vessels (paragraph 10.8);
- (vi) recording of skate maturity using the new staging guide (paragraph 10.12);
- (vii) recording of skate/ray capture, injury and release practices (paragraph 10.15);
- (viii) improved recording of by-catch data (paragraph 5.286);
- (ix) tagging and reporting of tagging programs (Appendix D);
- (x) improved recording and reporting of deck lighting in all fisheries (paragraph 10.18);
- (xi) reporting of seabirds caught by fisheries according to the revised criteria (paragraph 10.23);
- (xii) recording of the aerial extent of streamer lines (paragraph 10.27);
- (xiii) recording of the number of hooks related to each *Dissostichus* spp. sub-sample and the location of the line each sample was taken from (paragraph 10.30);
- (xiv) reporting of experience with sub-sampling methods (paragraph 10.33);

- (xv) alterations to the observer logbooks and cruise reports to reflect the recommended changes to streamer line specification in Conservation Measure 25-02 if adopted by the Commission (Appendix F);
- (xvi) alterations to the observer logbooks and cruise reports to reflect the recommended changes to the thawed bait requirement in Conservation Measure 25-02 if adopted by the Commission (Appendix F);
- (xvii) reporting of processing cuts for *Dissostichus* spp. (paragraph 10.36) and observations on spawning-related variations in conversion factors (paragraph 10.37).

10.41 The Working Group recommended that the Scientific Committee consider the appropriateness of vessels fishing in high latitudes that are not purpose-built or appropriately modified for working in sea-ice (paragraph 10.10).

10.42 The Working Group recommended that WG-FSA-SAM report on the data essential for stock assessment purposes in relation to setting observer priorities (paragraph 10.11).

10.43 The Species Identification Sheets should be updated in time for the 2003/04 season (paragraph 10.25).

10.44 The Working Group recommended that WG-FSA-SAM review sub-sampling methodologies for stock assessment purposes (paragraphs 10.29 to 10.32).

10.45 The Working Group recommended that all changes to the content and format of the *Scientific Observers Manual* should be coordinated through the technical coordinators. The Working Group noted that the *Scientific Observers Manual* is in need of a major review of its content and structure. This activity may best be achieved through an intersessional group that comprises technical coordinators, members of WG-FSA and the Secretariat.

CCAMLR WEBSITE

11.1 The Working Group reiterated its pleasure at the operation and use of the CCAMLR website. In particular, the Working Group appreciated the speed at which papers for the meeting had been placed on the website, and made available to participants. The Working Group thanked Mrs R. Marazas (Website and Information Services Officer) and other staff involved for their excellent work.

FUTURE WORK

12.1 Future work identified by the Working Group is summarised in Table 12.1 and Appendix E (ad hoc WG-IMAF), together with the persons or subgroups identified to take the work forward and references to sections of this report where the tasks are described. The Working Group noted that these summaries contain only those tasks identified at the meeting, and do not include ongoing tasks undertaken by the Secretariat, such as data processing and validation, publications and routine preparations for meetings.

12.2 The Working Group reviewed the activities of subgroups that had worked during the intersessional period. These subgroups, with the support of the Secretariat, had produced valuable work and information that had contributed to the assessments and review of information available at the meeting. WG-FSA agreed that the activities of several of these groups should be extended during the 2003/04 intersessional period. Where possible, each subgroup would focus on a small number of key issues. The subgroups would also provide a conduit for information on a wide range of related research. In addition, other tasks were specifically assigned to the Secretariat and/or Members.

12.3 The Working Group reminded participants that membership to the subgroups was open.

12.4 The subgroups for the intersessional period are:

- (i) a subgroup to continue developing assessment methods (coordinator to be canvassed by Dr Constable and the Convener in the intersessional period). This subgroup will interact and coordinate activities in the middle of the year (as detailed in Item 9);
- (ii) a subgroup to review, and where necessary assess, the biology and demography of species considered by the Working Group (Drs Collins and Belchier);
- (iii) a subgroup on by-catch (Drs Jones and O'Driscoll);
- (iv) a subgroup to identify, in conjunction with the SCAR EVOLANTA Program, up-to-date information on stock identity for species within the Convention Area (Dr Fanta);
- (v) a subgroup on fisheries acoustics (Drs O'Driscoll and S. Kasatkina (Russia));
- (vi) a subgroup on otolith exchange (CON) (Dr Belchier);
- (vii) a subgroup on tagging (Mr Smith, Mr Williams and Dr Belchier).

12.5 Each subgroup was requested to develop a work plan for the intersessional period, in consultation with the appropriate colleagues, the Convener of WG-FSA and the Chair of the Scientific Committee.

12.6 The Coordinator of WG-FSA-SAM is to coordinate with the Convener of CON regarding exactly what is required from the CON group.

12.7 The responsibilities for coordinating the intersessional activities of ad hoc WG-IMAF are set out in Appendix E.

12.8 It was noted that the system whereby a deadline of one week before the start of a WG-FSA meeting had been imposed for the receipt of Working Group papers by the Secretariat had proved successful. To allow greater time for participants to evaluate papers and also for subgroup conveners to summarise papers, it was agreed that papers for WG-FSA-04 should be submitted two weeks in advance of the meeting. Summary papers prepared by conveners of subgroups could be received one week before the meeting.

12.9 It was recognised that there are some papers dealing with data that the Secretariat would not be able to finalise before the start of the meeting. It was agreed that such papers should not be subject to the same deadline.

OTHER BUSINESS

Conservation Measures 10-04 and 24-02

13.1 Dr L. Pshenichnov (Ukraine) indicated that the current provisions of Conservation Measures 10-04 and 24-02 contain contradictory elements in respect of requirements for holding fishing licences and for the conduct of bottle tests as a prerequisite for commencing fishing. The Working Group noted this as a potential problem and suggested that he table a note on the topic, together with his suggested solution, for the meetings of SCIC and the Scientific Committee.

Background Documents

13.2 Last year, for the first time, much of the detail of both the methods and the results of assessments conducted at WG-FSA were collected in a set of Scientific Committee background documents. This practice had considerably reduced the size of the WG-FSA report whilst providing all the relevant details of the assessments to the Scientific Committee. However, it has had two unintended consequences:

- (i) The production of the background documents requires considerable work at WG-FSA, and they are often compiled only towards the end of the meeting when there is a high demand for time to be spent on other tasks.
- (ii) Background documents are not public documents. There exists the possibility that some of the work of WG-FSA which was once in the WG-FSA reports, and thus was public and easily accessed by scientists and other interested parties outside CCAMLR, is no longer available. This has the potential to decrease the transparency of the work of WG-FSA and the Scientific Committee.

13.3 The Working Group emphasised the need to develop a process that might more effectively record the work of WG-FSA from the start of the meeting, ease the burden of producing the background documents, and provide adequate transparency of its work.

13.4 One solution might be to place the background documents describing the analyses concluded at WG-FSA on the public domain part of the CCAMLR website. This would create the desired level of transparency, but the background documents would have to be constructed in a way that maintains data confidentiality. Furthermore, it would be necessary to ensure that the background documents were sufficiently well written that they were easily interpreted by non-CCAMLR scientists. This would have resource implications.

13.5 The Working Group recommended that the Scientific Committee consider this and other methods of maintaining transparency of its activities.

Meeting Preparation

13.6 The Working Group agreed that it would be useful for the Convener to distribute, at the start of each meeting, an informal document which listed meeting documents by agenda items. This was a routine practice at meetings of WG-EMM and was found to greatly assist participants in organising their documents. To this end, the Working Group urged participants to make sure that the relevant agenda item numbers are included in all documents which they submit to the meetings.

ADOPTION OF THE REPORT

14.1 The report of the meeting was adopted. The Working Group also adopted background papers SC-CAMLR-XXII/BG/17, BG/18, BG/19, BG/24, BG/27 and BG/28.

CLOSE OF MEETING

15.1 In closing the meeting, the Convener thanked all participants and subgroup coordinators for developing the work of WG-FSA over the past two years into an integrated structured approach to stock assessment. The Convener also thanked the Secretariat for another successful meeting and for its work during the intersessional period.

15.2 Dr Holt, on behalf of WG-FSA, thanked Dr Everson for his tremendous contribution to the work of CCAMLR. Dr Everson has been closely involved with CCAMLR since its inception, and has convened many of the Scientific Committee's working groups. Dr Everson was instrumental in establishing WG-EMM and in bringing the recent change in the format of WG-FSA. His leadership has greatly contributed to the work of CCAMLR.

15.3 Dr Naganobu also thanked Dr Everson for his scientific contribution, and for his fair-handed, and at times humorous, approach to chairing meetings.

15.4 Dr Miller acknowledged the important contribution which Dr Everson had made during his long association with CCAMLR.

15.5 This was the last year of Dr Everson's role as convener of WG-FSA. Dr Everson welcomed Dr Hanchet, incoming Convener, and wished him and the Working Group a very successful future.

15.6 The meeting was closed.

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Table 3.1: Catches (tonnes) of target species by region and gear reported from the CCAMLR Convention Area in the 2002/03 fishing season. Source: catch and effort reports submitted by 3 October 2003 unless indicated otherwise. (na – not applicable)

Target Species	Conservation Measure	Region	Gear	Catch (tonnes) of Target Species			
				Fishery	Other ^a	Total	Limit
<i>Champocephalus gunnari</i>							
	42-01 (2002)	48.3	Trawl	2 155	0	2 155	2 181
	42-02 (2002)	58.5.2	Trawl	2 343	0	2 343	2 980
<i>Dissostichus</i> spp.							
	41-02 (2002)	48.3	Longline	7 534	0 ^b	7 534	7810
	41-02 (2002)	48.3	Pot	0			
	41-03 (1999)	48.4	Longline	0	0	0	28
	na	58.5.1	French EEZ	3 686	0	3 686 ^c	-
	41-08 (2002)	58.5.2	West of 79°20'E	270	23 ^d	2 130 ^d	2 879 ^d
	41-08 (2002)	58.5.2	West of 79°20'E	1 837			
	na	58.6	French EEZ	436	0	436 ^c	-
	na	58.6	South African EEZ	24	0	24	-
	na	58.7	South African EEZ	106	0	106	-
<i>Dissostichus</i> spp. (exploratory fisheries)							
	41-04 (2002)	48.6	North of 60°S	Longline	0	0	455
	41-04 (2002)	48.6	South of 60°S	Longline	0	0	455
	41-05 (2002)	58.4.2		Longline	117	0	117
	41-06 (2002)	58.4.3a		Longline	0	0	250
	41-07 (2002)	58.4.3b		Longline	0	0	300
	41-09 (2002)	88.1	North of 65°S	Longline	229	0	229
	41-09 (2002)	88.1	South of 65°S	Longline	1 563	0	1 563
	41-10 (2002)	88.2	South of 65°S	Longline	106	0	106
<i>Electrona carlsbergi</i>							
	43-01 (2002)	48.3	Trawl	0	0	0	109000
<i>Euphausia superba</i>							
	51-01 (2002)	48	Trawl	110 333	0	110 333	4 000 000
	51-02 (2002)	58.4.1	Trawl	0	0	0	440 000
	51-03 (2002)	58.4.2	Trawl	0	0	0	450 000
Lithodidae							
	52-01 (2002)	48.3	Pot	0	1	1	1 600
<i>Martialia hyadesi</i>							
	61-01 (2002)	48.3	Jig	0	0	0	2 500

^a Other fisheries in the region

^b Combined (pot and longline) catches

^c Reported in STATLANT data

^d Combined (trawl and longline) catches

Table 3.2: Reported catch (tonnes) of *Dissostichus* spp. and estimated catch from IUU fishing in subareas and divisions in the Convention Area, and catch reported in the CDS in areas outside the Convention Area in the 2001/02 and 2002/03 seasons.

2001/02 Season

Inside	Subarea/Division	Reported Catch	IUU Catch	Total CCAMLR	Catch Limit
	48.3	5744	3	5 747	5 820
	48.4	0			28
	48.6	0			910
	58.4.2	0	295	295	500
	58.4.3a	0			250
	58.4.3b	0			300
	58.4.4	0	880	880	103
	58.5.1	4 154	6 300	10 454	0*
	58.5.2	2 756	3 489	6 245	2 815
	58.6	1 225	720	1 945	450*
	58.7	98	78	176	0*
	88.1	1 325	92	1 417	2 508
	88.2	0			250
Total Inside		15 302	11 857	27 159	
Outside	Area	CDS Catch EEZ	CDS Catch High Seas	Total Outside CCAMLR	
	41	9 560	4 472	14 032	-
	47		655	655	-
	51		10 620	10 620	-
	57		3 803	3 803	-
	81			0	-
	87	4 635	1 739	6 374	-
Total Outside		14 195	21 289	35 484	-
Global Total				62 643	

2002/03 Season (to October 2003)

Inside	Subarea/Division	Reported Catch	IUU Catch	Total CCAMLR	Catch Limit
	48.3	7 534	0	7 534	7 810
	48.4	0			28
	48.6	0			910
	58.4.2	117	113	230	500
	58.4.3a	0			250
	58.4.3b	0			300
	58.4.4	0	128	128	0*
	58.5.1	3 686	7 825	11 511	0*
	58.5.2	2 130	1 512	3 642	2 879
	58.6	460	354	814	0*
	58.7	106	138	244	0*
	88.1	1 792		1 792	3 760
	88.2	106		106	375
Total Inside		15 931	10 070	26 001	

(continued)

Table 3.2 (continued)

Outside	Area	CDS Catch EEZ	CDS Catch High Seas	Total Outside CCAMLR	
	41	5 174	1 934	7 108	-
	47		2 852	2 852	-
	51		3 643	3 643	-
	57		858	858	-
	81	38	1	39	-
	87	3 532	887	4 419	-
	Total Outside	8 744	10 175	18 919	-
Global Total				44 920	

Reported Catch: 2001/02 from STATLANT data;

2002/03 catch and effort reporting system except STATLANT data for France.

IUU Catch: from SCIC-03/5 Rev. 1.

CDS Estimate: data submitted to the CDS by 13 October 2003. The allocation between EEZ and high seas – particularly in 2001/02 and Area 41 – mostly based on the Secretariat's knowledge of vessel activity (known licence information from Area 41 EEZ, vessel size, trip duration etc.).

Catch limits agreed by the Commission.

* Outside EEZs

Table 3.3: Estimated effort, mean catch rates (tonnes/vessel/day) and total IUU catches (tonnes) by subarea/division in the unregulated fishery for *Dissostichus* spp. in the 2002/03 fishing season, extrapolated to the end of the season (30 November 2003). Details of all information used for the estimation of IUU catches have been archived with the Secretariat (SCIC-03/5 Rev. 1).

Estimated IUU catch by area/subarea/division:

To 1 October 2003:

[Column -8-] = ([Column -2-] + [Column -3-]) x [Column -5-] x [Column -6-] x [Column -7-]

To the end of the fishing season, i.e. 1 December 2003:

[Column -9-] = ([Column -2-] + [Column -3-] + [Column -4-]) x [Column -5-] x [Column -6-] x [Column -7-]

Area/ Subarea/ Division	No. of IUU Vessels Sighted ¹	No. of IUU Vessels Otherwise Reported ³	Plus No. of IUU Vessels Extrapolated to End of 2003 Season ⁴	Estimated No. Days per Fishing Trip ⁵	Estimated No. Trips per Year ⁶	Mean Catch Rate per Day (tonnes) ⁷	Estimated IUU Catch to 1 Oct 2003	Estimated IUU Catch 2002/03 Fishing Season
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-
48.3	0	-	-	-	-	-	0	
58.4.2	2		0.3	41	1.5	0.8	98	113
58.4.4		1	0.2	40	2.5	1.1	110	128
58.5.1	22 ²		9.2	24	1.9	5.5	5 518	7 825
58.5.2	4	2	1.0	24	2.0	4.5	1 274	1 512
58.6	5	2	1.2	40	1.8	0.6	302	354
58.7	2		0.3	40	1.5	1.0	120	138
88.1					1		0	0
88.2							0	0
Total IUU catch:							7 422	10 070

¹ From reports of vessel sightings submitted by Members.

² Sightings in Division 58.5.1 reported by France for the period 1 July 2002 to 30 June 2003 (CCAMLR-XXII/BG/10). The number of vessels sighted was reported monthly, with a maximum of five vessels per month. For that period, France estimated a level of IUU catch at a minimum of approximately 4 125 tonnes. The average period of fishing days per month for each vessel was estimated by France to be 25 days. Estimates presented in this table (Columns -8- and -9-) use the number of sightings reported from 1 December 2002 to 30 June 2003. The total number of sightings reported for this period was used. However, from the information presented, the Secretariat was not able to differentiate possible multiple sightings of the same vessel. Therefore, the Secretariat used the total number of vessels sighted for the period from 1 December 2002 to 30 June 2003. Any subsequent adjustment of sightings would result in the reduction of the number of vessels and hence, in the reduction of estimated IUU catch.

³ From information otherwise reported via port inspections or fishing vessels/traders.

⁴ Calculated pro rata for 1 October to 30 November 2003. Division 58.5.1 calculated from 1 July 2003 to 30 November 2003.

⁵ Estimates of the duration of fishing trips for IUU vessels have been agreed and used by WG-FSA for a number of years. Five-day catch and effort reports do not provide information required to estimate duration of fishing trips. As an alternative, estimates from CDS for 2003 could be used. Figures for 2002 are provided when no data exists for the 2003 season. These estimates are as follows:

Area/Subarea/Division	Average Days Fished		Mean Catch Rate/Day	
	2003	2002	2003	2002
48.3	66		3.6	
58.4.2		80		1.4
58.4.4		46		2.5
58.5.1	77			3.6
58.5.2 (longliners only)	52		5.1	
58.6		74		0.6
58.7	46		1.6	

⁶ From CDS data for the entire 2002, except for Division 58.5.2 taken from IUU information 2002 and Subarea 58.7 submitted by South Africa in 2002.

⁷ All mean catch rates from five-day catch and effort databases for the period 1 December 2002 to 1 October 2003.

Table 5.1: Summary of notifications for new and exploratory fisheries in 2003/04.

Member	Subarea/Division	Target Species	Fishery	Paper
Argentina	48.1, 48.2, 58.4.1, 58.4.4, 58.6, 58.7, 88.3	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/15
	48.6	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/16
	58.4.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/17
	58.4.3a, 58.4.3b	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/18
	58.5.2 west of 79°20'E	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/19
	58.5.1, 58.5.2 east of 79°20'E	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/20
	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/21
Australia	58.4.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/22
	58.4.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/23
	58.4.3a, 58.4.3b	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/24
	58.4.3a, 58.4.3b	<i>Dissostichus</i> spp., <i>Macrourus</i> spp.	Exploratory trawl	CCAMLR-XXII/25
Japan	48.6, 88.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/26
Korea, Republic of	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/27
Namibia	48.6, 58.4.4, 58.5.1, 58.5.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/28
	48.3, 48.6, 58.4.2, 58.4.3a, 58.4.3b, 58.5.2, 58.7, 88.1, 88.2, 58.4.4	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/29
	48.6	<i>Dissostichus</i> spp.	Exploratory longline ^a	CCAMLR-XXII/30
	58.4.1	<i>Dissostichus</i> spp.	Exploratory longline ^b	CCAMLR-XXII/31
New Zealand	48.6	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/32
	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/33
Norway	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline ^c	CCAMLR-XXII/51
Russia	58.4.2, 58.4.3a, 58.4.3b	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/37
	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/6
	58.4.2	<i>Chaenodraco wilsoni</i> , <i>Trematomus eulepidotus</i> , <i>Lepidonotothen kempi</i> , <i>Pleuragramma antarcticum</i>	Exploratory trawl ^d	CCAMLR-XXII/38
South Africa	48.6, 58.6, 88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/39
Spain	48.6, 88.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/7
UK	88.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/40
Ukraine	58.4.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/34
	58.4.3a, 58.4.3b	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/35
	88.1, 88.2	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/36
Uruguay	88.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/42
USA	58.4.1, 58.4.2, 58.4.3a, 58.4.3b, 58.5.2, 88.1	<i>Dissostichus</i> spp.	Exploratory longline	CCAMLR-XXII/41

^a One-page summary only; details received 30 September 2003^b One-page summary received 1 August 2003; details received 4 August 2003^c Notification faxed to the Secretariat 8 September 2003^d Notification received 29 July 2003

Table 5.2: Number of vessels notified in exploratory fisheries for *Dissostichus* spp. in the 2003/04 season (a), and number of vessels and catch limits for *Dissostichus* spp. agreed in conservation measures in force in the 2002/03 season (b). Notifications are for longline fisheries unless specified. N – northern sector; S – southern sector; ns – not specified.

Member	Subarea/Division																		
	48.1	48.2	48.3	48.6N	48.6S	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	88.1N	88.1S	88.2N	88.2S	88.3
(a) Notifications for exploratory fisheries for <i>Dissostichus</i> spp. in the 2003/04 season																			
Argentina	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Australia						1	3	3 ^a	3 ^a										
Japan				1											1	1			
Korea, Republic of															2	2	2	2	
Namibia			4	6	6	1	2	2	2	4	2	4		2	2	2	2	2	
New Zealand				3	3										6	6	6	6	
Norway															1	1	1	1	
Ukraine							2	2	2						3	3		3	
Russia							4	4	4						4	4		4	
Spain				1	1										2	2			
South Africa				2	2								2		2	2	2	2	
UK															1	1			
USA						2	2	2	2			2			2	2			
Uruguay															4	4			
Total Members	1	1	1	6	5	4	6	5	5	2	2	3	2	2	13	13	6	8	1
Total Vessels	2	2	4	15	14	6	15	15	15	6	4	8	4	4	32	32	15	22	2
(b) Conservation measures in force in the 2002/03 season																			
Nos. vessels*	0	0	ns	3	3	0	1	2	2	0 ^b	0 ^b	ns	0 ^b	0 ^b	13	13	0	9	0
Catch limit (t)	0	0	7810	455	455	0	500	250	300	0 ^b	0 ^b	2879	0 ^b	0 ^b	256	3504	0	375	0

^a Includes one multigear vessel (longline and trawl)

^b Outside EEZs

* Including maximum number at any one time

Table 5.3: Estimated seabed area for 600 to 1 800 m (km²), proportional area, proportional CPUE, and proportional CPUE weighted by seabed area for each of the proposed SSRUs.

SSRU	Area	Area (%)	CPUE (%)	CPUE x Area (%)
A	4 908	2.1	4.2	1.3
B	4 318	1.8	8.8	2.4
C	4 444	1.9	24.1	6.7
D	49 048	20.6	0.0	0.0
E	14 797	6.2	1.8	1.7
F	18 398	7.7	1.0	1.1
G	7 110	3.0	5.5	2.5
H	19 245	8.1	19.5	23.6
I	30 783	12.9	12.0	23.3
J	43 594	18.3	3.5	9.5
K	24 695	10.4	14.5	22.5
L	16 807	7.1	5.1	5.4
Total	238 148			

Table 5.4: Summary of costs, benefits and problems of different approaches to estimating abundance in Subarea 88.1. Note higher tag release rates would provide results more quickly.

	Juvenile Trawl Survey	Tag 3 500 Fish per Year	Depletion Experiment	Tagging and Depletion
If successful, number of years to get result	1 year	2 to 4 years	2 to 3 years	1 to 2 years
Number of years to get precise result	3 to 4 surveys	9 years	3 to 4 expts	2 to 3 expts
Earliest starting date	2004/05??	2003/04	2003/04?	2003/04?
Cost	Research survey lasting 6–8 weeks	2% catch per year	Catch restrictions	2% catch + restrictions
Potential problems	1. Juvenile location? 2. Bad ice years 3. Large area = multinational survey 4. Seabed?	1. Initial mortality 2. Tag loss / detection 3. Mixing assumps	1. Failed in 48.3 TOP 2. Movement 3. Extrapolation to subarea?	1. Initial mortality 2. Tag loss 3. Mixing 4. Extrapolation to subarea?
Other benefits	1. Monitor other species 2. Understand system better	1. Growth, movement and stock structure	1. Biomass of by-catch spp.	1. Growth, movement 2. Biomass by-catch spp.
Other issues	<i>Tangaroa</i> survey in 2004 may locate juveniles	More simulation needed	Negative perception simulation	Simulation studies

Table 5.5: Schedule of estimated *Dissostichus eleginoides* relative vulnerabilities-by-age for the seasons 1986–2003 in Subarea 48.3.

Age (years)	Relative Vulnerabilities	
	1998–2000, 2003	2001–2002
0.00	0.00	0.00
4.90	0.00	0.00
6.17	0.72	0.50
6.67	1.00	0.73
6.91	1.00	0.77
7.17	1.00	0.81
7.42	1.00	0.84
7.68	1.00	0.87
7.95	1.00	0.90
8.21	1.00	0.92
8.49	1.00	0.94
8.77	1.00	0.96
9.05	1.00	0.97
9.34	0.99	0.98
9.64	0.99	0.99
9.94	0.98	1.00
10.25	0.98	1.00
10.56	0.97	1.00
10.88	0.96	0.99
11.21	0.95	0.99
11.54	0.94	0.97
11.88	0.92	0.96
12.23	0.91	0.94
12.59	0.89	0.92
12.96	0.87	0.90
13.33	0.84	0.87
13.72	0.82	0.84
14.12	0.79	0.81
14.52	0.76	0.77
14.94	0.72	0.73
15.37	0.68	0.69
15.81	0.64	0.64
16.27	0.60	0.59
20.00	0.60	0.59
55.00	0.60	0.59

Table 5.6: Standardised series of CPUEs in kg/hook for *Dissostichus eleginoides* in Subarea 48.3, corrected for zero catch hauls.

Year	CPUE Estimate	Upper 95% CI	Lower 95% CI
1987	0.6102	0.6753	0.5451
1988	0.6080	0.6911	0.5248
1989	0.5325	0.5834	0.4816
1990	-	-	-
1991	0.5201	0.5590	0.4812
1992	0.6200	0.6434	0.5965
1993	0.7608	0.7889	0.7326
1994	0.5975	0.6407	0.5543
1995	0.6092	0.6318	0.5866
1996	0.3643	0.3768	0.3517
1997	0.2720	0.2826	0.2614
1998	0.2718	0.2830	0.2607
1999	0.3133	0.3251	0.3016
2000	0.3410	0.3512	0.3307
2001	0.3123	0.3235	0.3012
2002	0.3414	0.3513	0.3316
2003	0.3137	0.3220	0.3055

Table 5.7: Recruitment estimates from CMIX analyses of alternative datasets. The three datasets are those used in the 2002 assessment, using survey data from 1987–2002 (FSA-02); a series based on the same set of survey data, but in which the 2002 UK survey analyses were revised (FSA-03 new 02); and a series based on the same set of survey data, but in which both the 1990 and 2002 UK survey analyses were revised (FSA-03 new 90, 02).

Split-year	FSA-02	FSA-03 new 02	FSA-03 new 90, 02
1986			
1987	1.349	1.349	1.349
1988	0.845	0.845	0.846
1989	4.214	4.244	0.610
1990	9.374	9.374	0.885
1991	6.7	6.700	0.429
1992			
1993	11.799	11.799	11.799
1994	2.13	2.225	2.130
1995	1.003	0.984	1.003
1996	0.691	0.690	0.691
1997	2.947	2.947	2.947
1998	1.14	1.140	1.140
1999			
2000			0.381
2001	2.504	1.067	1.067
2002	4.207	1.066	1.066
2003	10.694	2.015	2.015
Mean	4.257	3.318	1.890
CV	0.90	1.06	1.50

Table 5.8: Catch history for *Dissostichus eleginoides* in Subarea 48.3. Fishing seasons are given (i.e. 1988/89 is 1 December 1988 to November 1989).

Fishing Season	Reported Catch (tonnes)	IUU Catch (tonnes)	Total Extractions (tonnes)
1984/85	521	0	521
1985/86	733	0	733
1986/87	1954	0	1954
1987/88	876	0	876
1988/89	7060	144	7204
1989/90	6785	437	7222
1990/91	1756	1775	3531
1991/92	3809	3066	6875
1992/93	3020	4019	7039
1993/94	658	4780	5438
1994/95	3371	1674	5045
1995/96	3602	0	3602
1996/97	3812	0	3812
1997/98	3201	146	3347
1998/99	3636	667	4303
1999/00	4904	1015	5919
2000/01	4047	196	4243
2001/02	5744	3	5747
2002/03	7534	0	7534

Table 5.9: Input parameters for the GYM to assess the long-term annual yield of *Dissostichus eleginoides* taken by longline in Subarea 48.3.

