SC-CAMLR-XXIII

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE TWENTY-THIRD MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
25–29 OCTOBER 2004

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Abstract

This document presents the adopted report of the Twenty-third Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 25 to 29 October 2004. 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-THIRD MEETING OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 25 to 29 October 2004)

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 25 to 29 October 2004 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 Mauritius, Netherlands and Peru (Acceding States), Mozambique and Indonesia (non-Contracting Parties), along with observers from ASOC, CCSBT, COLTO, FAO, IUCN, IWC and SCAR, and encouraged them to participate in the meeting as much as possible.

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

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

- Dr K. Sullivan (New Zealand) – CCAMLR Scheme of International Scientific Observation
- Drs R. Hewitt and P. Penhale (USA) – Ecosystem monitoring and management
- Dr S. Nicol – Krill resources
- Drs C. Jones (USA) and C. Davies (Australia) – Fish resources (except by-catch)
- Mr B. Watkins (South Africa) – Fish by-catch
- Dr G. Kirkwood (UK) – New and exploratory fisheries
- Dr C. Southwell (Australia) – Crab resources and Squid resources, and Scientific research exemption
- Prof. J. Croxall (UK) – Incidental mortality
- Ms K. Rivera (USA) – Additional monitoring and management issues
- Dr K.-H. Kock (Germany) – Management under conditions of uncertainty about stock size and sustainable yield
- Prof. B. Fernholm (Sweden) – 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-XXIII/1). The Scientific Committee agreed to expand Subitem 13(ii) to include consideration of the structure of the report from WG-FSA, and Item 14 to cover the election of a Vice-Chair. With these additions, the Agenda was adopted (Annex 3).

Report of the Chair

Intersessional meetings

1.7 The following meetings of working groups of the Scientific Committee were held during 2004:

(i) The tenth meeting of WG-EMM was held from 12 to 23 July in Siena, Italy. It was convened by Dr Hewitt and attended by 36 participants, representing 13 Members.

The Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management was held during the first week of WG-EMM, from 12 to 16 July and was convened by Dr A. Constable (Australia). Attendees at the workshop included an invited expert, Dr B. Fulton, from CSIRO in Australia.

(ii) The meeting of WG-FSA was held in Hobart from 11 to 22 October, prior to the Scientific Committee meeting. It was convened by Dr S. Hanchet (New Zealand).

WG-FSA-SAM met from 5 to 9 July in Siena, Italy, immediately prior to the WG-EMM meeting, and was convened by Dr Constable.

(iii) Ad hoc WG-IMAF conducted its meeting as part of WG-FSA-04. 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.

CCAMLR Scheme of International Scientific Observation

1.9 Scientific observations reported under the CCAMLR Scheme of International Scientific Observation and submitted to CCAMLR are summarised in SC-CAMLR-XXIII/BG/6. In accordance with the scheme, scientific observers were deployed on all vessels in all finfish fisheries in the Convention Area. A total of 55 observation programs was undertaken (for 44 longline and 11 trawl vessels). In addition, a single observation cruise was carried out on board a krill fishing vessel and data were reported in accordance with the scheme.

Fisheries

1.10 Under the conservation measures in force in the 2003/04 season (1 December 2003 to 30 November 2004), Members fished in 10 managed fisheries:

- fishery for *Champsocephalus gunnari* in Subarea 48.3
- fishery for *Champsocephalus gunnari* in Division 58.5.2
- fishery for *Dissostichus eleginoides* in Subarea 48.3
- exploratory fishery for *Dissostichus* spp. in Subarea 48.6
- fishery for *Dissostichus eleginoides* in Division 58.5.2
- exploratory fishery for *Dissostichus* spp. in Division 58.4.2
- exploratory fishery for *Dissostichus* spp. in Division 58.4.3b
- exploratory fishery for *Dissostichus* spp. in Subarea 88.1
- exploratory fishery for *Dissostichus* spp. in Subarea 88.2
- fishery for *Euphausia superba* in Area 48.

1.11 In addition, four other managed fisheries were conducted in the Convention Area in 2003/04:

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

1.12 In all, 16 Members fished: Argentina, Australia, Chile, France, Japan, New Zealand, Norway, Poland, Republic of Korea, Russia, South Africa, Spain, Ukraine, UK, Uruguay and the USA. In addition, Vanuatu fished for krill.

1.13 Based on data submitted to CCAMLR by 24 September 2004, and subject to various conservation measures in force for 2003/04, Members have reported a total catch of 87 133 tonnes of krill, 13 307 tonnes of toothfish and 2 737 tonnes of icefish from the Convention Area (SC-CAMLR-XXIII/BG/1). A number of other species have been taken as by-catch (Annex 5, Tables 6.3 and 6.4).

Scientific Committee representation at meetings of other international organisations

1.14 The Scientific Committee was represented at a number of meetings of other international organisations during the intersessional period. Observers' reports from these meetings were considered in detail under Agenda Item 9.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

2.1 For the 2003/04 season, reports and data were submitted by international and national observers from a total of 44 cruises fishing for *Dissostichus* spp. using longlines in the Convention Area. Cruises were undertaken in Subareas 48.3 (16), 48.6 (1), 58.6 and 58.7 (2), 88.1 and 88.2 (22), and in Divisions 58.4.2 and 58.4.3b (1) and 58.5.2 (2). Observers were deployed by eight Members: Australia (1), Chile (7), Russia (5), South Africa (14), Spain (1), Ukraine (2), UK (12) and Uruguay (2).

2.2 Trawl cruises fishing for finfish in Subarea 48.3 (6) and in Division 58.5.2 (5) were observed by 11 scientific observers (6 international and 5 national) provided by: Australia (5), South Africa (2), Spain (1) and the UK (3). A single trawl cruise fishing for krill in Area 48 was observed by a single international observer designated by Ukraine.

2.3 In the krill fishery, six sets of international scientific observer data were submitted for the 2002/03 fishing season, bringing the total submissions over all years to 14. Eleven of these datasets were submitted in the last two years by observers on board krill trawlers operating in Subarea 48.3 (South Georgia) (Annex 4, paragraph 3.22).

2.4 Observers on several krill fishing vessels noted that Antarctic fur seals were always present during krill fishing operations and described several incidental entanglements. It was also noted that entanglements were most common when the crews had limited experience in the krill fishery and that simple mitigation measures substantially reduced the problem. Accordingly, WG-EMM requested that descriptions of mitigation measures be submitted to ad hoc WG-IMAF as a matter of priority, and that once advice had been developed it would expect to recommend that mitigation measures be deployed on all krill fishing vessels (Annex 4, paragraphs 3.23 to 3.25).

2.5 WG-EMM recommended that international scientific observers continue to be placed on as many krill vessels as possible. Some participants considered that a high level of observation would be required to acquire the information necessary to determine sampling protocols, and that this ought to apply equally to all krill fisheries (Annex 4, paragraphs 3.29 and 3.30).

2.6 WG-EMM agreed to establish a dialogue with krill fishing vessel operators in order to obtain information on krill distribution patterns, overwintering tactics of krill, interactions between krill predators and the fishery, by-catch and the behaviour of fishing vessels. In particular, it was noted that the capture of acoustic data from echosounders used routinely on board fishing vessels could be valuable in describing distribution patterns. Members with an interest in collaborating on this topic were encouraged to develop appropriate proposals (Annex 4, paragraphs 3.31 to 3.42).

2.7 The Scientific Committee reiterated its advice (SC-CAMLR-XXI, paragraph 2.3) that all technical coordinators ensure that only the current versions of cruise reports and logbook forms be used, and should ensure that observers are aware of the correct data fields when recording data. In particular, observers need to be reminded to familiarise themselves with changes to the cruise reports, logbooks and associated instructions, and that all data fields requested need to be completed. Current observation requirements as detailed in conservation measures are summarised in Annex 5, Table 11.1.

2.8 Based on a recommendation received from WG-FSA, the Scientific Committee and the Commission agreed that there should be a major review of the *Scientific Observers Manual* (SC-CAMLR-XXII, paragraph 2.10 and Annex 5, paragraph 10.45; CCAMLR-XXII, paragraphs 4.5 and 6.17(iv)). The review refers to consideration of the manual format, structure and contents.

2.9 WG-EMM recommended that the review of the *Scientific Observers Manual* include consideration of: (i) the number of samples required for description of the catch of krill and the by-catch of other species; (ii) observer access to the factory decks in order to assess conversion factors and by-catch; (iii) extent of observer coverage required for unbiased data; and (iv) should include a meeting and/or correspondence involving practicing observers and observer coordinators (Annex 4, paragraph 3.43).

2.10 The Secretariat consulted intersessionally with technical coordinators and members of WG-FSA and WG-EMM in order to clarify potential shortcomings of the current manual and to elaborate a plan of work on the proposed review (WG-FSA-04/16). Several reasons for the proposed review of the manual were identified in the consultation. In general, the key need was that following extensive development and additions over many years, the manual is now due for an overhaul of its structure and contents (as it is also done periodically for other CCAMLR manuals and guidelines).

2.11 WG-FSA recommended that in order to accomplish the proposed review, the Scientific Committee and its working groups should first review research priorities for different fisheries, target and by-catch species and the types of data to be collected to allow research priorities to be met. An initial assessment of data collected by observers, an assessment of whether the collected data are used and the source of the data request are given in Annex 5, Table 11.2. This initial review needs additional input from other working groups and technical coordinators. The next stage of the review would be to determine whether existing data collection and recording protocols meet the identified data collection requirements. This phase should include development of clear guidance on prioritisation of observer tasks where requested data collection exceeds the time available to the observer at sea. The final stage of the review would be consideration of the most appropriate structure, format and contents of the manual.

2.12 In 2004, WG-FSA was not able to undertake the review of the manual and estimated that the proposed review of the manual could require more than one intersessional period. The Secretariat was requested to arrange for intersessional work in consultation with Mr N. Smith (New Zealand) and Dr E. Balguerías (Spain), technical coordinators of national observer programs and, as required, with other members of WG-FSA/ad hoc WG-IMAF and WG-EMM. The Working Group noted that additional resources, possibly including external consultants, may be needed to undertake the review in a comprehensive and timely manner.

2.13 The Secretariat advised that such consultant input could be estimated at comprising approximately 20 working days in 2005/06 and would cost about A$7 200. This would be additional to the A$20 000 allocated in the 2004/05 budget for Secretariat involvement in the manual's revision.

2.14 Unlike previous years, this year WG-FSA has not comprehensively assessed all CCAMLR scientific observer reports to compile and analyse additional data on compliance with relevant conservation measures. While this was mainly due to the large volume of observer reports received this year, WG-FSA felt it was inappropriate for it to carry out this type of analysis. The Scientific Committee recommended that SCIC could take initial responsibility for this function in future given its role and expertise in relation to compliance matters.

2.15 WG-FSA suggested that the Scientific Committee inform SCIC of the information identified by WG-FSA as relevant to its business, and that it may wish to further investigate electronic monitoring as a potential additional tool for monitoring compliance with conservation measures in future (Annex 5, paragraphs 11.56 to 11.60).

2.16 The Scientific Committee noted the recommendations by WG-FSA on data to be collected by observers (Annex 5, paragraphs 11.12 to 11.29).

2.17 The Scientific Committee endorsed the additions and modifications to the *Scientific Observers Manual* logbook data recording and reporting sheets, and instructions to scientific observers and technical coordinators outlined by WG-FSA (Annex 5, paragraph 11.61), and supported continuing action taken to ensure observer safety at sea (Annex 5, paragraph 11.9).

2.18 The Scientific Committee recommended the participation of Secretariat staff in the Fourth International Fisheries Observer Conference to be held from 8 to 11 November 2004 in Sydney, Australia, and the importance of feedback after that conference on the implementation of the CCAMLR Scheme of International Scientific Observation (Annex 5, paragraph 11.55).

Advice to the Commission

2.19 The Scientific Committee recommended:

(i) that international scientific observers continue to be placed on as many krill vessels as possible (paragraph 2.5);

(ii) that the timing and cost of the review of the *Scientific Observers Manual* (paragraphs 2.8 to 2.13) should be noted by the Commission;

(iii) that SCIC should take initial responsibility for the review of compliance with conservation measures using scientific observer reports (paragraph 2.14);

(iv) the implementation of changes to observer data collection outlined in paragraphs 2.16 and 2.17.

ECOSYSTEM MONITORING AND MANAGEMENT

General comments

3.1 Dr Hewitt, Convener of WG-EMM, reported that the 2004 meeting of WG-EMM was held from 12 to 23 July 2004 in Siena, Italy. Intersessional activities had been conducted by correspondence groups on preparations for this year's workshop, on the design of land-based krill predator surveys, and on the subdivision of CCAMLR statistical areas into ecologically-based harvesting units. During the meeting the following groups met:

- Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management

- Advisory Subgroup on Protected Areas
- Subgroup on CEMP Methods
- Ad hoc subgroup on subdividing the krill catch among SSMUs
- Steering Committee for the 2005 Workshop on Management Procedures
- Correspondence group on predator surveys
- Ad hoc subgroup on data collection on board fishing vessels
- Ad hoc subgroup on possible CCAMLR-sponsored activities during the International Polar Year (IPY).

3.2 These activities were summarised in three documents for consideration by the Scientific Committee:

(i) report of WG-EMM-04 (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 Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management (Annex 4, Appendix D);

(ii) synopses of working papers (SC-CAMLR-XXIII/BG/9) 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-04 to SC-CAMLR-XXIII (SC-CAMLR-XXIII/BG/18) containing appropriate references to paragraphs in the report of WG-EMM-04.

3.3 Similar to recent years, the agenda of WG-EMM-04 was structured to consider the status and trends in the krill fishery (Annex 4, section 3), the status and trends in the krill-centric ecosystem (Annex 4, section 4), and the status of management advice arising from these considerations (Annex 4, section 5). The information presented here is drawn from the report of WG-EMM-04 but is organised according to the agenda of SC-CAMLR-XXIII.

3.4 In particular, the Working Group drew the attention of the Scientific Committee to the highlights of the meeting, which will be discussed under several agenda items:

(i) the need for a consistent level of international observer coverage on krill fishing vessels (Agenda Item 2);

(ii) the need to establish an advisory subgroup on acoustic surveys (Agenda Item 3);

(iii) advice regarding protected areas (Agenda Item 3);

(iv) specification of plausible ecosystem models for testing management procedures (Agenda Item 3);

(v) 2005 Workshop on Management Procedures to evaluate options for subdividing the krill catch limit among SSMUs (Agenda Item 3);

(vi) publication of the CCAMLR-2000 Survey and representation of CCAMLR at the Fourth World Fisheries Congress (Agenda Item 12);

(vii) the need to develop plans for possible CCAMLR-coordinated activities during the IPY in 2007/08 (Agenda Item 15).

Status and trends in the krill-centric ecosystem

3.5 The Working Group reviewed information submitted on the status of krill predators, the krill resource and environmental influences (Annex 4, paragraphs 4.1 to 4.61).

3.6 The Working Group noted that the chinstrap penguin population monitored at Cape Shirreff, South Shetland Islands, continued to decline as it has over the past four seasons; however, all other breeding and foraging indices indicated that 2004 was an average year for the chinstrap and gentoo penguins at this site. Populations of gentoo, macaroni and eastern rockhopper penguins and Crozet shags continued to decrease at Marion Island in 2003/04. The decreases are thought to be due to a reduced availability of prey to birds foraging near the island (Annex 4, paragraphs 4.8 and 4.9).

3.7 The Working Group noted the potentially important influence of input from the Weddell Sea on the composition of the krill stock in the Scotia Sea and at South Georgia, which may vary considerably between years. The Working Group concluded that the role of the Weddell Sea warranted further consideration (Annex 4, paragraphs 4.17 to 4.20).

3.8 The density of krill in the Lazarev Sea (east of the Weddell Sea), observed in April 2004, was less than that observed in the South Shetland Islands. However, recruitment variability (high for the 2002 year class and low for the 2003 year class) was similar to that observed in the South Shetland Islands. Estimates of krill recruitment from observation in the vicinity of the South Shetland Islands indicate strong 2000, 2001 and 2002 year classes, which resulted in a substantial increase in the local krill population abundance, and poor recruitment from spawning in 2003 (Annex 4, paragraphs 4.29 to 4.33).

3.9 The Working Group noted a growing body of evidence suggesting that large-scale climatic variability has a potentially profound effect on the dynamics of the marine ecosystem in the southwest Atlantic Ocean (Scotia Sea). Variations in krill recruitment and reproductive success of krill predators have been linked to environmental variations (e.g. sea-surface temperature and extent of wintertime sea-ice). Questions remain, however, as to whether these variations represent propagation of ENSO signals from the Pacific Ocean, or a more immediate and broad-scale shift in baseline conditions corresponding to the postulated regime shift that affected conditions across the Pacific Ocean basin following the 1998 El Niño (Annex 4, paragraphs 4.34 and 4.42 to 4.49).

3.10 Dr M. Naganobu (Japan) noted the importance of examining ecosystem change, particularly in the Antarctic Peninsula region with a well-documented increase in temperature over past decades. He highlighted the need for more research on ecosystem change and variability through field projects, in particular, those which will be developed for implementation during the IPY.

3.11 Dr Constable noted that if ecosystem change is occurring, changes to existing models might be warranted. The assessment of krill may also need revision to take account of these changes.

3.12 Following last year's work on interpreting CEMP data, the Working Group reviewed the analysis by the Secretariat of data from Subarea 48.3. The Working Group agreed that ordination of variables according to functional groupings was a useful way to summarise and interpret variability in CEMP data and encouraged similar analyses for other regions. The Working Group also agreed that work should continue on describing the statistical properties of the CEMP parameters and combined indices, as well as procedures for making decisions based on summaries of CEMP data (Annex 4, paragraphs 4.50 to 4.61).

3.13 The Working Group reviewed a paper expressing concern with regard to exploitation of *D. eleginoides* and minke whales in the Ross Sea shelf ecosystem. The paper noted that this system was relatively unaffected by anthropogenic activities and that expansion of these fisheries could (i) prejudice scientific research programs designed to understand fundamental processes, such as the effect of climate change on the system; and (ii) create unforeseen effects on components of the ecosystem that are not currently monitored. Some participants took exception to the paper and expressed concern that conservation issues are given greater emphasis than the maintenance of sustainable fisheries. Other participants agreed with the conclusions of the paper and noted the need to coordinate conservation and management initiatives between CCAMLR and the IWC. The more general question was also raised as to how ecosystem changes due to natural causes can be separated from those due to fishing, if fisheries are occurring everywhere (Annex 4, paragraphs 4.68 and 4.79).

3.14 Dr Naganobu reported that Japan plans to conduct a research cruise focusing on environment–Antarctic krill–whale interactions in the Ross Sea and adjacent waters during a survey in 2004/05. The survey is intended to provide data which will contribute to an understanding of the Ross Sea ecosystem.

3.15 Dr Kock (IWC Observer) noted that Japan is currently engaged in scientific whaling in the Southern Ocean (Whaling Areas IIIe, IV, V, VIw), taking 440 minke whales each year.