Category	Parameter	Values
Age structure	Recruitment age	4 years
	Plus class accumulation	35 years
	Oldest age in initial structure	55 years
Recruitment		See Table 5.7
Natural mortality	Mean annual M	0.132–0.198
von Bertalanffy growth	t_0	–0.21
	L_∞	194.6 cm
	K	0.066
Weight-at-age	Weight–length parameter – A (kg)	2.5E-05
	Weight–length parameter – B	2.8
Maturity	L_{m50}	930 mm
	Range: 0 to full maturity	780–1 080 mm
Fishing season		
Spawning season	Set so that status of the stock is determined at the end of each year	1 Aug–1 Aug
Simulation characteristics	Number of runs in simulation	1001
	Depletion level	0.2
	Seed for random number generator	–24 189
Characteristics of trial	Years to remove initial age structure	1
	Observations to use in median SB_0	1001
	Year prior to projection	1983
	Reference Start Date in year	01/12
	Increments in year	24
	Years to project stock in simulation	35
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001
Fishing mortality		See Tables 5.5 and 5.8

Table 5.10: Input parameters for the 2003 assessment of long-term annual yield of *Dissostichus eleginoides*, taken by trawl in Division 58.5.2 using the GYM.

Category	Parameter	Values
Age structure	Recruitment age	4 years
	Plus class accumulation	35 years
	Oldest age in initial structure	55 years
Recruitment		See Table 5.12
Natural mortality	Mean annual M	0.13–0.2
von Bertalanffy growth	t_0	–2.46 ¹ years
	L_∞	2 465 mm
	K	0.029 year ^{–1}
Weight-at-age	Weight–length parameter – A (kg)	2.59E-09 kg
	Weight–length parameter – B	(mm ^B) 3.2064
Maturity	L_{m50}	930 mm
	Range: 0 to full maturity	780–1 080 mm
Spawning season		1 Jul–1 Jul
Simulation specifications	Number of runs in simulation	10 001
	Depletion Level	0.2
	Seed for random number generator	–24 189
Individual trial specifications	Years to remove initial age structure	1
	Observations to use in median SB ₀	1 001
	Year prior to projection	1985
	Reference Start Date in year	01/12
	Increments in year	24
	Vector of known catches	See Table 5.13
	Years to project stock in simulation	35
	Reasonable upper bound for Annual F	5.0
	Tolerance for finding F in each year	0.000001
Fishing mortality		See Table 5.13

¹ Adjusted from estimated parameter of $t_0 = -2.56$ years to start of fishing season on 1 December.

Table 5.11: Estimated cohort strengths of *Dissostichus eleginoides*, from surveys undertaken in Division 58.5.2 since 1990. Only values in boxes were included in the base-case assessment (see text for details). Observed and expected data are from the mixture analyses, the closeness of which indicates the quality of the fit. The time of the survey is relative to 1 December (rather than relative to 1 November as in previous reports).

Survey Year	Time	Area (km ²)	Observed	Expected		Density (n.km ⁻²)					
						Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1990	0.50	97 106	107.2	108.1	Mean	8.080	33.508	20.208	0.827	25.226	
					SE	5.897	13.552	11.251	11.505	14.082	
1992	0.17	70 271	51.7	51.8	Mean	14.117	13.200	14.501	3.430	0.019	2.117
					SE	5.156	7.036	7.845	4.473	5.449	3.342
1993	0.77	71 555	97.4	114.7	Mean	13.567	38.259	8.191	16.961	3.066	20.884
					SE	8.804	18.172	13.483	12.606	30.294	16.333
1999	0.33	85 428	366.2	357.9	Mean	17.741	16.206	138.11	56.785	60.897	40.323
					SE	7.862	13.323	42.657	55.348	50.870	38.189
2000	0.47	41 144	185.0	179.5	Mean	28.124	21.969	47.817	59.121	7.565	10.989
					SE	5.298	7.996	14.885	20.578	15.142	11.383
2001	0.48	85 169	247.5	252.4	Mean	19.542	34.018	38.172	45.538	32.165	16.738
					SE	7.798	12.849	20.534	30.762	42.367	41.086
2002	0.48	85 910	208.5	204.8	Mean	18.590	29.333	59.400	20.726	53.199	
					SE	6.722	11.475	21.202	21.993	17.117	
2003	0.42	42 280	116.8	115.6	Mean	15.798	17.298	22.452	45.041		
					SE	13.552	29.967	43.976	36.105		

Table 5.12: Time series of recruitments (millions of fish) for *Dissostichus eleginoides* in Division 58.5.2 based on a mean natural mortality of 0.165 year⁻¹. In sensitivity trials where recruitment in one or more years were not estimated from research surveys (denoted by - in table), recruitment was estimated from a lognormal distribution in the GYM with the calculated mean and CV.

Year at Age 4 Birthday	WG-FSA-2002	Estimates used in 2003 Assessment	2003 Estimates using Ages 3–6 only	2003 Estimates using Ages 3–7 only
1986	4.321	4.320	-	4.320
1987	0.120	0.121	0.121	0.121
1988	2.586	2.488	2.488	2.488
1989	3.790	3.790	3.805	3.790
1990	1.118	1.118	1.118	1.118
1991	0.667	0.667	0.667	0.667
1992	1.447	2.743	2.743	2.743
1993	0.825	0.825	0.825	0.825
1994	7.205	7.203	-	-
1995	9.226	9.223	-	9.224
1996	7.295	7.292	7.293	7.293
1997	15.043	14.165	15.038	14.165
1998	6.532	6.515	3.486	6.514
1999	2.332	2.329	2.329	2.329
2000	1.931	4.577	4.577	4.577
2001	2.236	2.209	2.208	2.209
2002	1.625	1.584	1.584	1.584
2003		0.675	0.675	0.675
Mean	4.018	3.991	3.264	3.802
CV	0.975	0.921	1.148	0.973

Table 5.13: Catch histories and fishing vulnerabilities (selectivities) for *Dissostichus eleginoides* in Division 58.5.2.

Season	Catch (Reported and IUU) (tonnes)	Size/Age (Vulnerability)	Size/Age Units
1995/96	3000	550 (0), 790 (1)	mm
1996/97	9044	(0), 6.0 (0.0), 7.0 (1), 7.9 (1), 8.0 (0)	years
1997/98	7915	0.0 (0), 6.0 (0.0), 10.0 (1), 10.0 (1), 12.0 (0)	years
1998/99	3974	0.0 (0), 5.5 (0.0), 6.0 (1), 13.0 (1), 15.0 (0)	years
1999/2000	4720	0.0 (0), 4.0 (0.0), 8.0 (1), 14.0 (1), 15.0 (0)	years
2000/01	4984	0.0 (0), 4.0 (0.0), 8.0 (1), 14.0 (1), 15.0 (0)	years
2001/02	6245	0.0 (0), 4.0 (0.0), 8.0 (1), 14.0 (1), 15.0 (0)	years
2002/03	Catch limit 2879 tonnes + illegal catch of 1512 tonnes = 4391 tonnes	0.0 (0), 4.0 (0.0), 8.0 (1), 14.0 (1), 15.0 (0)	years

Table 5.14: Results from 2003 assessments of yield according to the CCAMLR decision rules for *Dissostichus eleginoides* in Division 58.5.2 using the GYM.

	Catch Limit (tonnes)	Depletion Probability	Median Escapement
2003 estimate based on revised recruitment series including 2003 survey	2 873	0.09	0.50
Sensitivity tests			
Estimates of recruitment based on ages 3–7 only	2 748	0.09	0.50
Estimates of recruitment based on ages 3–6 only	2 150	0.10	0.55
Flat-top fishing vulnerability	3 731	0.08	0.50

Table 5.15: Input parameters for the GYM to undertake the short-term assessment of yield from the population of *Champscephalus gunnari* in the vicinity of South Georgia and Shag Rocks (Subarea 48.3). Starting abundance includes age 2+ fish.

Category	Parameter	Values	
Age structure	Recruitment age	3 fully selected 2 select begins	
	Plus class accumulation	10 years	
	Oldest age in initial structure	2 years	
	Initial biomass (age 2+)	29 694 467 kg: 22 393 000 kg (bottom trawl) + 7 301 467 kg (Acoustic estimate 8–58 m above the bottom)	
	Initial age structure	Age	Density % numbers/km ²
		2	71.18
		3	22.90
		4	0.00
		5	5.04
		6	0.88
	Nominal date of survey	31 Jan 2003	
	Survey timing: days since start of year	31 (for combined survey)	
Recruitment		0	
Natural mortality	Mean Annual M	0.71–0.71	
von Bertalanffy growth	t_0	–0.58	
	L_{∞}	557 mm	
	K	0.17	
		5.47E-7	
Weight-at-age	Weight–length parameter – A (kg)	5.47E-7	
	Weight–length parameter – B	3.42	
	Mean weight-at-age	Data source	Age
		von Bertalanffy	1
		2003 CMIX ¹	2
		2003 CMIX ¹	3
		von Bertalanffy	4
		2003 CMIX ¹	5
Maturity	L_{m50} (set so that the status of the whole stock is being monitored)	0 mm	
		Range: 0 to full maturity	
Spawning Season	Set so that status of the stock is determined at the end of each year	30 Nov–30 Nov	
Simulation specifications	Number of runs in simulation	1	
Individual trial specifications	Years to remove initial age structure	1	
	(set to 1 in order to project from survey to the beginning of the fishing season, would be set to 0 if there were catches following the survey and those catches be included as a catch history)		
	Year prior to projection (note this is the first year of the split year; if there were catches following the survey then this would be set to 2001)	2001	
	Reference Start Date in year	01/12	
	Increments in year	365	
	Years to project stock in simulation	2	
	Reasonable upper bound for annual F	5.0	
	Tolerance for finding F in each year	0.000001	
Fishing mortality	Catch since survey	2001/02: 471 tonnes 2002/03: 2 155 tonnes	
	The scenarios are to determine F to satisfy the decision rules.		

¹ 2003 re-run of the CMIX analysis of the combined 2002 bottom trawl survey data, see Figure 5.13.

Table 5.16: Input parameters for the GYM to undertake the short-term assessment of yield from the population of *Champscephalus gunnari* in the vicinity of South Georgia and Shag Rocks (Subarea 48.3). Starting abundance includes age 1+ fish. All parameters not shown are as in Table 5.15.

Category	Parameter	Values	
Age Structure	Initial biomass (age 2+)	35 059 000 kg: 22 706 000 kg (bottom trawl) + 12 353 000kg (acoustic estimate 8–58 m above the bottom)	
	Initial age structure	Age	Density % numbers/km ²
		1	50.26
		2	35.41
		3	11.39
		4	0.00
		5	2.51
		6	0.44

Table 5.17: Yield estimates of *Champscephalus gunnari* in Subarea 48.3 derived from two short-term (2-year) projections.

	Actual Yield in 2002/03 (tonnes)	Estimated Yield in 2003/04 (tonnes)
Projection 1 incorporating age 1+ fish in the 2001/02 biomass estimate	2155	3570
Projection 2 incorporating age 2+ fish in the 2001/02 biomass estimate	2155	2205

Table 5.18: Input parameters for the GYM to undertake the short-term assessment of yield from the population of *Champscephalus gunnari* in the vicinity of Heard Island in Division 58.5.2 (not including Shell Bank).

Category	Parameter	Values
Age structure	Recruitment age	2 years
	Plus class accumulation	10 years
	Oldest age in initial structure	10 years
	Initial biomass	2 322 000 kg
	Initial age structure (from CMIX)	Age 2 246
		Age 3 304
		Age 4 346
	Date of survey	1 May 2003
Recruitment		0
Natural mortality	Mean Annual M	0.4
von Bertalanffy growth	t_0	0.027
	L_∞	457 mm
	K	0.323
Weight-at-age	Weight-length parameter – A (kg)	2.6×10^{-10} kg
	Weight-length parameter – B	3.515
Maturity	L_{m50} (set so that the status of the whole stock is being monitored)	0 mm
	Range: 0 to full maturity	0 mm
Spawning season	Set so that status of the stock is determined at the end of each year	30 Nov–30 Nov
Simulation specifications	Number of runs in simulation	1
Individual trial specifications	Years to remove initial age structure (set to 1 in order to project from survey to the beginning of the fishing season, could be set to 0 if there were catches following the survey and those catches be included as a catch history)	1
	Year prior to projection (note this is the first year of the split year; if there were catches following the survey then this would be set to 2001)	2002
	Reference Start Date in year	01/12
	Increments in year	365
	Years to project stock in simulation	2
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001
Fishing mortality	The scenarios are to determine F to satisfy the decision rules.	

Table 5.19: Predicted and (*observed*) modal size of *Champscephalus gunnari* cohorts in Division 58.5.2 in 2002, 2003 and 2004 surveys and at the beginning of the 2003/04 and 2004/05 seasons.

Cohort (born)	2003 not born yet	2002 No data	2001 strong	2000 moderate	1999 very weak	1998 -----strong-----	1997
Age at May 2003		0+	1+	2+	3+	4+	5+
May 202			54	165 (189)	246 (268)	304 (329)	346
May 2003		54	165 (163)	245 (280)	304 (absent)	346 (346)	377 (363)
Dec 2003	54	123	215	282	330	365	-
May 2004	123	165	246	304	346	377	-
Dec 2004	165	215	282	330	365	-	-

Table 5.20: Input parameters for the GYM to assess γ for *Macrourus* spp. Length parameters are in millimetres. The parameters highlighted in bold form the input parameters run as the base case for each assessment.

Input Parameters	<i>M. carinatus</i> 58.5.2	<i>Macrourus</i> spp. 58.4.3	<i>M. holotrachys</i> 48.3		<i>M. whitsoni</i> 88.1	
			TL	Pre-anal Length	TL	Pre-anal Length
L_{∞}	690*	857	810	330	857	305
K	0.069*	0.048		0.101	0.048	0.048
t_0	-2.4*	-3.89		-0.69	-3.89	-2.92
Oldest age in stock	55	80	55	55	80	80
Last age in stock	25+	55	25	25	55	55
Minimum age in stock	1	1	1	1	1	1
Stock projection (yrs)	35	55	35	35	55	55
Natural mortality range	0.09–0.17	0.05–0.12	0.05–0.15	0.05–0.15	0.05–0.12	0.05–0.12
Length–weight						
a	2 x 10⁻⁹	1.609 x 10⁻⁸	8 x 10 ⁻⁹	7.846 x 10⁻⁶	1.609 x 10 ⁻⁸	1.347 x 10⁻⁶
b	3.1159	2.8603	2.93	2.19395	2.8603	2.5665
Birthday	Jul					
Spawning season	May–Sep	May–Sep	May–Sep	May–Sep	May–Sep	May–Sep
Fishing selectivity						
Min length 50%	320	320	600	220	440	145
Max length 50%	320	320	600	220	470	155
Range	160	160	392	110	160	60
Maturity						
Min length 50%	417	460	572	200	460	150
Max length 50%	512	500	731	290	500	170
Range	150	260	467	150	260	110
Recruitment						
Min CV	0.1	0.1	0.1	0.1	0.1	0.1
Max CV	0.32	0.32	0.32	0.32	0.32	0.32
CV of B_0	0.5	0.5	0.84	0.84	1.184	1.184

* These von Bertalanffy parameters are from van Wijk et al. (2003) and replace the original parameters presented in WG-FSA-02/48 ($L_{\infty} = 635$, $K = 0.088$ and $t_0 = -1.8$).

Table 5.21: Estimates of γ for *Macrourus whitsoni* in Subarea 88.1. Base-case values are given in Table 5.20. Sensitivity trials were carried out to investigate effect of variability in natural mortality (M), number of years in stock projection, CV of B_0 and recruitment CV on estimates of γ .

Length-based Parameters	Trial	1 001 Simulations	10 001 Simulations
Pre-anal length	Base case (from Table 5.20) High M = 0.08–0.15		0.01439 0.01732
Total length	Base case (from Table 5.20) 20-year projection ¹ 35-year projection Low M = 0.02–0.09 High M = 0.08–0.15 CV on B_0 = 0.5 CV on B_0 = 2.0 Recruitment CV = 0.5–0.7	0.01404 0.02138 0.01626 0.01126 0.01690 0.01814 0.01325 0.01372	

¹ Analogous to 2002 assessment when γ was estimated as 0.02165.

Table 5.22: Estimates of γ for *Macrourus carinatus* in Division 58.5.2. Base-case values are given in Table 5.20. Sensitivity trials were carried out to investigate effect of variability in natural mortality (M), number of years in stock projection, CV of B_0 and recruitment CV on estimates of γ .

Trial	10 001 Simulations
Stock projection 20 years ¹	0.03247
Old vb parameters, 35 years	0.02594
Low M = 0.05–0.10	0.02205
High M = 0.15–0.20	0.02984
Base case new von Bertalanffy parameters, 35 years	0.02511
Low M = 0.05–0.13	0.02169
High M = 0.12–0.20	0.02728
CV of B_0 = 1.0	0.02014

¹ Analogous to 2002 assessment when γ was estimated as 0.03226.

Table 5.23: Estimates of γ for *Macrourus* spp. in Division 58.4.3. Base-case values are given in Table 5.20. Sensitivity trials were carried out to investigate affect of variability in CV of B_0 on estimates of γ .

Trial	1 001 Simulations	10 001 Simulations
Base case (from Table 5.20)		0.01654
CV on B_0 = 1.0	0.01334	
CV on B_0 = 1.5	0.01243	

Table 5.24: Estimates of γ for *Macrourus holotrachys* in Subarea 48.3. Base-case values are given in Table 5.20 and are in pre-anal length. Sensitivity trials were carried out to investigate affect of variability in CV of B_0 and natural mortality on estimates of γ .

Trial	1 001 Simulations	10 001 Simulations
Base case (from Table 5.20)		0.02197
High M (0.1–0.2)	0.02505	
CV on $B_0 = 0.5$	0.02550	

Table 5.25: Estimated retained/discarded by-catch (in tonnes) of rajids and macrourids in the 2003 fishing season in each statistical area from fine-scale data. Figures in parentheses are by-catch as a percentage of target catch.

Species Group	Subarea/Division							
	48.3		58.6		58.7	88.1	58.5.1	58.5.2
			Inside EEZ	Outside EEZ				
Macrourids	74	(1)	112 (26)	107 (25)	9* (8)	65 (4)	592 (16)	5 (<1)
Rajids	37	(<1)	88 (20)	67 (15)	<1* (1)	11 (1)	745 (20)	35 (2)

* Data from catch and effort reports as fine-scale data was not available.

Table 5.26: Estimated total mortality (in tonnes) of fish cut off longlines in Subarea 48.3 and Division 58.5.2. The minimum and maximum columns are the estimates of total by-catch assuming all fish cut off survive or die respectively. The minimum values are from fine-scale estimates in Table 5.25. The cut-off catch is estimated using observer tally data. The Agnew method uses the results of the rajid survivorship experiment in Subarea 48.3 (WG-FSA-03/57) stratified by depth as described in the text.

Species Group	Subarea 48.3				Division 58.5.2		
	Minimum	Cut-offs	Maximum	Agnew Method	Minimum	Cut-offs	Maximum
Macrourids	74	174	248		5	-	-
Rajids	37	142	179	85	35	10	45

Minimum = minimum estimated catch from fine-scale data in Table 5.25, assuming all cut-offs survive.

Maximum = maximum estimated catch assuming all cut-offs die.

- Indicates data on by-catch was not recorded by observers.

Table 6.1: Observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subareas 48.3, 58.6, 58.7, 88.1, 88.2 and Divisions 58.4.2 and 58.5.2 during the 2002/03 season. Sp – Spanish method; Auto – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); O – opposite side to hauling; S – same side as hauling; * – information obtained from cruise report.

Vessel	Dates of Fishing	Method	Sets Deployed				No. of Hooks (thousands)			Hooks Baited (%)	No. of Birds Caught						Observed Seabird Mortality (birds/1 000 hooks)			Streamer Line in Use %		Offal Discharge during Haul (%)
			N	D	Total	%N	Obs.	Set	% Observed		Dead		Alive		Total		N	D	Total	N	D	
Subarea 48.3																						
Argos Georgia	1/5–30/8/03	Sp	432	7	439	98	385.9	1453.4	26	100	0	0	2	0	2	0	0	0	0	99	100	O (98)
Argos Helena	15/4–15/6/03	Sp	118	0	118	100	174.2	579.1	30	100	0	0	0	0	0	0	0	0	0	100		O (98)
Argos Helena	21/6–30/8/03	Sp	148	0	148	100	271.8	733.0	37	100	0	0	0	0	0	0	0	0	0	99		O
Cisne Verde	26/5–31/8/03	Sp	228	0	228	100	371.2	1332.7	27	100	0	0	0	0	0	0	0	0	0	100		O (76)
Ibsa Quinto	1/5–4/8/03	Sp	108	0	108	100	381.9	2000.1	19	100	0	0	0	0	0	0	0	0	0	100		O (98)
In Sung No. 66	22/5–29/8/03	Sp	151	3	154	98	257.3	1254.4	20	100	0	0	0	0	0	0	0	0	0	95	100	O (98)
Isla Aleganza	1/5–22/7/03	Sp	144	0	144	100	228.1	1281.3	17	100	0	0	0	0	0	0	0	0	0	69		O (100)
Isla Camila	25/5–10/7/03	Sp	184	0	184	100	179.9	861.6	20	99	0	0	0	0	0	0	0	0	0	100		O (100)
Isla Santa Clara	1/5–26/8/03	Sp	244	7	251	97	273.9	1380.5	19	100	0	0	2	0	2	0	0	0	0	99	100	O (98)
Isla Sofia	4/5–15/8/03	Sp	200	0	200	100	332.5	1107.5	30	100	0	0	0	0	0	0	0	0	0	100		O (73)
Ivan Klyushin	4/5–30/8/03	Auto	330	5	335	99	523.8	2020.8	25	96	2	0	0	0	2	0	0.004	0	0.004	100	100	O (61)
Jacqueline	4/5–30/8/03	Sp	134	0	134	100	612.5	2173.3	28	100	0	0	1	0	1	0	0	0	0	100		O (99)
Koryo Maru No. 11	2/5–30/5/03	Sp	217	0	217	100	442.4	1621.7	27	100	0	0	0	0	0	0	0	0	0	100		O (100)
Lodeynoye	7/7–23/7/03	Auto	35	0	35	100	77.0	121.5	63	80	0	0	1	0	1	0	0	0	0	100		O
Magallanes III	2/5–25/8/03	Sp	169	37	206	82	381.5	1458.2	26	100	0	0	0	0	0	0	0	0	0	99	97	O (68)
Polarpesca I	3/5–26/8/03	Sp	264	0	264	100	291.3	1450.9	20	100	0	0	0	0	0	0	0	0	0	100		O (86)
San Aotea II	4/5–22/6/03	Auto	133	0	133	100	384.1	915.2	41	100	0	0	0	0	0	0	0	0	0	100		O (1)
Shinsei Maru No. 3	1/5–16/6/03	Sp	78	5	83	94	145.1	661.2	21	100	0	0	0	0	0	0	0	0	0	100	80	O (89)
Shinsei Maru No. 3	19/6–20/6/03	Sp	6	0	6	100	6.6	34.8	19	100	0	0	0	0	0	0	0	0	0	100		O (83)
Shinsei Maru No. 3	2/7–30/8/03	Sp	119	0	119	100	216.8	864.6	25	100	0	0	0	0	0	0	0	0	0	80		O (95)
Tierra del Fuego	13/5–7/7/03	Sp	91	0	91	100	156.1	651.8	23	100	0	0	2	0	2	0	0	0	0	97		O (98)
Tierra del Fuego	22/7–25/8/03	Sp	68	0	68	100	104.0	399.4	26	100	0	0	0	0	0	0	0	0	0	100		O (97)
Viking Bay	10/5–23/8/03	Sp	309	0	309	100	255.8	1076.2	23	100	0	0	0	0	0	0	0	0	0	100		O (99)
Total						98.4	6453.7	25433.2	25								<0.001	0	<0.001			
Subareas 58.6, 58.7, Area 51																						
Koryo Maru No. 11	31/1–30/3/03	Sp	95	1	96	99	481.6	957.6	50	100	0	0	0	0	0	0	0	0	0	100	100	O (98)
South Princess	26/5–21/7/03	Auto	215	4	219	98	251.8	683.2	36	80	2	0	1	0	3	0	0.008	0	0.008	100	100	S (99)
Total						98	733.4	1640.8	45								0.003	0	0.003			
Division 58.4.2																						
Eldfisk	5/2–25/3/03	Auto	34	106	140	24	250.7	599.3	41	90	0	0	0	0	0	0	0	0	0	79	98	(0)
Total						24	250.7	599.3	41								0	0	0			
Division 58.5.2																						
Janas	6/5–22/6/03	Auto	94	0	94	100	288.4	641.4	44	94	0	0	0	0	0	0	0	0	0	100		(0)
Total						100	288.4	641.4	44								0	0	0			
Subareas 88.1, 88.2																						
Avro Chieftain	12/2–15/4/03	Auto	33	65	98	34	250.0	507.7	49	91	0	0	0	0	0	0	0	0	0	100	100	(0)
Avro Chieftain	1/5–3/6/03	Auto	27	20	47	57	153.2	266.1	57	86	0	0	0	0	0	0	0	0	0	100	100	(0)
Gudni Olafsson	20/2–14/3/03	Auto	22	20	42	52	92.0	174.2	52	91	0	0	0	0	0	0	0	0	0	100	100	(0)
Janas	28/12–9/3/03	Auto	25	94	119	21	288.8	472.6	61	90	0	0	0	0	0	0	0	0	0	100	100	(0)
San Aotea II	24/12–6/3/03	Auto	4	105	109	4	304.7	635.9	47	90	0	0	0	0	0	0	0	0	0	100	100	(0)
San Liberatore	15/2–27/4/03	Auto	43	72	115	37	167.6	467.0	35	90	0	0	0	0	0	0	0	0	0	100	100	(0)
Sonrisa	21/1–7/2/03	Auto	3	20	23	13	41.8	100.2	41	73	0	0	0	0	0	0	0	0	0	100	100	(0)
South Princess	18/1–2/3/03	Auto	18	81	99	18	172.9	335.0	51	84	0	0	0	0	0	0	0	0	0	100	100	S (1)
Volna	23/12–17/3/03	Sp	4	97	101	4	562.3	905.8	62	100	0	0	0	0	0	0	0	0	0	100	100	(0)
Yantar	24/12–19/3/03	Sp	7	120	127	6	481.8	952.5	50	100	0	0	0	0	0	0	0	0	0	100	100	(0)
Total						21	2515.1	4817.0	52								0	0	0			

Table 6.2: Estimated total seabird mortality for those vessels where seabird mortalities were observed in Subareas 48.3, 58.6, 58.7 and Area 51 during the 2002/03 season.

Vessel	Hooks Observed (thousands)	Hooks Set (thousands)	% Hooks Observed	% Night Sets	Estimated Number of Birds Caught Dead		
					Night	Day	Total
Subarea 48.3							
<i>Ivan Klyushin</i>	523.8	2020.8	25	99	8	0	8
Subareas 58.6, 58.7, Area 51							
<i>South Princess</i>	251.8	683.2	36	98	7	0	7
Total					15	0	15

Table 6.3: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subareas 48.3, 58.6 and 58.7 from 1997 to 2003.

Subarea	Year						
	1997	1998	1999	2000	2001	2002	2003
Subarea 48.3							
Estimated by-catch	5 755	640	210*	21	30	27	8
By-catch rate	0.23	0.032	0.013*	0.002	0.002	0.0015	0.0003
Subareas 58.6, 58.7							
Estimated by-catch	834	528	156	516	199	0	7
By-catch rate	0.52	0.194	0.034	0.046	0.018	0	0.003

* Excluding *Argos Helena* line-weighting experiment cruise.

Table 6.4: Species composition of birds killed in longline fisheries in Subareas 48.3, 58.6 and 58.7 and Area 51 during the 2002/03 season. N – night setting; D – daylight setting (including nautical dawn and dusk); DAC – cape petrel; DIC – grey headed albatross; PRO – white-chinned petrel; PCI – grey petrel; () – % composition.

Vessel	Dates of Fishing	No. Birds Killed by Group						Species Composition (%)			
		Albatross		Petrel		Total		DIC	PRO	PCI	DAC
		N	D	N	D	N	D				
Subarea 48.3											
<i>Ivan Klyushin</i>	4/5–30/8/03	1	0	1	0	2	0	1 (50)			1 (50)
Subareas 58.6, 58.7, Area 51											
<i>South Princess</i>	26/5–21/7/03	0	0	2	0	2	0		1 (50)	1 (50)	
Total (%)		0	0	2	0	2	0	1 (25)	1 (25)	1 (25)	1 (25)

Table 6.5: Compliance, as reported by observers, of streamer lines with the minimum specifications set out in Conservation Measure 25-02 during the 2002/03 season. Y: yes; N: no; -: no information; A: autoliner; Sp: Spanish; AUS – Australia; CHL – Chile; ESP – Spain; GBR – United Kingdom; JPN – Japan; KOR – Republic of Korea; NZL – New Zealand; RUS – Russia; URY – Uruguay; ZAF – South Africa.

Vessel Name (Nationality)	Dates of Fishing	Fishing Method	Compliance with CCAMLR Specifications	Compliance with Details of Streamer Line Specifications				Length of Streamers (m)	Streamer Line in Use %	
				Attachment Height above Water (m)	Total Length (m)	No. Streamers per Line	Spacing of Streamers per Line (m)		Night	Day
Subarea 48.3										
Argos Georgia (GBR)	15–30/8/03	Sp	Y	Y (6)	Y (165)	Y (5)	Y (5)	Y (5–2.8)	99	100
Argos Helena (GBR)	15/4–15/6/03	Sp	Y	Y (5)	Y (180)	Y (5)	Y (5)	Y (4–2)	100	
Argos Helena (GBR)	19/6–31/8/03	Sp	Y	Y (5)	Y (166)	Y (5)	Y (5)	-	99	
Cisne Verde (CHL)	26/5–31/8/03	Sp	Y	Y (5.5)	Y (151)	Y (6)	Y (5)	Y (7–5)	100	
Ibsa Quinto (ESP)	22/4–13/8/03	Sp	N	N (3.5)	Y (150)	Y (10)	Y (5)	-	100	
In Sung No. 66 (KOR)	22/5–30/8/03	Sp	Y	Y (6)	Y (168)	Y (5)	Y (5)	-	95	100
Isla Alegranza (URY)	1/5–24/7/03	Sp	N	N (3.5)	Y (150)	Y (8)	Y (10)	-	69	
Isla Camila (CHL)	1/5–12/7/03	Sp	Y	Y (4.5)	Y (150)	Y (5)	Y (5)	-	100	
Isla Santa Clara (CHL)	1/5–26/8/03	Sp	Y	Y (6)	Y (150)	Y (5)	Y (5)	-	99	100
Isla Sofia (CHL)	3/5–16/8/03	Sp	Y	Y (6)	Y (160)	Y (5)	Y (5)	Y (5–3.6)	100	
Ivan Klyushin (RUS)	4/5–30/8/03	A	Y	Y (6.5)	Y (151)	Y (5)	Y (5)	Y (4–1.5)	100	100
Jacqueline (GBR)	4/5–30/8/03	Sp	Y	Y (5)	Y (162)	Y (5)	Y (5)	-	100	
Koryo Maru 11 (ZAF)	2/5–31/8/03	Sp	Y	Y (6.5)	Y (180)	Y (10)	Y (5)	-	100	
Lodeynoye (RUS)	1/7–16/8/03	A	N	Y (5)	N (125)	Y (24)	Y (5)	N (2–1)	100	
Magallanes III (CHL)	2/5–25/8/03	Sp	Y	Y (5)	Y (163)	Y (5)	Y (5)	Y (6–3)	99	97
Polar Pesca 1 (CHL)	3/5–27/8/03	Sp	Y	Y (5)	Y (153)	Y (5)	Y (5)	-	100	
San Aotea II (NZL)	3/5–23/6/03	A	Y	Y (5)	Y (199)	Y (13)	Y (5)	-	100	
Shinsei Maru No.3 (JPN)	28/4–17/6/03	Sp	Y	Y (5)	Y (154)	Y (5)	Y (5)	-	100	80
Shinsei Maru No.3 (JPN)	17–26/6/03	Sp	Y	Y (5)	Y (154)	Y (5)	Y (5)	-	100	
Shinsei Maru No.3 (JPN)	2/7–30/8/03	Sp	Y	Y (5)	Y (232)	Y (9)	Y (5)	Y (7–2.5)	80	
Tierra del Fuego (CHL)	11/5–9/7/03	Sp	Y	Y (6)	Y (172)	Y (31)	Y (5)	-	97	
Tierra del Fuego (CHL)	22/7–23/8/03	Sp	Y	Y (7)	Y (150)	Y (30)	Y (5)	-	100	
Viking Bay (ESP)	10/5–24/8/03	SP	Y	Y (6)	Y (153)	Y (10)	Y (5)	-	100	
Subareas 58.6, 58.7										
Koryo Maru No. 11 (ZAF)	25/1–5/4/03	Sp	Y	Y (5)	Y (150)	Y (7)	Y (5)	Y (7–5)	100	100
South Princess (ZAF)	21/5–27/7/03	A	Y	Y (8)	Y (150)	Y (5)	Y (5)	Y (3.5–1.3)	100	100

(continued)

Table 6.5 (continued)

Vessel Name (Nationality)	Dates of Fishing	Fishing Method	Compliance with CCAMLR Specifications	Compliance with Details of Streamer Line Specifications				Length of Streamers (m)	Streamer Line in Use %	
				Attachment Height above Water (m)	Total Length (m)	No. Streamers per Line	Spacing of Streamers per Line (m)		Night	Day
Division 58.4.2										
<i>Eldfisk</i> (AUS)	18/1–8/4/03	A	Y	Y (6)	Y (150)	Y (5)	Y (5)	Y (4–1.3)	79	98
Division 58.5.2										
<i>Janas</i> (AUS)	23/4–8/7/03	A	Y	Y (5)	Y (150)	Y (15)	Y (2.5)	Y (4–1.5)	100	
Subareas 88.1, 88.2										
<i>Avro Chieftain</i> (NZL)	7/2–22/4/03	A	Y	Y (8)	Y (185)	Y (8)	Y (5)	Y (4–0.5)	100	100
<i>Avro Chieftain</i> (NZL)	25/4–10/6/03	A	Y	Y (7)	Y (192)	Y (12)	Y (4)	Y (11–4)	100	100
<i>Gudni Olafsson</i> (NZL)	6/2–27/3/03	A	Y	Y (8)	Y (167)	Y (11)	Y (4)	Y (7.5–2)	100	100
<i>Janas</i> (NZL)	20/12/02–18/3/03	A	Y	Y (6.5)	Y (250)	Y (16)	Y (4)	Y (5–1.3)	100	100
<i>San Aotea II</i> (NZL)	14/12/02–15/3/03	A	Y	Y (5)	Y (155)	Y (12)	Y (4)	Y (8–1.5)	100	100
<i>San Liberatore</i> (NZL)	6/2–7/5/03	A	Y	Y (8)	Y (175)	Y (7)	Y (5)	Y (8–1.5)	100	100
<i>Sonrisa</i> (NZL)	8/1–19/2/03	A	Y	Y (12)	Y (250)	Y (10)	Y (5)	Y (6–1)	100	100
<i>South Princess</i> (ZAF)	10/1–11/3/03	A	Y	Y (9)	Y (150)	Y (5)	Y (5)	Y (4–1.3)	100	100
<i>Volna</i> (RUS)	24/11/02–2/5/03	Sp	Y	Y (5)	Y (150)	Y (5)	Y (5)	Y (4–1.3)	100	100
<i>Yantar</i> (RUS)	27/11/02–22/4/03	Sp	Y	Y (5)	Y (150)	Y (6)	Y (5)	Y (4–0.8)	100	100

Table 6.6: Summary of compliance with Conservation Measure 25-02, based on data from scientific observers from the 1996/97 to the 2002/03 season. Values in parentheses are % of observer records that were complete. na – not applicable.

Subarea/ Time	Line Weighting (Spanish System Only)			Night Setting (% Night)	Offal Discharge (%) Opposite Haul	Streamer Line Compliance (%)										Total Catch Rate (birds/1 000 hooks)	
	Compliance %	Median Weight (kg)	Median Spacing (m)			Overall	Attached Height	Total Length	No. Streamers	Distance Apart	Night	Day					
Subarea 48.3																	
1996/97	0 (91)	5.0	45	81	0 (91)	6 (94)	47 (83)	24 (94)	76 (94)	100 (78)	0.18	0.93					
1997/98	0 (100)	6.0	42.5	90	31 (100)	13 (100)	64 (93)	33 (100)	100 (93)	100 (93)	0.03	0.04					
1998/99	5 (100)	6.0	43.2	80 ¹	71 (100)	0 (95)	84 (90)	26 (90)	76 (81)	94 (86)	0.01	0.08 ¹					
1999/00	1 (91)	6.0	44	92	76 (100)	31 (94)	100 (65)	25 (71)	100 (65)	85 (76)	<0.01	<0.01					
2000/01	21 (95)	6.8	41	95	95 (95)	50 (85)	88 (90)	53 (94)	94 (94)	82 (94)	<0.01	<0.01					
2001/02	63 (100)	8.6	40	99	100 (100)	87 (100)	94 (100)	93 (100)	100 (100)	100 (100)	0.002	0					
2002/03	100 (100)	9.0	39	98	100 (100)	87 (100)	91 (100)	96 (100)	100 (100)	100 (100)	<0.001	0					
Division 58.4.2																	
2002/03	Auto only	na	na	24 ⁵	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
Division 58.4.4																	
1999/00	0 (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					
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					
Subarea 88.1																	
1996/97	Auto only	na	na	50	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
1997/98	Auto only	na	na	71	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
1998/99	Auto only	na	na	1 ³	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
1999/00	Auto only	na	na	6 ⁴	No discharge	67 (100)	100 (100)	67 (100)	100 (100)	100 (100)	0	0					
2000/01	1 (100)	12	40	18 ⁴	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
2001/02	Auto only	na	na	33 ⁴	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0					
2002/03	100 (100)	9.6	41	21 ⁴	1 incidence of offal dumping	100 (100)	100 (100)	100 (100)	100 (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 210/XIX, 216/XX and 41-09 permit daytime setting south of 65°S in Subarea 88.1 if they could demonstrate a sink rate of 0.3 m/s.

⁵ Conservation Measure 41-05 permits daytime setting in Division 58.4.2 if the vessel can demonstrate a sink rate of 0.3 m/s.

Table 6.7: Vessel compliance (%) with Conservation Measure 25-02 during the 2002/03 season. Those vessels that achieved full compliance with all elements of the conservation measure are indicated in bold type. Values for night setting, offal discharge and streamer line setting are absolute proportions for all sets by each vessel. Values for line weighting and streamer line design are either full compliance (i.e. 100%) or not compliant (i.e. 0%). AUS – Australia; CHL – Chile; ESP – Spain; GBR – United Kingdom; JPN – Japan; KOR – Republic of Korea; NZL – New Zealand; RUS – Russia; URY – Uruguay; ZAF – South Africa.

Vessel	Number of Cruises	Night Setting	Offal Discharge	Line Weighting	Streamer Line Setting	Streamer Line Design
Subarea 48.3						
<i>Argos Georgia</i> (GBR)	1	98	100	100	99	100
<i>Argos Helena</i> (GBR)	2	100	100	100	99	100
<i>Cisne Verde</i> (CHL)	1	100	100	100	100	100
<i>Ibsa Quinto</i> (ESP)	1	100	100	100	100	0
<i>In Sung No. 66</i> (KOR)	1	98	100	100	95	100
<i>Isla Alegranza</i> (URY)	1	100	100	100	69	0
<i>Isla Camila</i> (CHL)	1	100	100	100	100	100
<i>Isla Santa Clara</i> (CHL)	1	97	100	100	99	100
<i>Isla Sofia</i> (CHL)	1	100	100	100	100	100
<i>Ivan Klyushin</i> (RUS)	1	99	100	Autoliner	100	100
<i>Jacqueline</i> (GBR)	1	100	100	100	100	100
<i>Koryo Maru No. 11</i> (ZAF)	1	100	100	100	100	100
<i>Lodeynoye</i> (RUS)	1	100	100	Autoliner	100	0
<i>Magallanes III</i> (CHL)	1	82	100	100	99	100
<i>Polar Pesca 1</i> (CHL)	1	100	100	100	100	100
<i>San Aotea II</i> (NZL)	1	100	100	Autoliner	100	100
<i>Shinsei Maru No.3</i> (JPN)	3	98	100	100	88	100
<i>Tierra del Fuego</i> (CHL)	2	100	100	100	98	100
<i>Viking Bay</i> (ESP)	1	100	100	100	100	100
Subareas 58.6, 58.7						
<i>Koryo Maru No. 11</i> (ZAF)	1	99	100	0	100	100
<i>South Princess</i> (ZAF)	1	98	1	Autoliner	100	100
Division 58.4.2						
<i>Eldfisk</i> (AUS)+	1	24	100	Autoliner	93	100
Division 58.5.2						
<i>Janas</i> (AUS)	1	100	100	Autoliner	100	100
Subareas 88.1, 88.2						
<i>Avro Chieftain</i> (NZL)*	2	41	100	Autoliner	100	100
<i>Gudni Olafsson</i> (NZL)*	1	52	100	Autoliner	100	100
<i>Janas</i> (NZL)*	1	21	100	Autoliner	100	100
<i>San Aotea II</i> (NZL)*	1	4	100	Autoliner	100	100
<i>San Liberatore</i> (NZL)*	1	37	100	Autoliner	100	100
<i>Sonrisa</i> (NZL)*	1	13	100	Autoliner	100	100
<i>South Princess</i> (ZAF)*	1	18	99	Autoliner	100	100
<i>Volna</i> (RUS)*	1	4	100	100	100	100
<i>Yantar</i> (RUS)*	1	6	100	100	100	100

* Conservation Measure 41-09 allows fishing in Subarea 88.1 during daylight periods if the vessel can demonstrate a minimum sink rate of 0.3 m/s.

+ Conservation Measure 41-05 permits daytime setting in Division 58.4.2 if the vessel can demonstrate a sink rate of 0.3 m/s.

Table 6.8: Estimate of seabird by-catch in the IUU *Dissostichus* spp. fishery in Subareas 48.3, 58.6 and 58.7 and Divisions 58.4.4, 58.5.1 and 58.5.2 in fishing season 2003 and 1996 to 2002 combined. Lower and upper refer to 95% confidence limit.

Subarea/ Division	Year	Estimated Total Potential Seabird By-catch		
		Lower	Median	Upper
48.3	2003	0	0	0
	1996–2002	1 811	3 441	56 031
58.5.1	2003	10 888	13 284	35 470
	1996–2002	36 101	44 047	117 611
58.5.2	2003	1 066	1 300	3 472
	1996–2002	30 792	37 570	100 315
58.4.4	2003	593	724	1 932
	1996–2002	15 717	19 177	51 204
58.6	2003	1 329	1 622	4 330
	1996–2002	41 948	51 181	136 659
58.7	2003	537	655	1 749
	1996–2002	11 569	14 115	37 690
88.1	2003	0	0	0
	1996–2002	32	39	104
Totals	2003	14 412	17 585	46 954
	1996–2002	137 969	169 570	499 613
Overall Total		152 381	187 155	546 567

Table 6.9: Summary of IMAF risk level and assessment in relation to proposed new and exploratory longline fisheries in 2003/04. Risk scales are as follows: 1 – low; 2 – average-to-low; 3 – average; 4 – average-to-high; 5 – high. Text in bold indicates conflict with IMAF advice provided. Text highlighted indicates issues needing resolution.

Area	Risk Scale	IMAF Risk Assessment	Notes
48.1	3	Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of black-browed and grey-headed albatrosses, southern giant petrels and white-chinned petrels (i.e. September to April), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.
48.2	3	Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of southern giant petrels (October to March), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.
48.3	5	High risk. Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April); ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal conflicts with advice provided with respect to the length of fishing season and appointment of only one observer (additional observer desirable but not mandatory – Conservation Measure 41-02).
48.6	2	Average-to-low risk – southern part of area (south of c. 55°S) of low risk. No obvious need for restriction of longline fishing season. Ensure strict compliance with Conservation Measure 25-02 as a seabird by-catch precautionary measure. Fishing during daytime should only be permitted under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/16) proposes to fish from 1 March to 31 August 2004 north of 60°S, and from 15 February to 15 October 2004 south of 60°S. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
48.6 (continued)			<ul style="list-style-type: none"> • Japan (CCAMLR-XXII/26) proposes to fish from 15 February to 15 October 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided. • Namibia has submitted three applications for Subarea 48.6, which conflict in their intentions to comply with necessary seabird by-catch conservation measures. The status of these applications is unclear. They have been submitted by fishing companies and may not be submissions from the Government of Namibia. 1. Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this subarea, and to removal of operational restriction to areas south of latitude 60°S. Note that appointment of only one observer is proposed (additional observer is mandatory – Conservation Measure 41-04). 2. Namibia (CCAMLR-XXII/28) proposes to fish from 1 December 2003 to August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Namibian observer. Intends to comply with Conservation Measure 29/XVI (sic) (25-02). Proposal does not conflict with advice provided. 3. Namibia (CCAMLR-XXII/30) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Namibian observer. Intention to comply with Conservation Measure 25-02 not stated. Proposal conflicts with advice provided with respect to compliance with Conservation Measure 25-02.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
48.6 (continued)			<ul style="list-style-type: none"> • New Zealand (CCAMLR-XXII/32) proposes to fish north of 60°S from 1 March to 31 August 2004, and south of 60°S from 15 February to 15 October 2004. Two scientific observers, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation; 24-hour observer coverage proposed. Intends to comply fully with Conservation Measure 25-02 north of 60°S. For fishing south of 60°S, a variation to Conservation Measure 25-02 is sought consistent with the approaches approved by CCAMLR in Conservation Measures 41-04, paragraphs 6 and 7 (minimum line sink rate of 0.3 m/s, three-bird limit for daylight setting, no offal discharge). Proposal does not conflict with advice provided. • South Africa (CCAMLR-XXII/39) proposes to fish during a season to be established at CCAMLR-XXII. States its acceptance of IMAF assessments and intent to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided. • Spain (CCAMLR-XXII/7) proposes to fish during a season to be established at CCAMLR-XXII. Intends to comply with Conservation Measures 25-02, 41-04 and 41-09. Proposal does not conflict with advice provided.
58.4.1	3	<p>Average-to-low risk. Ensure strict compliance with Conservation Measure 25-02 as a seabird by-catch precautionary measure. Longline fishing season limits of uncertain advantage. Fishing during daytime should only be permitted under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p> <p><u>Note: a conservation measure relating to a research plan for exploratory fisheries (41 series) does not exist for this fishery. The relevant conservation measure which will be drafted if this fishery is approved should require all vessels to have at least two scientific observers on board throughout all fishing activities, similar to the requirement of Conservation Measure 41-05 for Division 58.4.2.</u></p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. • Australia (CCAMLR-XXII/22) proposes to fish from 1 December 2003 to 30 November 2004 (south of 60°S); and from 1 May to 31 August 2004 (north of 60°S). Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Australian observer. Intends to comply with or exceed the provisions of Conservation Measure 25-02, specifically through offal retention and the use of twin streamer lines. Seek exemption to night-setting requirements through achieving a sink rate of at least 0.3 m/s to a depth of 15 m as specified in Conservation Measure 24-02. Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to permit a derogation to setting of longlines at night.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.1 (continued)			<ul style="list-style-type: none"> • Namibia (CCAMLR-XXII/31) proposes to fish from 1 December 2003 to 30 November 2004. Number of scientific observers on each vessel not stated. Intention to comply with Conservation Measure 25-02 not stated. <u>Proposal conflicts with advice provided with respect to adherence to Conservation Measure 25-02. Use of two observers strongly recommended.</u> • The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided. <u>Use of two observers strongly recommended.</u>
58.4.2	2	<p>Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of giant petrels (October to March), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/17) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. • Australia (CCAMLR-XXII/23) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Australian observer. Intends to comply with or exceed the provisions of Conservation Measure 25-02, specifically through offal retention and the use of twin streamer lines. Seeks exemption to night-setting requirements through achieving a sink rate of at least 0.3 m/s to a depth of 15 m as specified in Conservation Measure 24-02. Proposal does not conflict with advice provided. • Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.2 (continued)			<ul style="list-style-type: none"> • Russia (CCAMLR-XXII/37) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Russian observer, with 24-hour observer coverage. Seeks approval to set during daylight hours south of 55°S through achieving a sink rate of at least 0.3 m/s (as specified in Conservation Measures 24-02 and 41-05). Proposal does not conflict with advice provided for Division 58.4.2. • Ukraine (CCAMLR-XXII/34) proposes to fish from 15 December 2003 to 30 April 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02 but seeks a variation to permit daylight setting of lines in high latitudes after meeting the requirements of Conservation Measure 24-02. Proposal does not conflict with advice provided. • The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided, noting advice provided at the meeting that two observers will be provided to comply with Conservation Measure 41-05.
58.4.3a	3	<p>Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September to April), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/18) proposes to fish from 1 May to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. • Australia (CCAMLR-XXII/24) proposes to fish from 1 May to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Australian observer. Intends to comply with or exceed the provisions of Conservation Measure 25-02, specifically through offal retention, the use of twin streamer lines, and possibly through setting catch limits for bird species. Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.3a (continued)		<ul style="list-style-type: none"> Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Note that appointment of only one observer is proposed (additional observer desirable but not mandatory – Conservation Measure 41-06). Russia (CCAMLR-XXII/37) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Russian observer, with 24-hour observer coverage. Seeks approval to set during daylight hours south of 55°S through achieving a sink rate of at least 0.3 m/s (as specified in Conservation Measures 24-02). Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Ukraine (CCAMLR-XXII/35) proposes to fish from 1 March [1 May] to 30 May 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided with respect to fishing season. The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Note that appointment of only one observer is proposed (additional observer desirable but not mandatory – Conservation Measure 41-06). 	

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.3b	3	<p>Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September to April), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/18) proposes to fish from 1 May to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. • Australia (CCAMLR-XXII/24) proposes to fish from 1 May to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Australian observer. Intends to comply with or exceed the provisions of Conservation Measure 25-02, specifically through offal retention, the use of twin streamer lines, and possibly through setting catch limits for bird species. Proposal does not conflict with advice provided. • Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). <u>Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Note that appointment of only one observer is proposed (additional observer desirable but not mandatory – Conservation Measure 41-06).</u> • Russia (CCAMLR-XXII/37) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Russian observer, with 24-hour observer coverage. Seeks approval to set during daylight hours south of 55°S through achieving a sink rate of at least 0.3 m/s (as specified in Conservation Measures 24-02). Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.3b (continued)			<ul style="list-style-type: none"> Ukraine (CCAMLR-XXII/35) proposes to fish from 1 March [1 May] to 30 May 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided with respect to fishing season. The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Note that appointment of only one observer is proposed (additional observer desirable but not mandatory – Conservation Measure 41-06).
58.4.4	3	<p>Average risk. Ensure strict compliance with Conservation Measure 25-02. Prohibit longline fishing during the breeding season of albatrosses and petrels (September to April), except where fishing is undertaken under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p> <p><u>Note: a conservation measure relating to a research plan for exploratory fisheries (41 series) does not exist for this fishery. The relevant conservation measure which will be drafted if this fishery is approved should require all vessels to have at least two scientific observers on board throughout all fishing activities, similar to the requirement of Conservation Measure 41-05 for Division 58.4.2.</u></p>	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. <u>Namibia has submitted two applications for Division 58.4.4, which conflict in their intentions to comply with necessary seabird by-catch conservation measures. The status of these applications is unclear. They have been submitted by fishing companies and may not be submissions from the Government of Namibia.</u> 1. Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). <u>Proposal does not conflict with advice provided, subject to amendment to Conservation Measure 24-02 to include this division, and to removal of operational restriction to areas south of latitude 60°S. Use of two observers strongly recommended.</u>

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.4.4 (continued)			2. Namibia (CCAMLR-XXII/28) proposes to fish from 1 December 2003 to August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Namibian observer. Intends to comply with Conservation Measure 29/XVI (sic) (25-02). <u>Proposal conflicts with advice provided with respect to fishing season.</u>
58.5.1	5	High risk. Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April); ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/20) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. <u>Proposal conflicts with advice provided with respect to fishing season.</u> Namibia (CCAMLR-XXII/28) proposes to fish from 1 December 2003 to August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Namibian observer. Intends to comply with Conservation Measure 29/XVI (sic) (25-02). <u>Proposal conflicts with advice provided with respect to fishing season.</u>
58.5.2 west of 79°20'E	4	Average-to-high risk. Prohibit longline fishing within the breeding season of the main albatross and petrel species (September to April). Ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/19) proposes to fish from 1 May to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.
58.5.2 east of 79°20'E	4	Average-to-high risk. Prohibit longline fishing within the breeding season of the main albatross and petrel species (September to April). Ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/20) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.5.2	4	Average-to-high risk. Prohibit longline fishing within the breeding season of the main albatross and petrel species (September to April). Ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). <u>Proposal conflicts with advice provided with respect to the length of fishing season.</u> Namibia (CCAMLR-XXII/28) proposes to fish from 1 December 2003 to August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Namibian observer. Intends to comply with Conservation Measure 29/XVI (sic) (25-02). <u>Proposal conflicts with advice provided with respect to fishing season.</u> The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided.
58.6	5	High risk. Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April); ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. <u>Proposal conflicts with advice provided with respect to fishing season.</u> South Africa (CCAMLR-XXII/39) proposes to fish during a season to be established at CCAMLR-XXII. States its acceptance of IMAF assessments and intent to comply with Conservation Measure 25-02 and Conservation Measure 41-09, paragraph 19. Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
58.7	5	High risk. Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April); ensure strict compliance with Conservation Measure 25-02.	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal conflicts with advice provided with respect to fishing season. • Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal conflicts with advice provided with respect to the length of fishing season.
88.1	3	<p>Average risk overall. Average risk in northern sector (<i>D. eleginoides</i> fishery), average-to-low risk in southern sector (<i>D. mawsoni</i> fishery).</p> <p>Longline fishing season limits of uncertain advantage. Ensure strict compliance with Conservation Measure 25-02 as a seabird by-catch precautionary measure. Fishing during daytime should only be permitted under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/21) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided. • Japan (CCAMLR-XXII/26) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided. • The Republic of Korea (CCAMLR-XXII/27) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02 'with some relaxation'. Proposal may not conflict with advice provided, but there is insufficient information to assess. Note that Conservation Measure 41-09 requires the appointment of two observers to each vessel.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
88.1 (continued)			<ul style="list-style-type: none"> • Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided. Note that Conservation Measure 41-09 requires the appointment of two observers to each vessel. • New Zealand (CCAMLR-XXII/33) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation; 24-hour observer coverage proposed. A variation to Conservation Measure 25-02 is sought consistent with the approaches approved by CCAMLR in Conservation Measure 41-09, paragraphs 8 and 9 (minimum line-sink rate of 0.3 m/s, three-bird limit for daylight setting; no offal discharge). New Zealand again proposes that this variation be subject to the provisions of Conservation Measure 24-02 relating to experimental line-weighting trials. Proposal does not conflict with advice provided. The proposal to conduct integrated line-weighting trials including a variation to Conservation Measure 25-02 subject to the conditions outlined in WG-FSA-03/17, does not conflict with advice provided. • Norway (CCAMLR-XXII/51) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal conflicts with advice provided in that Conservation Measure 41-09 requires the appointment of two observers to each vessel. • Russia (CCAMLR-XXII/6) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Russian observer, with 24-hour observer coverage. Intends to comply with Conservation Measure 25-02 north of 65°S. Seeks approval to set during daylight hours south of 65°S through achieving a sink rate of at least 0.3 m/s (as specified in Conservation Measures 24-02). Proposal does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
88.1 (continued)		<ul style="list-style-type: none"> • South Africa (CCAMLR-XXII/39) proposes to fish during a season to be established at CCAMLR-XXII. States its acceptance of IMAF assessments and intent to comply with Conservation Measure 25-02 and restrictions in Subarea 88.1 as per Conservation Measure 41-09, paragraph 19. Proposal does not conflict with advice provided. • Spain (CCAMLR-XXII/7) proposes to fish during a season to be established at CCAMLR-XXII. Intends to comply with Conservation Measures 25-02, 41-04 and 41-09. Proposal does not conflict with advice provided. • The UK (CCAMLR-XXII/40) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measures 24-02, 25-02 and 41-09. Proposal does not conflict with advice provided. • Ukraine (CCAMLR-XXII/36) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02 but seek a variation to permit daylight setting of lines in high latitudes after meeting the requirements of Conservation Measure 24-02. Proposal does not conflict with advice provided. • Uruguay (CCAMLR-XXII/42) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided. • The USA (CCAMLR-XXII/41) proposes to fish during a season to be established at CCAMLR-XXII. Provision of one scientific observer on each vessel is proposed to be appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. Proposal does not conflict with advice provided. Note that Conservation Measure 41-09 requires the appointment of two observers to each vessel, and the US delegate confirmed intent to meet this requirement for each vessel. 	