3.16 Dr Constable noted that in general, the potential ecosystem effects of all fishing should be considered, including the potential effects of bottom longlining on benthic habitats. Dr V. Sushin (Russia) suggested that additional data should be collected and comparisons with the Atlantic sector should be made, prior to reaching conclusions on the state of the Ross Sea. Prof. C. Moreno (Chile) cautioned that the issue is not with the amount of data, but that if fishing results in habitat damage, a precautionary approach should be implemented.

3.17 The Working Group reviewed submitted information on land-breeding predators foraging on fish and squid. The Working Group requested the Scientific Committee to reconsider how it wishes to treat matters relating to ecosystem interactions involving fish and squid (Annex 4, paragraphs 4.80 to 4.84).

3.18 The Scientific Committee indicated that it wished to defer advice on this topic until:

(i) modelling initiatives involving food chains with considerable dependence on fish and squid are developed;

(ii) data time series with potential utility to assist in contributing to CEMP initiatives had been fully evaluated, especially taking account of the recommendations in the CEMP review.

3.19 In the meantime, it noted the proposed development of work on icefish might offer an appropriate focus for relevant work and the Scientific Committee endorsed the request to Members undertaking relevant research to support these initiatives, including by submitting appropriate papers to both WG-EMM and WG-FSA.

Subgroup on Acoustic Surveys and Analysis Methods

3.20 The Working Group reviewed a reanalysis of the CCAMLR-2000 Survey data using previously published refinements to the expected acoustic target strength of krill. The Working Group noted that while it requested this analysis, it had insufficient expertise at the meeting to comment on the results. The Working Group further agreed that it is important to develop a process by which such methodological advances are incorporated into the work of the group and that this should not become a protracted process where there is inactivity in the absence of appropriate feedback (Annex 4, paragraphs 4.87 to 4.91).

3.21 The Working Group also noted that WG-FSA had similar difficulties in interpreting acoustic surveys of icefish and recommended that a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) be established to advise the Scientific Committee in a timely fashion on protocols in acoustic surveys and analyses (paragraphs 3.94 to 3.96).

3.22 The Working Group recommended the following terms of reference:

To develop, review and update as necessary, protocols on:

(i) the conduct of acoustic surveys to estimate biomass of nominated species;

(ii) the analysis of acoustic survey data to estimate the biomass of nominated species, including estimation of uncertainty (bias and variance) in those estimates;

and that the immediate issues to be addressed by this subgroup are the acoustic protocols for assessing Antarctic krill in Area 48 and *C. gunnari* in Subarea 48.3 (Annex 4, paragraphs 4.90, 4.92 and 4.93).

3.23 Specifically, the Working Group requested that the subgroup consider whether a new model of krill target strength should replace the current CCAMLR-endorsed standard and provide their comments in time for the 2005 meeting of WG-EMM (Annex 4, paragraph 4.123; see also paragraphs 3.79 and 3.80).

New surveys

3.24 The Working Group reviewed announcements by Australia for a survey of krill in Division 58.4.2 (southwest Indian Ocean) and Japan for a survey of krill in Area 88 (Ross Sea). The Working Group noted that the recommendations of SG-ASAM with respect to krill target strength would be relevant to the analyses of data from these surveys (Annex 4, paragraphs 4.112 to 4.115).

3.25 Members welcomed these surveys, and noted the importance of a reassessment of acoustics methods. Dr Nicol further noted that the Australian survey was designed to provide data to CCAMLR to allow for a new estimate of the krill biomass to revise the catch limit, rather than relying on data collected in 1981.

CEMP methods

3.26 The Working Group reviewed a series of recommendations with respect to the CEMP standard methods that were developed during an informal workshop held at the Secretariat during February 2004 (Annex 4, paragraphs 4.109 to 4.111, Table 2).

Management of Protected Areas

3.27 Following consideration by the Subgroup on Protected Areas and recommendations of the Working Group (Annex 4, paragraphs 5.1 to 5.37), the Scientific Committee recommended that the Commission approve:

(i) the revised Conservation Measure 91-01, Annex 91-01/A ‘Information to be included in Management Plans for CEMP Sites’ (WG-EMM-04/19);

(ii) the Management Plan for ASPA No. 149, Cape Shirreff and San Telmo Island, Livingston Island, South Shetlands Islands, which is currently undergoing review by the ATCM (WG-EMM-04/8);

(iii) the Management Plan for ASPA No. 145, Port Foster, Deception Island, South Shetland Islands, which is currently undergoing review by the ATCM (SC-CAMLR-XXII/BG/14). Notwithstanding approval, the Scientific Committee also wished to transmit advice for substantive improvements to the originators of this plan (Annex 4, paragraph 5.14).

3.28 In respect of the subgroup’s term of reference relating to MPAs, Prof. Croxall:

(i) noted that CCAMLR had important responsibilities, as an organisation with the attributes of an RFMO, but with a wider conservation mandate, for participating in the international discussion on the development and implementation of MPAs as management tools for the world oceans;

(ii) introduced two papers, previously submitted to WG-EMM, which he believed provided important background information for CCAMLR’s work in this area.

SC-CAMLR-XXIII/BG/30 discussed the applicability of international conservation instruments to the establishment of MPAs in Antarctica and SC-CAMLR-XXIII/BG/28 listed current and proposed Antarctic MPAs within the Antarctic Treaty System.

3.29 Prof. Croxall noted that the UK had indicated, through an intersessional document placed on the CCAMLR website, its belief that more effective and coordinated progress was needed on this topic. The UK document suggested the need to:

(i) acquire and synthesise relevant background information;

(ii) create frameworks and mechanisms for addressing the topic in general and for examination of specific proposals.

3.30 In respect of the first suggestion, the UK believed there was merit in developing links with IUCN which, particularly through its Global Marine Program, was well placed to advise on the nature of current international initiatives of particular relevance to the Convention Area.

3.31 In respect of the second suggestion, the UK hoped that the subgroup could develop approaches which encourage the development and review of case studies relevant to proposals for different types of MPA, *inter alia*:

(i) areas within EEZs;

(ii) areas adjoining or linking existing EEZ MPAs;

(iii) areas surrounding islands or archipelagos of exceptional marine biodiversity;

(iv) large-scale areas of (or including) unique characteristics, perhaps particularly where management of harvestable marine resources coexists with extensive scientific research programs;

(v) seamount and canyon habitats with unique and/or highly diverse biological assemblages.

3.32 In respect of the last category (paragraph 3.31(v)), Prof. Croxall drew attention to the review paper, SC-CAMLR-XXIII/BG/29, on the biology, ecology and vulnerability of seamount communities and to the recent publication 'Seamounts: Biodiversity and Fisheries' (*Fisheries Centre Research Reports*, 2004, Vol. 12, No. 5) which contained a global review of potential seamount locations, indicating that there were at least 900 such sites within the Convention Area.

3.33 Prof. Croxall noted that although the topic of MPAs is a management tool available to CCAMLR and is an important element of the work of the Subgroup on Protected Areas, there has been insufficient time and expertise available during subgroup meetings at WG-EMM to make real progress. He recommended that a workshop should be held to review current principles and practices in this field, to assess how these would be best applied to the Convention Area and to consider existing and forthcoming proposals relating to MPAs in the Convention Area.

3.34 Dr Constable supported consideration of MPAs to improve conservation of biodiversity in the Southern Ocean. One way forward might be to conduct an inventory and risk assessment of various habitats; however, it was likely to take a very long time for this analysis to lead to management advice. He suggested that in the interim of this work being concluded, the use of open and closed areas in new and exploratory fisheries could provide the best opportunity for the Commission to protect future options for the conservation and rational use of Antarctic marine living resources.

3.35 Dr Shust agreed that these issues would require focused attention and that future considerations should take into account the whole ecosystem. For example, the Ross Sea has been discussed from a variety of viewpoints, but not in a holistic manner. The Scientific Committee should develop a plan to move forward, such as a workshop with submitted papers addressing all of the issues, including science, management, legal jurisdiction etc.

3.36 Dr E. Barrera-Oro (Argentina) agreed that a framework for discussion was required in order to make progress. In particular, he highlighted the importance of seamounts as marine habitats and their vulnerability to bottom trawling.

3.37 Dr E. Fanta expressed Brazil's strong support for the establishment of MPAs as an important tool for the maintenance of biodiversity and the targeted resources.

3.38 Dr Naganobu noted that the consideration of MPAs in the Convention Area should include not only conservation but also rational use according to Article II of CCAMLR.

3.39 Dr H.-C. Shin (Republic of Korea) observed that MPAs are one of a suite of management tools and that the application of MPAs should not restrict future management options.

3.40 Dr Fanta (SCAR Observer) reported that at the 2004 SCAR Life Sciences Standing Scientific Group (LSSSG) meeting in Bremen, Germany, the importance of MPAs was discussed, as well as procedures related to protected areas with a marine component. Dr Fanta noted that LSSSG might be conducting an exercise to identify areas to be protected for their outstanding values. SCAR could then decide on a plan that would be submitted to the ATCM and to CCAMLR in the case of an MPA. This topic will remain as a permanent agenda item in the LSSSG.

3.41 Dr Kock observed that the 1994 designation of the Southern Ocean Whale Sanctuary by the IWC was based on political considerations, rather than science. At its 2004 meeting, the IWC extended the sanctuary designation for an additional 10 years, while noting that designation of sanctuaries should be based on solid scientific rationale in the future.

3.42 Several Members stressed the urgency to make progress, noting that the depleted stocks of the past have not yet risen to pre-unregulated fishing levels even after several decades.

3.43 Dr Penhale suggested that an ad hoc group be convened during the Scientific Committee meeting in order to formulate a recommended plan of action for making progress, rather than waiting another year for the next meeting of the subgroup. She noted that additional expertise would be advisable to augment the expertise of those who attend the subgroup meetings during WG-EMM.

3.44 The Chair of the Scientific Committee appointed Dr Penhale to convene an ad hoc group to formulate a plan of action and to report back to the Scientific Committee before the end of its meeting.

3.45 The ad hoc subgroup met with the goal for furthering the discussion of MPAs as one of a suite of management tools available to support the goals of CCAMLR.

3.46 Early in the discussion, the group identified a workshop as a means to bring together various points of view and expertise in a focused manner. While many enthusiastically endorsed a workshop on MPAs, others cautioned that a workshop must be grounded in the goals of CCAMLR, including rational use as well as conservation. This was endorsed unanimously. The worldwide activity on MPAs in various government and intergovernmental organisations was cited, along with the need and opportunity for CCAMLR to apply its expertise in the Convention Area to a discussion of MPAs.

3.47 It was suggested that a workshop should deal with principles and practices involved in the establishment of MPAs and should address the pros and cons of different approaches. Several Members noted the importance of clearly addressing the rationale for MPAs versus other management tools as well as the level of protection required in a particular area, along with a description of the values to be protected and the extent of available scientific data. Others noted that once established, a scheme for period review of MPAs would be desirable. Some Members promoted the precautionary approach, including the importance for helping restore depleted fish stocks and assisting in the maintenance of ecological function and sustainable stocks in regulated fisheries.

3.48 Other potential topics for such a workshop included consideration of the relevant areas/scales of different types of potential MPAs (e.g. in relation to water mass movement and its effect on organisms within an MPA), the concepts of connectivity and corridors, the value of seamounts as marine habitats, conservation of biodiversity, and 'lessons learned' from established MPAs in other parts of the ocean.

3.49 Another suggestion was to consider discussion papers on proposals currently under development or in a conceptual phase that related to MPAs in the Convention Area. Examples given were the South African plan for the Prince Edward Island EEZ (CCAMLR-XXIII/BG/22), a revision of Antarctic Specially Managed Area No. 1 at Admiralty Bay by Brazil and Poland, the Balleny Islands plan under development by New Zealand, and ongoing discussions regarding the value of the least modified ecosystem of the Ross Sea.

3.50 Another desirable goal would be to start to evaluate needs for marine habitat conservation through a comprehensive review of the whole Convention Area, including defining the principal marine habitats involved and assessing the scientific data available in each area.

3.51 Members noted that while CCAMLR scientists were the experts in the Convention Area, scientists in governmental, intergovernmental and non-governmental organisations have long-established expertise in the development and management of MPAs. It was recommended that the workshop include invited experts, to take advantage of the large body of MPA knowledge that could be used to promote the goals of CCAMLR. Prior to the workshop, a paper could be produced to place existing MPA material in the context of CCAMLR's goals.

3.52 Draft terms of reference for the workshop were developed during the meeting:

(i) to review current principles and practices related to the establishment of Marine Protected Areas;

(ii) to discuss how the use of Marine Protected Areas could be used to contribute to furthering the objectives of CCAMLR;

(iii) to consider proposals that are currently under development or in a conceptual phase that relate to Marine Protected Areas in the Convention Area;

(iv) to discuss the types of scientific information that may be required for the development of Marine Protected Areas to further the objectives of CCAMLR, including the identification of biophysical regions across the Convention Area.

3.53 Practical issues addressed included the potential venue and timing of a workshop and financial support for such an endeavour. While Members recognised that these practical issues might not be resolved during the meeting, the Scientific Committee endorsed in principle the concept of a CCAMLR workshop on MPAs, and requested that the Chair of the Subgroup on Protected Areas act as Convener of the workshop. Intersessional tasks would include the creation of a steering committee to develop the agenda and suggested background papers, as well as identifying the appropriate venue and timing of the workshop.

3.54 Dr Penhale introduced a topic arising from WG-EMM-04 regarding the review of protected area management plans containing marine areas which are referred by the ATCM to CCAMLR for review and approval. WG-EMM recommended that CCAMLR devise a ‘general rule’ for proposals in coastal areas so that CCAMLR only focuses on protected areas with marine components that are of central interest to CCAMLR, rather than addressing areas only metres offshore or only containing a minimal area (Annex 4, paragraph 5.31).

3.55 The Scientific Committee agreed that such a mechanism would be welcome in that it would focus only on those protected areas that have potential impact on the goals of CCAMLR and would increase the efficiency of interactions between the ATCM and CCAMLR. It noted that such a scheme would need to be transparent, so that any Party would have the opportunity to call for review of a management plan that was proposed for ‘non-discussion’. It requested that WG-EMM advise on what such a general rule might be.

3.56 Dr Sullivan noted that New Zealand planned to continue work on a revised Balleny Islands management plan, which will have a solid scientific basis.

3.57 Dr Fanta reported that Brazil had undertaken three years of environmental monitoring research in Admiralty Bay in order to provide new scientific data for the revision of the plan.

Edmonson Point proposed ASPA

3.58 Dr Hewitt provided background information on the status of a proposed new ASPA at Edmonson Point, Woods Bay, Ross Sea (CCAMLR-XXIII/41). The management plan, which requires approval by CCAMLR due to the inclusion of a marine area in the site, was received too late for consideration at WG-EMM. This will result in a one-year delay in consideration by the Scientific Committee and the Commission, and a further delay in being available for approval by the ATCM whose own intersessional review will be reported to their June 2005 meeting. Under these circumstances, some Members at WG-EMM wished to make allowances for the late submission and to permit the subgroup to review the plan. It was agreed that the subgroup could continue to work intersessionally, pending a decision by the Scientific Committee as to whether it would accept advice on the Edmonson Point management plan directly from the subgroup (Annex 4, paragraphs 5.27 to 5.37).

3.59 Dr Penhale (Chair, Subgroup on Protected Areas) summarised the intersessional review of the Edmonson Point plan. The consensus of the few Members who provided comments was support of the plan, which was viewed as well written and scientifically sound, with a clear description of the values to be protected.

3.60 The Chair stated that his concern, which had nothing to do with the merits of the management plan, was that if the rules of procedure were not upheld in this case, other exceptions would be sought in the future. He reiterated that the normal course of action is for the Subgroup on Protected Areas to report to WG-EMM, and for WG-EMM to report to the Scientific Committee which formulates advice to the Commission.

3.61 At the request of the Chair, Dr M. Vacchi (Italy) provided some background on the plan. He noted that the values to be protected focused on the diverse terrestrial and freshwater components of the ecosystem, which provide an excellent site for climate change research. Years of research at an Adélie penguin colony within the site have contributed to the goals of CEMP. The marine component consists mostly of an area extending only 200 m offshore.

3.62 A discussion followed which focused on various aspects of the situation. Members were strongly supportive of the plan itself, citing the high quality of the plan, including the maps, and the solid scientific research that has been conducted at the site. There was some concern that a delay could have negative implications, if increasing pressures to the site were to emerge. All agreed that the inclusion of the small marine component would not affect the goals of CCAMLR, as it was extremely unlikely that any fishing activities could be conducted within the site.

3.63 Despite the positive support for the proposed management plan, a consensus could not be reached as to whether the Scientific Committee should review the plan. Some Members felt that the need for protection, particularly with the reality of at least one year's delay, warranted making an exception to the rules. Others felt that the rules and procedures should be strictly adhered to and that the plan should be referred to the 2005 meeting of the subgroup at WG-EMM. In the absence of consensus, the plan was referred to the subgroup for formal discussion at the 2005 meeting of WG-EMM. Despite this lack of a formal positive recommendation, many Members recommended that the Commission indicate to the ATCM that, based on the existing informal review, there appeared to be no objections to the plan.

3.64 In the discussion that followed, two general themes emerged. One was that the Edmonson Point plan provided a concrete example of the need to develop criteria by which management plans referred to CCAMLR by the ATCM could be initially categorised into two groups: those which are of interest to CCAMLR (thus requiring review) and those containing such minor marine areas that formal review would be unwarranted (paragraph 3.55).

3.65 The second point was the recommendation that the rules and procedures of the subgroup should be reviewed in order to increase operational efficiency and to facilitate interactions with both WG-EMM and WG-FSA, two groups with interests in many of the topics referred to the subgroup.

Management advice on allocation of the krill catch limit among SSMUs

3.66 As part of its long-term work plan, the Working Group indicated that it would forward a recommendation in 2004 for the subdivision of the precautionary catch limit of krill in Area 48 among SSMUs adopted by the Commission in 2002. The Working Group considered five options (see Hewitt et al., 2004, for a description of these options). However, consensus on a recommendation was not achieved. Instead, the Working Group agreed to use the modelling framework outlined at this year's workshop to evaluate the various assumptions underlying each of the options (Annex 4, paragraphs 5.39 to 5.60).

3.67 Drs Sushin and Naganobu noted that the krill catch currently shows a decline in Subarea 48.3, suggesting that allocation of precaution catch limit of krill by SSMU is not an extremely urgent matter at this time.

3.68 Other Members reaffirmed that, irrespective of the interpretation of current trends in krill fishing effort, recommendations for the subdivision of the precautionary catch limit for krill among SSMUs have been required by the Commission. This subdivision is essential to the management of krill fishing in Area 48 and the development of appropriate recommendations is proceeding according to a process and plan endorsed by all Members of the Scientific Committee (Table 1).

Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management

3.69 During the first week of the 2004 meeting of the Working Group, a workshop was held to specify plausible operating models of the krill-centric ecosystem that could be used to test alternative management procedures. This was the third workshop in the long-term work plan of WG-EMM to develop a revised krill management procedure (Table 2).

3.70 In developing its long-term plan, the Working Group and the Scientific Committee agreed that the revised krill management procedure should be based on ecosystem monitoring. These observations can then be used as a basis for an assessment of the state of the system. In a parallel fashion, specified management objectives can be used as a basis to define the desirable states of the system. The difference between the observed state and the desired state triggers decision rules. These decision rules act on the only part of the ecosystem amenable to control – that is, the fishery (Figure 1).