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
88.2	1	<p>Low risk. No obvious need for restriction of longline fishing season. Ensure strict compliance with Conservation Measure 25-02 as a seabird by-catch precautionary measure. Fishing during daytime should only be permitted under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> • Argentina (CCAMLR-XXII/21) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. • The Republic of Korea (CCAMLR-XXII/27) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02 'with some relaxation'. <u>Proposal may not conflict with advice provided, but there is insufficient information to assess. Note that Conservation Measure 41-10 requires the appointment of two observers to each vessel.</u> • Namibia (CCAMLR-XXII/29) proposes to fish from 1 December 2003 to 30 November 2004. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 29/XVI (sic) (25-02) or other measures determined by CCAMLR, noting that some variation to the application of paragraph 3 (night-setting requirement) has been previously allowed in Subarea 88.1 (Conservation Measure 24-02). Proposal does not conflict with advice provided. <u>Note that Conservation Measure 41-10 requires the appointment of two observers to each vessel.</u> • New Zealand (CCAMLR-XXII/33) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation; 24-hour observer coverage proposed. A variation to Conservation Measure 25-02 is sought consistent with the approaches approved by CCAMLR in Conservation Measure 41-09, paragraphs 8 and 9 (minimum line sink rate of 0.3 m/s, three-bird limit for daylight setting, no offal discharge). New Zealand again proposes that this variation be subject to the provisions of Conservation Measure 24-02 relating to experimental line-weighting trials. Proposal does not conflict with advice provided. The proposal to conduct integrated line-weighting trials including a variation to Conservation Measure 25-02 subject to the conditions outlined in WG-FSA-03/17, does not conflict with advice provided.

(continued)

Area	Risk Scale	IMAF Risk Assessment	Notes
88.2 (continued)			<ul style="list-style-type: none"> Norway (CCAMLR-XXII/51) proposes to fish during a season to be established at CCAMLR-XXII. One scientific observer on each vessel is proposed, appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02. <u>Proposal conflicts with advice provided in that Conservation Measure 41-10 requires the appointment of two observers to each vessel.</u> Russia (CCAMLR-XXII/6) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Russian observer, with 24-hour observer coverage. Intends to comply with Conservation Measure 25-02 north of 65°S. Seeks approval to set during daylight hours south of 65°S through achieving a sink rate of at least 0.3 m/s (as specified in Conservation Measure 24-02). Proposal does not conflict with advice provided. South Africa (CCAMLR-XXII/39) proposes to fish during a season to be established at CCAMLR-XXII. States its acceptance of IMAF assessments and intent to comply with Conservation Measure 25-02 and restrictions in Subarea 88.1 as per Conservation Measure 41-09, paragraph 19. Proposal does not conflict with advice provided. Ukraine (CCAMLR-XXII/36) proposes to fish from 1 December 2003 to 31 August 2004. Two scientific observers on each vessel are proposed, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation. Intends to comply with Conservation Measure 25-02 but seek a variation to permit daylight setting of lines in high latitudes after meeting the requirements of Conservation Measure 24-02. Proposal does not conflict with advice provided.
88.3	1	<p>Low risk. Restrictions on timing of longline fishery probably inappropriate. Ensure strict compliance with Conservation Measure 25-02 at least until further data on seabird–fishery interactions are available. Fishing during daytime should only be permitted under the provisions currently prescribed under Conservation Measure 24-02. In addition, vessels that catch a total of three (3) birds shall revert to night setting.</p>	<ul style="list-style-type: none"> Argentina (CCAMLR-XXII/15) proposes to fish from 1 December 2003 to 30 November 2004. Two scientific observers on each vessel are proposed, one appointed in accordance with the CCAMLR Scheme of International Scientific Observation and one Argentine observer who will record incidental mortality of seabirds. Intends to comply with Conservation Measure 25-02 or other measures determined by CCAMLR. Proposal does not conflict with advice provided.

Table 6.10: Seabird mortality and live capture by species, recorded by observers in the CCAMLR Convention Area over the last three seasons. DIC – grey headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; PDM – great-winged petrel; PWD – Antarctic prion; DAC – cape petrel; PYD – Adélie penguin; PTZ – unidentified petrel; MAI – southern giant petrel; PWX – unidentified prion; UNK – unidentified bird. Data from 1999, 2000 and 2001 are from cruise reports. Data from 2002 and 2003 are from logbook data in the CCAMLR database.

[illegible]

Table 10.1: The discharge of hooks in fish heads and offal from longline vessels during 2003 as reported by scientific observers. The ‘*n*’ values are the number of individual vessels in each fishery; for those vessels where multiple observer reports were available, the category remained the same on all cruises.

Area	<i>n</i> (vessels)	Hooks Discharged in Fish Heads in Offal		
		Yes	No	No Information
48.3	19	4	12	3
58.6 / 58.7	2	1	1	
88.1 / 88.2	9	1	8	
58.4.2	1		1	
58.5.2	1		1	
	32	6 (18.8%)	23 (71.9%)	3 (9.4%)

Table 12.1: List of tasks identified by WG-FSA for the 2003/04 intersessional period. The paragraph numbers (Ref.) refer to this report – many others are ongoing tasks identified in previous years. Tasks identified by ad hoc WG-IMAF are listed in Appendix E. Priority: high priority (1); general request (2). Subgroups: Subgroup on assessment methods (SGassessment), Subgroup on biology, ecology and demography (SGbiology); Subgroup on fisheries acoustics (SGacoustic); Subgroup on by-catch (SGbycatch); CCAMLR Otolith Network (CON).

Task		Ref.	Priority	Action Required	
				Members/Subgroups	Secretariat
Organisation of the meeting					
1.	Submit papers to WG-FSA-04 two weeks before the meeting, recognising that conveners of subgroups and the Secretariat shall submit papers one week before meeting.	12.8, 12.9	1	Members to implement	Coordinate and implement
2.	Convener to circulate list of documents with agenda items one week before the meeting.	13.6	1	Convener	Coordinate and implement
Review of available information					
3.	Continue loading of all fishery surveys reported to CCAMLR.	3.3	1		Implement
4.	Develop routine validation procedures for database extractions.	5.108	1		Implement
5.	Update information on catches of target species.	3.14	1		Implement
6.	Update estimates of reported catches, catches from IUU fishing and total removals by season and area within the Convention Area.	3.16	1	Members to provide information on IUU fishing	Coordinate and implement
7.	Update estimates of catches reported in CDS data by season and area outside the Convention Area.	3.20	1		Implement
8.	Update information on scientific observations.	3.23	1		Implement
9.	Development of acoustic techniques for assessing fish stocks.	3.41	2	SGacoustic to implement	
10.	Provide accurate reporting of by-catch by vessels and Flag States.	5.231	1	Members to implement	Remind
Preparation of assessments					
11.	Prepare catch-weighted length-frequency plots for all fisheries.	5.108	1		Implement
12.	Update species profiles for toothfish, icefish and by-catch.	7.10	1	SGbiology to implement	

(continued)

Table 12.1 (continued)

	Task	Ref.	Priority	Action Required	
				Members/Subgroups	Secretariat
13.	Continue investigation of length at maturity of toothfish in Subareas 48.3 and 88.1 for determination of minimum length of size in the fishery.	5.32	2	SGassessment to implement	
14.	Update assessment manual.	9.2	1	SGassessment to implement	
Assessments and management advice					
15.	Further examine survey design and how variability in survey catchability may be incorporated in assessments.	9.5, 9.6, 9.9	2	Members to implement	Remind
16.	Re-examine acoustic data for <i>C. gunnari</i> and provide robust estimate of biomass.	9.10	1	SGacoustic to coordinate	
17.	Transfer all relevant national data on by-catch to the CCAMLR database.	9.12	2	Members to implement	Remind
18.	Conduct further studies of survivorship of discarded rajids.	5.276	2	Members to implement	Remind
19.	Review data requirements, collection methods and priority of observers tasks for fish and invertebrate by-catch.	5.287	1	SGbycatch to implement	
20.	Analysis of fish and invertebrate by-catch by vessel from fine-scale data, and reports from Members/observers on fishing methods that minimise by-catch.	5.285, 5.298, 10.15	1	SGbycatch to implement	
21.	Conduct further studies on avoidance of by-catch of rajids and rattails.	5.280, 5.281	2	Members to implement	Remind
22.	Continue tagging rajids.	App. D 16	2	Members to implement	Remind
23.	Reanalyse the CPUE data from the fishery for <i>D. mawsoni</i> in Subarea 88.1.	5.38–5.40	2	Members to implement	Remind
24.	Review research and data collection plans for new and exploratory fisheries.	5.60	1	SGassessment to implement	
25.	Examine assumptions of tag–recapture experiments through simulations.	7.16	1	Members to implement	

(continued)

Table 12.1 (continued)

	Task	Ref.	Priority	Action Required	
				Members/Subgroups	Secretariat
	Biology, ecology and demography of target and by-catch species				
26.	Continue to collect biological data on by-catch species, including invertebrate species, and in particular information on biomass of the important species.	5.227	1	Members to implement	Remind
27.	Conduct further validation of ageing of <i>Dissostichus</i> spp.	9.5	1	CON to implement	
28.	Conduct further work on ageing of <i>C. gunnari</i> .	9.9	1	CON to implement	
	Consideration of ecosystem management				
29.	Develop methods to incorporate data on <i>C. gunnari</i> into ecosystem models.	8.13	2	Members to implement	Remind
	Future assessments				
30.	Evaluate alternative methods of assessment.	9.6, 9.13	1	SGassessment to implement	Provide support
31.	Develop a list of data extractions, which could be undertaken prior to the next meeting.	9	1	SGassessment to advise	Coordinate and implement
32.	Hold an intersessional meeting to further the development of assessment methods.	12.4	1	SGassessment to implement	
33.	Review and evaluate methods to estimate abundance of recruits in toothfish assessments.	9.6	1	SGassessment to implement	
34.	Methods of standardising CPUE and application to toothfish assessments.	9.6	1	SGassessment to implement	
35.	Methods by which data derived from exploratory fisheries, including mark-recapture data, could lead to assessments.	5.56	1	SGassessment to evaluate	
36.	Examination of long-term management procedures for mackerel icefish, including decision rules.	9.10	1	SGassessment to implement	

(continued)

Table 12.1 (continued)

Task		Ref.	Priority	Action Required	
				Members/Subgroups	Secretariat
37.	Methods for integrating acoustic and trawl survey data into assessments of abundance of mackerel icefish.	9.10	1	SGassessment and implement	
38.	Methods of estimating survivorship, mortality and total removals of rajids.	9.12	1	SGassessment to implement	
Scheme of International Scientific Observation					
39.	Updates, revisions, and additions to the <i>Scientific Observers Manual</i> , cruise report and electronic logbook (in particular in relation to revisions to Conservation Measure 25-02, definition of dead seabirds and revised rajid by-catch reporting instructions).	10.40	1	Coordinate and implement	
40.	Provision of nautical twilight algorithm to technical coordinators for distribution to observers.	10.3	1	Technical coordinators to implement	Remind
41.	Reiterate need to collect data describing hooks in offal, decklighting, rajid maturity, rajid by-catch, aerial extent of streamer lines, number of hooks hauled during target species sampling, detailed conversion factor data, and the number of hooks observed during by-catch observations.	10.40	1	Technical coordinators to implement	Remind
42.	Update the <i>Species Identification Sheets</i> .	10.25	1	Dr Collins to coordinate, Technical coordinators to implement	Implement
CCAMLR website					
43.	Further develop the bibliography of CCAMLR working documents and make available online.	13.5	1	Coordinate and implement	

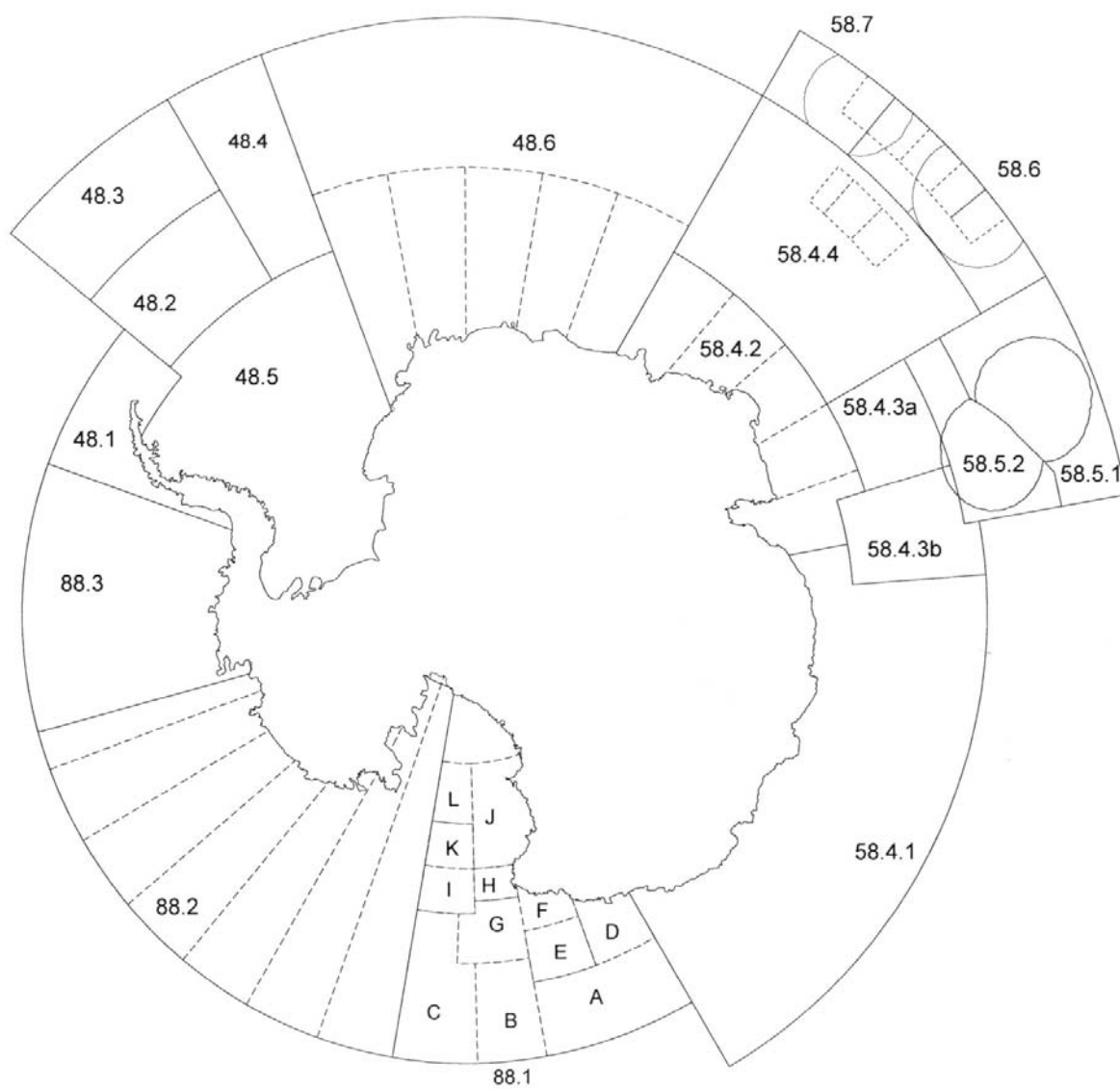


Figure 5.1: Proposed SSRU boundaries for Subarea 88.1.

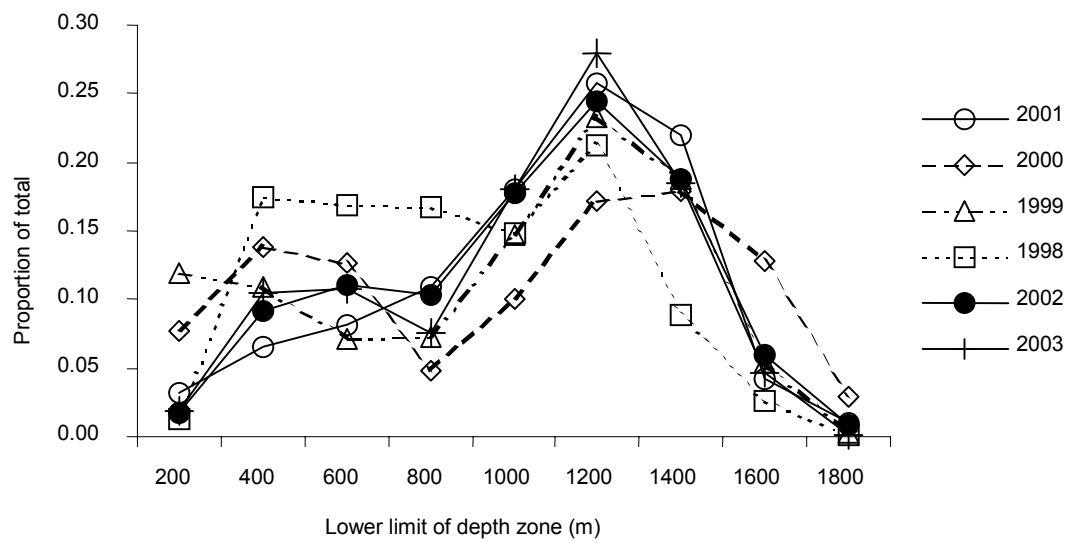


Figure 5.2: Distribution of longline effort for *Dissostichus eleginoides* by depth zone and year in Subarea 48.3.

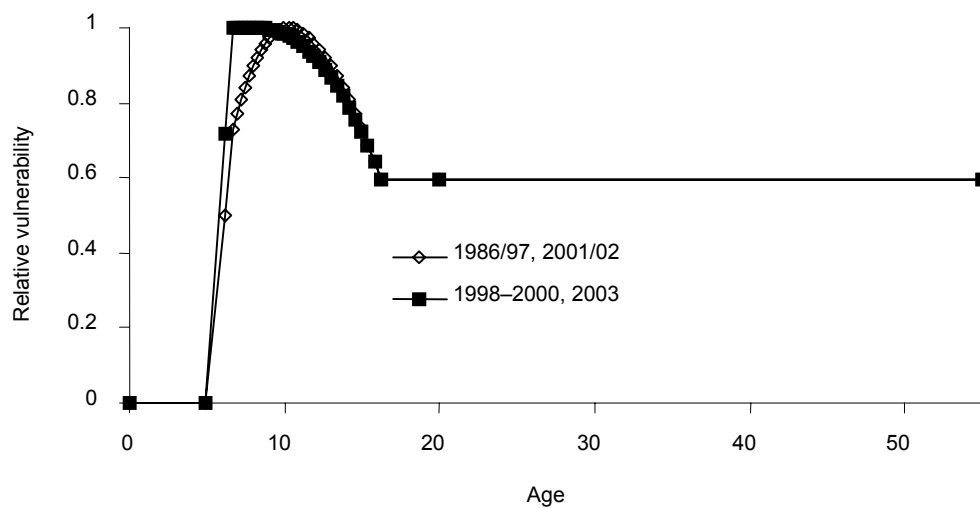


Figure 5.3: Estimated vulnerabilities by age for *Dissostichus eleginoides* in Subarea 48.3.

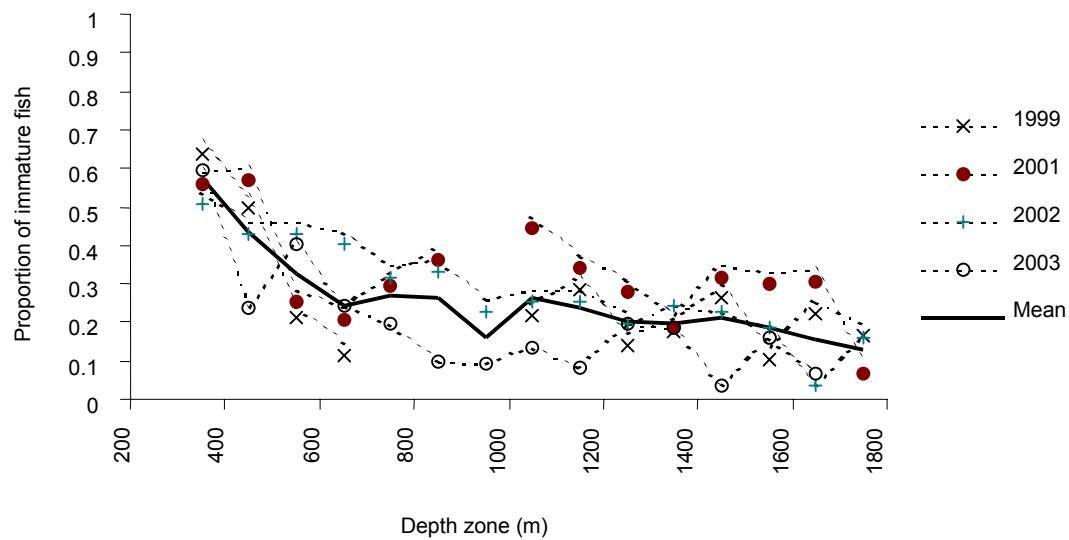


Figure 5.4: Proportions of immature fish (stage 1) in the catch by depth zone, calculated from biological data collected by observers. Hauls where the depth range of the set exceeded 50 m were omitted from the analysis, as were years with less than 2 000 fish sampled in each depth zone in such hauls.

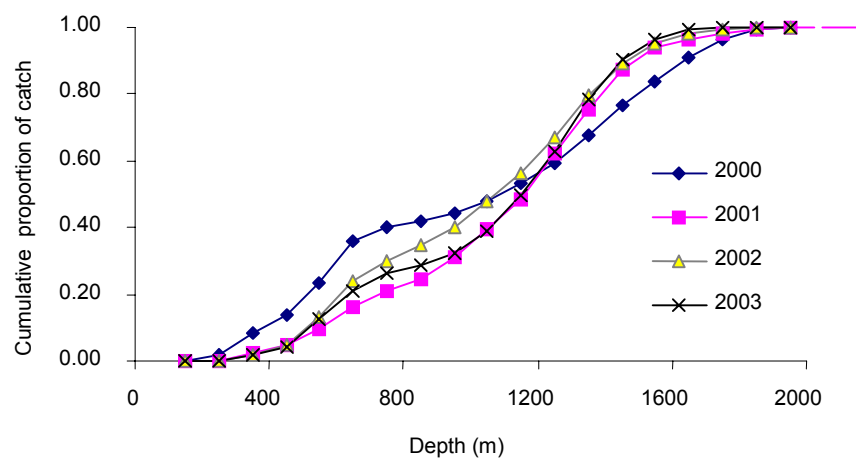


Figure 5.5: Cumulative *Dissostichus eleginoides* catch (in biomass) by depth zone in Subarea 48.3.

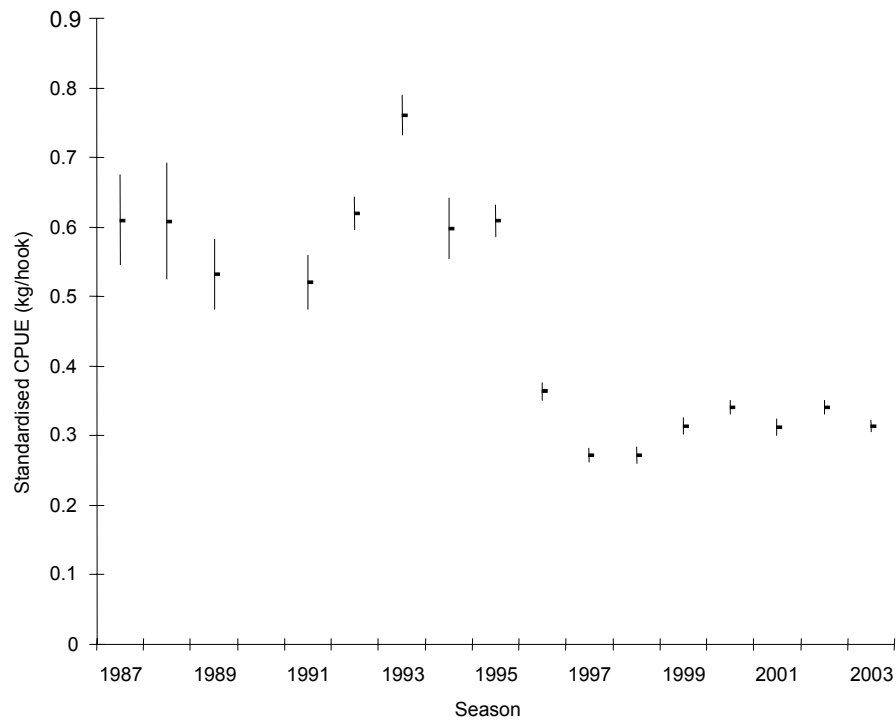


Figure 5.6: Standardised longline CPUE by season for *Dissostichus eleginoides* in Subarea 48.3.

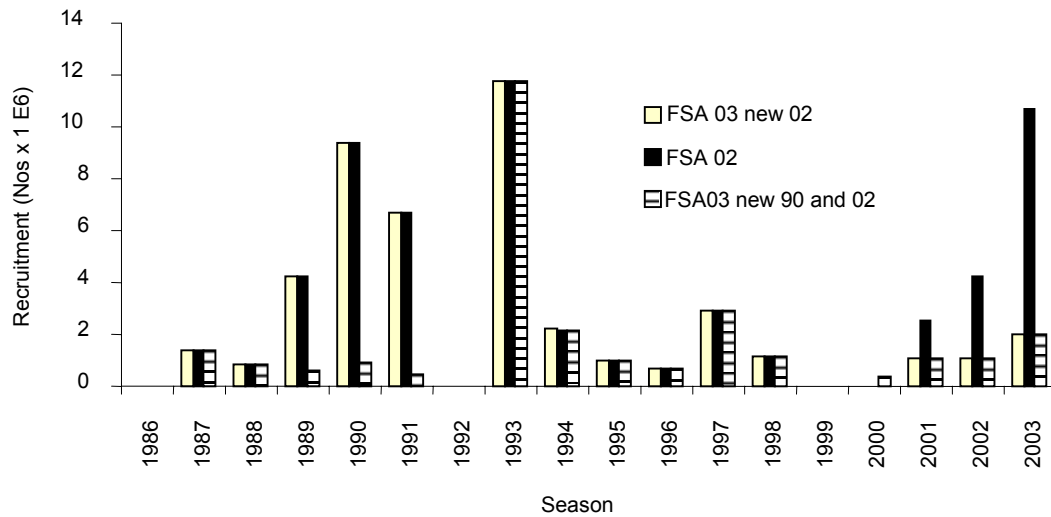


Figure 5.7: Comparison of series of estimates of recruitment of *Dissostichus eleginoides* in Subarea 48.3. The three series shown are those used in the 2002 assessment, using survey data from 1987 to 2002 (FSA-02), a series based on the same set of survey data, but in which the 2002 UK survey analyses were revised (FSA-03 new 02), and a series based on the same set of survey data, but in which both the 1990 and 2002 UK survey analyses were revised (FSA-03 new 90, 02).

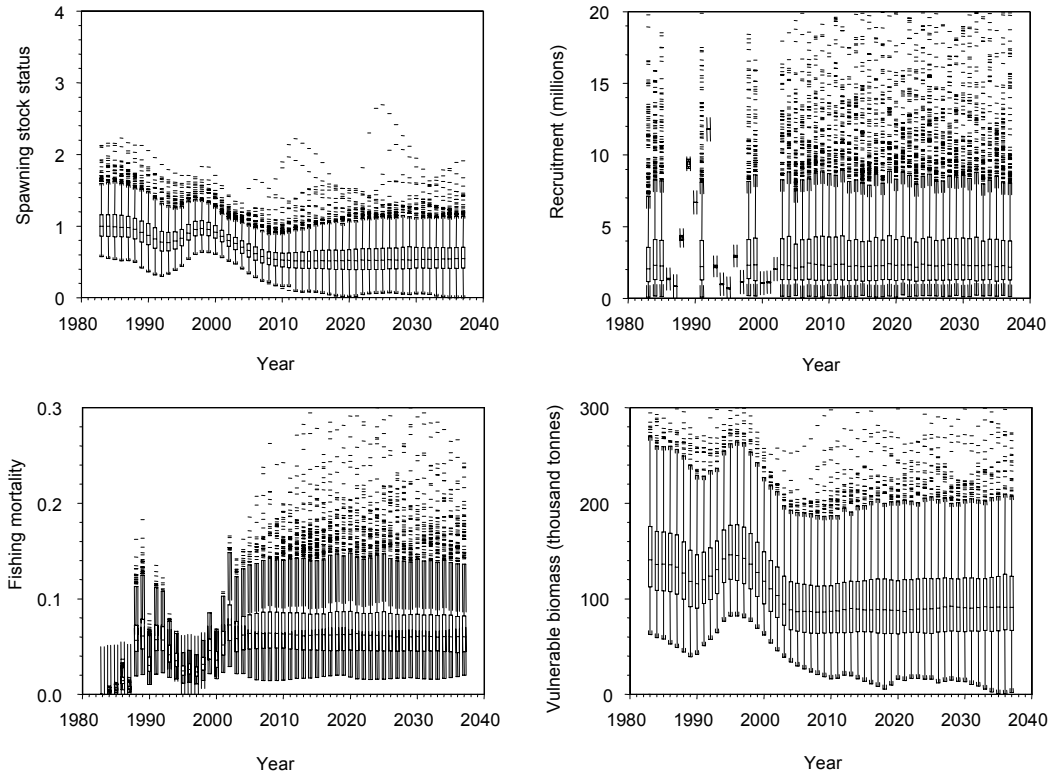


Figure 5.8: Historical and projected trajectories for the assessment trial based on recruitment series using revised length densities for *Dissostichus eleginoides* from the 2002 UK survey in Subarea 48.3.

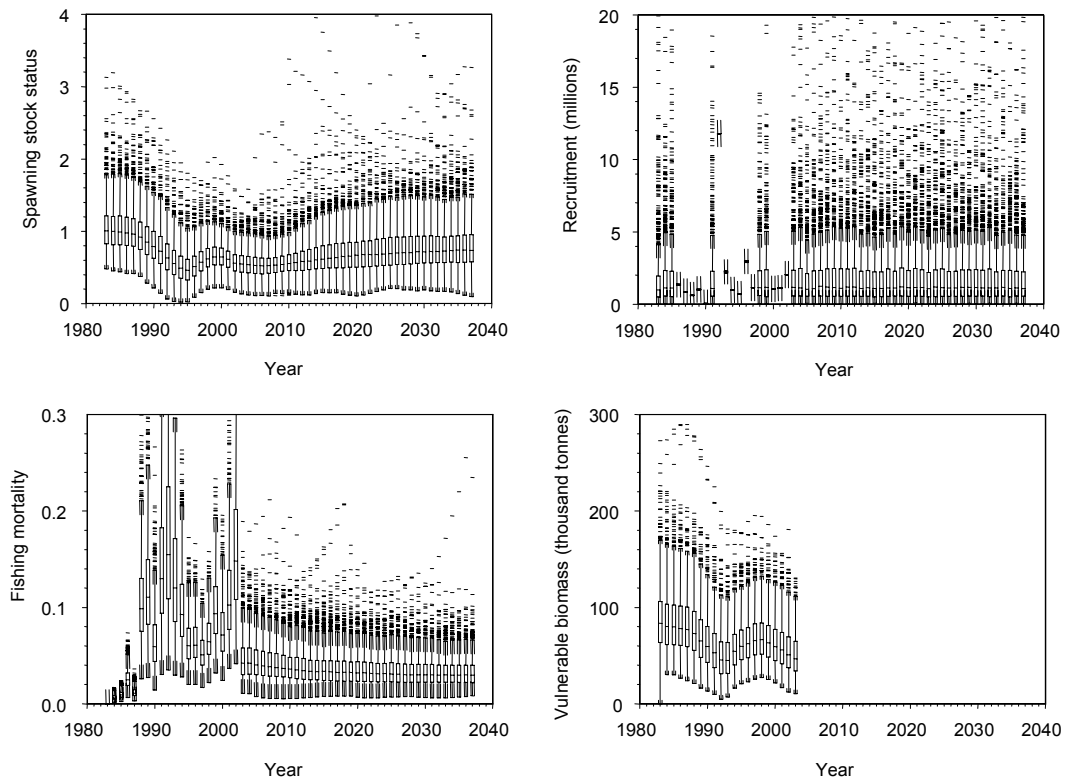


Figure 5.9: Historical and projected trajectories for the assessment trial based on recruitment series using revised length densities for *Dissostichus eleginoides* from the 1990 and 2002 UK surveys in Subarea 48.3.

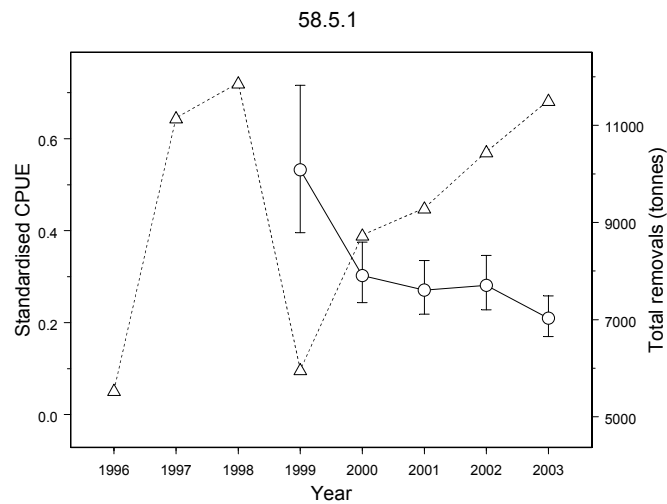


Figure 5.10: Time series of total removals (dashed line) and standardised CPUE (kg/hook, solid line) obtained from the GLMM. Error bars represent approximate 95% confidence bounds on the standardised CPUE estimates.

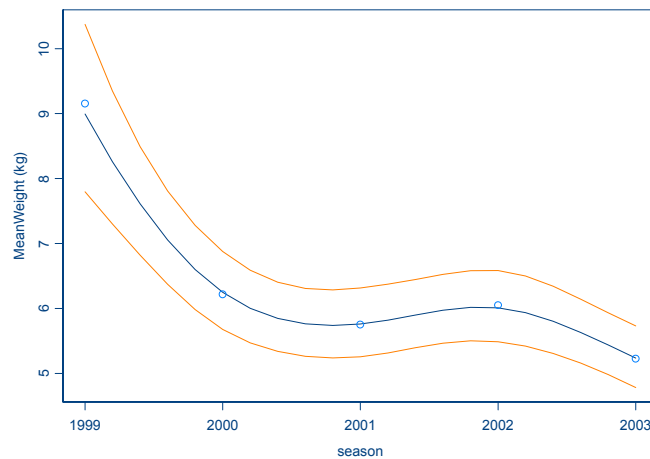


Figure 5.11: Time series of standardised average weights (kg) obtained from the LMM fitted to $\log(\text{average weight})$ using a cubic smoothing spline. Error bounds represent approximate 95% confidence bounds on the estimates.

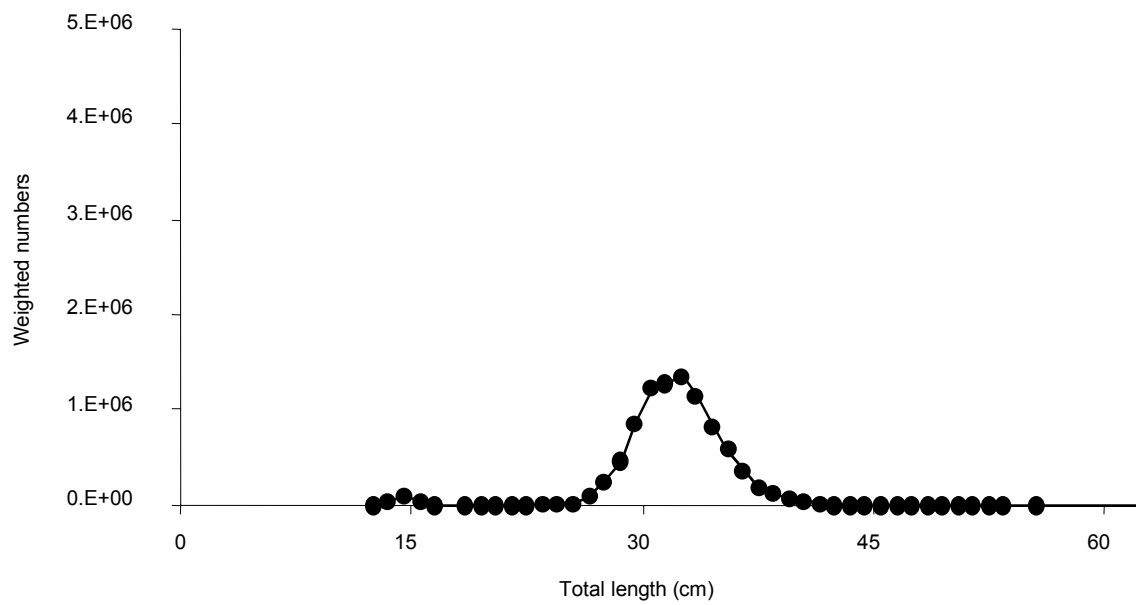


Figure 5.12: Catch-weighted length frequency of the catch of *Champsocephalus gunnari* in 2002/03 in Subarea 48.3.

	Component 1	Component 2	Component 3	Component 4	Component 5
Means of mixture components	163.342	244.932	299.998	377.563	409.997
Standard deviations of mixture components	10.304	15.4509	18.9246	23.8176	25.8636
Total density of each mixture component	3834.82	1482.45	149.991	9.00E-04	1.26E-04
SD of each mixture component density	2362.43	765.301	83.6559	2.38E-02	5.57E-03

Sum of the observed densities = 6491.93

Sum of the expected densities = 5467.25

Parameters of linear standard deviations

Intercept = 0.114885E-03

Slope = 0.630820E-01

difference in observed and expected 1024.68

add this density to component 1, which is underestimated

	Component 1	Component 2	Component 3	Component 3	Component 5
Means of mixture components	163.342	244.932	299.998	377.563	409.997
Standard deviations of mixture components	10.304	15.4509	18.9246	23.8176	25.8636
Total density of each mixture component	4859.5	1482.45	149.991	9.00E-04	1.26E-04
SD of each mixture component density	2362.43	765.301	83.6559	2.38E-02	5.57E-03

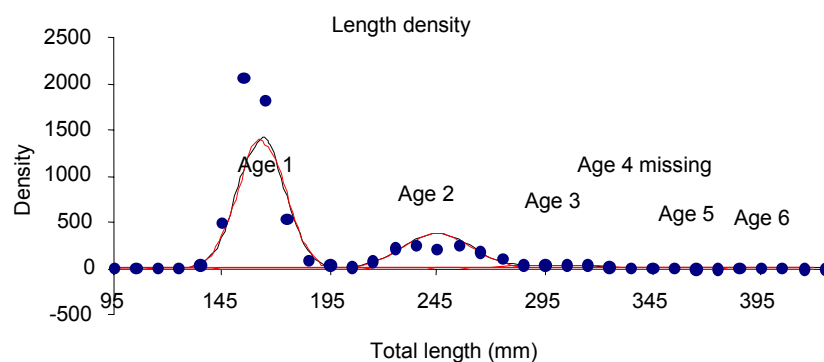
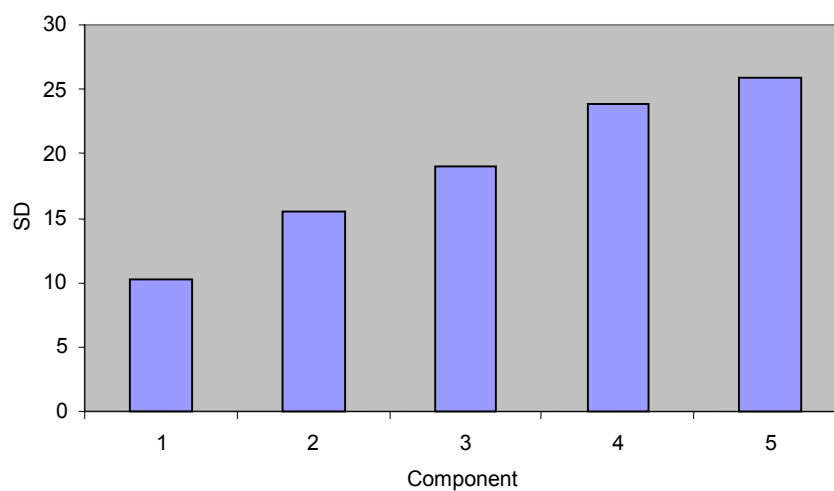


Figure 5.13: Results of the CMIX analysis of the catch-weighted length frequencies from pelagic tows conducted concurrently with the 2002 Russian acoustic survey in Subarea 48.3.

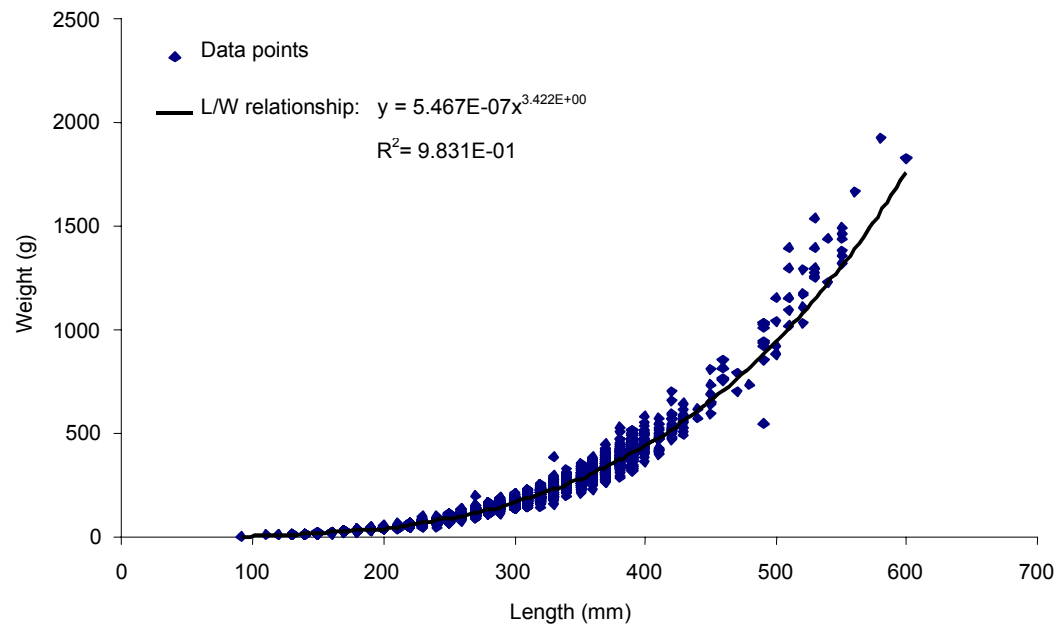


Figure 5.14: Length–weight data and fitted model based on data from UK trawl surveys in 2002 and 2003.

	Component 1	Component 2	Component 3	Component 4	Component 5
Means of mixture components	154.872	239.224	288.558	359.352	409.97
Standard deviations of mixture components	12.2864	18.6277	22.3365	27.6586	31.4639
Total density of each mixture component	55.4557	397.135	188.858	47.4703	8.30474
SD of each mixture component density	19.8776	109.225	53.1716	18.6949	15.8575

Sum of the observed densities = 719.963

Sum of the expected densities = 693.312

Parameters of linear standard deviations

Intercept = 0.643705

Slope = 0.751766E-01

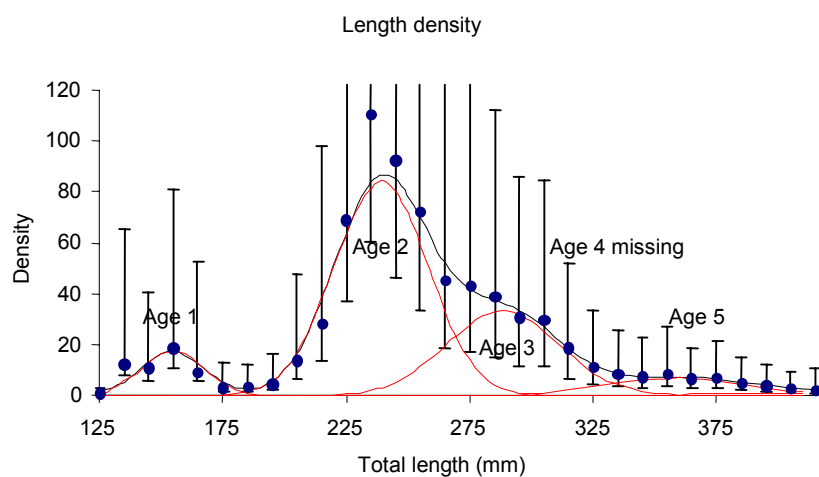
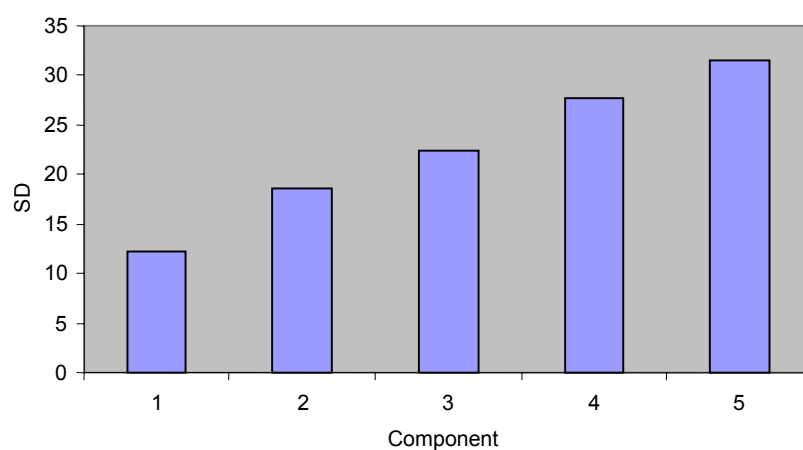


Figure 5.15: Results of the CMIX analysis of the length densities from the combined 2002 bottom trawl surveys in Subarea 48.3.

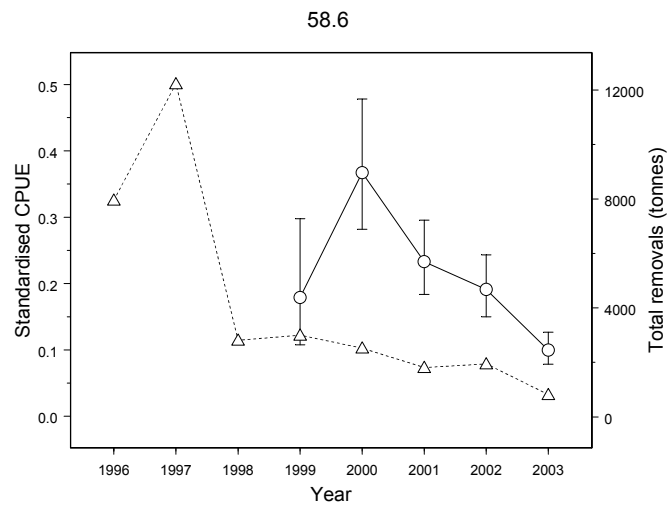


Figure 5.16: Time series of both total removals (dashed line) and standardised CPUE (kg/hook, solid line) obtained from the GLMM. Error bars represent approximate 95% confidence bounds on the standardised CPUE estimates.

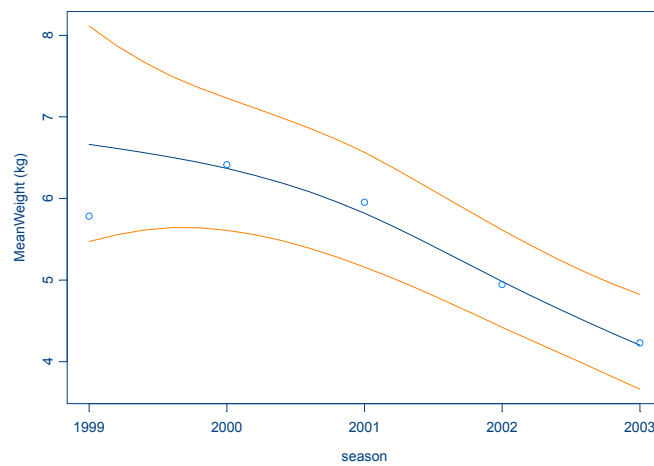


Figure 5.17: Time series of standardised average weight (kg) obtained from the LMM. Error bounds represent approximate 95% confidence bounds on the estimates.

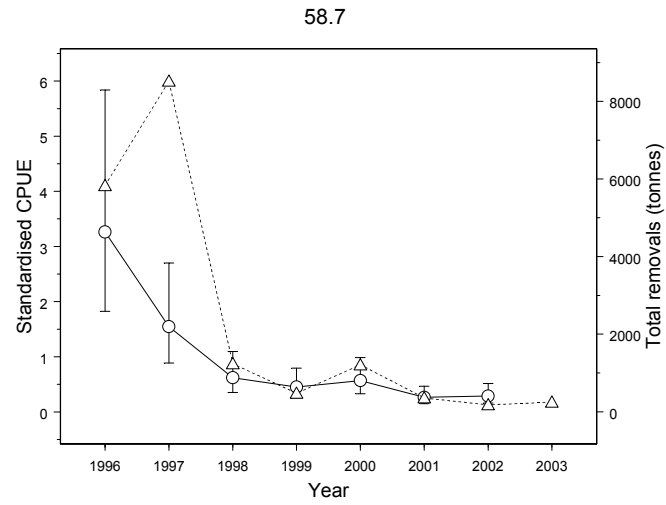


Figure 5.18: Time series of total removals (dashed line) and standardised CPUE (kg/hook, solid line) obtained from the GLMM. Error bars represent approximate 95% confidence bounds on the estimates.

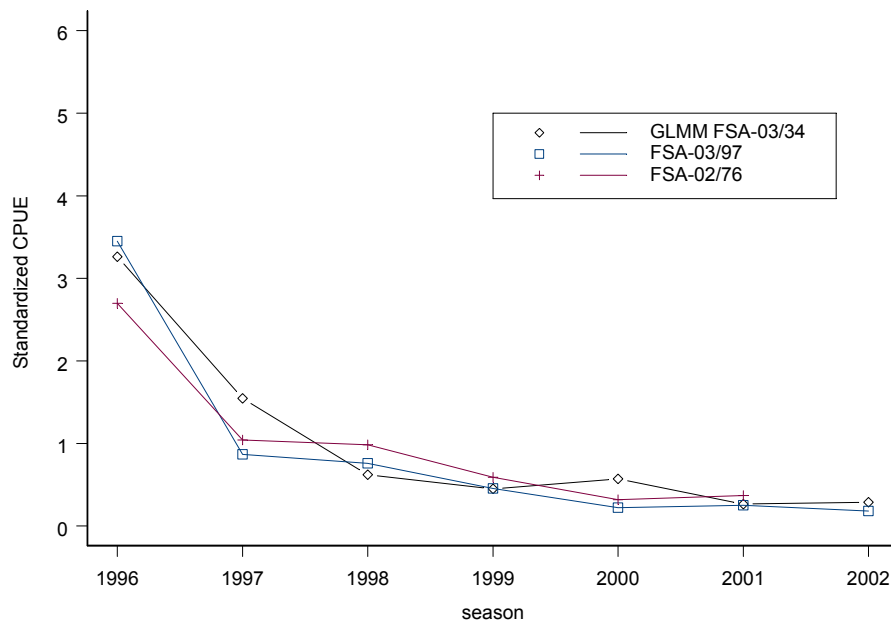


Figure 5.19: Comparison of standardised CPUE time series: estimated at WG-FSA-03 (GLMM WG-FSA-03/34) and the series given in WG-FSA-02/76 and WG-FSA-03/97.

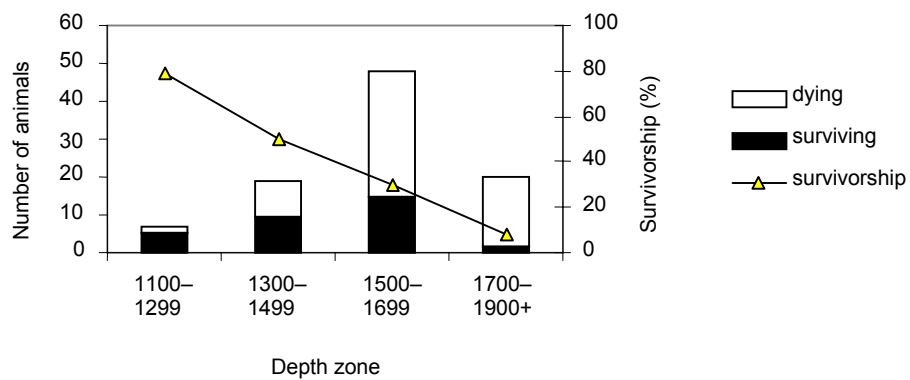


Figure 5.20: The number (and percent survivorship) of rajids by depth zone from the survivorship data recalculated from WG-FSA-03/57.

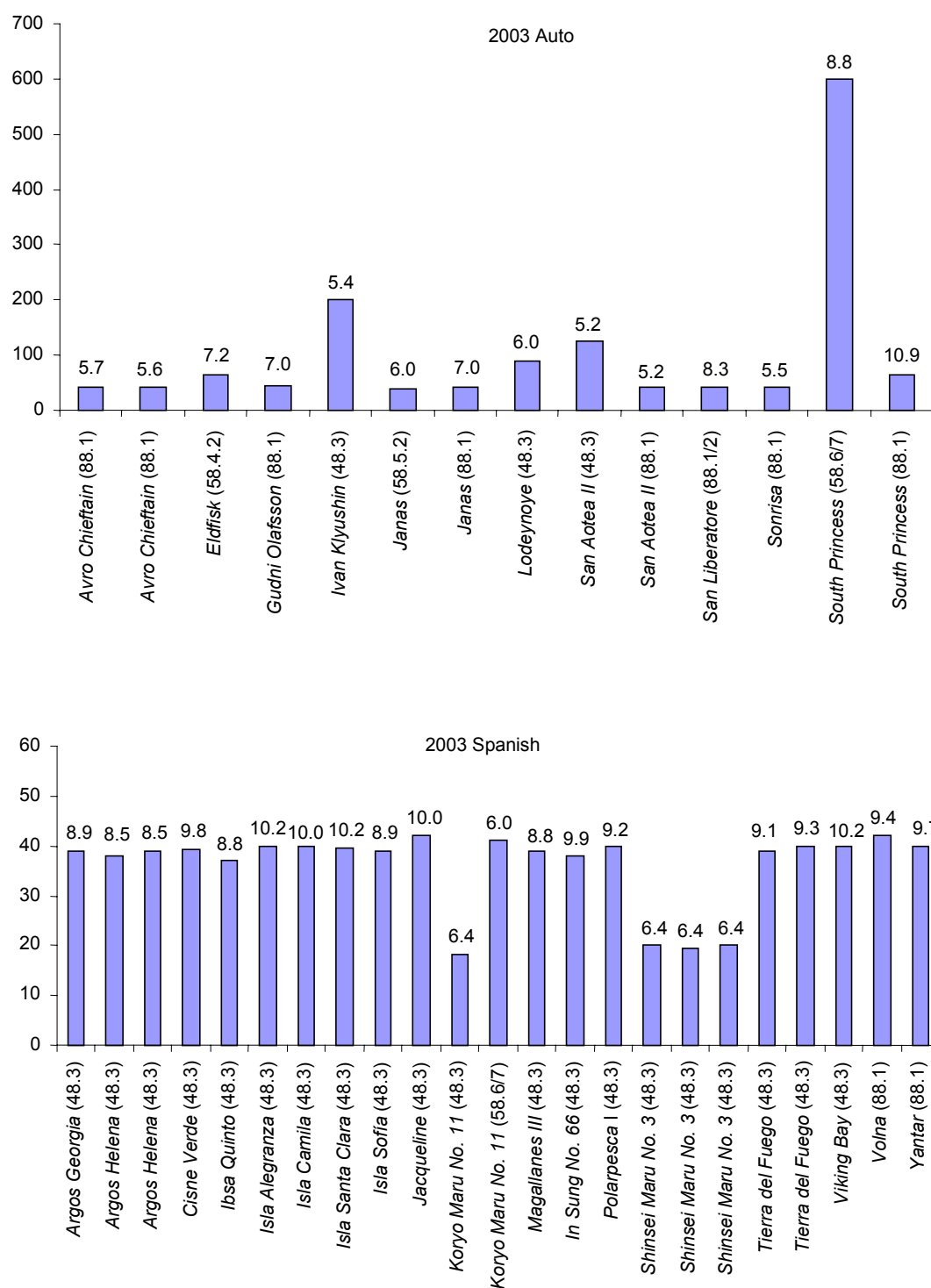


Figure 6.1: Longline weight spacing (y-axis in metres) and weights used (kilograms) by Spanish and autoline systems during the 2003 season.