3.71 In order to test the performance of alternative management procedures, the Working Group agreed to specify an operational model that would simulate the krill-centric ecosystem. The management procedure that performs best with respect to achieving the objectives of conservation and rational use, and is the most robust with respect to errors in specifying and observing the system, would be the preferred alternative (Figure 2).

3.72 The Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management, an element in the Scientific Committee's long-term program of work for WG-EMM, was convened by Dr Constable during the first week of the 2004 meeting of WG-EMM. Abbreviated terms of reference were:

(i) to review the approaches used to model marine ecosystems;

(ii) to consider plausible operating models for the Antarctic marine ecosystem;

(iii) to advance a program of work to develop and implement operating models that could be used to investigate the robustness of different management approaches to underlying uncertainties in the ecological, fishery, monitoring and assessment systems.

3.73 The report of the workshop is included as Appendix D in the WG-EMM-04 report (Annex 4). Discussion of the workshop report is recorded in Annex 4, paragraphs 2.1 to 2.31. The workshop report was organised around six general headings:

(i) review of intersessional activities
(ii) desirable attributes of ecosystem models
(iii) conceptual representation of ecosystem models
(iv) plausible scenarios for the Antarctic marine ecosystem
(v) model formulation and specification
(vi) future work.

3.74 A steering committee coordinated intersessional work in preparation for the workshop. These activities included consultation with ecosystem modelling experts, review of relevant literature, review of available software, consideration of data requirements, and preliminary specifications of model components.

3.75 Dr Fulton was invited to the workshop in recognition of her expertise in developing models used to evaluate management strategies. She provided background on management strategy evaluation, steps for developing ecosystem models, and case examples of two management regimes that she has evaluated. She also provided guidance to workshop participants as they laid out the conceptual design and specification of various components of a model of the Antarctic marine ecosystem. Her contributions were critical to the success of the workshop.

3.76 The general attributes required of an ecosystem model used to evaluate management procedures were reviewed and agreed. These include the incorporation of fishing effects, specification of observations and monitoring programs, flexibility in the degree of aggregation possible among taxonomic groups, use of multiple spatial and temporal scales, flexibility in how interactions between components are simulated, and incorporation of external conditions and processes.

3.77 Conceptual models were developed for the following system components: physical environment, primary production, pelagic herbivores and invertebrate carnivores, harvested species (krill and icefish), mesopelagic species, marine mammals, birds and fisheries. The aim was to provide a flexible framework for considering how each taxon might be influenced by the rest of the ecosystem. Schematic diagrams and tables were developed to describe key population processes and interactions with other components of the system. These specifications can now be used by programmers to produce a modelling framework. The performance of plausible models developed within this framework can then be tested with respect to underlying structural assumptions and observation errors.

3.78 Discussion of plausible scenarios that need to be considered in evaluating the robustness of krill management procedures to structural uncertainties of the model focused on two broad topics. The first was concerned with the plausibility of the model and the second was concerned with questions of ecosystem dynamics. Of several possible scenarios, the following were accorded the highest priority:

(i) behaviour of the model system in response to artificial (i.e. known) forcing functions in order to better understand the properties of the model;

(ii) effects of alternative formulations of krill transport on ecosystem dynamics;

(iii) effects of climate change on primary production and/or ocean circulation.

The Working Group also requested guidance from the Scientific Committee with regard to the priorities for exploring realistic scenarios and future work.

3.79 With respect to model formulation and specification, the Working Group agreed that it would be desirable to develop an ecosystem model as a series of connected modules rather than a single large piece of software. The Working Group also agreed that particular attention should be paid to how interactions between taxa are simulated, how time and space are resolved, and how peripheral processes and boundary conditions are incorporated.

3.80 The Working Group agreed that future work will entail validating and refining the conceptual models developed during the workshop as well as the specification of additional ones. In this regard it requested WG-FSA review the fish, squid and fisheries components, and provide component details for toothfish and demersal species. This request is described in more detail in paragraph 7.2 of the workshop report (Annex 4, Appendix D).

3.81 Dr Hanchet (WG-FSA Convener) reported that the Working Group had insufficient time to address this topic during its 2004 meeting, but would conduct a review prior to the 2005 meeting.

3.82 Dr Constable noted that it was important to consider the interactions between krill, icefish and the respective fisheries in Subarea 48.3 in the development of operating models. The development of an icefish-related monitoring program is a separate issue. It could be considered later in the development of management procedures for either fishery. He suggested that papers to underpin modelling efforts should be directed to WG-EMM and papers related to icefish monitoring be directed to WG-FSA. He observed the overlap between the two Working Groups in the areas of modelling, monitoring and acoustics and recommended streamlining the work effort.

3.83 With respect to next year's Workshop on Management Procedures, the Working Group noted that initial exploration of management options could be achieved using spatially structured krill population models that allow exploration of the interactions between:

- the krill population
- spatial catch limits and the fishery
- krill predators
- transport of krill.

3.84 The Working Group agreed to establish a steering committee to further the development of plausible ecosystem models and established terms of reference that include coordination of further development of the modelling framework, publication of work, input from the Secretariat, and support of future WG-EMM workshops. The Working Group requested that Members consider representation on the steering committee, and that the structure of the committee, including its convener, be determined by the time of the meeting of the Scientific Committee. To that end, the Chair of the Scientific Committee agreed to coordinate the process, with assistance from Dr Constable, during the 2004/05 intersessional period (Annex 4, paragraphs 5.62 to 5.64).

Future Work of WG-EMM

3.85 The Working Group agreed that plans for conducting synoptic surveys of land-based predators should continue. In particular, the planning will consider field methods, survey design, logistical requirements and methods of data analysis. The Working Group recommended that this work should initially be done through intersessional correspondence. The Working Group further directed the correspondence group for land-based predator surveys to develop a work plan, including financial implications, in time for the 2004 meeting of the Scientific Committee. Subsequently, the correspondence group developed the work plan which includes a workshop in 2006 (Table 1; Annex 4, paragraphs 6.1 to 6.11).

3.86 The Working Group agreed that the objective for the 2005 Workshop on Management Procedures should be to evaluate options for the subdivision of the precautionary catch limit of krill in Area 48 among the SSMUs. These options include subdivisions developed according to (Annex 4, paragraphs 6.12 and 6.13):

(i) spatial distribution of catches by the krill fishery;

(ii) spatial distribution of predator demand;

(iii) spatial distribution of krill biomass;

(iv) spatial distribution of krill biomass minus predator demand;

(v) spatially explicit indices of krill availability that may be monitored or estimated on a regular basis;

(vi) pulse-fishing strategies in which catches are rotated within and between SSMUs.

3.87 Dr Constable noted that the Commission had requested this work be undertaken and that it was prudent to be able to provide advice concerning the options involving the establishment of SSMUs before catches reach critical levels. Some Members expressed support for the continuation of this work, while other Members expressed negative views on the concept of SSMUs. The Chair of the Scientific Committee reiterated that the Scientific Committee's role is to provide the Commission with advice solely based on scientific principles.

3.88 The Working Group further agreed that these candidates should be evaluated by quantifying the degree to which they are robust or sensitive both to a range of assumptions about the structure and function of the predator–krill–fishery system and to the data or conditions that are used to initialise the candidate procedures. Robustness and sensitivity will be determined by measures of performance of important attributes of the krill–predator–fishery system, which could include factors such as catch rates and predator survival (Annex 4, paragraph 6.14).

3.89 In preparation for the workshop, three intersessional correspondence groups were established to identify appropriate data, define alternative assumptions, and specify performance measures with respect to the krill resource, the krill fishery and krill predators. Members were also requested to develop models that would be able to explicitly consider alternative structural assumptions and produce identified performance measures (Annex 4, paragraphs 6.15 to 6.24)

3.90 The Working Group noted that the workshop planned for 2005 should be viewed as the first workshop to evaluate management procedures for the krill fishery (i.e. the subdivision of the krill catch limit among SSMUs). The Working Group further noted that it may be useful to convene a workshop in 2006 that considers CEMP in the context of an operating model of the Antarctic ecosystem. This workshop would be the second evaluation of management procedures for the krill fishery (Annex 4, paragraphs 6.25 to 6.27).

3.91 The Working Group updated its long-term work plan and asked for endorsement by the Scientific Committee (Table 1).

3.92 The Working Group also noted the need to (i) consolidate work that overlaps with WG-FSA and WG-IMAF, (ii) review information that is of interest to the Working Group but due to time constraints receives limited consideration, (iii) make available quantitative expertise, (iv) respond to broader conservation issues, and (v) establish new subgroups to consider specific issues. Furthermore, it noted the increased demands on the Secretariat in support of the Working Group and recommended that the Scientific Committee, in consultation with the Secretariat, consider how to best coordinate and structure the work of its working groups and subgroups (Annex 4, paragraphs 6.28 to 6.30).

3.93 Members endorsed the plan of work and noted that the strategic planning activity was the venue in which to merge appropriate activities of WG-EMM and WG-FSA.

3.94 Dr Hanchet called attention to the WG-FSA advice to the Scientific Committee summarised in SC-CAMLR-XXIII/BG/27, paragraphs 10.23 to 10.26. These recommendations include the establishment of SG-ASAM in conjunction with WG-EMM, coordinated work on icefish-centred ecosystem monitoring in conjunction with the krill-centred monitoring program, and encouragement for Members to conduct ecosystem-based research in areas where icefish populations occur, using the data collected for ecosystem modelling.

3.95 Some Members supported the establishment of SG-ASAM, but noted that there is a critical lack of expertise among those attending either WG-EMM or WG-FSA. It was suggested to bring in experts from groups such as the ICES-FAST group. Obtaining assistance from those already focused on the topic could result in a more efficient means to bring best practices to the working groups.

3.96 Other Members felt that outside experts might be too busy to focus on CCAMLR's issues. Asking others to solve CCAMLR's issues would be unproductive. It was noted that expertise is to be found among Member countries which could provide acoustic experts to address the tasks.

3.97 Dr Fanta reported that she is chairing, in conjunction with Dr Kock, an ad hoc subgroup of WG-FSA on ecosystem interactions. The goal of the subgroup is to discuss how an ecosystem monitoring program centred on icefish could be established and what would be needed to build an ecosystem model of such a system. A preliminary search revealed that there is a great amount of data available in CCAMLR documents, as well as in publications outside the CCAMLR arena. An action plan will be developed and circulated intersessionally. Members are asked to contribute with papers on icefish biology and interactions with other elements of the ecosystem.

3.98 The Chair of the Scientific Committee reiterated the need for experts to participate in the working groups and in workshop activities in order to make progress.

Management advice

3.99 The Scientific Committee called to the attention of the Commission the following items arising from WG-EMM:

(i) the need to establish an advisory subgroup on acoustic surveys (paragraphs 3.21 and 3.22);

(ii) specification of plausible ecosystem models for testing management procedures (paragraphs 3.69 to 3.84);

(iii) 2005 Workshop on Management Procedures to evaluate options for subdividing the krill catch limit among SSMUs (paragraph 3.86);

(iv) a future workshop on MPAs (paragraphs 3.44 to 3.53);

(v) a future workshop on large-scale surveys of land-based predators (Table 1);

(vi) the need for a review of the rules and procedures related to the work of the Subgroup on Protected Areas and to develop additional criteria in reviewing protected areas referred to CCAMLR from the ATCM (paragraphs 3.64 and 3.65);

(vii) the need for the Scientific Committee to consolidate work that overlaps with WG-FSA and WG-IMAF (paragraph 3.92);

(viii) the WG-EMM long-term plan of work (Table 1).

3.100 The Scientific Committee recommended that the Commission approve (paragraph 3.27):

(i) revised Conservation Measure 91-01, Annex 91-01/A 'Information to be included in Management Plans for CEMP Sites';

(ii) Management Plan for ASPA No. 149, Cape Shirreff and San Telmo Island, Livingston Island, South Shetlands Islands, which is currently undergoing review by the ATCM;

(iii) Management Plan for ASPA No. 145, Port Foster, Deception Island, South Shetland Islands, which is currently undergoing review by the ATCM, along with advice for improvements to the originators of this plan (Annex 4, paragraph 5.14).

HARVESTED SPECIES

Krill resources

Status and trends

2002/03 season

4.1 The total catch of krill for the 2002/03 season was 117 728 tonnes. Most of the catch came from within three of the 15 SSMUs in Area 48 (north of Livingston Island, west of Coronation Island and northeast of South Georgia) (Annex 4, paragraph 3.1).

2003/04 season

4.2 The krill catch reported prior to the meeting was 87 133 tonnes (SC-CAMLR-XXIII/BG/1) (Table 2). Seven Members had been fishing for krill, all in Area 48. A single vessel from Vanuatu had also been fishing for krill in Area 48 and during the Scientific Committee meeting submitted its catch data to the Secretariat. This vessel caught 14 979 tonnes of krill bringing the total catch of krill in the Convention Area to 102 112 tonnes.

4.3 The Vanuatu-flagged vessel (the *Atlantic Navigator*) appears to be using new technology to catch and process krill. Dr E. Marschoff (Argentina) reported that Argentinian authorities had been approached by the Vanuatu-flagged vessel about landing krill in Ushuaia. The krill were being caught using a pumping system and the anticipated catch had been stated as 20 000–30 000 tonnes. The company had not responded to requests for more details.

4.4 The Scientific Committee was informed that the Vanuatu vessel carried a Uruguayan observer and that Uruguay would provide information to CCAMLR on the catch, fishing methods used and by-catch. Uruguay was requested to submit a paper to WG-EMM next year detailing the Vanuatu krill fishing operation.

4.5 The UK catch had been from an icefish vessel which had also fished experimentally for krill. The operation was unlikely to generate considerable catches in the future.

Fishing plans for 2004/05

4.6 All Members fishing for krill submitted details of their intentions on the pro forma developed at the 2003 meeting (SC-CAMLR-XXII, Annex 6). Eight Members announced the intention to fish for krill in Area 48 using 13 vessels and a total projected catch of 226 000 tonnes (Annex 4, Table 1). The Scientific Committee acknowledged that the submission of these data was a significant development.

4.7 The projected krill catch for 2004/05 (226 000 tonnes) was considerably higher than the 2003/04 catch and was also higher than the catch projected for the 2003/04 season (165 000 tonnes; SC-CAMLR-XXII, Table 4). The Scientific Committee agreed that the predicted catches are likely to be estimates of potential catches and that a total catch of 160 000 tonnes in 2004/05 might be a more reasonable expectation.

4.8 Dr Sushin reminded the Scientific Committee that in contrast to the predicted catch which had increased during the last three years, the reported catch decreased by 25% from 126 000 tonnes in 2001/02 to 102 000 tonnes in 2003/04 season. This fact indicated that the krill fishery might actually be declining rather than increasing and that discussions of future trends should be based on factual data rather than on combined notifications.

4.9 The Scientific Committee noted that the krill fishery notifications should be used to indicate interest and trends in the fishery rather than to accurately predict future catches, and encouraged the future submission of this information. In particular, the number of vessels and the products derived might be useful indicators of trends.

4.10 Information on the trends in the krill fishery contained in SC-CAMLR-XXII, Table 4, would be most useful when viewed in a time series which would allow the detection of multi-year trends in fishing interest. It was recognised that projections of future catches were likely to be higher than actual catches but the Scientific Committee agreed that there was value in obtaining these data so that significant changes in the fishery might be detected in advance.

4.11 The entry of non-Members fishing for krill using new technology suggested that the nature of the fishery could change and that these changes could be driven by developments occurring outside the CCAMLR community. WG-EMM needs to be able to assess the effects of any changes in fishing technology on the krill fishery and the Scientific Committee noted the continued paucity of information on the economic and technological drivers of the krill fishery.

4.12 The Japanese krill catch is now less than 50% of the annual catch and the krill fishery is now being operated by vessels from a larger number of Member and non-Member nations. Such a situation will lead to greater uncertainty in long-term predictions of krill catches.

4.13 The Scientific Committee noted a report from ASOC (SC-CAMLR-XXIII/BG/25) addressing the conservation of krill within the Antarctic ecosystem and the factors which might affect the development of the fishery. The paper suggested that the subdivision of the krill catch in Area 48 into SSMUs should be accorded a high priority and indicated the utility of haul-by-haul data and scientific observers to the work of the Scientific Committee. The paper also recommended the use of VMS on krill vessels, the submission of detailed fishing plans and the coordination of scientific research on krill.

Advice to the Commission

4.14 The krill catch in 2003/04 was likely to be lower than 2002/03 but projected catch levels submitted by Members continued to indicate the potential to increase the catch substantially in 2004/05.

4.15 The Commission should note the utility of the information provided by Members on the newly developed fishing plan pro forma and the Scientific Committee recommended that submission of data using this form should continue.

4.16 The Commission's attention was drawn to the catch of krill taken by a vessel from a non-Member (Vanuatu, an Acceding State) and the Scientific Committee noted that this new entrant might be using new technology which could affect the operation of the krill fishery in future.

4.17 The Scientific Committee's ability to predict trends in the krill fishery was still being hampered by a lack of information on technological and economic developments.

Fish resources

Fishery Plans

4.18 The Scientific Committee noted that there had been a reorganisation and reconstruction of the database by the Secretariat that holds the time series of information used in the Fishery Plans. Information and revised layout for the Fishery Plan are set out in Annex 5, paragraphs 3.9 to 3.11.

4.19 The Scientific Committee was concerned that there may be different definitions of 'Fishery' in the revised Fishery Plan and Conservation Measure 32-01, as well as issues related to gear and fishery status. The Scientific Committee asked that all definitions contained in Fishery Plans should be harmonised with conservation measures.

Status and trends

Fishing activity in the 2003/04 season

4.20 Nine finfish fisheries, including five exploratory fisheries, were conducted under the conservation measures in force in 2003/04. 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 48.6, 88.1, 88.2 and Division 58.4.2 and 58.4.3b. 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.

4.21 The Scientific Committee noted that catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in the 2003/04 fishing season are summarised in Table 3. These had been updated to 24 September 2004 and reported in SC-CAMLR-XXIII/BG/1.

4.22 The Scientific Committee noted that catch, effort and length data were submitted for all fisheries managed under conservation measures, and that data were also submitted from fisheries operating in EEZs, albeit not all in the standard CCAMLR format.

Reported catches of *Dissostichus* spp. inside the Convention Area

4.23 Reported catches of *Dissostichus* spp. are shown in Annex 5, Table 3.1. Inside the CCAMLR Convention Area a total of 13 307 tonnes was reported during the 2003/04 season (Table 3) compared with 18 507 tonnes in the previous season (Table 4).

Reported catches of *Dissostichus* spp. outside the Convention Area

4.24 Catches outside the Convention Area were 10 966 tonnes during the 2003/04 season compared with 24 137 tonnes in the previous season. This information is detailed in Annex 5, Table 3.3. The Scientific Committee additionally noted that the catch of *Dissostichus* spp. outside the Convention Area, as reported in the CDS data, in 2003/04 was 6 342 and 3 701 tonnes for Areas 41 and 87 respectively, down from 10 001 and 5 745 tonnes respectively for 2002/03.