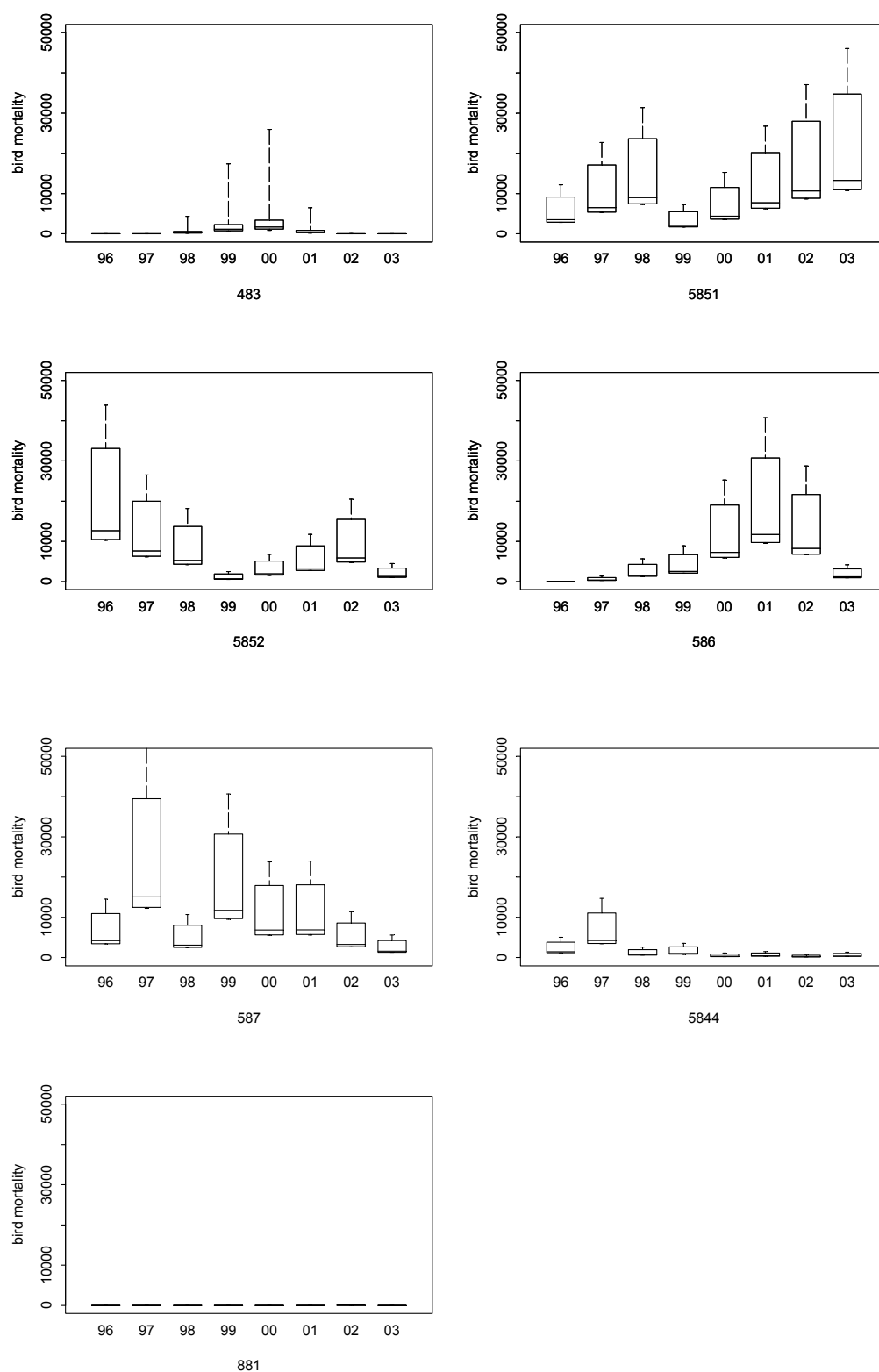


Figure 6.2: Box plots of estimates of potential by-catch of seabirds caught in the IUU fisheries in different subareas and divisions of the Convention Area from 1996 to 2003. Values shown are median, with interquartiles and upper and lower ranges.

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 23 October 2003)

1. Opening of the meeting
2. Organisation of the meeting and adoption of the agenda
3. Review of available information
 - 3.1 Data requirements specified in 2002
 - 3.1.1 Development of the CCAMLR database
 - 3.1.2 Data processing
 - 3.1.3 Other
 - 3.2 Fisheries information
 - 3.2.1 Catch, effort, length and age 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
 - 3.2.5 Research surveys
 - 3.2.6 Mesh/hook selectivity and related experiments affecting catchability
4. Preparation for assessments
 - 4.1 New information extending time series
 - 4.1.1 Estimation of total removals
 - 4.1.2 Standing stock
 - 4.1.3 Recruitment series
 - 4.1.4 CPUE
 - 4.2 Other parameters
 - 4.3 SSRU boundaries
 - 4.4 Status of current assessment methods
5. Assessments and management advice
 - 5.1 New and exploratory fisheries in 2002/03 and for 2003/04
 - 5.1.1 New and exploratory fisheries in 2002/03
 - 5.1.2 New fisheries notified for 2003/04
 - 5.1.3 Exploratory fisheries notified for 2003/04
 - 5.1.4 Progress towards assessments of new and exploratory fisheries

- 5.2 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 *Champscephalus gunnari* South Georgia (Subarea 48.3)
 - 5.2.5 *Champscephalus gunnari* Heard Island (Division 58.5.2)
- 5.3 Other Fisheries
 - 5.3.1 *Dissostichus eleginoides* Prince Edward and Marion Islands (Subarea 58.7) and Crozet Islands (Subarea 58.6)
 - 5.3.2 Antarctic Peninsula (Subarea 48.1) and South Orkney Island (Subarea 48.2)
 - 5.3.3 South Sandwich Islands (Subarea 48.4)
 - 5.3.4 *Electrona carlsbergi* South Georgia (Subarea 48.3)
 - 5.3.5 Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)
 - 5.3.6 *Martialia hyadesi* (Subarea 48.3)
- 5.4 By-catch
 - 5.4.1 Assessments of the status of by-catch species or groups
 - 5.4.2 Assessments of the expected impact of target species fisheries on the by-catch species or groups
 - 5.4.3 Consideration of mitigation measures
 - 5.4.4 Advice to the Scientific Committee
- 5.5 Regulatory framework
- 5.6 Evaluation of the threats arising from IUU activities
 - 5.6.1 Review of historical trends in IUU activity
 - 5.6.2 Evaluation of future threats of IUU activity
 - 5.6.3 Advice to the Scientific Committee
- 6. Incidental mortality of mammals and seabirds arising from fishing (ad hoc WG-IMAF Report)
 - 6.1 Intersessional Work of ad hoc WG-IMAF
 - 6.2 Incidental mortality of seabirds during regulated longline fishing in the Convention Area
 - 6.2.1 Data submitted for the 2002/03 and the beginning of the 2003/04 seasons
 - 6.2.2 Evaluation of levels of incidental mortality
 - 6.2.3 Implementation of Conservation Measure 25-02 (2002)
 - 6.2.4 Research into and experience with mitigating measures
 - 6.2.5 Revision of Conservation Measure 25-02 (2002)
 - 6.3 Incidental mortality of seabirds during unregulated longline fishing in the Convention Area

- 6.4 Incidental mortality of seabirds during longline fishing outside the Convention Area
- 6.5 Research into the status and distribution of seabirds
- 6.6 International and national initiatives relating to incidental mortality of seabirds in relation to longline fishing
- 6.7 Incidental mortality of seabirds in relation to new and exploratory fisheries
 - 6.7.1 Assessments of risk in CCAMLR subareas and divisions
 - 6.7.2 New and exploratory fisheries operational in 2002/03
 - 6.7.3 New and exploratory fisheries proposed for 2003/04
- 6.8 Other incidental mortality
 - 6.8.1 Interactions involving marine mammals with longline fishing operations
 - 6.8.2 Interactions involving marine mammals and seabirds with trawl or pot fishing operations
- 6.9 Advice to the Scientific Committee
- 7. Biology, ecology and demography of target and by-catch species
 - 7.1 Information available to the meeting
 - 7.2 Update species profiles
 - 7.3 Tagging programs
 - 7.4 Identify gaps in the knowledge
- 8. Considerations of ecosystem management
 - 8.1 Interactions with WG-EMM
 - 8.2 Ecological interactions (e.g. multi-species, benthos etc.)
- 9. Future Assessments
 - 9.1 New and planned assessment methods
- 10. Scheme of International Scientific Observation
 - 10.1 Summary of information extracted from observer reports and/or provided by technical coordinators
 - 10.2 Implementation of observer program
 - 10.2.1 *Scientific Observers Manual*
 - 10.2.2 Sampling strategies
 - 10.2.3 Priorities

- 10.3 Information relevant to SCIC
 - 10.4 Advice to the Scientific Committee
- 11. CCAMLRL website
- 12. Future Work
 - 12.1 Data requirements
 - 12.2 Organisation of intersessional activities in subgroups
 - 12.3 Plans for WG-FSA-04
 - 12.4 Long-term plans
- 13. Other business
- 14. Adoption of the report
- 15. Close of the meeting.

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(Hobart, Australia, 13 to 23 October 2003)

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LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 23 October 2003)

WG-FSA-03/1	Provisional and Annotated Provisional Agenda for the 2003 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-03/2	List of participants
WG-FSA-03/3	List of documents
WG-FSA-03/4	Species profile: mackerel icefish I. Everson (United Kingdom)
WG-FSA-03/5	Bibliography on mackerel icefish K.-H. Kock (Germany) and I. Everson (United Kingdom)
WG-FSA-03/6	Fishery information for WG-FSA-03 Secretariat
WG-FSA-03/7	Survey database Secretariat
WG-FSA-03/8	Notification of Australia's intention to conduct pot fishing trials in Division 58.5.2 for <i>Dissostichus eleginoides</i> Delegation of Australia
WG-FSA-03/9	The diet of black-browed albatrosses at the Diego Ramirez Islands, Chile J. Arata (Chile) and J.C. Xavier (United Kingdom)
WG-FSA-03/10	The Evangelistas Islets, Chile: a new breeding site for black-browed albatrosses J. Arata (Chile), G. Robertson (Australia), J. Valencia (Chile) and K. Lawton (Australia)
WG-FSA-03/11	Summary report on the status of black-browed and grey-headed albatrosses breeding in Chile G. Robertson (Australia), J. Valencia and J. Arata (Chile)

WG-FSA-03/12	Is our attempt to estimate biomass of Antarctic fish from a multi-species survey appropriate for all targeted species? <i>Notothenia rossii</i> in the Atlantic Ocean sector – revisited K.-H. Kock (Germany), M. Belchier (United Kingdom) and C.D. Jones (USA) (<i>CCAMLR Science</i> , submitted)
WG-FSA-03/13	Analysis of dietary overlap in Antarctic fish (Notothenioidei) from the South Shetland Islands: no evidence of food competition E. Barrera-Oro (Argentina) (<i>Polar Biology</i> , 25 (10), in press (2003))
WG-FSA-03/14	Report of the Subgroup on Fisheries Acoustics (British Antarctic Survey, Cambridge, 18 to 22 August 2003)
WG-FSA-03/15	Toothfish, skate and longline by-catch survey in Subarea 48.3 M. Belchier, M. Collins, M. Endicott, I. Everson, S. Hawkins, T. Marlow, T. Mulvey and R. Paterson (United Kingdom)
WG-FSA-03/16	Aspects of the ecology of the bigeye grenadier at South Georgia S.A. Morley, T. Mulvey, J. Dickson and M. Belchier (United Kingdom)
WG-FSA-03/17	Request to conduct an integrated weight longline trial on autoline vessels in Statistical Subareas 88.1 and 88.2 in 2003/04 G. Robertson (Australia) and N. Smith (New Zealand)
WG-FSA-03/18	Streamer lines to reduce seabird by-catch in longline fisheries E.F. Melvin (USA) (<i>Washington Sea Grant Program</i> , WSG-AS 00-03)
WG-FSA-03/19	Off the hook: an informational video for Alaska longliners E.F. Melvin and D. Mercy (USA) (<i>Washington Sea Grant Program</i> , WSG-AV 00-01)
WG-FSA-03/20	Focusing and testing fisher know-how to solve conservation problems: a common sense approach E.F. Melvin and J.K. Parrish (USA) (<i>Putting Fishers' Knowledge to Work. Fisheries Centre Research Reports</i> , 11: 224–226)
WG-FSA-03/21	Main points in WG-EMM-03/05 (fish monitoring using Antarctic shags) and additional comments, on the recommendation from WG-EMM to WG-FSA to be consider in its 2003 meeting R. Casaux, E. Barrera-Oro and E. Marschoff (Argentina)
WG-FSA-03/22	CCAMLR streamer line requirements revisited E.F. Melvin (USA) (<i>CCAMLR Science</i> , submitted)

- WG-FSA-03/23 The effectiveness of integrated weight (fast sinking) longlines in reducing white-chinned petrel mortality in the New Zealand ling longline fishery
G. Robertson (Australia), M. McNeill (New Zealand),
B. Wienecke (Australia), N. Smith (New Zealand) and
M. Bravington (Australia)
- WG-FSA-03/24 Beached birds: a guide used by north pacific groundfish observers to identify seabirds incidentally caught in fisheries
T. Hass and S. Davis (USA)
- WG-FSA-03/25 Second International Fishers Forum: executive summary
Western Pacific Regional Fishery Management Council
- WG-FSA-03/26 The area north of Joinville–D’Urville Islands (Subarea 48.1) a former fishing ground at the tip of the Antarctic Peninsula – revisited
K.-H. Kock (Germany), L. Pshenichnov (Ukraine), K. Skora (Poland), Zh.A. Frolkina (Russia) and C.D. Jones (USA)
(*CCAMLR Science*, submitted)
- WG-FSA-03/27 Killer whale *Orcinus orca* and sperm whale *Physeter macrocephalus* interactions with longline vessels in the Patagonian toothfish fishery at South Georgia, South Atlantic
M.G. Purves (United Kingdom), D.J. Agnew (United Kingdom),
E. Balguerías (Spain), C.A. Moreno (Chile) and B. Watkins (South Africa)
(*CCAMLR Science*, submitted)
- WG-FSA-03/28 Descriptive analysis of acoustic data collected during the 2003 exploratory fishery for toothfish in the Ross Sea
R.L. O’Driscoll and G.J. Macaulay (New Zealand)
- WG-FSA-03/29 Review of small-scale research unit boundaries used for the assessment and management of *D. mawsoni* in Subarea 88.1
S.M. Hanchet (New Zealand)
- WG-FSA-03/30 An examination of latitudinal variation in the growth rates of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea
P.L. Horn (New Zealand)
- WG-FSA-03/31 Southern seabird solutions – and update
J. Molloy and N. Smith (New Zealand)
- WG-FSA-03/32 Preliminary assessment of mackerel icefish, *Champsocephalus gunnari*, on the Heard Island Plateau (Division 58.5.2) based on a survey in April–May 2003
A.J. Constable, C.R. Davies, R. Williams and T. Lamb (Australia)

WG-FSA-03/33	Preliminary assessment of <i>Dissostichus eleginoides</i> on the Heard Island Plateau (Division 58.5.2) based on a survey in April–May 2003 A.J. Constable, C.R. Davies, R. Williams and T. Lamb (Australia)
WG-FSA-03/34	Modelling catch and effort data using generalised linear models with random cruise and stratum-by-year effects: trawl fishery for <i>Dissostichus eleginoides</i> in CAMLR Area 58.5.2 S.G. Candy (Australia) (CCAMLR Science, submitted)
WG-FSA-03/35	Modelling catch and effort data using generalised linear models with random cruise effects: trawl fishery for mackerel icefish (<i>Champsocephalus gunnari</i>) in CAMLR Area 58.5.2 S.G. Candy (Australia)
WG-FSA-03/36	Performance assessment of underwater setting chutes, side setting and blue-dyed bait to minimize seabird mortality in hawaii longline tuna and swordfish fisheries – Final Report August 2003 E. Gilman (USA), N. Brothers (Australia), D. Kobayashi, S. Martin, J. Cook, J. Ray, G. Ching and B. Woods (USA)
WG-FSA-03/37	Demography and population trends of the Atlantic yellow-nosed albatross R. Cuthbert (United Kingdom), P.G. Ryan, J. Cooper (South Africa) and G. Hilton (United Kingdom) (<i>The Condor</i> , 105: 439–452 (2003))
WG-FSA-03/38	Standing stock, biology, diet and spatial distribution of demersal finfish from the 2003 US AMLR bottom trawl survey of the South Shetland Islands (Subarea 48.1) C.D. Jones (USA), K.-H. Kock, (Germany), J. Ashford, A. DeVries, K. Dietrich (USA), S. Hanchet (New Zealand), T. Near, T. Turk (USA) and S. Wilhelms (Germany)
WG-FSA-03/39	Information on incidental mortality of seabirds and other protected species in the US West Coast pelagic longline fishery D. Petersen, L. Enriquez and S. Fougner (USA)
WG-FSA-03/40	Report of the Subgroup on Assessment Methods (London, United Kingdom, 12 to 15 August 2003)
WG-FSA-03/41	New Zealand Draft National Plan of Action – Seabirds J. Nicolson and D. Randall (New Zealand)
WG-FSA-03/42	Length at maturity of the Antarctic skates <i>Amblyraja georgiana</i> and <i>Bathyraja eatonii</i> in the Ross Sea M.P. Francis (New Zealand)

WG-FSA-03/43	Preliminary standardised CPUE analysis of the New Zealand part of the toothfish fishery in CCAMLR Subarea 88.1, from 1988/89 to 2002/03 R.G. Blackwell and S.M. Hanchet (New Zealand)
WG-FSA-03/44	The toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2002/03: New Zealand vessel summary M.L. Stevenson, S.M. Hanchet and P.L. Horn (New Zealand)
WG-FSA-03/45	Brief Report on the New Zealand BioRoss Research Program J. Burgess (New Zealand)
WG-FSA-03/46	Information on the spawning season and gonadosomatic indices of <i>Dissostichus mawsoni</i> from Subarea 88.1 in the 2002/03 season G.J. Patchell (New Zealand)
WG-FSA-03/47	Research under way in New Zealand on seabirds vulnerable to fisheries interactions S. Waugh and S. Grayling (New Zealand)
WG-FSA-03/48	On the problem of some fish ranges in Subarea 88.1 V.G. Prutko (Ukraine)
WG-FSA-03/49	Some data on Antarctic toothfish <i>Dissostichus mawsoni</i> reproduction in the Ross Sea (Subarea 88.1) in the period from December 2002 to March 2003 V.G. Prutko and L.A. Lisovenko (Ukraine)
WG-FSA-03/50	On the problem of fish tagging V.G. Prutko (Ukraine)
WG-FSA-03/51	Progress toward Australia's National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (NPOA-Seabirds) M. Drynan and L. Brown (Australia)
WG-FSA-03/52	Research under way in Australia on seabirds vulnerable to fisheries interactions B. Baker and R. Gales (Australia)
WG-FSA-03/53	Progress toward an Agreement on the Conservation of Albatrosses and Petrels B. Baker (Australia)
WG-FSA-03/54	On peculiarities of icefish (<i>Champsocephalus gunnari</i>) vertical distribution in different habitats J.A. Frolkina (Russia) and V.V. Herasimchuk (Ukraine) (CCAMLR Science, submitted)

WG-FSA-03/55	Peculiarities of icefish <i>Champsocephalus gunnari</i> (Channichthyidae) distribution in South Georgia area during the surveys made by STM <i>Atlantida</i> in 2000 and 2002 Zh.A. Frolkina, S.M. Kasatkina and N.N. Zhigalova (Russia) (CCAMLR Science, submitted)
WG-FSA-03/56	Estimates of bird by-catch by IUU vessels in Subarea 48.3, 1998–2001 D.J. Agnew (United Kingdom)
WG-FSA-03/57	The survivorship of rays discarded from the South Georgia longline fishery M. Endicott and D.J. Agnew (United Kingdom) (CCAMLR Science, submitted)
WG-FSA-03/58	By-catch of rays in the 2002/03 toothfish fishery around South Georgia D.J. Agnew, J. Pearce and M. Endicott (United Kingdom)
WG-FSA-03/59	Skate captures during the 2003 South Georgia research survey M. Endicott (United Kingdom)
WG-FSA-03/60	The food and feeding of five species of icefish in the Elephant Island – South Shetland Islands Region in March 2003 K.-H. Kock, H. Flores (Germany), C.D. Jones (USA), S. Wilhelms and S. Schöling (Germany)
WG-FSA-03/61	Diet of two icefish species from the South Shetland Islands and Elephant Island, <i>Champsocephalus gunnari</i> and <i>Chaenocephalus aceratus</i> 2001–2003 H. Flores, K.-H. Kock, S. Wilhelms (Germany) and C.D. Jones (USA)
WG-FSA-03/62	Validation of sink rates of longlines measured by two different methods B. Wienecke and G. Robertson (Australia) (CCAMLR Science, submitted)
WG-FSA-03/63 Rev. 1	A summary of observations on board longline vessels operating within the CCAMLR Convention Area Secretariat
WG-FSA-03/64 Rev. 1	Summary of observations aboard trawlers operating in the Convention Area during the 2002/03 season Secretariat
WG-FSA-03/65 Rev. 1	A summary of scientific observations related to Conservation Measures 25-01 (1996), 25-02 (2002) and 25-03 (1999) Secretariat

WG-FSA-03/66	Fine-scale genetic investigation into Patagonian toothfish structure within the west Indian Ocean sector of the Southern Ocean S.A. Appleyard, R. Williams and R.D. Ward (Australia) (<i>CCAMLR Science</i> , submitted)
WG-FSA-03/67	Report of the Subgroup on By-catch
WG-FSA-03/68	The Australian exploratory toothfish fishery in CCAMLR Division 58.4.2 in season 2002/03 Delegation of Australia
WG-FSA-03/69	A review of the <i>Somniousus</i> (sleeper shark) subgenus and a risk assessment of the sleeper shark by-catch caught in Australian sub-Antarctic fisheries E.M. van Wijk, R. Williams and J.D. Stevens (Australia)
WG-FSA-03/70	Summary and update of tagging of Patagonian toothfish at Heard and Macquarie Islands Delegation of Australia
WG-FSA-03/71	Coordinating approaches to incidental mortality arising from fisheries A.J. Constable, C. Davies, A.T. Williamson, R. Williams and E. van Wijk (Australia)
WG-FSA-03/72	A possible model of metapopulation structure of <i>Dissostichus eleginoides</i> in the southern Indian Ocean R. Williams, A.J. Constable, C. Davies and S. Candy (Australia)
WG-FSA-03/73	Fish and invertebrate by-catch from Australian fisheries for <i>D. eleginoides</i> and <i>C. gunnari</i> in Division 58.5.2 E.M. van Wijk and R. Williams (Australia)
WG-FSA-03/74	Mackerel icefish <i>Champsocephalus gunnari</i> in the diet of upper trophic level predators at South Georgia: implications for fisheries management K. Reid, S. Hill and T. Diniz (United Kingdom)
WG-FSA-03/75 Rev. 1	Otolith microstructure of juvenile fish, the first annulus radius and pelagic stage duration of icefish <i>Champsocephalus gunnari</i> (Channichthyidae) in the South Georgia area L.V. Shcherbich (Russia) (<i>CCAMLR Science</i> , submitted)
WG-FSA-03/76	<i>In situ</i> observations of the scavenging fauna of the South Georgia slope M.A. Collins, I. Everson, R. Patterson, P.M. Bagley, C. Yau, M. Belchier and S. Hawkins (United Kingdom)

WG-FSA-03/77	Assessment of stone crab (Lithodidae) density on the South Georgia slope using baited video cameras M.A. Collins, C. Yau, F. Guillfoyle, P. Bagley, I. Everson, I.G. Priede and D. Agnew (United Kingdom) (<i>ICES J. Mar. Sci.</i> , 59: 370–379 (2002))
WG-FSA-03/78	Data and parameter values from the previous year that might be used for assessments at WG-FSA 2003 I. Everson (United Kingdom)
WG-FSA-03/79	Incidental mortality of birds on trawl vessels fishing for icefish in Subarea 48.3 J. Hooper, D. Agnew and I. Everson (United Kingdom)
WG-FSA-03/80	Determining toothfish otolith structure using oxytetracycline at South Georgia – a preliminary report M.G. Purves, M. Belchier, D.J. Agnew, G. Moreno and T.R. Marlow (United Kingdom)
WG-FSA-03/81	Brief report on the sink rates of Spanish system longlines with special reference to the line weighting regimes of Agnew et al. (2000) G. Robertson (Australia), T. Reid and B. Sullivan (United Kingdom)
WG-FSA-03/82	The use of genetic markers to identify the species and provenance of albatrosses among seabird by-catch M.C. Double, C. Abbott and R. Alderman (Australia)
WG-FSA-03/83	Proposal for a workshop to examine the influence of Southern Ocean physical dynamics on the population structure and movement of <i>Dissostichus eleginoides</i> and <i>D. mawsoni</i> J.R. Ashford, E. Hofmann, P. Smith and P. Gaffney (USA)
WG-FSA-03/84	Is population structure of Patagonian toothfish (<i>Dissostichus eleginoides</i>) determined by the Antarctic Circumpolar Current? J.R. Ashford, C.M. Jones, E. Hofmann (USA), I. Everson (United Kingdom) and G. Duhamel (France)
WG-FSA-03/85	Sampling toothfish from longlines with unequal probabilities J.R. Ashford (USA)
WG-FSA-03/86 Rev. 1	Preliminary results from a study examining spatial structure and connectivity in Patagonian toothfish (<i>Dissostichus eleginoides</i>) in the South Atlantic section of the Southern Ocean J.R. Ashford (USA), A. Arkhipkin (United Kingdom) and C.M. Jones (USA)

- WG-FSA-03/87 Estimating the age of large numbers of *Dissostichus eleginoides* caught off Kerguelen
J. Ashford (USA), G. Duhamel (France), C. Jones and S. Bobko (USA)
(CCAMLR Science, submitted)
- WG-FSA-03/88 Can trace element signatures in the otoliths of *Dissostichus eleginoides* record capture size?
J.R. Ashford and C.M. Jones (USA)
- WG-FSA-03/89 Monitoring of relative abundance of fjord *Notothenia rossii*, *Gobionotothen gibberifrons* and *Notothenia coriiceps* at Potter Cove, South Shetland Islands, in years 2000 to 2003
E. Barrera-Oro, E. Marschoff, R. Casaux and B. Gonzalez (Argentina)
- WG-FSA-03/90 A tagging protocol for toothfish (*Dissostichus* spp.) in the Ross Sea
N.W.McL. Smith and K.J. Sullivan (New Zealand)
- WG-FSA-03/91 Seabird mortality and the Falkland Islands trawling fleet
B.J. Sullivan, T.A. Reid, L. Bugoni and A.D. Black (United Kingdom)
- WG-FSA-03/92 Longliners, black-browed albatross mortality and bait scavenging in the Falkland Islands: what is the relationship?
T.A. Reid and B.J. Sullivan (United Kingdom)
- WG-FSA-03/93 United States research under way on seabirds vulnerable to fisheries interactions
Delegation of the USA
- WG-FSA-03/94 2003 Report of the CCAMLR Otolith Network
- WG-FSA-03/95 Operational interactions between cetaceans and the Patagonian toothfish (*Dissostichus eleginoides*) industrial fishery off Southern Chile
R. Hucke-Gaete, C.A. Moreno and J.A. Arata (Chile)
(CCAMLR Science, submitted)
- WG-FSA-03/96 Integrating CPUE with the GY model: examination of the effects of shortening the CPUE series and incorporating elements of uncertainty into the *D. eleginoides* assessment of Subarea 48.3
I.R. Ball, S. Candy and A.J. Constable (Australia)
(CCAMLR Science, submitted)

WG-FSA-03/97	Progress on the application of an age-structured production model fitted to commercial catch-rate and catch-at-length data to assess the toothfish (<i>Dissostichus eleginoides</i>) resource in the Prince Edward Island vicinity A. Brandão and D.S. Butterworth (South Africa)
WG-FSA-03/98	Analysis of longline fleet operation on the Patagonian toothfish (<i>Dissostichus eleginoides</i>) in the subarea of the South Georgia Island (48.3) in 1989–2003 N.V. Kokorin and A.F. Petrov (Russia)
WG-FSA-03/99	Patagonian toothfish maturity in fishing area 48.3 (South Georgia and Shag Rocks) K.V. Shust and A.N. Kozlov (Russia)
WG-FSA-03/100	The efficacy of video-based electronic monitoring technology for at-sea monitoring of the halibut longline fishery
WG-FSA-03/101	Conservation status of seabirds at risk from longline fishing in the Convention Area (From: <i>BirdLife's Online World Bird Database</i> , BirdLife International, 2003)
Other Documents	
WG-EMM-03/5	The use of Antarctic shags to monitor coastal fish populations: evaluation and proposals after 5 years of test of a standard method R. Casaux and E. Barrera-Oro (Argentina) (<i>CCAMLR Science</i> , submitted)
WG-EMM-03/7	Mackerel icefish size and age at South Georgia and Shag Rocks A.W. North (United Kingdom)
WG-EMM-03/8	Populations of surface-nesting seabirds at Marion Island, 1994/95 to 2002/03 R.J.M. Crawford, J. Cooper, B.M. Dyer, M.D. Greyling, N.T.W. Klages, P.G. Ryan, S.L. Petersen, L.G. Underhill, L. Upfold, W. Wilkinson, M.S. de Villiers, S. du Plessis, M. du Toit, T.M. Leshoro, A.B. Makhado, M.S. Mason, D. Merkle, D. Tshingana, V.L. Ward and P.A. Whittington (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/11	Population dynamics of the wandering albatross <i>Diomedea exulans</i> at Marion Island: long-line fishing and environmental influences D.C. Nel, F. Taylor, P.G. Ryan and J. Cooper (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))

WG-EMM-03/14	Conserving surface-nesting seabirds at the Prince Edward Islands: the roles of research, monitoring and legislation R.J.M. Crawford and J. Cooper (South Africa) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/32	Diseases outbreak threatens Southern Ocean albatrosses H. Weimerskirch (France) (<i>Biological Conservation</i> , submitted)
WG-EMM-03/41	Exchange of wandering albatrosses <i>Diomedea exulans</i> between the Prince Edward and Crozet Islands: implications for conservation J. Cooper (South Africa) and H. Weimerskirch (France) (<i>African Journal of Marine Science</i> , 25, in press (2003))
WG-EMM-03/42	Mackerel icefish ecological indices I. Everson (United Kingdom), K.-H. Kock (Germany) and A.W. North (United Kingdom)
WG-EMM-03/53	Trends in bird and seal populations as indicators of a system shift in the Southern Ocean H. Weimerskirch, P. Inchausti, C. Guinet and C. Barbraud (France) (<i>Antarctic Science</i> , 15 (2): 249–256 (2003))
WG-EMM-03/60	Growth of mackerel icefish (<i>Champsocephalus gunnari</i>) and age-size composition of populations in subarea of South Georgia K.V. Shust and E.N. Kuznetsova (Russia)
WG-FSA-SAM-03/1	Provisional Agenda for the 2003 Meeting of the Working Group on Fish Stock Assessment Subgroup on Assessment Methods (SAM)
WG-FSA-SAM-03/2	List of participants
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WG-FSA-SAM-03/4	WG-FSA Subgroup on Assessment Methods: summary of current CCAMLR assessments to end of 2002 A. Constable (Subgroup Coordinator)
WG-FSA-SAM-03/5	Verification of the CMIX procedure on species with known age-length keys P. Gasiukov (Russia)
WG-FSA-SAM-03/6	Methodical problems of trawl and acoustic surveys in mackerel icefish stock assessment S.M. Kasatkina, P.S. Gasiukov and Zh.A. Frolkina (Russia)
WG-FSA-SAM-03/7	Growth of mackerel icefish (<i>Champsocephalus gunnari</i>) and age-size composition of population in subarea of the South Georgia K.V. Shust and E.N. Kuznetsova (Russia)

WG-FSA-SAM-03/8	Review of management boundaries (SSRUS) used for the assessment of <i>D. mawsoni</i> in Subarea 88.1 P. Horn and S. Hanchet (New Zealand)
WG-FSA-SAM-03/9	Descriptive analysis of acoustic data collected during the 2003 exploratory fishery for toothfish in the Ross Sea R.L. O'Driscoll and G.J. Macaulay (New Zealand)
WG-FSA-SAM-03/10	A feasibility study for stock assessment of <i>D. mawsoni</i> in the Ross Sea (Subareas 88.1 and 88.2) using a tag and recapture experiment K.J. Sullivan, N.W.McL. Smith, J. McKenzie and S.M. Hanchet (New Zealand)
WG-FSA-SAM-03/11	Preliminary results of simulations looking at the optimal use of research sets in Subarea 88.1 S. Hanchet and I. Ball (New Zealand)
WG-FSA-SAM-03/12 Rev. 1	Modelling catch and effort data using generalised linear models, the Tweedie Distribution, and random vessel effects: longline fishery for <i>Dissostichus eleginoides</i> in CAMLR Area 48.3 S. Candy (Australia) (CCAMLR Science, submitted)
WG-FSA SAM-03/13	Predicting average weight-at-age from weight-at-length and length-at-age models with and without density dependence for <i>Dissostichus eleginoides</i> from the Heard Island Plateau S. Candy and A. Constable (Australia) (CCAMLR Science, submitted)
WG-FSA-SAM-03/14	The Generalised Yield Model Version 5: structure, specifications and examples for validation A. Constable (Australia)
WG-FSA-SAM-03/15	Fish Heaven 2.0: summary of modifications and additions to earlier versions and illustrations of its application as a tool for evaluating fisheries management systems I. Ball (Australia)
WG-FSA-SAM-03/16	JGYM – a Java version of the Generalised Yield Model R.N. Vilhelm (United Kingdom)
CCAMLR-XXII/6	Notification by Russia of its intention to continue an exploratory fishery for <i>Dissostichus</i> spp. in CCAMLR Subareas 88.1 and 88.2 for the 2003/04 season Delegation of Russia

CCAMLR-XXII/7	Notification of Spain's proposal to initiate exploratory fisheries for toothfish (<i>Dissostichus</i> spp.) in CCAMLR Subareas 48.6 and 88.1 in the 2003/04 season Delegation of Spain
CCAMLR-XXII/8 Rev. 1	Draft Rules of Access to and Use of CCAMLR Data Secretariat
CCAMLR-XXII/15	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Subareas 48.1, 48.2, 58.6, 58.7, 88.3 and Divisions 58.4.1, 58.4.4) Delegation of Argentina
CCAMLR-XXII/16	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Subarea 48.6) Delegation of Argentina
CCAMLR-XXII/17	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Division 58.4.2) Delegation of Argentina
CCAMLR-XXII/18	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Divisions 58.4.3a, 58.4.3b) Delegation of Argentina
CCAMLR-XXII/19	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Division 58.5.2 west of 79°20'E) Delegation of Argentina
CCAMLR-XXII/20	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Divisions 58.5.1, 58.5.2 east of 79°20'E) Delegation of Argentina
CCAMLR-XXII/21	Notification of Argentina's intention to conduct exploratory Fisheries for <i>Dissostichus</i> spp. in CCAMLR areas (Subareas 88.1, 88.2) Delegation of Argentina
CCAMLR-XXII/22	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.1 for <i>Dissostichus</i> spp. Delegation of Australia
CCAMLR-XXII/23	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.2 for <i>Dissostichus</i> spp. Delegation of Australia

CCAMLR-XXII/24	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.3 a and b for <i>Dissostichus</i> spp. Delegation of Australia
CCAMLR-XXII/25	Notification of Australia's intention to conduct an exploratory trawl fishery in Division 58.4.3 a and b for <i>Dissostichus</i> spp. and <i>Macrourus</i> spp. Delegation of Australia
CCAMLR-XXII/26	Notification of Japan's intention to initiate exploratory longline fisheries for <i>Dissostichus</i> spp. in Subareas 48.6 and 88.1 Delegation of Japan
CCAMLR-XXII/27	Notification of exploratory longline fisheries for <i>Dissostichus</i> spp. in Subareas 88.1 and 88.2 Delegation of the Republic of Korea
CCAMLR-XXII/28	Notification of exploratory longline fisheries for <i>Dissostichus</i> spp. in Subarea 48.6 and Divisions 58.4.4, 58.5.1 and 58.5.2 Delegation of Namibia
CCAMLR-XXII/29	Notification of exploratory longline fisheries for <i>Dissostichus</i> spp. in Subareas 48.3, 48.6, 58.7, 88.1 and 88.2 and Divisions 58.4.2, 58.4.3, 58.4.4 and 58.5.2 Delegation of Namibia
CCAMLR-XXII/30	Notification of new and exploratory longline fisheries for <i>Dissostichus</i> spp. in Subarea 48.6 Delegation of Namibia
ADDENDUM CCAMLR-XXII/30	ADDENDUM Notification of new and exploratory longline fisheries for <i>Dissostichus</i> spp. in Subarea 48.6 Delegation of Namibia
CCAMLR-XXII/31	Notification of longline fisheries for <i>Dissostichus</i> spp. in Division 58.4.1 outside national jurisdiction Delegation of Namibia
CCAMLR-XXII/32	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Subarea 48.6 Delegation of New Zealand
CCAMLR-XXII/33	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Subareas 88.1 and 88.2 Delegation of New Zealand

CCAMLR-XXII/34	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Division 58.4.2 Delegation of Ukraine
CCAMLR-XXII/35	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Divisions 58.4.3a and 58.4.3b Delegation of Ukraine
ADDENDUM CCAMLR-XXII/35	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Divisions 58.4.3a and 58.4.3b Delegation of Ukraine
CCAMLR-XXII/36	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Subareas 88.1 and 88.2 Delegation of Ukraine
ADDENDUM CCAMLR-XXII/34 CCAMLR-XXII/35 CCAMLR-XXII/36	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Division 58.4.2 (CCAMLR-XXII/34), Divisions 58.4.3A and 58.4.3B (CCAMLR-XXII/35) Subareas 88.1 and 88.2 (CCAMLR-XXII/36) Delegation of Ukraine
CCAMLR-XXII/37	Notification of intention to continue an exploratory longline fishery for <i>Dissostichus</i> spp. in Divisions 58.4.2 and 58.4.3a, 58.4.3b Delegation of Russia
CCAMLR-XXII/38	Notification of intention to conduct an exploratory trawl fishery for neritic fish species (<i>Chaenodraco wilsoni</i> , <i>Trematomus eulepidotus</i> , <i>Lepidonotothen kempfi</i> , <i>Pleurogramma antarcticum</i> and others) in Division 58.4.2 Delegation of Russia
CCAMLR-XXII/39	Notification of exploratory fisheries for <i>Dissostichus</i> spp. Delegation of South Africa
CCAMLR-XXII/40	Notification of intention to participate in the exploratory fishery for <i>Dissostichus</i> spp. in Subarea 88.1 Delegation of the United Kingdom
CCAMLR-XXII/41	Notification of intention to conduct new and exploratory longline fisheries Delegation of the USA
CCAMLR-XXII/42	Notification of an exploratory fishery for <i>Dissostichus</i> spp. in Subarea 88.1 Delegation of Uruguay

CCAMLR-XXII/51	Notification of exploratory fisheries for <i>Dissostichus</i> spp. in the 2003/04 season Delegation of Norway
CCAMLR-XXII/52	Assessing the compliance of fishing vessels with conservation measures Delegation of the European Community
CCAMLR-XXII/BG/8	Implementation of fishery conservation measures in 2002/03 Secretariat
SC-CAMLR-XXII/BG/1	Catches in the Convention Area in the 2001/02 and 2002/03 seasons Secretariat
SC-CAMLR-XXII/BG/5 Rev. 1	Summary of notifications of new and exploratory fisheries in 2003/04 Secretariat
SCIC-03/5 Rev. 1	Estimation of IUU catches of <i>Dissostichus</i> spp. taken inside the Convention Area during the 2002/03 fishing season Secretariat

REPORT OF THE AD HOC SUBGROUP ON TAGGING

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A number of papers reported ongoing tag–recapture experiments in CCAMLR waters. In South Georgia almost 2 500 *Dissostichus eleginoides* have been tagged by the UK since 2000 with over 50 recaptures (Everson, 2002; WG-FSA-03/80). At Heard and McDonald Islands 7 115 *D. eleginoides* have been tagged by Australia since 1998 with 1 209 recoveries, and at Macquarie Island 5 650 fish have been tagged since 1995 with 560 recaptures (WG-FSA-03/70). In McMurdo Sound, over 5 000 *D. mawsoni* have been tagged by the USA since the early 1980s with 15 recaptures (A. de Vries, pers. comm.). Further north in the Ross Sea, nearly 2 000 *D. mawsoni* and *D. eleginoides* have been tagged by New Zealand since 2000 with 21 recaptures (WG-FSA-SAM-03/10). A further 12 *D. mawsoni* were tagged in 2003 by Russia in Subarea 88.1 (WG-FSA-03/50).

2. The results of all studies clearly indicate that substantial numbers of both species of toothfish survive the tagging event. The subgroup noted that the tagging results have also provided an insight into the nature of movement of toothfish in CCAMLR waters (WG-FSA-03/72). Furthermore, the recapture rate around Macquarie Island was high enough to provide a precise estimate of stock size (Tuck et al., 2003).

3. Dr S. Hanchet (New Zealand) went on to present a feasibility study for the stock assessment of *D. mawsoni* in the Ross Sea (Subareas 88.1 and 88.2) using a tag and recapture experiment (WG-FSA-SAM-03/10). A simulation study was carried out to determine how many years it would take to obtain a precise estimate of annual recruitment and survivorship over a range of initial stock sizes. An operating model was developed reflecting current knowledge on *D. mawsoni* population dynamics. The operating model was run under various tagging scenarios and the data supplied to the Jolly–Seber estimator. Scenarios were run 10 000 times and the bias and variance in Jolly–Seber estimates assessed.

4. The results suggested that for a range of initial stock sizes of 2 to 20 million recruits, and at a release rate of 3 500 tags per year, it would take 12 years to obtain a precise estimate of survivorship. (Note that because the tagging experiment has already been running for three years, with almost 2 000 tags released already, a precise result would be obtained in nine years.) After this time the risk of failure to detect a stock decline rate of 0.05 or greater was less than 5% over all initial stock size assumptions. Clearly a more concentrated tagging effort with a faster rate of release of tagged fish would provide an answer in a shorter time period.

5. The subgroup noted that there are a number of assumptions that have to be met to achieve an unbiased estimate of abundance using tag–recapture experiments (see also WG-FSA-SAM-03/10). It would be necessary to quantify initial mortality, tag loss and tag detection rates, as these can lead to bias in the abundance estimate. There could also be problems caused by mixing assumptions, and also by emigration and immigration. However, the subgroup also noted that some of these issues could be addressed as the tagging program develops and through further simulation studies.

6. The subgroup recommended that tagging of toothfish be a requirement of the research plan for the conservation measure in Subareas 88.1 and 88.2, and noted that this could be usefully extended to include all new and exploratory toothfish fisheries.

7. The subgroup also noted that there may be costs associated with existing research plans in some SSRUs where the fishing grounds are only small. The requirement for tagging may also have a cost in lost revenue. The subgroup noted the Commission's desire to ensure the cost of research and assessments are commensurate with the value of the fishery. The subgroup also noted that it would be beneficial to review this matter in the future.

8. The subgroup considered that at the very least a tagging study would provide valuable data on growth, behaviour, movement rates and stock structure. It had some concerns over potential biases when using the approach to estimating absolute abundance and recommended that the following assumptions of the model be examined, where possible, through simulation during the intersessional period:

- effect on the estimator of tagging only small fish;
- effect of unequal mixing – both between areas and between depths;
- trade-offs of putting many tags in a small area versus a few tags over a wider area;
- effect of closure of areas between years due to sea-ice;
- potential for emigration into an area with no fishing;
- effect of alternate tagging estimators – Seber (1982), Tuck et al. (2003).

9. The subgroup then went on to discuss the protocol for tagging toothfish in the Ross Sea (WG-FSA-03/95). It first considered what rate of tag release might be appropriate. It noted the successful experience of New Zealand, which had requested that their fishers tag one toothfish per tonne during the 2002/03 season (WG-FSA-SAM-03/09). The subgroup agreed that each vessel should tag one toothfish per tonne, with a maximum of 500 fish per vessel per subarea. It also agreed that it was important to get a good spread of fish throughout the area, and recommended fish be tagged in each SSRU.

10. With regard to the tagging protocol, the following items were further addressed and it was agreed that:

- (i) the preferred tagging type is a 'T' bar tag (various colours) manufactured by Hallprint Pty, South Australia – contact details are given in the protocol paper;
- (ii) NIWA in New Zealand (on behalf of the NZ Ministry of Fisheries) offered to act as the repository for all tagging data from the Ross Sea fishery. Tags can be printed with the legend 'RTN TO: NIWA, PO BOX 14-901, WGTN, NEW ZEALAND'. Initially, all tagging data can be stored on the NIWA tagging database;
- (iii) tags should be inserted in the dorsal surface of the fish between the dorsal spines (see WG-FSA-03/95 for photo). When double tagging, tags should be placed on opposite sides of the fish;
- (iv) at least 20% of the fish should be double tagged (Mr R. Williams (Australia)) noted that the loss rate in their tagging program is estimated to be about 1%, and that the cost and time taken to put in a second tag are minimal);
- (v) observers (or where appropriate experienced Fishing Industry technicians) should do the tagging. Mr Williams noted that some individual toothfish have been recaptured on several occasions and appear to be quite resilient to tagging;

- (vi) handling details should follow the guidelines outlined in the tagging protocol. Care should be taken to either tag the fish quickly, or alternatively to store it in a seawater tank, to avoid the possibility of freezing of the eye membrane (WG-FSA-03/50);
- (vii) a random sample of fish of all sizes would probably be required to obtain an unbiased estimate. However, it also agreed that survival of smaller fish was likely to be better, so tagging small fish for the coming season was advocated and optimal fish size for tagging would be reconsidered next year;
- (viii) a reward system should be considered for tag recoveries. Various options were lottery tickets, prize draws, colour coded tags with different rewards and T-shirts. Mr Williams noted that quick feedback to the fishers and observers on release details is almost as important as a reward.

11. The recovery phase of the fish and the responsibilities of the observers in the tag-recapture program were also considered. In New Zealand the tagging program was initiated by the fishing industry and there should be good reporting of tags by its vessels in Subarea 88.1. It was also noted that there are two observers on each longline vessel in Subarea 88.1, and that up to 50% of the hooks are directly observed. By scaling the tags up by the proportion of hooks observed it would be possible to determine the number of tags in the entire catch. This could then be compared to the total reported on the non-observed hooks.

12. Observers would also be responsible for keeping a record of tag releases and tag recaptures, and in time electronic worksheets could be set up for automatic storage of the tagging data in their electronic logbooks. The observers were responsible for returning the tags and for the extraction of otoliths from tagged fish. The subgroup noted that all otoliths should be stored in the dark, as some may have been marked with tetracycline for age validation experiments (WG-FSA-03/80).

13. The subgroup thanked New Zealand for developing the tagging protocol and recommended that the tagging protocol be further developed, taking account of members' comments. Revision of the protocol will be undertaken and circulated to members of the group by email. The group recommended that the final version be completed by mid-November and be sent to the Secretariat for inclusion in the observer reports for the coming 2003/04 season.

14. The subgroup also noted a novel method for fish tagging involving the use of painted hooks (WG-FSA-03/50). Although the idea is intuitively appealing, the group considered that it would not be useful for estimating stock abundance. However, it could have potential for exploring within-season movements of toothfish, that may be associated with spawning migrations.

15. The subgroup discussed several papers on tagging skates. WG-FSA-03/73 summarised the results of skate tagging in Division 58.5.2. The study had mainly tagged *Bathyraja eatonii*, and there have been eight recaptures (2%) after 208 to 823 days at liberty. The tagged skates had moved little and grown slowly whilst at liberty. WG-FSA-03/59 reported the release of 30 skates in Subarea 48.3. Mr N. Smith (New Zealand) noted that in 2002/03 a further 800 skates were tagged by New Zealand vessels in Subareas 88.1 and 88.2

(CCAMLR-XXII/33), and that one of several recaptured skates had been at liberty for three years. A Russian vessel in Subarea 88.1 tagged about 500 skates (WG-FSA-03/50).

16. The subgroup agreed that it was important to continue to tag skates that were cut off from the longline. Recoveries of the skates could provide important information on movement, survivorship and also, if measured on release, growth.

17. It was agreed that the exchange of ideas and work should continue during the intersessional period within the subgroup. Mr Smith, Mr Williams and Dr M. Belchier (UK) would act as co-conveners of the subgroup with Mr Smith leading the group over the next 12 months. Dr D. Agnew (UK) commented that toothfish are also tagged in South America and around the Falkland/Malvinas Islands and that a wider tagging community could be included in the exchange of ideas.

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APPENDIX E

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMAF FOR 2003/04

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMAF FOR 2003/04

The Secretariat will coordinate the intersessional work of the IMAF group. An interim review of work will be conducted in June 2004 and advised to ad hoc WG-IMAF at the time of WG-EMM (July 2004). The outcome of the intersessional work will be reviewed in September 2004 and reported as a tabled paper to WG-IMAF in October 2004.

¹ In addition to work coordinated by the Science Officer (Secretariat) * SODA: Scientific Observer Data Analyst

Task/Topic		Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
1.	Planning and coordination of work:				
1.1	Circulate materials on IMAF matters as contained in reports of current meetings of CCAMLR.	Standing request		Dec 2003	Place all relevant sections of CCAMLR-XXII on IMAF page of CCAMLR website and notify IMAF group members, and technical coordinators and (via them) scientific observers.
1.2	Circulate papers submitted to WG-FSA on IMAF matters.	Standing request		Dec 2003	Circulate the list of papers submitted to WG-FSA on IMAF matters and advise that copies of papers are available on the CCAMLR website.
1.3	Acknowledge work of technical coordinators and scientific observers.	Standing request		Dec 2003	Commend technical coordinators and all observers for their efforts in the 2001/02 fishing season.
1.4	Review new and exploratory fishery notifications.	Standing request	B. Baker (Australia)	At submission deadline	Transmit hard copies of notifications to Mr Baker to prepare initial draft of IMAF table.
1.5	Membership of WG-IMAF.	Standing request	Members	Nov 2003/ as required	Request nomination of new members to IMAF. Request all Members to send their representatives to the next IMAF meeting.
1.6	Allocation of submitted papers to agenda items.	13.6	Convener	Before meeting	Prepare list and post on website.

Task/Topic		Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
2.	Members' research and development activities:				
2.1	Update information on national research programs on albatrosses, giant petrels and white-chinned petrels, in relation to:	Standing request 6.136	Members, IMAF members, technical coordinators, nominated scientists	Nov 2003/ Sep 2004	Review existing standard formats for this submission, where available. Secretariat to develop new formats as appropriate. Explicit reminder to IMAF members in July 2004.
	(i) status and trends of populations;				
	(ii) foraging range and distribution;				
	(iii) genetic profiles of albatrosses, giant petrels and white-chinned petrels;				
	(iv) number and nature of by-catch specimens and samples.	6.158	R. Gales		
2.2	Risk assessment of seabird by-catch in the Convention Area.	Standing request	IMAF members	Nov 2003/ Sep 2004	Further work as appropriate to update SC-CAMLR-XXII/BG/18 for the Scientific Committee. Circulate any new tabled papers relating to seabird at-sea distributions to Mr Baker, Prof. Croxall and Dr Gales – and to other WG-IMAF members as requested. Liaise with BirdLife International (via Prof. Croxall) in respect of outputs from seabird range workshop.
2.3	Information on the development and use of fisheries-related methods of the avoidance of incidental mortality of seabirds. In particular, information is sought on the following:	Standing request	Members, IMAF members, technical coordinators	Nov 2003/ Sep 2004	Request information, collate responses for IMAF-04.
	• seabird capture rates in relation to dyed and artificial bait, snoodline and mainline colour, bait depth and sink rates;	6.73	Japan	Oct 2004	Report research to IMAF-04.
	• optimum configuration of line-weighting regimes and equipment;				
	• automated methods for adding and removing weights to and from the line;				
	• line-setting devices for autoline vessels;				
	• underwater longline setting devices;				
	• feasibility of using video recording of line hauling operations for observations on seabird incidental catch;				
	• tests of/experiences with paired streamer lines and boom-and-bridle arrangements.				

Task/Topic		Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
2.4	Integrated line-weighting trial in Subareas 88.1 and 88.2.	6.86–6.89	New Zealand, Australia	2003/04 season	Reports to IMAF-04.
2.5	Information on measures for mitigating incidental seabird mortality in trawl fisheries, especially for icefish in Subarea 48.3.		Members as appropriate; especially UK	Nov 2003/ Sep 2004	Collate responses for IMAF-04.
2.6	Review data from scientific observer reports on incidental mortality in krill fishery.	6.230–6.231	Members as appropriate, IMAF members	As soon as report available	Collate for IMAF-04 all reports received by 1 October 2004.
2.7	Experimental trials of mitigation measures in French EEZs.	6.31	Robertson, IMAF scientists, France	As soon as possible	Report to IMAF-04.
2.8	Fisher exchange for French EEZs.	6.32	New Zealand, France	As soon as possible	
2.9	Information on new vessel design.	6.22(v)	France	By Oct 2004	
3.	Information from outside the Convention Area:				
3.1	Information on longline fishing effort in the Southern Ocean to the north of the Convention Area.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2004	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Brazil, Chile, UK, South Africa, Uruguay, New Zealand, Australia); review situation at IMAF-04. Request information from other parties (Members and non-Contracting Parties, e.g. Republic of Korea, Taiwan, Japan, People's Republic of China; international organisations (especially CCSBT, ICCAT, IOTC), known to be fishing, or collecting data on fishing, in areas adjacent to the Convention Area. Review at IMAF-04.
3.2	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	Standing request 6.131	Members, IMAF members	Sep 2004	Repeat request to all IMAF members, especially to those relevant to item 3.1 above; review at IMAF-04.
3.3	Reports on use and effectiveness of mitigating measures outside the Convention Area.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2004	Request information on use/implementation of mitigating measures, especially provisions in Conservation Measures 25-02 and 25-03, as under item 3.1 above; review responses at IMAF-04.

Task/Topic		Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
3.4	Reports on nature of observer programs, including observer coverage.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2004	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Brazil, Chile, UK, South Africa, Uruguay, New Zealand, Australia); review situation at IMAF-04. Request information from other parties (Members and non-Contracting Parties, e.g. Republic of Korea, Taiwan, Japan, China; international organisations (especially CCSBT, ICCAT, IOTC), known to be fishing, or collecting data on fishing in areas adjacent to the Convention Area. Review at IMAF-04.
4.	Cooperation with international organisations:				
4.1	Participation at the 2004 meeting of CCSBT-ERSWG; invite CCSBT to attend WG-IMAF.	Standing request	CCSBT Secretariat	As required	Invite and nominate observers as decided by the Scientific Committee.
4.2	Cooperation with ICCAT, IATTC and IOTC on specific issues regarding incidental mortality of seabirds.	Standing request 6.186–6.187	CCAMLR observers	Nov 2003/ Sep 2004	Brief CCAMLR observers on desired feedback on IMAF matters (seabird by-catch levels and mitigating measures).
4.3	Input to ICCAT agenda, especially in relation to seabird resolutions and issues, implementation of ICCAT resolution.	6.183	Relevant Members, IMAF members, EC	Nov 2003/ May 2004	
4.4	Collaboration and interaction with all tuna commissions (ICCAT, IATTC, IOTC, CCSBT) and regional fishery management organisations with responsibility for fisheries in areas where Convention Area seabirds are killed.	6.178	Relevant Members, CCAMLR observers	Nov 2003 and at specific meetings	Request information on: (i) annual data on distribution level of longline fishing effort; (ii) existing data on levels of seabird by-catch; (iii) mitigating measures currently in use and whether voluntary or mandatory; (iv) nature and coverage of observer program. Support regulations for use of mitigating measures at least as effective as Conservation Measure 25-02.
4.5	Potential inputs to WCPFC.	6.190	IMAF members, Convener		Prepare potential risk assessment.
4.6	Progress with NPOAs in respect of FAO IPOA–Seabirds.	Standing request 6.175	Relevant Members, IMAF members	By Oct 2004	Solicit reports to CCAMLR on progress for information and make review.