Estimates of catch and effort from IUU fishing inside the Convention Area

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

4.26 The Scientific Committee noted that the highest level of IUU catch inside the Convention Area during the 2003/04 season was 643 tonnes from Division 58.5.1, down from 7 825 tonnes from this division during the 2002/03 season.

4.27 The Scientific Committee noted the sharp decrease in estimates of overall IUU catch. Issues related to trends in IUU fishing are discussed under Item 7 of this report.

Research surveys

4.28 The Scientific Committee noted the following research surveys undertaken in 2003/04: a multidisciplinary research survey in Subareas 48.3, 48.4 and 48.6 by the USA (Annex 5, paragraph 3.23); a random stratified bottom trawl survey in Division 58.5.2 by Australia (Annex 5, paragraph 3.24); a random stratified bottom trawl survey in Subarea 48.3 by the UK (Annex 5, paragraph 3.25); and a multidisciplinary research survey in Subarea 88.1 by New Zealand (Annex 5, paragraph 3.23).

4.29 A simulation approach to evaluating toothfish recruitment surveys (Annex 5, paragraph 3.27) was endorsed by the Scientific Committee, as well as endorsing research towards combining acoustic and trawl survey data to estimate *C. gunnari* standing stock size (Annex 5, paragraphs 3.33 to 3.39).

Fish biology/ecology/demography

Tagging studies

4.30 The Scientific Committee noted that substantial progress has been made in fish tagging studies, endorsed the continuation of toothfish tagging as a requirement for all new and exploratory toothfish fisheries (Conservation Measure 41-01, Annex C), and encouraged their use in all fisheries where appropriate. The Scientific Committee recognised the substantial progress made to advance CCAMLR Member tagging programs in the Convention Area (Annex 5, paragraphs 3.43 to 3.47), and endorsed recommendations and changes to tagging protocols set out in these paragraphs.

4.31 The Scientific Committee requested that contact names for the various Member country tagging programs be made available to the Secretariat.

4.32 Dr Constable noted that Australian research of t-bar tag detection using wire-coded Tirus tags demonstrated that there can be a lower detection of t-bar tags when these tag types are used without the addition of wire-coded tags. Dr Constable encouraged other tagging programs to evaluate tag detection levels using similar methods, as accurate estimates of tag detection rate was an important parameter in the use of tagging data to estimate biomass.

Biological parameters

4.33 The Scientific Committee noted new information on biological parameters (Annex 5, paragraphs 3.53 to 3.58), including length–mass relationships for *D. mawsoni* in different areas in Subarea 88.1; estimates of age and growth of *Amblyraja georgiana* in Subarea 88.1; partial age validation of *D. eleginoides* in Division 58.5.2; new growth curves for *D. eleginoides* in Subarea 48.3; a comparison of age densities of *C. gunnari* between CMIX and direct ageing; and a review of icefish biology including length–mass and growth. The Scientific Committee encouraged continued work on population parameters important for the assessment process.

4.34 The Scientific Committee invited papers that considered the relationship between life-history parameters, such as natural mortality (M) and von Bertalanffy growth parameters. The Scientific Committee noted that the life-history theory predicts that such relationships should be constant within species, and that changes in the state of ecosystems due to harvest and environmental changes may alter these relationships.

Stock structure

4.35 The Scientific Committee noted that several papers investigated stock structure of species in different parts of the Convention Area. These are summarised in Annex 5, paragraphs 4.34 to 4.36.

4.36 The Scientific Committee agreed that *D. eleginoides* in Subarea 48.3 should be separated into three parts for the purposes of assessment and management. It endorsed the recommendation that the assessment only be applied to the area around Shag Rocks/South Georgia and that Maurice Ewing Bank to the north and the North Scotia ridge in the west be considered as separate areas for which there is no information.

General biology and ecology

4.37 The Scientific Committee noted a large number of papers tabled at WG-FSA which contained substantial biological information on target and non-target species (Annex 5, paragraph 9.1).

4.38 Subjects addressed in these papers included diet of *D. eleginoides* and *D. mawsoni*; diet, ageing methods, and population biology of *C. gunnari*; spawning information and population biology of *D. mawsoni* in the Ross Sea; and new information on by-catch species, ichthyoplankton sampling, a marine biodiversity initiative, a detailed review of icefish biology, and biology of various other icefish species.

4.39 The Scientific Committee agreed that species profiles are a valuable tool for summarising the history of research and current understanding of target species for assessments, and considered it important that they are updated annually with new information either presented to, or generated by, WG-FSA.

4.40 The Scientific Committee noted information relating to a proposed age determination workshop on *C. gunnari* (Annex 5, paragraphs 9.8 to 9.12). The Scientific Committee endorsed this workshop and saw it as an important first step towards reconciling difficulties in age determination of this species.

Developments in assessment methods

4.41 The Scientific Committee noted the substantial progress made on assessment methods by WG-FSA-SAM at its intersessional meeting held at the University of Siena, Siena, Italy, from 5 to 9 July 2004. Results of this workshop are summarised in Annex 5, paragraphs 4.3

to 4.12. The Scientific Committee noted that WG-FSA had tasked future work priorities for WG-FSA-SAM, and endorsed the recommendations for the development and evaluation of assessment methods as set out in Annex 5, paragraph 4.15.

4.42 A number of papers with elements contributing to assessment methods were noted by the Scientific Committee. These papers are summarised in Annex 5, paragraphs 4.18 to 4.33. The papers dealt with a wide range of issues, many of which are considered in the assessment sections of the Fishery Reports. Six papers provided preliminary stock assessments for active fisheries in the CCAMLR Convention Area. Some of these assessments involved existing 'CCAMLR approved' methods (i.e. short-term projection for icefish, and recruitment-based long-term yield for toothfish), whilst others used alternative approaches (e.g. tagging estimators, ASPM) proposed for application to *D. eleginoides*.

4.43 The points concerning the assessment timetable this year were noted by the Scientific Committee. These are set out in Annex 5, paragraph 4.39. The Scientific Committee noted that all the assessments undertaken by WG-FSA this year were initially based on preliminary assessment working papers that were subsequently reviewed independently by WG-FSA.

Assessment and management advice

Assessed fisheries

4.44 The Scientific Committee welcomed the development of Fishery Reports compiled by WG-FSA for assessed fisheries (Annex 5, Item 5), and noted each Fishery Report included:

1. Details of the fishery
2. Stocks and areas
3. Parameter estimation
4. Stock assessment
5. Fish and invertebrate by-catch
6. Bird and marine mammal by-catch
7. Ecosystem implications/effects
8. Harvest controls.

D. eleginoides at South Georgia (Subarea 48.3)

4.45 The catch limit for the *D. eleginoides* fishery in Subarea 48.3 in the 2003/04 season was 4 420 tonnes (Conservation Measure 41-02). The catch from this fishery during the 2003/04 season, as reported by 1 October 2004 in the catch and effort reporting system, was 4 482 tonnes, the vast majority of which had been taken by longline. The fishery was active from 1 May to 21 August 2004 (Annex 5, paragraph 5.103, Table 5.13).

4.46 The Scientific Committee noted the revised areas for inclusion of catches in the assessment of the South Georgia and Shag Rocks stocks of *D. eleginoides* in Subarea 48.3 defined in Annex 5, Figure 5.5, and used by WG-FSA for determining catches to be included in the 2004 assessment (Annex 5, Table 5.14). The Scientific Committee recommended that the revised areas be adopted for the current and future assessments.

4.47 The Scientific Committee thanked the Working Group for the considerable work undertaken, intersessionally and at this year's meeting, to review and revise the assessment of long-term yield for *D. eleginoides* in Subarea 48.3 (Annex 5, paragraphs 5.104 to 5.115).

4.48 The Scientific Committee recalled its request for a review of methods to estimate recruitment of *D. eleginoides* from surveys (SC-CAMLR-XXII, paragraphs 4.49 and 4.50), and noted the progress made by the Working Group with respect to evaluation of survey design and use of CMIX (Annex 5, paragraphs 3.27 and 5.115 to 5.120).

4.49 The Scientific Committee welcomed the progress that had been made with the development of the ASPM approach (Annex 5, paragraphs 5.138 to 5.141). The Scientific Committee noted that at this stage the results of the ASPM were highly sensitive to the weighting factors applied to the different data inputs and values specified for fixed parameters and encouraged further development and evaluation of the ASPM in order to better understand the properties of the model and the potential application of the approach to *D. eleginoides*.

4.50 The Scientific Committee recalled the problems identified last year with the estimates of recruitment for *D. eleginoides* in Subarea 48.3 (SC-CAMLR-XXII, paragraphs 5.104 to 5.111). WG-FSA has corrected the problems identified with the survey data and revised the assessment of recruitment-based long-term annual yield (Annex 5, paragraphs 4.3 and 4.4). At its last meeting, the Commission noted that should previous catches have been above precautionary yield levels, then this will be taken into account when calculating subsequent precautionary yields (CCAMLR-XXII, paragraph 4.50; SC-CAMLR-XXII, paragraph 5.123). The Scientific Committee noted the following results from WG-FSA this year using the method adopted in 1995, including the method for giving greater emphasis to simulation trials that have similar trends to the standardised CPUE time series, and using the revised recruitment data (Annex 5, Table 5.26, Series FSA-04 48.3 vB) with all other input parameters the same as last year (called the 'base-case' scenario):

(i) the new series of recruitments had a substantially lower mean;

(ii) without adjusting for the CPUE series, the stock would have a 0.67 probability of depletion over the next 35 years with zero catch over that time (Figure 3);

(iii) 31% of simulation trials in this unadjusted calculation had insufficient fish in the simulated population for the annual catches in the historical catch record to be taken;

(iv) by taking account of the standardised CPUE, thereby substantially reducing the influence of trials that could not produce the historical catch series, the revised probability of depletion is 0.52 (Figure 4);

(v) if this assessment is correct then the binding part of the decision rule would be the probability of depletion (Annex 5, paragraph 5.146), which indicates a zero catch;

(vi) the long-term annual yield arising from this set of parameters but without any historical fishing or recruitment series was estimated to be 1 900 tonnes.

4.51 The reanalysed standardised CPUE series showed similar downward trends over the whole time series to those shown in the past but showed no downward trend over the period since 1996. It was noted that the general long-term trend in the CPUE was evident in the trends in median vulnerable biomass from the simulation trials. The stable pattern of CPUE in the most recent years, however, was not shown in the trials, which show a downward trend in vulnerable biomass (Annex 5, Figure 5.14a). There is a question whether the CPUE series could be hyperstable, where the fishing fleet concentrates on aggregations while the overall abundance declines. This will need to be explored using spatial analytical tools.

4.52 An analysis of tagging data undertaken by the working group indicated a current vulnerable biomass of around 51 000–61 000 tonnes. While the confidence regions were relatively narrow, it was noted that a number of uncertainties remained about the estimates, including the relative contribution of some areas where the estimation of abundance from tags have much wider confidence intervals (northeast South Georgia), the low number of releases and recoveries in the assessment to date and the need to further explore the assumptions concerning mixing of tags and constant recapture rate. Although some of the issues in the tagging analysis concerning tag mixing and the distribution of fishing effort were examined at the working group, some issues will need further investigation in the intersessional period to resolve these uncertainties.

4.53 The Scientific Committee noted that the results of the tagging analysis and the results of the assessment of vulnerable biomass in the simulation trials based on the set of parameters applied in the base-case scenario above were incompatible.

4.54 The Scientific Committee noted the discussion by WG-FSA concerning the outcomes of its assessment work this year (Annex 5, paragraphs 5.165 to 5.172) and used these as the basis for the following discussion.

4.55 The Scientific Committee agreed that the set of parameters in the base-case scenario need to be urgently reviewed as it is unlikely that the current parameter set is the one that should be used in the future. It noted, however, that a number of parameters could be altered to result in a vulnerable biomass consistent with the estimate from the tagging assessment (Annex 5, Figure 5.13, Table 5.29), including:

(i) the time series of recruitment in the years immediately prior to the historical catch and survey series;

(ii) the magnitude of the initial biomass;

(iii) the degree of bias, if present, in the estimates of abundance of recruits from surveys, leading to bias in the mean recruitment used in the simulation trials;

(iv) the value (or range) of natural mortality;

(v) the growth rate of fish; and/or

(vi) the vulnerability of the population to the fishery.

4.56 The Scientific Committee noted that should the surveys be negatively biased, as discussed by WG-FSA, then an estimate of long-term annual yield consistent with the results of the tagging data would be between 4 200 and 4 900 tonnes. However, if other parameters are altered in the assessment to give the estimate of vulnerable biomass, then the status of the spawning stock might be lower, requiring a lower long-term yield.

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

4.57 There was insufficient information from analyses for the Scientific Committee to choose between options without further work to refine the parameter inputs and examine the sensitivity of the assessment to uncertainties in these inputs. It agreed that there was a need to undertake work in the coming year to attempt to resolve these uncertainties. In the interim, the Scientific Committee felt that: (i) the status of the spawning stock is unlikely to be as low as that indicated by the base-case scenario (Annex 5, Figure 5.14a); and (ii) that it was unlikely to be as high as when the recruitment series is scaled to the tagging analysis (Annex 5, Figure 5.14b).

4.58 The Scientific Committee was unable to recommend a specific catch limit for *D. eleginoides* in Subarea 48.3 for the coming season. The Scientific Committee directed the Commission to the following two approaches developed by the Scientific Committee in determining a catch limit for the coming season:

(i) The first approach is to choose a catch that, given the base-case conditions, should not substantially increase the probability of the spawning stock being depleted. Figure 3 is provided to indicate the change in probability of depletion given a specified annual catch. The probabilities that account for the CPUE series are those where greater emphasis is given to simulation trials that have similar trends during the historical catch series to the trends indicated by the standardised CPUE. The increase in the slope of both graphs around a catch level of 2 000 tonnes is a reflection that the base-case assesses sustainable yield at 1 900 tonnes. The Scientific Committee agreed that the decision of what level of catch could be taken without a ‘substantial increase in the probability of depletion’ was not a scientific issue and fell within the remit of the Commission.

(ii) The second approach is based on the tagging estimates and scaled recruitment series. These suggest annual yields of 4 200 to 4 900 tonnes, but considering the uncertainty surrounding some of the assumptions discussed above, a more conservative yield could be calculated by taking the lower 95% confidence limit of the tagging analysis. This gives an annual yield of 3 050 to 3 750 tonnes.

4.59 A further precautionary approach to the fishery that is recommended by the Scientific Committee for the forthcoming season is to divide the catch limit into areas (Annex 5, paragraph 5.173). The Scientific Committee recommended that the catch limit should be distributed according to the areas shown in Figure 4 by the following proportions:

- Area 1 (West Shag Rocks): 0%
- Area 2 (Shag Rocks): 30%
- Area 3 (South Georgia): 70%.

4.60 The CPUE in West Shag Rocks has shown a substantial decline over the last five years. Hence the Scientific Committee recommended closure of that area. In the last three years 38% of the total catch from Areas 2 and 3 has been taken from Shag Rocks. The proposal will therefore reduce the proportion of the catch taken in this area.

4.61 In order to ensure the monitoring of the stock in the West Shag Rocks area, the Scientific Committee recommended that research fishing be undertaken in this area that would be subject to the research exemption limit of 10 tonnes and any catch taken from this area will be counted towards the catch limit.

Future work for *D. eleginoides* (Subarea 48.3)

4.62 The Scientific Committee agreed that it was important to use assessment methods that are robust to assumptions about the relationship between vulnerable biomass and spawning stock status and requested that WG-FSA provide advice on the assessment methods in this regard.

4.63 The Scientific Committee noted the issues identified by WG-FSA and requested that it consider the following issues in order to resolve the outstanding uncertainties in the current status of the stock and estimated long-term yield for *D. eleginoides* in Subarea 48.3:

(i) recruitment

  (a) revision of survey design in Subarea 48.3 to estimate abundance of pre-recruit *D. eleginoides,* particularly in the areas around Shag Rocks;

  (b) review of the effect of stratification on estimates of abundance of cohorts using CMIX (Annex 5, paragraph 5.123);

  (c) review of length-at-age relationship and estimated growth parameters for use in the CMIX analysis (Annex 5, paragraphs 5.116 to 5.120);

(ii) fine-scale spatial analyses of catch and effort data to further examine the potential for hyperstability in the CPUE series;

(iii) assessment methods

  (a) further sensitivity analysis and evaluation of the GYM assessment (paragraph 4.55);

  (b) further development and evaluation of the current and alternative tagging estimators (Annex 5, paragraph 5.135);

  (c) further development and evaluation of the ASPM (Annex 5, paragraph 5.141).

D. eleginoides at Kerguelen Islands (Division 58.5.1)

4.64 The Scientific Committee thanked Prof. G. Duhamel (France) for the provision of haul-by-haul catch and effort data for Division 58.5.1 for the second year. This allowed the analyses completed by WG-FSA in 2003 to be updated for the 2003/04 season.

4.65 The Scientific Committee recalled that it had considered it imperative to substantially reduce total removals in Division 58.5.1 in light of the increase in total removals and corresponding decline in standardised CPUE evident in the results of last year's analysis.

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

4.66 The Scientific Committee welcomed the substantial reduction in total removals reported for the 2003/04 season but noted that in the absence of a stock assessment, it was not possible to judge whether this reduction in catches, if sustained, would allow the declining trends in standardised CPUE and mean length of fish to be halted, or reversed (Annex 5, paragraphs 5.177 to 5.180).

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

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

4.68 The catch limit for *D. eleginoides* in Division 58.5.2 for the 2003/04 season was 2 873 tonnes (Conservation Measure 41-08) for the period from 1 December 2003 to 30 November 2004. The catch reported for this division as of 1 October 2004 was 2 269 tonnes. It is expected that the catch limit will be taken before the end of the current fishing season.

4.69 The Scientific Committee noted that for the purposes of assessment, the long-term yield and setting of catch limits apply to the area to the west of 79°20'E.

4.70 Prof. J. Beddington (UK) reiterated his concern (SC-CAMLR-XXII, paragraph 4.85) about the internal consistency of life-history parameters used in the assessment, in particular the values of K and M, but acknowledged that it may be important to consider the potential impacts of changes in the nature of populations and the broader ecosystem due to fishing and other human interventions.

4.71 Dr Constable indicated that the von Bertalanffy parameters for *D. eleginoides* in Division 58.5.2 are derived from an ongoing program of work using ages from readings of otoliths which have been validated using strontium marks, tag–recapture data and, more recently, daily growth increments. He also noted that the results of recent preliminary analyses undertaken in collaboration with Dr M. Collins (UK), using the lengths of larval *D. eleginoides* for Subarea 48.3 (provided in Belchier, 2004 (WG-FSA-04/92)) to estimate growth curve, indicated that this helps to better describe the lower end of the growth curve but has negligible effect on the length-at-age relationship in the range used in the assessment of yield.

4.72 Prof. Duhamel noted that the proportion of the catch of *D. eleginoides* taken by longline in Division 58.5.2 had increased between the 2003 and 2004 seasons and asked whether this had been accounted for in the vulnerability function used in the assessment. He also asked what was the expected trend in the future with respect to the proportion of the catch taken by trawl and longline.