	Task/Topic	Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
4.7	Input to CWP agenda, concerning coordination of fishery reporting on seabird by-catch.	SC-XXI 9.13	Data Manager	At CWP meeting	Place item on agenda; table appropriate CCAMLR/IMAF papers; report back to IMAF.
4.8	Assist Japan in improving its NPOA and use of mitigating measures.	SC-XX 4.58, 4.66, CC-XX 6.29 6.180	Members, IMAF	As feasible	Await response to CCAMLR by Japan. Discuss progress at IMAF-04.
4.9	Support for ACAP.	6.170	Members as appropriate; Australia		Update report from Australia to IMAF-04.
4.10	Third International Fishers' Forum.	6.166	Members, IMAF members	As feasible	Facilitate venue and input for IFF3.
4.11	IUCN Red List: Seabirds	Standing request	Secretariat	Aug 2004	Obtain from BirdLife International, circulate to IMAF members and table for SC-CAMLR-XXIII, any revisions to the conservation status of albatross, <i>Macronectes</i> and <i>Procellaria</i> species.
4.12	BirdLife International	Standing request		Sep 2004	Request information from BirdLife International about its activities of relevance to IMAF, in particular its Seabird Program and 'Save the Albatross Campaign'.
4.13	Southern Seabird Solutions	6.156–6.157	Ms Molloy	Oct 2004	Report on progress to IMAF-04.
5.	Data acquisition and analysis:				
5.1	Preliminary analyses of data from the current fishing season.	Standing request	Technical coordinators	Sep–Oct 2004	Standing request: summarise and analyse current year data at a level adequate to facilitate assessment at IMAF-04.
5.2	Acquisition from EEZs and elsewhere as appropriate, of seabird incidental mortality data for trawl fisheries.	Standing request	Members, especially France	Nov 2003/ Sep 2004	Request Members for appropriate data.
5.3	Acquisition of original data in CCAMLR format on seabird incidental mortality for French EEZs in Subarea 58.6 and Division 58.5.1 for 2001, 2002 and 2003.	6.24	France	As soon as possible	Request France to submit reports and data logbooks prepared by national observers for the current and past fishing seasons, preferably using CCAMLR reporting formats.
5.4	Provision by France of details of mitigation measures in use in their EEZs, analysis of by-catch statistics etc. for intersessional evaluation.	SC-XXI 5.6 6.24	France, IMAF	As soon as possible	

Task/Topic		Paragraphs of WG-FSA Report	Members' Assistance ¹	Start/ Completion Deadlines	Action
5.5	Analyses of data submitted by France for previous years.	6.24	SODA*	As soon as possible	Consult France for technical/data clarification. Consult Convener for analytical clarification.
5.6	Review presentation of IUU data in reports.	6.120		Oct 2004	Scientific Committee advice for IMAF-04.
6.	Scientific observer issues:				
6.1	Preliminary analysis of data from 2003/04 fisheries.	Standing request	SODA*	IMAF meeting	Produce draft tables equivalent to Tables 6.1 to 6.7 and 6.10 of the FSA-03 report.
6.2	Revise <i>Scientific Observers Manual</i> in order to incorporate agreed changes to instructions, logbook and cruise report forms.	10.23, 10.40	Secretariat	Jan–Feb 2004	Make additions and modifications agreed by WG-IMAF and WG-FSA, translate into all CCAMLR official languages and circulate the revised manual to Members and technical coordinators.
6.3	Draft poster material for ‘revision’ of <i>Fish the Sea Not the Sky</i> .	SC-XXII 5.53	IMAF	Oct 2004	Submit to IMAF-04 for consideration.
6.4	Undertake major review of the content and structure of the <i>Scientific Observers Manual</i> to be coordinated by the Secretariat and conducted by an intersessional group that comprises technical coordinators and members of WG-FSA (IMAF).	10.45 SC-XXII 2.10 CC-XXII 4.5, 6.17(iv)	Secretariat, IMAF/FSA and technical coordinators	Mar–Aug 2004	Invite participants, identify main issues of the proposed revision, develop agenda, coordinate intersessional work and prepare a report to IMAF-04 with proposals relating to seabird and marine mammal observations.
7.	Revision of Conservation Measure 25-02.	6.93	IMAF		Review, especially line-weighting provisions for autoliners, at IMAF-04.

DRAFT CONSERVATION MEASURE 25-02 (2003)^{1,2}**Minimisation of the Incidental Mortality of Seabirds in the Course of Longline Fishing
or Longline Fishing Research in the Convention Area**

The Commission,

Noting the need to reduce the incidental mortality of seabirds during longline fishing by minimising their attraction to fishing vessels and by preventing them from attempting to seize baited hooks, particularly during the period when the lines are set, and

Recognising that in certain subareas and divisions of the Convention Area there is also a high risk that seabirds will be caught during line hauling,

Adopts the following measures to reduce the possibility of incidental mortality of seabirds during longline fishing.

1. Fishing operations should be conducted in such a way that hooklines³ sink beyond the reach of seabirds as soon as possible after they are put in the water, therefore:
 - vessels using autoline systems should add weight to the hookline or use integrated weight hooklines while deploying longlines. Integrated weight (IW) longlines of a minimum of 50 g/m or attachment to non-IW longlines of 5 kg weights at 50 to 60 m intervals are recommended;
 - vessels using the Spanish method of longline fishing, should release weights before line tension occurs; weights of at least 8.5 kg mass shall be used, spaced at intervals of no more than 40 m, or weights of at least 6 kg mass shall be used, spaced at intervals of no more than 20 m.
2. Longlines shall be set at night only (i.e. during the hours of darkness between the times of nautical twilight⁴)⁵. During longline fishing at night, only the minimum ship's lights necessary for safety shall be used.
3. The dumping of offal is prohibited while longlines are being set. The dumping of offal during the haul shall be avoided. Any such discharge shall take place only on the opposite side of the vessel to that where longlines are hauled. For vessels or fisheries where there is not a requirement to retain offal on board the vessel, a system shall be implemented to remove fish hooks from offal and fish heads prior to discharge.
4. Vessels which are so configured that they lack on-board processing facilities or adequate capacity to retain offal on board, or the ability to discharge offal on the opposite side of the vessel to that where longlines are hauled, shall not be authorised to fish in the Convention Area.
5. A streamer line shall be deployed during longline setting to deter birds from approaching the hookline. Specifications of the streamer line and its method of deployment are given in the appendix to this measure.

6. A haul seabird deterrent designed to discourage birds from accessing baits during the haul of longlines 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-catch⁶.
7. Every effort should be made to ensure that birds captured alive during longlining are released alive and that wherever possible hooks are removed without jeopardising the life of the bird concerned.

¹ Except for waters adjacent to the Kerguelen and Crozet Islands

² Except for waters adjacent to the Prince Edward Islands

³ Hookline is defined as the groundline or mainline to which the baited hooks are attached by snoods.

⁴ The exact times of nautical twilight are set forth in the Nautical Almanac tables for the relevant latitude, local time and date. A copy of the algorithm for calculating these times is available from the Secretariat. All times, whether for ship operations or observer reporting, shall be referenced to GMT.

⁵ Wherever possible, setting of lines should be completed at least three hours before sunrise (to reduce loss of bait to/catches of white-chinned petrels).

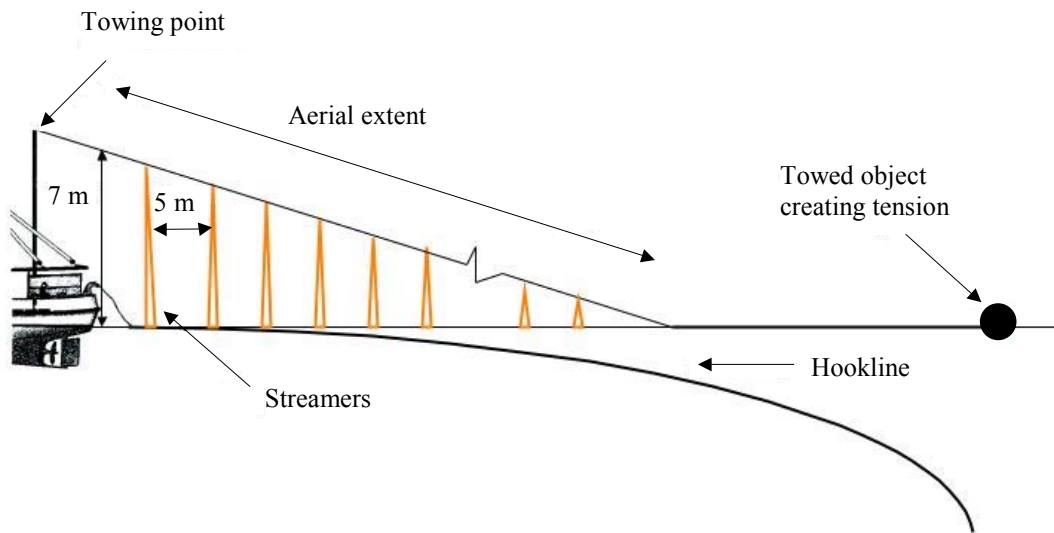
⁶ The current definition of these levels of risk is contained in SC-CAMLR-XXII/BG/17.

⁷ Plastic tubing should be of a type that is manufactured to be protected from ultraviolet radiation.

APPENDIX TO CONSERVATION MEASURE 25-02

1. The aerial extent of the streamer line, which is the part of the line supporting the streamers, is the effective seabird deterrent component of a streamer line. Vessels are encouraged to optimise the aerial extent and ensure that it protects the hookline as far astern of the vessel as possible, even in crosswinds.
2. The streamer line shall be attached to the vessel such that it is suspended from a point a minimum of 7 m above the water at the stern on the windward side of the point where the hookline enters the water.
3. The streamer line shall be a minimum of 150 m in length and include an object towed at the seaward end to create tension to maximise aerial coverage. The object towed should be maintained directly behind the attachment point to the vessel such that in crosswinds the aerial extent of the streamer line is over the hookline.
4. Branched streamers, each comprising two strands of a minimum of 3 mm diameter brightly coloured plastic tubing⁷ or cord, shall be attached no more than 5 m apart commencing 5 m from the point of attachment of the streamer line to the vessel and thereafter along the aerial extent of the line. Streamer length shall range between minimums of 6.5 m from the stern to 1 m for the seaward end. When a streamer line is fully deployed, the branched streamers should reach the sea surface in the absence of wind and swell. Swivels or a similar device should be placed in the streamer line in such a way as to prevent streamers being twisted around the streamer line. Each branched streamer may also have a swivel or other device at its attachment point to the streamer line to prevent fouling of individual streamers.
5. Vessels are encouraged to deploy a second streamer line such that streamer lines are towed from the point of attachment each side of the hookline. The leeward streamer line should be of similar specifications (in order to avoid entanglement the leeward streamer line may need to be shorter) and deployed from the leeward side of the hookline.

Streamer Line



**NOTIFICATION OF INTENT TO PARTICIPATE
IN THE ANTARCTIC KRILL FISHERY**

**NOTIFICATION OF INTENT TO PARTICIPATE
IN THE ANTARCTIC KRILL FISHERY**

Member: _____

Fishing season: _____

Number of vessels: _____

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: _____ %

_____ %

_____ %

_____ %

Information provided in this notification will be considered to be preliminary. It is recognised that operational factors may affect actual catch levels and areas of operation.

GUIDELINES FOR LANGUAGE SUPPORT FOR *CCAMLR SCIENCE*

GUIDELINES FOR LANGUAGE SUPPORT FOR *CCAMLR SCIENCE*

These guidelines are for language support for manuscripts where initial evaluation by the Editor has revealed substantial problems with the English text (see SC-CAMLR-XXI, paragraphs 12.16 to 12.18).

Papers of authors whose native language is one of the CCAMLR official languages:

Actions:

- (i) Request re-submission of the paper for publication both in English and the original language subject to the following conditions:
 - (a) the paper in its original language should be subject to thorough scientific editing within the national scientific community;
 - (b) the paper should then be translated into the best quality English within the means of the author(s).
- (ii) Language and scientific editing of the translation will then be undertaken by the Secretariat.

Papers of authors whose native language is not one of the CCAMLR official languages:

Actions:

- (i) Request re-submission of the paper for publication subject, where appropriate, to the following conditions:
 - (a) the paper could first be written in the original language, subjected to thorough scientific editing within the national scientific community and then translated into the best quality English within the means of the author; or
 - (b) the paper could originally be written in the best quality English within the means of the author(s) and then subjected to thorough scientific editing within national or international scientific communities.
- (ii) Request two reviewers to evaluate whether the scientific content of the paper meets publication requirements and, if it does, determine whether one of reviewers could be tasked with scientific and language editing of the paper subject to a pre-agreed fee, up to a maximum of A\$1 000.
- (iii) The paper edited by the first reviewer will then be subject to the normal review process by both reviewers.

**SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE
FOR THE 2003/04 INTERSESSIONAL PERIOD**

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2003/04 INTERSESSIONAL PERIOD

No.	Task	Reference to paragraphs in SC-CAMLR-XXII	Deadline	Action Required	
				Secretariat	Members
1.	Scheme of International Scientific Observation				
1.1	Revise the <i>Scientific Observers Manual</i> .	2.1, 2.8	February	Implement	
1.2	Electronic logbooks should become standard for all scientific observations on krill vessels.	2.1	February	Assist	Implement
1.3	Translate electronic logbooks into all official languages.	2.1	March	Implement	
1.4	Use the new observer report format in all fisheries in 2003/04.	2.2	Ongoing	Assist	Implement
1.5	Inform the Secretariat if a new species code is required, so that Secretariat may assign one.	2.5	Ongoing	Implement	Implement
1.6	Undertake a major review of the content and structure of the <i>Scientific Observers Manual</i> .	2.10	September	Coordinate	Participate
2.	Ecosystem monitoring and management				
2.1	Undertake tasks identified by WG-EMM.	Annex 4, Table 3	June	Implement	Implement
2.2	Analyse sources of variability in the CEMP indices and the consequences of such variability on the power to detect change on the full suite of indices.	3.9	June	Implement	Implement
2.3	Define the data requirements and analytical procedures required to evaluate the indices of krill availability derived from fisheries data.	3.10	June	Assist	Implement
2.4	Maintain a register of the wide range of non-CEMP time-series data that were of use to the CEMP Review workshop and of potential utility to future workshops in support of the work of WG-EMM.	3.14	June	Implement	
2.5	Develop an ordination approach whereby the nature of the covariation in multivariate CEMP indices could be described and presented on an annual basis.	3.21	June	Implement	
2.6	Continue work on developing methods to utilise CEMP data in making decisions on the status of the krill-centric ecosystem.	3.22	Ongoing	Assist	Implement
2.7	Revise the <i>CEMP Standard Methods</i> for the collection of tissue sample to be used to detect chemical indicators of metabolic stress and pollutants and determining fur seal pup growth rate (C2).	3.31	February	Implement	
2.8	Make further progress on the subdivision of the precautionary catch limit among SSMUs.	3.40–3.43, 3.72	June	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXII	Deadline	Action Required	
				Secretariat	Members
2.9	Implement the method for using the diet of Antarctic shags (<i>Phalacrocorax bransfieldensis</i>) to monitor the abundance of young life history stages of coastal fish species.	3.57	Ongoing	Assist	Implement
2.10	Submit time series of data of fish composition in the diet of Antarctic shags.	3.58	Ongoing	Assist	Implement
2.11	Refer the Management Plan for ASPA No. 145 to the Subgroup on Protected Areas for review during WG-EMM-04.	3.75	August	Assist	Implement
3.	Harvested species				
3.1	Undertake tasks identified by WG-FSA.	Annex 5, Table 12.1	September	Implement	Implement
3.2	Submit information on detailed plans for fishing for krill in the upcoming season.	4.6, 4.8, 4.14	June	Assist	Implement
3.3	Provide further details of fishing activities in the Reports of Members' Activities (optional).	4.9	September	Assist	Implement
3.4	Report krill catches by SSMU.	4.11	June	Implement	
3.5	Develop approaches to validate CEMP indices of krill availability based on fisheries information.	4.12	June	Assist	Implement
3.6	Examine the uncertainties associated with the acoustic estimates of biomass of <i>C. gunnari</i> and determine how these uncertainties may be incorporated into the assessments.	4.35–4.41	September	Assist	Implement
3.7	Explore potential options for reducing catches of immature <i>D. eleginoides</i> in Subarea 48.3 and implications for doing so, including restricting fishing in shallower depths.	4.44, 4.75	September	Assist	Implement
3.8	Develop validation procedures all data extractions and analytical procedures used in assessments.	4.48	September	Implement	Implement
3.9	Review and evaluate the entire process of estimating <i>D. eleginoides</i> recruitment from trawl surveys for use in assessments, including a variety of general analytical and interpretation issues.	4.49–4.55, 4.73	September	Assist	Implement
3.10	Take steps to substantially reduce total removals of <i>D. eleginoides</i> in Division 58.5.1 from 2003 levels.	4.82	December	Assist	Implement (France)
3.11	Submit papers to the next meeting of WG-FSA-SAM examining the effect of survey design of the estimation of recruitment of <i>D. eleginoides</i> .	4.86	June	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXII	Deadline	Action Required	
				Secretariat	Members
3.12	Members collecting data in a non-standard format should ensure that all by-catch data are transferred to the CCAMLR database.	4.141	Ongoing	Assist	Implement
3.13	Undertake further studies on skate survivorship.	4.143	September	Assist	Implement
3.14	Understand inter-vessel differences in by-catch which could be used to develop mitigation and avoidance measures for by-catch.	4.145, 4.149	September	Assist	Implement
3.15	Report data on by-catch as accurately as possible in all data formats (STATLANT data, haul-by-haul data, catch and effort reports).	4.147, 4.151	Ongoing	Assist	Implement
3.16	Observers should record the proportion of hauls/sets observed for both retained/discarded by-catch and cut off/lost by-catch, and the number of fish which are cut or lost from longlines.	4.152	Ongoing	Assist	Implement
3.17	Review the data requirements for fish and invertebrate by-catch and the priority tasks for observers in collecting this information.	4.153	September	Assist	Implement
3.18	When not retained for processing, all rajids should be cut from lines while still in the water where possible, except on the request of the observer during the observer's biological sampling period.	4.155	Ongoing	Assist	Implement
3.19	Report to the Secretariat on the methods or strategies of fishing that minimise non-target fish by-catch.	4.156	September	Assist	Implement
4.	New and exploratory fisheries				
4.1	In order to undertake exploratory fishing in subareas or divisions currently closed by conservation measures, Members will need to follow the procedures outlined in Conservation Measure 24-01.	4.169, 4.210	Ongoing	Assist	Implement
4.2	Carry out further tagging simulation studies in Subarea 88.1.	4.194	September	Assist	Implement
4.3	Review practicalities and possible research designs for carrying out a trawl survey on juvenile <i>Dissostichus</i> spp. in the Ross Sea.	4.194	September	Assist	Implement
4.4	Carry out simulation studies to determine optimal ways to direct fishing effort to achieve the necessary contrast in fishery and stock parameters that could lead to an assessment of <i>Dissostichus</i> spp. in Subarea 88.1.	4.194	September	Assist	Implement
4.5	Examine more appropriate SSRU by-catch levels in Subarea 88.1.	4.199	September	Assist	Implement
4.6	Review the research plan and data collection plans specified in Conservation Measure 41-01.	4.209	September	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXII	Deadline	Action Required	
				Secretariat	Members
5.	Incidental mortality				
5.1	Undertake tasks identified by WG-IMAF.	Annex 5, Appendix E	September	Implement	Implement
5.2	Implement mitigating measures, trials of such measures and exchange of fishers, in relation to longline fisheries in the French EEZs in Subarea 58.6 and Division 58.5.1.	5.57	January	Assist	Implement (France)
5.3	Submit data on longline fishery operations in areas adjacent to the Convention Area.	5.57	Ongoing	Assist	Implement
5.4	Submit data on seabird population sizes, foraging ranges and provenance of by-catch.	5.57	September	Assist	Implement
5.5	Support international initiatives, especially IFF3 and ACAP.	5.57	Ongoing	Assist	Implement
5.6	Submit progress reports on the development and implementation of FAO NPOAs.	5.57	September	Assist	Implement
5.7	Take even more stringent measures to combat IUU fishing in the Convention Area in order to protect populations of seabirds at serious risk.	5.58	Ongoing	Assist	Implement
5.8	Request RFMOs, with competences in areas adjacent to the Convention Area, to take action in respect of mitigation of seabird by-catch.	5.58	January	Implement	
6.	Additional monitoring and management issues				
6.1	Work with the Secretariat in order to improve presentation and develop standardised procedures for the analysis of marine debris data.	6.4	September	Implement	Implement
6.2	Submit information on marine debris on the CCAMLR standard reporting forms.	6.14	Ongoing	Assist	Implement
7.	Management under conditions of uncertainty about stock size and sustainable yield				
7.1	Update the fishery plans.	7.1	Ongoing	Implement	
7.2	Submit data on the Spanish fishing operation in Area 51 outside the EEZs.	7.7	September	Assist	Implement (Spain)
7.3	Submit bathymetric data from Area 51 which would allow a better estimate of seabed area to be made.	7.10	September	Assist	Implement (Russia)

No.	Task	Reference to paragraphs in SC-CAMLR-XXII	Deadline	Action Required	
				Secretariat	Members
8.	Secretariat supported activities				
8.1	Develop a plan for the storage of data from acoustic surveys.	12.8–12.10	June	Implement	Assist
8.2	Establish a tagging database for the receipt of tag data submitted by Members in a standard electronic format.	12.11	March	Implement	
8.3	Develop a flow chart illustrating the process for requesting and receiving data.	12.17	March	Implement	
8.4	Ensure that adequate security is provided to CCAMLR data and other information held on the meeting networks.	12.20	Ongoing	Assist	Implement (meeting organisers)
8.5	Submit, where possible, monthly catch and effort data for the fisheries were listed in Table 1 of SC-CAMLR-XXII/BG/7.	12.28	February	Assist	Implement
8.6	Examine descriptions of the krill fisheries during the 1970s which had been published in various BIOMASS reports.	12.28	March	Implement	
8.7	Prepare a paper for comment by WG-EMM and WG-FSA to support the Scientific Committee's decision on the guidelines for submission of papers to its meetings.	12.33	May	Implement	Working groups to consider
9.	Other tasks				
9.1	Inform the Scientific Committee and its working groups of relevant developments of FIRMS-FIGIS.	9.17	Ongoing	Implement	
9.2	Participate as observer in selected international meetings.	9.22	Ongoing	Implement	Implement
9.3	Develop a system of documentation and pro forma which would enable WG-FSA to maintain a complete archive of its assessments.	10.6	June	Implement	Assist

**GLOSSARY OF ACRONYMS AND ABBREVIATIONS
USED IN SC-CAMLR REPORTS**

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN SC-CAMLR REPORTS

AAD	Australian Antarctic Division
ACAP	Agreement on the Conservation of Albatrosses and Petrels
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
AMD	Antarctic Master Directory
AMLR	Antarctic Marine Living Resources
APEC	Asia-Pacific Economic Cooperation
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
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
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks (SCAR/SCOR)

BROKE	Baseline Research on Oceanography, Krill and the Environment
CAC	Comprehensive Assessment of Compliance
cADL	calculated Aerobic Dive Limit
CAF	Central Ageing Facility
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
CCAS	Convention on the Conservation of Antarctic Seals
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CCSBT-ERSWG	CCSBT Ecologically Related Species Working Group
CDS	Catch Documentation Scheme for <i>Dissostichus</i> spp.
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CF	Conversion Factor
CITES	Convention on International Trade in Endangered Species
CMIX	CCAMLR's Mixture Analysis Program
CMS	Convention on the Conservation of Migratory Species of Wild Animals
COFI	Committee on Fisheries (FAO)
COLTO	Coalition of Legal Toothfish Operators
COMM CIRC	Commission Circular (CCAMLR)
COMNAP	Council of Managers of National Antarctic Programs (SCAR)
CON	CCAMLR Otolith Network
CPD	Critical Period–Distance
CPPS	Commission on the South Pacific

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)
CTD	Conductivity Temperature Depth Probe
CV	Coefficient of Variation
C-VMS	Centralised Vessel Monitoring System
CWP	Coordinating Working Party on Fishery Statistics (FAO)
DCD	<i>Dissostichus</i> Catch Document
DPM	Dynamic Production Model
DPOI	Drake Passage Oscillation Index
DWBA	Distorted wave Born approximation model
EASIZ	Ecology of the Antarctic Sea-Ice Zone
E-CDS	Electronic Web-based Catch Documentation Scheme for <i>Dissostichus</i> spp.
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see 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
EPOS	European <i>Polarstern</i> Study
EPROM	Erasable Programmable Read-Only Memory

FAO	Food and Agriculture Organization of the United Nations
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)
FPI	Fishing to Predation Index
FRAM	Fine Resolution Antarctic Model
FV	Fishing Vessel
GAM	Generalised Additive Model
GATT	General Agreement on Tariffs and Trade
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 (US Global Change Research Program)
GLOCHANT	Global Change in the Antarctic (SCAR)
GMT	Greenwich Mean Time
GOOS	Global Ocean Observing System (SCOR)
GOSEAC	Group of Specialists on Environmental Affairs and Conservation (SCAR)
GOSOE	Group of Specialists on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
GRT	Gross Registered Tonnage
GTS	Greene et al., (1990) linear TS versus length relationship

GYM	Generalised Yield Model
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
ICES	International Council for the Exploration of the Sea
ICES FAST Working Group	ICES Fisheries Acoustics Science and Technology Working Group
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
IHO	International Hydrographic Organisation
IKMT	Isaacs-Kidd Midwater Trawl
IMAF	Incidental Mortality Arising from Fishing
IMALF	Incidental Mortality Arising from Longline Fishing
IMO	International Maritime Organization
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
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, Unregulated and Unreported
IW	Integrated Weight
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
JAG	Joint Assessment Group
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
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)
LSSSG	SCAR Life Sciences Standing Scientific Group
LTER	Long-term Ecological Research (USA)
MARPOL Convention	International Convention for the Prevention of Pollution from Ships
MBAL	Minimum Biologically Acceptable Limits
MEA	Multilateral Environmental Agreement
MFTS	Multiple-Frequency Method for in situ TS Measurements

MIA	Marginal Increment Analysis
MPA	Marine Protected Area
MRAG	Marine Resources Assessment Group (UK)
MSY	Maximum Sustainable Yield
MV	Merchant Vessel
MVBS	Mean Volume Backscattering Strength
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	Northeast 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)
OECD	Organisation for Economic Cooperation and Development
PBR	Permitted Biological Removal
PCA	Principal Component Analysis

PCR	Per Capita Recruitment
PTT	Platform Terminal Transmitter
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
SAF	Sub-Antarctic Front
SACCF	Southern Antarctic Circumpolar Current Front
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-EASIZ	Ecology of the Antarctic Sea-Ice Zone (SCAR Program)
SCAR-COMNAP	SCAR Council of Managers of National Antarctic Programs
SCAR-GOSEAC	SCAR Group of Specialists on Environmental Affairs and Conservation
SCAR-GSS	SCAR Group of Specialists on Seals
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
SeaWiFS	Sea-viewing Wide field-of-view Sensor
SIBEX	Second International BIOMASS Experiment
SIC	Scientist-in-Charge
SIOFC	Southern Indian Ocean Fisheries Commission
SIR Algorithm	Sampling/Importance Resampling Algorithm
SO GLOBEC	Southern Ocean GLOBEC
SOI	Southern Oscillation Index
SO JGOFS	Southern Ocean JGOFS
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Specially Protected Area
SPC	Secretariat of the Pacific Community
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
TDR	Time Depth Recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
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 Environmental Programme
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
US AMLR	United States Antarctic Marine Living Resources Program
US LTER	United States Long-term Ecological Research
UV	Ultra-Violet
UW	Unweighted
VMS	Vessel Monitoring System
VPA	Virtual Population Analysis
WAMI	Workshop on Assessment Methods for Icefish (CCAMLR)
WCO	World Customs Organization
WFC	World Fisheries Congress
WCPFC	Western and Central Pacific Fisheries Convention
WG-CEMP	Working Group for the CCAMLR Ecosystem Monitoring Program (CCAMLR)
WG-EMM	Working Group on Ecosystem Monitoring and Management (CCAMLR)
WG-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 Arising from Fishing (CCAMLR)
WG-Krill	Working Group on Krill (CCAMLR)
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WSC	Weddell–Scotia Confluence
WS-Flux	Workshop on Evaluating Krill Flux Factors (CCAMLR)
WS-MAD	Workshop on Methods for the Assessment of <i>D. eleginoides</i> (CCAMLR)
WTO	World Trade Organization
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable Bathythermograph
XML	Extensible Mark-up Language
Y2K	Year 2000