4.73 Dr Constable indicated that the future trend in proportion of the catch to be taken by longline in Division 58.5.2 was unclear at this stage, although it was likely that it would increase. He confirmed that the assessment has been performed using the trawl vulnerability function, which is age based and incorporates variation in length-at-age, and that this approach was considered precautionary by WG-FSA and the Scientific Committee. He also noted that the Working Group had requested a review of the vulnerabilities used in the assessment and that this would be pursued in the intersessional period.

4.74 The Scientific Committee noted the recommended exemption from night-setting requirements for autoline vessels operating in Division 58.5.2 in 2005, subject to the conditions proposed in Annex 5, paragraph 7.86 (paragraph 5.48(ii)).

Management advice for *D. eleginoides* at Heard and McDonald Islands (Division 58.5.2)

4.75 The Scientific Committee recommended that the catch limit for Division 58.5.2 in the 2004/05 season be revised to 2 787 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.

4.76 The remaining provisions of Conservation Measure 41-08 should be carried forward for the 2004/05 season.

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

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

4.78 The Scientific Committee reiterated its previous concern (SC-CAMLR-XXII, paragraph 4.92) 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 5.297 and 5.298).

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

4.79 The Scientific Committee noted the dramatic decline in CPUE since 2000, even under the relatively low levels of total removals in recent years, and stressed that it is imperative that future total removals be reduced until an assessment of the current status of the stock is available.

4.80 In this regard, the Scientific Committee recommended that a tag–recapture experiment be conducted, consistent with other toothfish fisheries in the CCAMLR Convention Area, and noted that a recruitment survey would greatly assist in conducting a stock assessment for Subarea 58.6.

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

4.81 The Scientific Committee welcomed the revised assessment of *D. eleginoides* in the South African EEZ around the Prince Edward Islands (Annex 5, paragraphs 5.269 to 5.295) and noted that despite revisions to the assessment it had not been possible to resolve the conflicting signals between the trends in CPUE and length frequency of the catch. The Scientific Committee encouraged further development of the assessment model, in particular ways in which it may be applied to the CCAMLR decision rules.

4.82 The Scientific Committee noted that the Fishery Report for the Prince Edward Islands extends: over much of Subarea 58.7, east into Subarea 58.6, south into Division 58.4.4, and north into Area 51 (Annex 5, paragraph 5.276). The Scientific Committee agreed to request advice from the Commission on the most appropriate area for considering the assessment of toothfish in Subarea 58.7.

4.83 The Scientific Committee indicated that, should South Africa choose to initiate a tagging program for *D. eleginoides* in Subarea 58.7, then it would be the natural depository for the coordination of tag returns from that area.

4.84 The Scientific Committee noted that in respect to mitigation, Conservation Measure 33-03 was in force within the South African EEZ.

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

4.85 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.

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

4.86 The Scientific Committee recommended that Conservation Measure 32-01, which prohibits targeted fishing for *D. eleginoides* outside the EEZ, remain in force.

C. gunnari at South Georgia (Subarea 48.3)

4.87 The catch limit for the fishery for *C. gunnari* in Subarea 48.3 in the 2003/04 season was 2 887 tonnes (Conservation Measure 42-01). All fishing took place between 9 December 2003 and 25 April 2004 with a total catch of 2 686 tonnes.

4.88 The estimate of yield was calculated using the established short-term assessment method using the results of the 2004 UK survey and updated catches (Annex 5, paragraphs 5.219 to 5.234).

4.89 The Scientific Committee noted the conclusion of the Working Group that bottom trawl surveys underestimate the abundance of *C. gunnari* due to all age classes spending time in midwater and therefore not being sampled by the bottom trawl.

4.90 The Scientific Committee noted that estimates of the midwater biomass of *C. gunnari* from acoustics had been used in the 2003 assessment (SC-CAMLR-XXII, Annex 5, paragraph 5.153), but that an estimate of the biomass of *C. gunnari* from an acoustic survey was not available for 2004.

4.91 The Scientific Committee requested that approaches to the use of combined estimates of biomass from trawl and acoustic surveys, including accounting for variations in trawl gear between surveys, be given further consideration by WG-FSA-SAM. It also requested consideration of whether a constant scaling factor can be used to routinely adjust survey catches from particular trawl years. The Scientific Committee noted the already heavy workload planned for the 2005 meeting of WG-FSA-SAM and acknowledged that it may not be possible to fully consider this issue in the coming intersessional period.

4.92 Prof. Beddington enquired whether there was a substantial proportion of the biomass of *C. gunnari* in the midwater in Division 58.5.2.

4.93 Dr Constable noted the Scientific Committee's previous considerations of this issue, and recalled that the results presented at the 2000 WAMI workshop (SC-CAMLR-XX, Annex 5, paragraph 7.19) demonstrated that there were very few occasions in which the distribution of *C. gunnari* in Division 58.5.2 would not be fully sampled by the bottom trawl.

4.94 Dr Collins concurred with Dr Constable and stated that it was important to recognise that there were significant differences in the nature of the ecosystems in Subarea 48.3 and Division 58.5.2 that resulted in different feeding behaviours and depth distributions. In particular, he noted that *C. gunnari* in Subarea 48.3 feed predominantly on krill (*E. superba*), while in Division 58.5.2, where *E. superba* are absent, they feed on a broader range of invertebrates and fish.

4.95 The Scientific Committee agreed that there are likely to be differences in the nature of the ecosystems and population dynamics of target and by-catch species among areas due to different biophysical characteristics and histories of exploitation.

4.96 Dr Constable noted that the proposal for a bottom trawl fishery for *C. gunnari* in this area is an exploratory fishery because of the need to acquire and review data with respect to impacts of this fishing method on benthic habitats and the efficiency of bird mitigation. In other respects, the fishery would be expected to have the same fishing selectivity as the pelagic trawl fishery. As such, the catch from a bottom trawl fishery would be considered as part of the total assessed yield for *C. gunnari* in Subarea 48.3.

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

4.97 The Scientific Committee recommended that the catch limit for *C. gunnari* should be revised to 3 574 tonnes for the period from 1 December 2004 to 30 November 2005.

4.98 The Scientific Committee had no information from which to consider or revise its advice of 2003 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.

4.99 The Scientific Committee recommended the continuation of other aspects of Conservation Measure 42-01, pending the Commission decision on the proposal for an exploratory bottom trawl fishery for *C. gunnari* in Subarea 48.3. If approved by the Commission, the prohibition of bottom trawling contained in Conservation Measure 42-01 would need to be lifted. The Scientific Committee's views on this proposal are contained in paragraphs 4.127 to 4.134.

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

4.100 The Fishery Report for *C. gunnari* in Division 58.5.2 is provided in Annex 5, paragraphs 5.243 to 5.268.

4.101 The Scientific Committee noted the trawl fishery for *C. gunnari* in Division 58.5.2 has caught 51 tonnes from a catch limit of 292 tonnes in the 2003/04 fishing season (Conservation Measure 42-02). Historical reported catches along with the respective catch limits and number of vessels active in the fishery are shown in Annex 5, Table 5.55.

4.102 The assessment of yield followed the short-term projection method updated with catches for the 2003/04 season and results of the 2004 survey (see Annex 5, paragraphs 5.258 to 5.260).

4.103 The Scientific Committee noted the there was a substantial increase in recruitment for age-2 fish, but a lack of age-3 fish in the length-frequency plots. Dr Constable noted that this is consistent with age structure and estimates of recruitment from previous years, and should be expected. Prof. Beddington noted with concern that there may be problems with the CMIX program in fitting and decomposing age groups, and recommended that sensitivities in the CMIX program be evaluated. Dr Constable agreed with the need to examine the issues raised by WG-FSA with respect to CMIX, and recommended that CMIX be investigated as part of the work of WG-FSA-SAM. The Scientific Committee agreed that simulation approaches should be adopted for evaluation of all CCAMLR methods.

4.104 The Scientific Committee noted that the current method for estimating an annual catch limit is appropriate in the absence of alternative approaches, but noted that there may be other methods that could be explored in the future. The Scientific Committee requested that WG-FSA give further consideration to the development of alternative assessment methods that would provide for a robust long-term management procedure.

4.105 Prof. Fernholm drew the attention of the Scientific Committee to the comment that by-catch of benthos in Division 58.5.2 monitored by observers is much lower in areas that have subsequently become the main fishing grounds (Annex 5, paragraph 5.212). Dr Sushin requested that scientific data be presented that further elucidated this finding. Dr Constable noted that data on by-catch has been supplied to CCAMLR, and is available for WG-FSA to analyse.

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

4.106 The Scientific Committee recommended that the catch limit for *C. gunnari* should be revised to 1 864 tonnes for the period from 1 December 2004 to 30 November 2005.

4.107 The remaining provisions of Conservation Measure 42-02/B should be carried forward to the 2004/05 season.

C. gunnari at Kerguelen Islands (Division 58.5.1)

4.108 No new information has been provided to WG-FSA on icefish in Division 58.5.1.

Management advice for *C. gunnari* (Division 58.5.1)

4.109 The Scientific Committee recommended that the fishery for *C. gunnari* within the French EEZ of Division 58.5.1 should remain closed in the 2004/05 season until information on stock status is obtained from a survey.

Other finfish fisheries

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

4.110 No surveys have been conducted during the 2003/04 season in these two areas, and there was no information available for which to revise the current prohibition of fishing.

Management advice (Subareas 48.1 and 48.2)

4.111 The Scientific Committee recommended that Conservation Measures 32-02 and 32-03 should remain in force.

D. eleginoides at South Sandwich Islands (Subarea 48.4)

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

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

4.113 The Scientific Committee recommended that Conservation Measure 41-03, paragraph 7, be carried forward for 2004/05.

Electrona carlsbergi (Subarea 48.3)

4.114 No new information was made available to WG-FSA for *E. carlsbergi* in Subarea 48.3 on which to base an assessment.

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

4.115 The Scientific Committee noted that Conservation Measure 32-17 remains in force.

New and exploratory fisheries

New and exploratory fisheries in the 2003/04 season

4.116 Ten conservation measures relating to 12 exploratory fisheries were in force during the 2003/04 season, but fishing only occurred in respect of five conservation measures and five fisheries. There was no reported fishing activity with respect to the following areas: Subarea 48.6 south of 60°S, Divisions 58.4.1 and 58.4.3a (Annex 5, Table 5.1).

4.117 Fishing occurred only in the following areas: Subarea 48.6 north of 60°S, Divisions 58.4.2 and 58.4.3b, and Subareas 88.1 and 88.2. Fishery Reports have been prepared only for Subareas 88.1 and 88.2, as these were the only areas with significant levels of fishing activity.

4.118 In most of the active exploratory fisheries, the fishing effort was low and the catches reported were relatively small. As has been the case for the last few years, the notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 41-09. A total of 2 166 tonnes of *Dissostichus* spp. was taken against a catch limit of 3 250 tonnes (see Annex 5, Table 5.2).

4.119 The catch limit of 375 tonnes was taken by three New Zealand-flagged vessels in the exploratory *Dissostichus* spp. fishery in Subarea 88.2 (see Annex 5, Table 5.3).

4.120 The exploratory fishery in Division 58.4.2 was undertaken by one Australian-flagged vessel which caught 20 tonnes of *Dissostichus* spp. against a catch limit of 500 tonnes. Fishing was carried out in SSRUs D and E.

4.121 An exploratory fishery was undertaken in Division 58.4.3b for the first time by one Australian-flagged vessel which caught 7 tonnes of *Dissostichus* spp. against a catch limit of 300 tonnes.

4.122 The exploratory fishery in Subarea 48.6 (north of 60°S) was undertaken by one Japanese-flagged vessel which caught 7 tonnes of *Dissostichus* spp. against a catch limit of 455 tonnes.

4.123 Conservation Measure 41-01 requires all vessels to carry out a research plan which includes completing a minimum number of research sets on entering an SSRU, and to tag and release *Dissostichus* spp. at the rate of one toothfish per tonne of green-weight catch throughout the season. WG-FSA had requested advice from the Scientific Committee regarding presentation of these data on research sets and tagging rates.

4.124 The Scientific Committee agreed that it was unable to respond fully at this meeting, but noted that it would be useful if WG-FSA could at least present time series of CPUE data based on research sets that could be compared with similar time series of data from normal commercial fishing. In this context, the methodology suggested in Annex 5, paragraph 5.20, may allow some progress to be made

Notifications for new and exploratory fisheries in the 2004/05 season

4.125 A summary of new and exploratory fisheries notifications for 2004/05 is given in Table 1 of SC-CAMLR-XXIII/BG/3. No notifications have been received from Members for exploratory fisheries in closed areas. No notifications have been made for new fisheries.

4.126 Thirteen members submitted a total of 26 notifications for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1, 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b.

Notification for exploratory bottom trawling in Subarea 48.3

4.127 There was one notification for an exploratory bottom trawl fishery for *C. gunnari* in Subarea 48.3 (CCAMLR-XXIII/16). As described in Annex 5, paragraph 5.28, the motivation behind the notification was to find a method of fishing, combining both bottom and midwater trawls, that would reduce the impact of the icefish fishery on birds while minimising, as far as possible, impacts on benthos.

4.128 Dr Kock noted that the seabird by-catch in the current fishery, while of concern, was not so large that it posed a conservation threat to the species concerned. He also noted that the by-catch was concentrated on a small number of hauls on some vessels, usually on trawls where some problem occurred during setting and hauling, leading the pelagic trawl to remain unduly long at the surface. Further, some trawlers caught no birds while others took a number of birds. Thus the potential exists for reducing seabird by-catch by improving current fishing methods. In contrast, use of bottom trawl gear would inevitably have at least a local effect on the benthos, especially the epi-benthos, and would result in an increased by-catch of other species (e.g. *Chaenocephalus aceratus*, *Gobionotothen gibberifrons*). In particular, he drew attention to the nest guarding strategy used by *C. aceratus*, which would lead this species to be potentially impacted by bottom trawls that damage the seabed in the months following spawning. He therefore advised against resumption of bottom trawling.

4.129 Dr Jones reiterated his concerns about resumption of bottom trawling expressed in Annex 5, paragraph 5.32, noting that a recent research cruise (WG-FSA-04/61) had demonstrated sponge-dominated communities and that the western part of the shelf contained invertebrate communities that included glass sponges and corals. In his view, it is not known whether or not a switch to bottom trawling would actually reduce the seabird by-catch, whereas it is well known that use of a bottom trawl will damage the benthos and lead to by-catch of other fish species.

4.130 Dr Sullivan noted that the principal reason for undertaking the exploratory bottom trawl fishery was to attempt to mitigate the seabird by-catch. In his view, it would be preferable that further trials of mitigation measures were undertaken using the current pelagic trawl gear, rather than initiating bottom trawling operations that inevitably would carry with it the risk of by-catch of both benthos and other fish species.

4.131 Dr Marschoff concurred with this view and noted that there was a worldwide trend towards the elimination of bottom trawling.

4.132 In response, Dr D. Agnew (UK) drew attention to Annex 5, paragraphs 5.28 and 5.29. He reiterated that the reason for the exploratory fishery proposal (CCAMLR-XXIII/16) was to explore alternative methods of fishing for icefish in Subarea 48.3 that might reduce the incidental mortality of seabirds whilst minimising impacts on other ecosystem components such as benthos and by-catch fish species. He thanked WG-FSA and the Scientific Committee for their comments and noted that the research and data collection plan would be modified following the suggestions made by WG-FSA. The area for exploratory bottom trawling was defined so that known areas of high benthic vulnerability would be avoided, and data on benthic interactions would be collected from as wide an area as possible so as to identify areas where impacts on benthos might be low. This would provide the essential data that would enable an assessment of the future potential for bottom trawling to both reduce seabird mortality and minimise benthic impacts, to be made next year (Annex 5, paragraphs 5.37 and 5.38). Currently such data are unavailable to WG-FSA.

4.133 In answer to the issues raised by Drs Kock, Sullivan, Jones and Marschoff, Dr Agnew confirmed that the exploratory fishery would take place earlier than April and so would not disrupt the spawning behaviour of *C. aceratus*. He noted that fish by-catch would be regulated according to Conservation Measure 33-01, which is already in place. Furthermore, although Dr Kock may not consider that catches of 80–100 seabirds in the midwater trawl fishery was cause for concern, it was still worth exploring alternative fishing methods that might reduce these levels of seabird by-catch.

4.134 Finally, Dr Agnew drew attention to the fact that the Commission currently sanctions a bottom trawl fishery for icefish in Division 58.5.2. Annex 5, paragraphs 5.211 and 5.268 reported that the potential impacts of fishing gear on benthic communities in Division 58.5.2 are limited by the strategy of fishing trawling gear lightly or just off the bottom coupled with a marine reserve. The UK proposal (CCAMLR-XXIII/16) notified the intent to use exactly the same gear and fishing techniques in Subarea 48.3 as are used in Division 58.5.2, which should have similarly negligible effects on benthos. In Division 58.5.2, large areas of ground sensitive to the effects of bottom trawling are protected (Annex 5, paragraph 5.211). The UK proposal also clearly identified large areas of the South Georgia and Shag Rocks shelf, comprising 75% of the fishable area in Subarea 48.3, which would be protected from bottom trawling. Therefore, and similar to the situation in Division 58.5.2, the size and number of grounds that could be trawled this year would be small.

Notifications of exploratory fisheries for *Dissostichus* spp.

4.135 Notifications for exploratory fisheries for *Dissostichus* spp. in 2004/05 are summarised, grouped by subarea or division, along with the numbers of vessels, in Table 2 of SC-CAMLR-XXIII/BG/3. All notifications were submitted by the deadline. As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions.

4.136 There has been a large number of notifications for fishing in Subareas 88.1 (10 notifications for up to 21 vessels), 88.2 (five notifications for up to 10 vessels) and Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3b (between 7 and 11 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.

4.137 If a large number of vessels actually undertake exploratory fishing, this may lead to problems with the standardisation of CPUE data for assessments and it may also reduce the effectiveness of the move-on rule for by-catch.

4.138 It is likely that there will also be additional administrative problems in determining closure dates for fishing in SSRUs when many vessels are fishing simultaneously in a subarea or division (see CCAMLR-XXIII/38).

4.139 WG-FSA-04/18 summarised a proposal by the Delegation of Japan to extend the fishing season for the exploratory fishery for *Dissostichus* spp. in Subarea 48.6 north of 60°S in the 2004/05 season. Conservation Measure 41-04 (2003) currently defines the fishing season as being from 1 March to 31 August. Noting that an extension to the fishing season would not conflict with the ad hoc WG-IMAF assessment (Annex 5, paragraphs 7.193 to 7.196 and Table 7.16), the Scientific Committee recommended that the fishing season for this region during 2004/05 be extended to cover the full year from 1 December 2004 to 31 November 2005.

Progress towards assessments of new and exploratory fisheries

4.140 The Scientific Committee was unable to develop management advice based on assessments of yield and is therefore unable to provide any new advice on catch limits for any of the exploratory fisheries.

4.141 Given the large number of notifications for 2004/05, the Scientific Committee reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status for exploratory fisheries. In this context, it welcomed progress in the development of methods for monitoring abundance and estimating precautionary yields described in WG-FSA-04/36 and WG-FSA-SAM-04/8 (see also paragraph 4.152).

Exploratory fishery for *Dissostichus* spp. in Subareas 88.1 and 88.2

4.142 The Fishery Report for the exploratory fishery in Subareas 88.1 and 88.2 is given in Annex 5, paragraphs 5.50 to 5.91.

4.143 The fishery saw a steady expansion of effort from 1997/98 to 2000/01, a slight drop in 2001/02, followed by an increase in 2002/03, and an almost three-fold increase in 2003/04. The catch of *D. mawsoni* has shown a steadier increasing trend over the same period, peaking at 2 166 tonnes in Subarea 88.1 and 374 tonnes in Subarea 88.2 for the 2003/04 season. There has been a general trend towards fishing deeper over the course of the exploratory fishery, though in 2003/04 fishing was slightly shallower than in 2002/03.

4.144 Although the total catch was about 67% of the catch limit for Subarea 88.1, catch limits in the four SSRUs B, C, G and H (see Figure 4) were exceeded by 1.8, 2.2, 0.1 and 199 tonnes respectively. Heavy ice conditions restricted fishing south of 73°S. Consequently little catch was taken in SSRUs J–L. With the southern SSRUs closed by ice, the fishery was effectively closed from mid-March 2004.

4.145 It was noted that the catch limits were exceeded because of the rapid changes in fishing pattern, the late submission of catch and effort reports, difficulties in forecasting closures in SSRUs, time lags in reporting, small catch limits in some SSRUs, and communication problems between the Secretariat, some Members and vessels (CCAMLR-XXIII/38).

4.146 Analysis of the genetic diversity for *D. mawsoni* from Subareas 48.1, 88.1 and Division 58.4.2 found weak genetic variation between the three areas. For assessment purposes, WG-FSA agreed that Subareas 88.1 and 88.2 should be treated as a single stock unit (Annex 5, paragraph 5.63).

4.147 Referring to Annex 5, Figure 5.2, Dr Constable noted that, while the evidence for genetic differentiation was not strong, there were some indications that the Ross Sea and adjacent areas off continental Antarctica could be separated for management purposes. In this context he suggested that, as part of a precautionary approach, it may be preferable that SSRUs D, E and F were considered separately from the other SSRUs.

4.148 Dr Hanchet noted that to date SSRUs A, D, E and F have contributed little to catches in Subarea 88.1, and fish taken there tend to be smaller than in the rest of the subarea. However, in his opinion there was as yet insufficient evidence to draw conclusions on stock structure.

4.149 Dr K. Shust (Russia) agreed that there was not enough information to be definitive about stock structure and that for the moment the two subareas should be treated as a single stock.

4.150 The Scientific Committee requested that WG-FSA examine the stock structure in Subareas 88.1 and 88.2 in greater detail next year.

4.151 A standardised CPUE analysis of the three main fishing grounds in Subarea 88.1 showed no significant trend from 1998/99 to 2002/03, but showed a large decline in 2003/04 (Annex 5, Table 5.6). The decline in 2003/04 was thought to be related to a combination of extreme ice conditions and effects from a large number of vessels operating in a confined area.

4.152 It has not yet been possible to undertake a stock assessment for Subareas 88.1 and 88.2, but the Scientific Committee welcomed the development by New Zealand of an integrated assessment model for Subarea 88.1 (WG-FSA-04/36), which is able to analyse data on catch, CPUE, proportions-at-age in the catch, and tag–release and recapture data. It also noted that WG-FSA-SAM-04 had recommended that tag–recapture experiments be used in conjunction with experimental manipulation of effort to monitor toothfish and the wider ecosystem effects of toothfish fisheries.

4.153 The Scientific Committee expressed concern that three by-catch limits were exceeded in Subarea 88.1 during the 2003/04 exploratory fishery:

(i) the limit of 124.2 tonnes for *Macrourus* spp. in SSRU I was exceeded by 141 tonnes (114%);

(ii) the limit of 20 tonnes for *Macrourus* spp. in SSRU E was exceeded by 12.2 tonnes (61%);

(iii) the limit of 20 tonnes for 'all other combined species' in SSRU I was exceeded by 1.8 tonnes (9%).

4.154 Three options for allocation of macrourid by-catch between SSRUs in Subarea 88.1 based on the current total catch limit of 520 tonnes were explored. For the 2004/05 season, it was agreed that the current SSRU by-catch limits should remain unchanged. For further discussion of this, see paragraphs 4.175 to 4.180.

4.155 Dr L. Pshenichnov (Ukraine) presented a proposal from Ukraine to amend a number of conservation measures that relate to exploratory *Dissostichus* spp. fisheries (SC-CAMLR-XXIII/7). The intention of the paper was to ensure that these conservation measures met the requirements of paragraph 2 of Conservation Measure 41-01, to ensure the spread of fishing throughout the geographic and bathymetric range of the stock.

4.156 In Subarea 88.1, some Members were concerned that Conservation Measure 41-09, which sets catch limits for every SSRU, had set a catch limit of zero in some SSRUs. They considered that alternative catch limits for SSRUs were possible, such that a nominal catch limit (e.g. 20 tonnes) could be set in areas which had not previously been fished but where there was adequate seabed suitable for fishing (e.g. SSRU D).

4.157 The Scientific Committee discussed the difference between areas within Subarea 88.1; west of 170°E along the continental coastal margin was considered very different from the Ross Sea area east of this longitude, where the exploratory fishery has concentrated to date. Dr Constable suggested the development of a consistent strategy for coastal Antarctic fisheries outside the Ross Sea was required.

4.158 The Scientific Committee recommended that to maximise the return of information from the tagging program in Subarea 88.1 to the east of 170°E, the 2003/04 catch limits for those SSRUs be retained in 2004/05.

4.159 In Divisions 58.4.1 (Conservation Measure 41-05) and 58.4.2 (Conservation Measure 41-11), a system of open and closed areas was put in place for the last fishing season. Some Members felt that the conservation measures provided adequate opportunities for fishing in these divisions, which had not been fully taken up (only one vessel fished in Division 58.4.2 in 2003 for a total catch of 20 tonnes). Others felt that all areas should be open to the exploratory fishery but with reduced catch limits for each SSRU.

4.160 Dr Pshenichnov advised that the Delegation of Ukraine proposed to discuss at the Commission meeting all the items contained in SC-CAMLR-XXIII/7 which were not discussed at the Scientific Committee.

4.161 The Scientific Committee noted that there were many issues that the Commission would need to consider in managing new and exploratory fisheries, including: (i) ensuring the development of a fishery does not outpace the Scientific Committee's ability to provide assessments and advice so that the Commission can achieve its objectives; (ii) ensuring that activities do not prejudice future options for the Commission, including conservation and rational use; and (iii) providing the ability to detect changes in the ecosystem arising from fishing.

Management advice

4.162 The Scientific Committee reiterated the necessity for Members fishing in exploratory fisheries to ensure that the required research sets are completed (Conservation Measure 41-01) and submitted to the Secretariat in a timely and accurate format. In addition, *Dissostichus* spp. should be tagged and data submitted in accordance with Conservation Measure 41-01. All tagging should be conducted according to the revised tagging protocol.

4.163 For high-latitude areas with narrow continental shelves, the Scientific Committee recommended that the existing depth limit should be retained in order to avoid impact on benthic communities in shallower waters. It would also provide opportunities to better understand and assess the potential effects of fishing before it occurs throughout the area. In this respect the Scientific Committee recommended the extension of the approach from Division 58.4.1 into Division 58.4.2.

4.164 A large number of notifications was received for exploratory fisheries in 2004/05 in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2 and 58.4.3b. Large numbers of vessels fishing in a particular SSRU may lead to difficulties with the standardisation of CPUE data for assessments and may also reduce the effectiveness of the move-on rule to limit by-catch in the fishery (Annex 5, paragraphs 6.72 and 6.73).

4.165 As indicated in CCAMLR-XXIII/38, there are additional administrative problems in determining closure dates for fishing in SSRUs when many vessels are fishing simultaneously in a subarea or division.

4.166 The Scientific Committee noted that the number of vessels participating in the Subarea 88.1 toothfish fishery had increased substantially in the 2003/04 season, and had the largest number of vessels fishing in any of the CCAMLR statistical areas in this season. The Scientific Committee reiterated the urgent need for data that will lead towards a formal assessment, and welcomed the progress with the tagging program and the development of an integrated stock assessment model. Because of the potential importance of tagging data for stock assessments in this subarea, it assigned a very high priority to carrying out further mark–recapture experiments.

4.167 The Scientific Committee was unable to provide any new advice on catch limits for *Dissostichus* spp. or any by-catch species in any of the exploratory fisheries. However, for Subarea 88.1, the Scientific Committee had agreed that the current SSRU by-catch limits should remain unchanged (paragraph 4.154) and it also recommended the 2003/04 catch limits for *Dissostichus* spp. east of 170°E be retained in 2004/05 (paragraph 4.158).

4.168 The Scientific Committee reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status for all exploratory fisheries.

4.169 Advice on incidental mortality of seabirds in relation to new and exploratory fisheries is given in paragraph 5.23.

4.170 The Scientific Committee was unable to reach consensus on its views regarding the exploratory bottom trawl fishery for *C. gunnari* in Subarea 48.3 (paragraphs 4.127 to 4.134).

Fish and invertebrate by-catch

4.171 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.

A work plan was agreed which addressed these issues as described below.

Assessment of the status of by-catch species or groups

4.172 The macrourids and rajids were identified as priority by-catch taxa for which assessments of status are required (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.154).

4.173 The Scientific Committee endorsed the advice of WG-FSA that there was insufficient information on which to base an estimate of γ for *A. georgiana* in Subarea 88.1 (Annex 5, paragraphs 6.4 and 6.5). The Scientific Committee was also in agreement that there was currently no new information with which to update the estimates of γ for macrourids (Annex 5, paragraphs 6.6 and 6.16 to 6.18).

4.174 Mean standardised catch rates for *M. whitsoni* and *B. eatoni* were calculated from two SSRUs in Subarea 88.1 (Annex 5, Table 6.1) based on data from the NZ BioRoss survey. The information was also used to estimate B_0 for *M. whitsoni* in two SSRUs in Subarea 88.1. The biomass estimate rates for *M. whitsoni* in these two SSRUs are given in Annex 5, paragraph 6.11. The Scientific Committee, however, agreed that given the low number of survey tows these estimates of yield should not be used for management advice (Annex 5, paragraphs 6.7 to 6.14).

Management of by-catch limits by SSRU in Subarea 88.1

4.175 By-catch limits for macrourids were exceeded in SSRU E and I in the 2003/04 fishery, even though the total macrourid by-catch was only 69% of the subarea catch limit (Annex 5, paragraphs 5.77 and 6.22). Considerable variation between SSRUs and mean macrourid CPUE was found in Subarea 88.1 (Annex 5, paragraph 6.23).

4.176 Allocation of catch limits as the product of the proportional CPUE and the proportional seabed area in SSRUs which are open for fishing was proposed (WG-FSA-04/20) but the conclusion reached was that it was not clear if this approach provided better catch limits than using the existing rule.

4.177 The Scientific Committee encouraged further work to examine by-catch limits in SSRUs in Subarea 88.1 (SC-CAMLR-XXII, paragraph 4.199).

4.178 The Scientific Committee noted that WG-FSA emphasised that it had no additional information to revise scientific advice on the overall catch limit, which is currently set at 16% of the *Dissostichus* spp. catch limit. This was derived from the by-catch limit for *Macrourus* spp. in Division 58.5.2 which was 16% of the catch limit for *Dissostichus* spp. in 2002/03 (CCAMLR-XXI, paragraph 11.53). Three options for the allocation of macrourid by-catch between SSRUs in Subarea 88.1 were developed and are listed below. Indicative catch limits under all three options (Annex 5, Table 6.2) were based on the 2003/04 macrourid catch limit of 520 tonnes.

Option 1 – status quo
16% of the catch limit of *Dissostichus* spp. or 20 tonnes whichever is greater.

Option 2 – CPUE proportional limits
Catch limits as the product of the proportional CPUE and the proportional seabed area in SSRUs which are open for fishing (WG-FSA-04/20).

Option 3 – fixed SSRU limits
Low catch limits (e.g. 20 tonnes) in northern and southern SSRUs where few rattails occur. Higher catch limits (e.g. 150 tonnes) in the other SSRUs.

4.179 The Scientific Committee recommended that the move-on rule requiring vessels to move to another location at least 5 n miles distant if the by-catch of any one species is equal to or greater than 1 tonne (Conservation Measure 33-03) should be retained for any of the proposed options.

4.180 The Scientific Committee discussed the advantages and disadvantages of these three options (Annex 5, paragraph 6.26) and recommended that the status quo option remain for the 2004/05 season, or until additional information is available for a revised assessment.

Estimation of by-catch levels and rates

4.181 By-catch information from STATLANT data, fine-scale data (haul-by-haul), and catch and effort data (reported by vessel in 5-day, 10-day or monthly periods) was compared in 2003 and WG-FSA concluded that fine-scale data is the most comprehensive of the three datasets for estimating levels of total removals of by-catch (SC-CAMLR-XXII, Annex 5, paragraph 5.283).

4.182 Estimates of total by-catch removals by area for the 2003/04 fishing season are presented for longline fisheries (Annex 5, Table 6.3) and trawl fisheries (Annex 5, Table 6.4). In general, rajid (skate and ray) by-catch during 2003/04 was considerably lower than macrourid by-catch in all areas, with the exception of Division 58.5.2. However it is important to note that the estimates for rajids are conservative and do not include those individuals cut or lost from longlines.

4.183 Discrepancies between estimates of total removals based on fine-scale data extracted during WG-FSA and those presented in CCAMLR-XXIII/38, WG-FSA-04/20 and 04/68 were noted by the Working Group and it urged the Secretariat to develop standard methods to summarise by-catch removals by area and species prior to WG-FSA-05. It also recommended that the by-catch subgroup liaise intersessionally with the Secretariat to try and improve the reporting, transferral and extraction of by-catch data.

Identification of levels of risk

4.184 WG-FSA considered the possibility of producing risk assessments for fish and invertebrate by-catch species in a similar way to the assessment of seabirds.

4.185 The Scientific Committee noted that defining risk was problematic but considered it possible to categorise risk for marine species. This 'risk categorisation' might include (but not be restricted to) consideration of:

(i) life history characteristics which would make a species vulnerable to fishing activities (e.g. growth rates, age at maturity, habitat range, spawning behaviour, diet, trawl or longline catchability and co-occurrence with exploited species);

(ii) the overlap between the distribution of the species and fishing or other human activities. The overlap could be considered on a proportional basis if the distribution is known. When the distribution is not known, then it would be noted where overlap exists;

(iii) any assessments or other information about population status;

(iv) conservation measures in place to avoid and mitigate by-catch.

4.186 The Working Group prepared a summary table on the risk assessment for the sleeper shark (*Somniosus antarcticus*) in Division 58.5.2 (Annex 5, Table 6.5). This table was extracted from WG-FSA-03/69 and serves as an example to encourage Members to collate information intersessionally to allow risk categorisation for other major by-catch species in the CCAMLR Convention Area.

Consideration of mitigation measures

4.187 The Working Group compared by-catch rates by vessel in the 2003/04 season and the analysis suggested that the use of the Spanish longline system, as opposed to autolining, may reduce by-catch rates of *Macrourus* spp. in Subarea 88.1 (Annex 5, Figure 6.1b). There was, however, little difference in mean relative by-catch of rajids between the two gear configuration in Subarea 88.1 (Annex 5, Figure 6.1a). 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.

4.188 At WG-FSA-04, the Working Group recommended that, wherever possible, vessels 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 (Annex 5, paragraph 6.75).

4.189 WG-FSA had indicated to the Scientific Committee that it may be difficult to detect tagged rays if they are cut off at the sea surface rather than being brought on board. Depending on sea state, identification of the tags may be possible when the rajids break the surface. If the tag identification rate is low, WG-FSA suggested a relaxation of the requirement to cut all rajids from the line on specified vessels and/or for specified time periods.

4.190 The Scientific Committee noted that where there are a large number of vessels operating within a new and exploratory fishery, the 'move-on rule' (paragraph 4 of Conservation Measure 33-03) may be ineffective to mitigate by-catch when another vessel moves into the area vacated by a vessel forced to move after exceeding the by-catch limit.

4.191 The Scientific Committee noted that some conservation measures, including Conservation Measure 33-03, contain by-catch move-on provisions originally based on the trawl method of fishing. The definitions currently used are not appropriate to define the operations of a longline vessel. The Scientific Committee recommended that a more appropriate definition of the path of a longline is a line between the position of the first anchor on the line being deployed and the position at which the last anchor of that set is deployed.

4.192 The Scientific Committee suggested the following modification be made to appropriate conservation measures:

> '…if, in the course of a directed fishery, the by-catch of any one species is equal to or greater than x tonnes in any one haul or set, then the fishing vessel shall move to another location at least 5 n miles distant. The fishing vessel shall not return to any point within 5 n miles of the location where the by-catch exceeded x tonnes for a period of at least five days. The location where the by-catch exceeded x tonnes is defined as the path followed by the fishing vessel. For a trawl the path is defined from the point at which the fishing gear was first deployed from the fishing vessel to the point at which the fishing gear was retrieved by the fishing vessel. For a longline the path is defined from the point at which the first anchor of a set was deployed to the point at which the last anchor of that set was deployed.'

4.193 In order to adequately assess by-catch levels and rates, it is necessary to have accurate reporting of information on the total removals of by-catch taxa at a fishery level. The Scientific Committee noted the concern of WG-FSA on the paucity of information about rajids lost from longlines and that observer logbooks and forms have been revised to improve by-catch data information due to uncertainty by observers about by-catch data recording protocols.

Management advice

4.194 There were no new assessments of by-catch species in 2004.

4.195 There was no new information to update the estimate of precautionary by-catch limit of 360 tonnes for *M. carinatus* in Division 58.5.2 (SC-CAMLR-XXII, paragraph 4.134).

4.196 There was no new information to update the estimates of precautionary yield for *Macrourus* spp. of 26 tonnes in Division 58.4.3a and 159 tonnes in Division 58.4.3b (SC-CAMLR-XXII, Annex 5, paragraph 5.259).

4.197 The Scientific Committee agreed that trawl survey estimates of *M. whitsoni* in Subarea 88.1 did not provide reliable estimates of standing stock because of the small number of tows, which did not provide a representative sample of the overall area.

4.198 In the absence of assessments for by-catch species, the Scientific Committee recommended that precautionary measures, which place upper limits on by-catch and reduce the potential for localised depletion, be adopted.

4.199 The Scientific Committee recommended that future work include research towards generating population parameters and estimates of standing stock for macrourids and rajids.

4.200 The Scientific Committee suggested that the development of avoidance and mitigation measures for by-catch species be given high priority.

4.201 The Scientific Committee considered alternative options for managing macrourid by-catch by SSRU in Subarea 88.1 (Annex 5, paragraph 6.26). It was agreed that Option 1, status quo (16% of the catch limit of *Dissostichus* spp. or 20 tonnes whichever is the greater), should remain in force. The Scientific Committee agreed more data on distribution and abundance of *Macrourus* spp. in Subarea 88.1 is needed in order to revise allocation of catch limits between SSRUs.

4.202 It was recommended by the Scientific Committee 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) assessment of the status of by-catch species and groups;

(ii) estimation of by-catch levels and rates;

(iii) assessment of risk, both in terms of geographical areas and population demography;

(iv) mitigation measures;

(v) by-catch reporting.

4.203 The Scientific Committee strongly reiterated the need for accurate reporting of by-catch in all data formats and recommended that estimates of total removals by area be summarised by the Secretariat for all by-catch species prior to WG-FSA-05.

4.204 The Scientific Committee 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.

4.205 Members were encouraged by the Scientific Committee to collate information to allow risk characterisation for major by-catch species in the CCAMLR Convention Area.

4.206 The Scientific Committee recommended that further work should be carried out in the intersessional period to compare by-catch levels arising from different gear configurations and to determine whether this information could be used to develop mitigation and avoidance measures for by-catch.

4.207 It was recommended that vessels be advised that, where possible, they should cut all rajids from their lines whilst the rajids were still in the water, except on the request of the scientific observer.

4.208 The Scientific Committee noted that a relaxation of the above requirement to cut all rajids from lines whilst still in the water may be necessary so that tag and recapture programs could be conducted in longline fisheries if the detection probability of tagged rajids at the sea surface is low. Members and observers were requested, where feasible, to provide a report to the Secretariat on methods or strategies of fishing that minimise non-target fish by-catch.

4.209 WG-FSA requested that the Scientific Committee note the potential impact of competition between vessels in new and exploratory fisheries on by-catch mitigation (Annex 5, paragraph 6.73).

Crab resources

4.210 No target fishery for stone crabs was carried out in 2002/03 or 2003/04, and no proposal for the harvest of crabs has yet been received by CCAMLR for the 2004/05 season.

Advice to the Commission

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

Squid resources

Martialia hyadesi (Subarea 48.3)

4.212 No target fishery for squid (*Martialia hyadesi*) was carried out in 2002/03 or 2003/04, and no new request has been submitted to CCAMLR to continue exploratory fishing for this species in 2004/05.

Advice to the Commission

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

INCIDENTAL MORTALITY

5.1 The Scientific Committee reviewed the report of ad hoc WG-IMAF (Annex 5, section 7). It endorsed the report and its conclusions, and the plan of intersessional work (Annex 5, Appendix D) 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 2004

5.2 The Scientific Committee noted that:

(i) for Subarea 48.3, the total estimated seabird by-catch in 2004 was 18 birds at a rate of 0.001 birds/thousand hooks, a slight increase compared with last year but values are still the second lowest yet recorded for this area (Annex 5, paragraphs 7.8 and 7.9 and Tables 7.1 to 7.3);

(ii) within the South African EEZs in Subareas 58.6 and 58.7, the total estimated seabird by-catch was 39 birds at a rate of 0.025 birds/thousand hooks, increased values over the previous two years. The total estimated seabird by-catch rate is only 20% of that in 2001 (Annex 5, paragraphs 7.10 and 7.11 and Tables 7.1 to 7.3);

(iii) a single seabird was observed killed in Subarea 88.1 after seven successive years of zero incidental mortality. No incidental mortality of seabirds was observed in Subarea 88.2 (for the third successive year) (Annex 5, paragraph 7.12), nor in Subarea 48.6, Divisions 58.4.3b (first year of longline fishing in these areas), and 58.4.2 and 58.5.2 (for the second successive year) (Annex 5, paragraph 7.13 and Tables 7.1 to 7.3).

5.3 The Scientific Committee noted that these totals represent slight increases in the estimated seabird by-catch in parts of the Convention Area, compared with the data reported in the last two years (Annex 5, paragraph 7.9 and Table 7.3).

5.4 The Scientific Committee welcomed the submission by France of historical data from longline fishing in the French EEZs in Subarea 58.6 and Division 58.5.1 for the 2001/02 and 2002/03 fishing seasons (Annex 5, paragraphs 7.16 to 7.19 and Tables 7.5 to 7.8). It noted that the reported totals of birds killed in these two years are based on retention of all birds brought on board each vessel, rather than on subsampling by observing some proportion of the total hooks set (Annex 5, paragraphs 7.20 and 7.21). Overall it noted that:

(i) in Subarea 58.6 (Crozet) in 2001/02, 1 243 birds were reported killed during setting of 7.4 million hooks, at a rate of 0.167 birds/thousand hooks. In 2002/03, 720 birds were reported killed during setting of 6.6 million hooks, at a rate of 0.109 birds/thousand hooks, a decrease in annual by-catch rate of 53% (Annex 5, paragraphs 7.16 to 7.19);

(ii) in Division 58.5.1 (Kerguelen) in 2001/02, 10 814 birds were reported killed during setting of 11.5 million hooks, at a rate of 0.936 birds/thousand hooks. In

2002/03, 13 926 birds were reported killed during setting of 26.9 million hooks, at a rate of 0.518 birds/thousand hooks, a decrease in annual by-catch rate of 45% (Annex 5, paragraphs 7.16 to 7.19).

5.5 The Scientific Committee welcomed the intersessional work by France to address this problem, including:

(i) collaborative interactions and mitigation experiments involving testing of IWLs, technical exchange of mitigation information, evaluation of coloured hookline, and initiation of a study on the population status of white-chinned and grey petrels on Kerguelen and Crozet (Annex 5, paragraph 7.35);

(ii) in 2004, revision to fishing practices (on offal discharge, night setting, line weighting and streamer lines) including requirement to use at least two streamer lines that adhere to the provisions of Conservation Measure 25-02, fishery closure during February, use of white-coloured hookline, and a line-weighting regime of 8 kg/120 m on autoliners (Annex 5, paragraphs 7.39 and 7.40);

(iii) the results of an analysis of the 2001/02 and 2002/03 data which indicated that seabird mortality was mainly of white-chinned petrels (93%) in October and between January and April, followed by grey petrels (5%) caught between April and November; higher seabird by-catch rates occurred around Kerguelen, the more heavily fished area; autoline vessels caught many times more birds than vessels using the Spanish system; and a significant part of the mortality of white-chinned and grey petrels is explained by season, area and method of fishing (Annex 5, paragraph 7.22).

5.6 The Scientific Committee welcomed the submission of data from the 2003/04 fishing season (Annex 5, paragraphs 7.23 to 7.30). It noted that data through February 2004 were reported as for the two previous years. From March onward, data were recorded as by-catch observed on a proportion of the hooks set. Combining the totals of birds reported killed during the first half of the fishing season with the number of birds estimated killed in the second half of the season indicated that 342 and 3 666 birds were killed in Subarea 58.6 and Division 58.5.1 respectively (Annex 5, paragraph 7.28 and Tables 7.9 and 7.10). Compared to last year, this represents reductions in birds killed of 42.5% (66.4% if reported data only are used) in Subarea 58.6 and 73.7% (85.1% if reported data only are used) for Division 58.5.1 (Annex 5, paragraph 7.29 and Table 7.11). Of the total 4 008 birds estimated killed, 95% were white-chinned petrels and 5% grey petrels, both globally threatened species.

5.7 The Scientific Committee welcomed the substantial improvements in seabird by-catch resulting from changes implemented by France in the management of these fisheries. It also thanked New Zealand and Australia for assisting, respectively, in the exchange of fishing experience and the trials of IWLs. However, it noted the advice of ad hoc WG-IMAF that further improvements were desirable and possible, and recommended:

(i) weighting regimes (including IWLs) that will ensure that longlines sink at >0.25 m/s be used (Annex 5, paragraph 7.45(ii));

(ii) standards for streamer lines as outlined in Conservation Measure 25-02 be complied with (Annex 5, paragraph 7.45(iii));

(iii) observer coverage and duties should be sufficient to ensure that at least 25% of hooks are observed on every vessel (Annex 5, paragraph 7.45(v));

(iv) fishery closures in high-risk periods during seabird breeding seasons be maintained (Annex 5, paragraph 7.45(vi));

(v) France supply 2000/01 data so that a comprehensive conspectus of the history of seabird by-catch in this fishery is possible (Annex 5, paragraph 7.34);

(vi) France conduct an analysis of the 2004 data to evaluate vessel-specific factors contributing to high levels of by-catch (Annex 5, paragraph 7.25).

5.8 France indicated that it intended to implement these recommendations as far as was operationally feasible within the fisheries concerned.

5.9 Prof. Beddington asked how the recent by-catch levels, exceeding 30 000 seabirds in the last three years, related to the size of the populations particularly affected.

5.10 Prof. Duhamel indicated that there were no reliable population (or demographic) data for white-chinned and grey petrels at either Kerguelen or Crozet, which is why France had just funded the initiation of studies of this kind. Estimates from the 1980s suggested that populations of white-chinned petrels at Kerguelen and Crozet were in the order of hundreds of thousands and tens of thousands respectively. For grey petrels, values were an order of magnitude lower in each case.

Implementation of Conservation Measures 24-02, 25-02, 25-03, 41-09 and 41-10

5.11 The Scientific Committee noted that compliance with Conservation Measure 25-02 is summarised as follows:

(i) Streamer lines – compliance with streamer line design was 64% compared with 92% last year (Annex 5, paragraph 7.47). The majority of the vessels that failed to fully comply this year would have complied under the previous specifications (Annex 5, paragraph 7.58). Vessels in Subarea 48.6, South African EEZ in Subareas 58.6 and 58.7, and Divisions 58.4.2, 58.4.3b and 58.5.2, used streamer lines on all sets; in Subarea 48.3, seven of 16 vessels undertook sets without using a streamer line; and in Subareas 88.1 and 88.2, six vessels undertook some sets without using a streamer line (Annex 5, paragraph 7.49 and Table 7.12).

(ii) Offal discharge – in Subarea 88.1, one vessel did not comply with requirements to not discharge offal (Conservation Measures 41-09 and 41-10). One vessel in Subarea 48.3 and one vessel in the South African EEZ in Subarea 58.6 were observed discharging offal during the set (Annex 5, paragraphs 7.50 and 7.51 and Table 7.13).

(iii) Discard of hooks – fishing gear, snoods and hooks, were occasionally being disposed of at sea on eight vessels. Hooks were present in discards on eight vessels, a daily occurrence on one of them (Annex 5, paragraph 7.52).

(iv) Night setting – in the South African EEZs in Subareas 58.6 and 58.7 compliance was 83%, compared to 98 and 99% in the past two years; in Division 58.5.2 compliance was 99%; in Subarea 48.3 compliance was 98% (Annex 5, paragraph 7.53).

(v) Line weighting (Spanish system) – in Subarea 48.3 compliance was 87% compared to 100% last year; the single Spanish system vessel fishing in the South African EEZs in Subareas 58.6 and 58.7 fully complied (Annex 5, paragraph 7.55).

(vi) Line weighting (autoline system) – the requirement to achieve a line sink rate of 0.3 m/s when fishing in daylight in Subareas 48.6, 88.1 and 88.2 and Division 58.4.2 was met by all vessels (Annex 5, paragraph 7.57 and Figure 7.1).

5.12 In relation to overall compliance with Conservation Measure 25-02, 13 of 40 vessels (33%) fully complied with all measures at all times throughout the Convention Area, compared to 48% last year (Annex 5, paragraph 7.61). Some vessels failed to comply by small margins and it was re-emphasised that vessels should be advised to exceed the standards to prevent compliance failure.

5.13 With respect to Conservation Measure 25-03, four of eight vessels did not comply with the prohibition of discharge of offal during the shooting and hauling of gear. This level of compliance is lower than in 2003, when only two vessels discharged offal (Annex 5, paragraph 7.62 and Table 7.14).

5.14 The Scientific Committee noted with concern that compliance with some of these conservation measures was considerably less than last year. Although some of this could be attributed to the time taken for familiarisation with those elements of Conservation Measure 25-02 changed last year, failure to use streamer lines, discharge of offal in Subarea 88.1 (and thereby risking creating an attraction of seabirds to vessels) and inadequate line weighting, could not be so regarded. It recommended that all involved make every effort to improve compliance in order to reattain, and preferably exceed, the levels of compliance reported in 2003.

Revision of Conservation Measures 24-02 and 25-02 and related matters

5.15 The Scientific Committee noted that future revision to Conservation Measure 25-02 would require:

(i) consistently collected data on the aerial extent of the streamer line (Annex 5, paragraph 7.66);

(ii) research on the sink rate of external weighted autolines to allow mandatory line-weighting regimes for autoliners to be included in the conservation measure (Annex 5, paragraph 7.93 and Figure 7.2);

and requested that appropriate data are provided as soon as possible.

5.16 It noted that, based on the success of trials of IWLs, reducing white-chinned petrel by-catch by 98% in 2002 and 92% in 2003 in New Zealand areas comparable to the highest risk levels in the Convention Area (Annex 5, paragraph 7.74), coupled with successful trials in Division 58.5.1 (Annex 5, paragraph 7.76), a protocol for using IWLs in new and exploratory fisheries is included in a draft revision of Conservation Measure 24-02 (Annex 5, paragraphs 7.95 and 7.110).

5.17 The Scientific Committee endorsed the recommendation for exemption from night-setting requirements for autoline vessels operating in Division 58.5.2 in 2005, subject to the conditions proposed in Annex 5, paragraph 7.86.

Assessment of incidental mortality of seabirds during IUU longline fishing in the Convention Area

5.18 The Scientific Committee endorsed the advice that:

(i) the methods used to estimate seabird by-catch associated with IUU fishing were the same as revised and adopted last year. IUU removals were reported for the first time from Division 58.4.3 and this was allocated the same seabird by-catch rate as Division 58.4.4 (Annex 5, paragraphs 7.113 to 7.115);

(ii) the much lower estimates of IUU toothfish removals (full details provided in SC-CAMLR-XXIII/BG/23) means that estimates of IUU seabird by-catch, 5 311 birds (95% confidence interval 4 352 to 14 166 birds), are the lowest ever reported for the Convention Area and 30% less than the value for 2003 (Annex 5, paragraph 7.117 and Table 7.15);

(iii) even these reduced levels of IUU seabird by-catch were of substantial concern and likely unsustainable for some of the populations concerned (Annex 5, paragraph 7.121);

(iv) the Commission should continue to take action in respect of seabird mortality caused by IUU fishing (Annex 5, paragraph 7.122).

Incidental mortality of seabirds during longline fishing outside the Convention Area

5.19 The Scientific Committee noted that new data on mortality of seabirds outside the Convention Area relevant to fisheries and/or seabirds within the Convention Area, had been presented by Chile, Uruguay and New Zealand (Annex 5, paragraphs 7.125 to 7.129).

Research into the status and distribution of seabirds at risk

5.20 The Scientific Committee noted and endorsed, as appropriate, that:

(i) in response to the revised reporting format devised intersessionally, national research summaries and details of data on status, trends and distribution (at sea) of albatross and petrel populations had been received only from Australia, New Zealand and the USA (Annex 5, paragraph 7.130);

(ii) reports from other Members were essential to enable the linking of data on fishing effort and seabird by-catch with population dynamics and foraging range. Argentina, France, South Africa and the UK were particularly urged to make relevant data available as soon as possible (Annex 5, paragraphs 7.130 to 7.134);

(iii) there had been no changes since last year to the global conservation status (as reviewed annually by BirdLife International on behalf of IUCN) of albatross and petrel species of relevance to the Convention Area (Annex 5, paragraph 7.135);

(iv) new data on remote-recorded at-sea distributions of albatrosses and petrels, of considerable relevance to CCAMLR, have been requested from BirdLife International (Annex 5, paragraphs 7.144 and 7.145);

(v) a comprehensive survey in 2003/04 of all colonies of black-browed, grey-headed and wandering albatrosses throughout South Georgia indicated continuing declines for all species, that the rate of decline in wandering albatrosses is increasing, and that trends at the Bird Island colonies monitored annually are representative of the overall South Georgia population (Annex 5, paragraphs 7.151 and 7.152).

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

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

(i) ACAP – now in force; CCAMLR attending inaugural meeting as observer, tabling paper summarising work of relevance to ACAP and hoping to develop close links (Annex 5, paragraphs 7.155 to 7.158);

(ii) FAO (NPOA-Seabirds) – noting the adoption of plans by New Zealand and Falkland/Malvinas Islands, the completion of a draft plan by Brazil and progress towards plans by Chile and Taiwan (paragraphs 9.23 to 9.26; Annex 5, paragraphs 7.161 to 7.163);

(iii) RFMOs – recollecting renewed attempts last year for more effective collaboration (SC-CAMLR-XXII, paragraph 5.28), progress with the main tuna commissions was regarded as discouraging (Annex 5, paragraphs 7.165 to 7.173);

(iv) non-governmental organisations – new initiatives with Southern Seabird Solutions and BirdLife International of considerable interest to CCAMLR were commended and Members urged to collaborate (Annex 5, paragraphs 7.174 to 7.177).

5.22 Prof. Croxall, as Convener of ad hoc WG-IMAF, drew particular attention to the continuing difficulties of developing a constructive dialogue and practical progress on issues of seabird by-catch with those RFMOs most relevant to mitigating by-catch of Convention Area seabirds in areas to the north of the Convention Area. There seemed to be some evidence of potential progress with CCSBT and IATTC (Annex 5, paragraphs 7.167 and 7.170), but ICCAT and IOTC still did not appear to be addressing the issue in a manner appropriate to their responsibilities (see also CCAMLR-XXII, paragraphs 5.17 to 5.19).

Incidental mortality of seabirds in relation to new and exploratory fisheries

5.23 The Scientific Committee noted that:

(i) fifteen of the 29 applications for exploratory longline fisheries for 2003/04 were undertaken (Annex 5, paragraph 7.184). Only in Subarea 88.1 was any seabird by-catch (one bird) reported. This could not be attributed to any failure of compliance with the suite of mitigation measures employed, which remain highly effective at avoiding seabird by-catch in areas where these new and exploratory fisheries have so far been undertaken (Annex 5, paragraph 7.185);

(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 as SC-CAMLR-XXIII/BG/21. There were no changes this year to levels of risk (Annex 5, paragraphs 7.181 to 7.183 and 7.191 and Figure 7.3);

(iii) however, a substantial review of the summary presentation of advice to simplify and improve consistency was undertaken, incorporated into SC-CAMLR-XXIII/BG/21 and summarised in Annex 5, Table 7.16 (Annex 5, paragraphs 7.186 to 7.190);

(iv) the 35 proposals by 13 Members for new and exploratory fisheries in seven subareas/divisions of the Convention Area in 2004/05 were addressed in relation to the advice in SC-CAMLR-XXIII/BG/21 and Annex 5, Table 7.17. The results, summarised in Annex 5, Table 7.16, indicate that, with the single potential inconsistency resolved at the meeting, all are in conformity with advice relating to incidental mortality of seabirds (Annex 5, paragraphs 7.194 and 7.195);

(v) issues relating to:

(a) exemptions in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.43a and 58.4.3b from setting longlines at night, subject to Conservation Measure 24-02 and seabird by-catch limits;

(b) exemptions in Divisions 58.4.3a and 58.4.3b in respect of recommended closed seasons, subject to Conservation Measure 24-02 and seabird by-catch limits;

(c) including reference to the definition of birds caught (as adopted by the Commission last year) in all relevant conservation measures;

are addressed in SC-CAMLR-XXIII/BG/21 and in Annex 5, paragraphs 7.197 to 7.202.

Interactions involving marine mammals and seabirds and trawl finfish fishery operations

5.24 The Scientific Committee noted that three Antarctic fur seals were reported killed in the icefish fishery in Division 58.5.2.

5.25 It also noted that:

(i) the only seabird mortality observed in trawl fishing operations in 2003/04 was in the icefish fishery in Subarea 48.3 where 87 seabirds were killed and another 136 released alive (Annex 5, paragraph 7.206 and Table 7.18);

(ii) in this fishery, following reduction in total birds killed in each of the last three years, values had more than doubled in 2004. Mortality rates were nearly double those last year (Annex 5, paragraphs 7.209 and 7.210 and Table 7.18);

(iii) despite extensive attempts to devise and improve mitigation measures for use in this fishery, limited success was reported (Annex 5, paragraphs 7.218 and 7.219);

(iv) taking into account the increase in by-catch, the status of the birds killed and the continued difficulties with mitigation, the Working Group had made various suggestions as to how the situation might be improved, including:

    (a) supporting an application for further trials of mitigation measures in 2004/05, including a relaxation of the vessel seabird by-catch limit (Annex 5, paragraphs 7.219 and 7.220);

    (b) an overall seabird by-catch limit for all vessels in this fishery;

    (c) a reduction in the vessel seabird by-catch limit (Annex 5, paragraphs 7.211 to 7.217).

5.26 Prof. Moreno indicated that, as far as Chilean vessels operating in this fishery were concerned, the observed mortality related mainly to single hauls in February, when the greatest number of seabirds was associated with vessels. All vessels involved had tried hard to implement effective mitigation measures. He was opposed to setting reduced by-catch limits for vessels in this fishery, as this would act as a disincentive to continue to address this difficult problem and to improve fishing practice.

5.27 Prof. Beddington agreed with Prof. Moreno and further noted that the levels and rates of by-catch mortality in this fishery were at levels that would have a negligible effect on the populations concerned. In the case of black-browed albatrosses, 26 birds killed out of a population of over 100 000 birds and for white-chinned petrels, 59 birds killed out of a population of several hundred thousand birds. He viewed the existing by-catch limits as sufficiently precautionary and could not support any change to the existing regulations.

5.28 Mr B. Baker (Australia) observed that the suggestions for reduced by-catch limits were intended to encourage better mitigation measures to be developed and to reward those vessels with lower by-catch rates with longer fishing seasons. Importantly, the by-catch of threatened and endangered seabirds needs to be avoided in this fishery.

5.29 Dr Marschoff accepted that the by-catch rates were unlikely to affect the populations concerned but noted that CCAMLR had always endeavoured to set the highest standards and therefore a more stringent by-catch limit would be appropriate.

5.30 Prof. Moreno observed that he supported all attempts to reduce by-catch but was very concerned that, in simply attempting to reduce levels in one fishery in one area in the manner proposed, the problem would not be solved and would potentially be exported to other areas through the continued operation of vessels with inadequate mitigation. He favoured supporting the current attempts to improve mitigation measures in the fishery by working more closely with the fishers and captains who were trying to solve the problem.

5.31 Prof. Beddington agreed with Prof. Moreno and expressed concern with the comments of Mr Baker, which implied that the Working Group was exceeding its brief in seeking, in effect, to manage effort and participation in this fishery rather than simply advising on the use of mitigation measures. He reiterated his concern at over-reacting to a problem that was trivial compared to the scale of known and estimated by-catch mortality through longlining in other parts of the Convention Area, through IUU fishing and outside the Convention Area.

5.32 Dr Constable suggested that ad hoc WG-IMAF should invite and review data and submissions on the potential effects of by-catch levels and rates in this fishery on the seabird populations concerned, particularly threatened and endangered species.

5.33 Prof. Croxall, as Convener of ad hoc WG-IMAF, observed that the Working Group had discussed this topic in the past. It had noted:

(i) the lack of appropriate demographic models (a situation now being remedied by the initiatives described in Annex 5, paragraph 7.153);

(ii) the lack of reliable data on mortality rates of the relevant seabird species in longline (and trawl) fisheries outside the Convention Area and in IUU fisheries generally;

(iii) that the goal with significantly depleted populations of globally-threatened seabird species is restoration to previous levels;

(iv) that therefore the main objectives should be to minimise by-catch mortality rates in all fisheries where appropriate management is feasible.

However he agreed that it was important to recommend management actions that are consistent with the level of risk to the species and populations concerned.

Interactions involving marine mammals and krill fishing operations

5.34 Revised data for 2002/03 indicate that a minimum of 114 Antarctic fur seals were caught in krill fishing operations in Area 48, 53 of which were killed and 61 released alive (Annex 5, paragraph 7.228).

5.35 Data for 2003/04 comprise a report from Area 48 of the international scientific observer on *Top Ocean* which records 154 seals entrapped, of which 142 were killed, and reports from UK observers on six vessels (including *Top Ocean*) in Subarea 48.3 which indicated entrapment of 292 seals (Annex 5, paragraphs 7.229 to 7.231).

5.36 A variety of mitigation devices, including those developed by Japan in recent years and tested in 2002/03, were used on vessels fishing for krill (Annex 5, paragraphs 7.238 to 7.241). Each device either greatly reduced or eliminated entrapment of fur seals (Annex 5, paragraphs 7.239 to 7.241).

5.37 The Scientific Committee recommended that:

(i) information on all devices should be combined and circulated to CCAMLR Members and other interested parties (Annex 5, paragraph 7.242);

(ii) every vessel fishing for krill should employ a device for excluding seals or facilitating their escape from the trawl net (Annex 5, paragraph 7.243);

(iii) observers should be required on krill trawl vessels to collect reliable data on seal entrapment and on the effectiveness of devices used to mitigate this (Annex 5, paragraph 7.236);

(iv) noting experiences on *Top Ocean* this year (Annex 5, paragraphs 7.232 to 7.235), data forms should be completed accurately, consistently and comprehensively by all observers (Annex 5, paragraph 7.236);

(v) the UK be requested to submit their observer data to the Secretariat (Annex 5, paragraph 7.237).

5.38 Dr Naganobu re-emphasised the success experienced with the use of the Japanese seal exclusion devices and recommended their use by other krill fishing vessels which should be encouraged to test the devices.

5.39 Prof. Croxall agreed, but observed that the Working Group had been unable to recommend any one particular device, partly because several devices seemed equally effective and partly because of concern that different devices might work best with the gear type and configuration on different vessels. He supported the recommendation for further trials of all devices and that observers submit detailed reports on their effectiveness.

5.40 Dr Shust expressed surprise at the sudden recognition of this problem and suggested that it could simply reflect unusual events and conditions in one particular year.

5.41 Prof. Beddington noted that the problem had only been identified once more detailed reports on krill fishing practice, especially data from observers, had been obtained. He further noted that even with observers, the *Top Ocean* experience indicated that substantial under-reporting could still occur.

5.42 Dr Pshenichnov observed that the report from the UK observer on the *Konstruktor Koshkin* of zero entanglement confirmed the effectiveness of the net design on this vessel for allowing seals to escape or avoid entrapment.

5.43 Overall, however, the Scientific Committee welcomed the substantial progress on this issue and noted that the recommendations in paragraph 5.37 should allow a very substantial resolution of the problem.

Other

5.44 The Scientific Committee agreed that Ms Rivera and Mr Smith should be appointed as Co-conveners of ad hoc WG-IMAF. It thanked Prof. Croxall and Mr Baker, the retiring Convener and Deputy Convener respectively, for their work on behalf of the Working Group.

Advice to the Commission

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

General advice

5.46 The Commission was requested to note:

(i) the continuing low levels and rates of seabird by-catch in regulated longline fisheries in most parts of the Convention Area in 2004 (paragraphs 5.2 and 5.3);

(ii) substantial reductions in by-catch levels and rates (by 73 and 76% respectively) in the French EEZs in 2004, reflecting substantial intersessional initiatives by France, including revision to fishing practices (paragraphs 5.5 and 5.6);

(iii) assessment of implementation of relevant conservation measures, including reduced effectiveness compared with 2003 (paragraphs 5.11 to 5.14);

(iv) the success of trials of IWL gear, particularly in New Zealand areas comparable to the highest risk levels in the Convention Area, reducing white-chinned petrel by-catch by over 90% in each of two years (paragraph 5.16);

(v) estimates of potential seabird by-catch associated with IUU longline fishing in the Convention Area in 2004 and that these are the lowest values so far estimated (paragraph 5.18(i) and (ii));

(vi) new data on mortality of seabirds from the Convention Area in adjacent regions provided by Chile, Uruguay and New Zealand (paragraph 5.19);

(vii) request to BirdLife International for analysis and provision of data on distributions of albatrosses and petrels at sea derived from remote recording (paragraph 5.20(iv));

(viii) continuing declines of albatross populations at South Georgia, including increased rates of decline for wandering albatrosses (paragraph 5.20(v));

(ix) good progress with national and international initiatives involving ACAP, FAO NPOA-Seabirds and initiatives developed by Southern Seabird Solutions and BirdLife International (paragraph 5.21(i), (ii) and (iv));

(x) levels of seabird and marine mammal by-catch in trawl fisheries in the Convention Area in 2004, notably of seabirds in the icefish fishery in Subarea 48.3 (paragraph 5.25(i) and (ii)) and of fur seals in krill fisheries in Area 48 (paragraph 5.35);

(xi) that the Scientific Committee had appointed Ms Rivera and Mr Smith as Co-conveners of ad hoc WG-IMAF following the retirement of the existing Convener, Prof. Croxall, and Deputy Convener, Mr Baker (paragraph 5.44).

5.47 The Commission was requested to endorse:

(i) recommendations for improvements to by-catch mitigation measures for implementation in the French EEZs (paragraphs 5.7 and 5.8);

(ii) recommendations for improved performance in implementation of conservation measures related to mitigation of seabird by-catch (paragraph 5.14);

(iii) requests for key data on streamer line aerial extent and sink rate of externally weighted autolines to enable improvements to Conservation Measure 25-02 to be proposed (paragraph 5.15);

(iv) provision of reports from Argentina, France, South Africa and the UK, and other Members as appropriate, for summarised data on status, trends and distribution (at sea) of albatross and petrel populations (paragraph 5.20(ii)).

Specific advice

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

(i) revisions to Conservation Measure 24-02 as incorporated into the draft measure (paragraph 5.16);

(ii) exemption from night-setting requirements for autoline vessels operating in Division 58.5.2 in 2005, subject to the conditions proposed in Annex 5, paragraph 7.86 (paragraph 5.17);

(iii) continued action in respect of seabird mortality caused by IUU fishing (paragraph 5.18(iv));

(iv) continue to request improved collaboration and cooperation from RFMOs in respect of by-catch of seabirds from the Convention Area (paragraphs 5.21(iii) and 5.22);

(v) advice in relation to proposals for new and exploratory longline fisheries in the Convention Area in 2005 (paragraph 5.23);

(vi) in relation to krill trawl fisheries, recommendations relating to the use of seal excluder devices, the presence of observers and the collection and submission of appropriate data (paragraphs 5.37 and 5.43);

(vii) advice in relation to seabird by-catch levels and trials of mitigation measures in relation to icefish trawl fisheries in Subarea 48.3 (paragraphs 5.25(iv) and 5.26 to 5.33).

ADDITIONAL MONITORING AND MANAGEMENT ISSUES

Marine debris

6.1 Following last year's practice, 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-XXIII/BG/11).

6.2 The CCAMLR marine debris database contains data from 11 sites, all within Area 48. Of these, four sites have data for at least three years that have been collected according to CCAMLR standard methods. It should be noted that Uruguay has submitted data on beached marine debris from their site on King George Island for the fourth consecutive year and the data have been included in this year's review. Members, locations and durations are as follows:

(i) beached marine debris: Chile (Cape Shirreff, Livingston Island, South Shetland Islands 1993 to 1997), UK (Bird Island, South Georgia 1989 to present, and Signy Island, South Orkney Islands 1991 to present) and Uruguay (King George Island, South Shetland Islands 2001 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-XXIII/BG/11 indicated that:

(i) marine debris, principally packaging items, fishing gear, and wood items, reached a peak in the period from 1994 to 1996 at Bird Island and Signy Island and has declined thereafter;

(ii) whereas the level of marine debris found in seabird colonies at Bird Island increased particularly since 1998, substantial declines from previous seasons were noted in 2004, with fishing gear such as lines and hooks continuing to form the major part of the debris;

(iii) marine mammal (Antarctic fur seal) entanglement at Bird Island reached a peak in 1993 and has shown a general decline since, with the lowest levels on record being reported for the 2003 and 2004 seasons. Packaging bands, synthetic string and longline fragments continue to be the main entanglement material;

(iv) marine mammal (Antarctic fur seal) entanglements were reported for the first time from Cape Shirreff;

(v) for the first time an Adélie penguin was reported entangled at King George Island during the 2002 season, with nylon wrapped around its wing;

(vi) the number of seabirds contaminated with hydrocarbons remains low.

6.4 The Scientific Committee discussed a Secretariat recommendation for the formation of a task group to develop a set of standardised procedures for analysing marine debris data which could include a time-series analysis exploring the relationship of marine debris levels at monitored sites with the level of debris in the marine environment in the Convention Area (SC-CAMLR-XXIII/BG/11, paragraph 35).

6.5 Prof. Croxall suggested that an alternative to an additional intersessional group might be to invite Members with experience in the analysis of marine debris to submit papers, particularly on the technical aspects of the monitoring and evaluation of such data. Dr Constable also suggested that the Scientific Committee could solicit information from CEP for information relating to monitoring marine debris or marine pollution methods that they might use or propose for estimating trends.

6.6 The Scientific Committee welcomed these suggestions for procedures to help develop analysis of marine debris and invited the submission of pertinent papers for consideration by the Scientific Committee next year.

Surveys of marine debris on beaches

6.7 Standardised surveys of marine debris were reported from Signy Island, South Orkney Islands (SC-CAMLR-XXIII/BG/15), and Bird Island, South Georgia (SC-CAMLR-XXIII/BG/13). Marine debris surveyed decreased 60% on Signy Island and levels on Bird Island were the lowest since 1990. A decrease in plastic packaging bands at both sites was encouraging, yet their continued presence indicates that the ban on their use in the Convention Area in 1995/96 (Conservation Measure 25-01) has yet to prove entirely effective and should continue.

6.8 Surveys in 2002/03 and 2003/04 at Cape Shirreff indicated substantial decreases in the number and weight of plastics since 1996/97 (SC-CAMLR-XXIII/BG/10). Surveyed items included: plastic packaging bands, sanitary/medical type debris, incinerated plastic and egg cartons. The latter item raises concern about the possible transmission of avian diseases. The reductions in marine debris support the view that implementation of Conservation Measure 25-01 has been effective in achieving these results.

Entanglement of marine mammals in marine debris

6.9 Standardised reporting of the entanglement of Antarctic fur seals in marine debris was reported from Signy Island, South Orkney Islands (SC-CAMLR-XXIII/BG/12), where no entangled animals were recorded, and Bird Island, South Georgia (SC-CAMLR-XXIII/BG/14), where 14 entangled seals were recorded between 1 April and 31 October 2003, an increase of 56% from the previous year, and 11 entangled seals were recorded during the 2003/04 summer, a 45% decrease from the previous year and the lowest number of entanglements recorded. Plastic packaging bands and nylon braid were the most frequently recorded entangling material. Although the plastic packaging band entanglements were reduced in summer (27%), they caused the majority of winter entanglements (71%). For the second year, no entanglements in fishing nets were observed.

Marine debris associated with seabird colonies

6.10 Marine debris associated with seabirds at Bird Island, South Georgia, from 1 April 2003 to 31 March 2004 was reported in SC-CAMLR-XXIII/BG/16. There were 52 items of fishing gear (mostly longlining gear), a substantial reduction from last year. More of these items were associated with wandering albatrosses than with any other species. Plastic items were most frequently associated with grey-headed albatrosses. The quantity of fishing gear and entanglements associated with giant petrels was well above the average.

Seabirds and marine mammals soiled with hydrocarbons

6.11 One case of contamination with oil of a wandering albatross was recorded at Bird Island, South Georgia, between 1 April 2003 and 31 March 2004 (SC-CAMLR-XXIII/BG/16). The soiling was of a small area of plumage and breeding success was apparently not affected.

Submission of additional information on marine debris

6.12 Dr Fanta reported that the Brazilian Antarctic Program had removed debris (wood, metal, plastic, glass) from its Antarctic station since 1985; in recent years virtually no debris of marine origin had been reported.

6.13 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.

6.14 Mr Watkins reported that data were collected in 2003/04 on marine debris at Marion Island and it is South Africa's intention to submit the data to CCAMLR next year.

Marine mammal and bird populations

6.15 The Scientific Committee noted reports from WG-EMM and ad hoc WG-IMAF with respect to information on the status of marine mammal and bird populations in the Convention Area (section 3 and paragraphs 5.24 to 5.43). The Scientific Committee confirmed its view that a general review of this topic should occur every five years. It noted that the last review of bird populations occurred in 2000 and of marine mammal populations in 2001. It was suggested that the relevant expert groups of SCAR be requested to provide a review of the current status and trends of these populations in the Convention Area. Dr Fanta indicated that these SCAR groups would next meet in 2006 and had anticipated this request and would expect to complete it at the 2006 meetings.

6.16 Dr Constable suggested that information on trends may arise from the many aspects of work being undertaken by the Scientific Committee and its working groups. This work includes information on distribution and abundance of predators, ecosystem modelling considerations reflecting the marine biodiversity of the Convention Area, and assessments of the impacts of incidental mortality on bird populations.

6.17 Prof. Croxall noted that these suggestions potentially involved very considerable additional work, unlikely to be accomplished without considerable refinement of the precise requirements, either by WG-EMM or relevant SCAR experts, within such a limited time span.

Management advice

6.18 The Scientific Committee agreed that further consideration for refinement of CCAMLR's requirements for information on the status and trends of marine mammal and bird populations be undertaken and communicated to the relevant SCAR experts during the intersessional period. The Scientific Committee further tasked the correspondence group on land-based predators to develop and/or refine CCAMLR's requirements, in consultation with the Convener of WG-EMM and liaise with the SCAR representative to the Scientific Committee (Dr Fanta).

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY ABOUT STOCK SIZE AND SUSTAINABLE YIELD

7.1 The Scientific Committee noted the deliberations of WG-FSA on the apparent decline of catches of *Dissostichus* spp. outside the CCAMLR Convention Area in 2003/04 (Annex 5, paragraphs 3.18 and 3.19).

7.2 The Scientific Committee noted WG-FSA's discussions with respect to IUU fishing (Annex 5, paragraphs 8.1 to 8.13).

7.3 Prof. Moreno reported, with respect to Area 87, that the catch of *D. eleginoides* has declined in recent years, and particularly last year. One of the causes for this decline could be attributed to the fact that *D. eleginoides* under the age of 5 or 6 years is not found off the Chilean coast. These fish probably originate from spawning grounds near Cape Horn, although the migration pattern of juvenile *D. eleginoides* is known to follow a complex pattern and is still poorly understood. Another cause for the decline is likely to be overfishing.

7.4 Dr Barrera-Oro added that *D. eleginoides* has also declined on the Argentinean part of the Patagonian shelf and slope (Area 41). Current annual catches have declined to about 2 000 tonnes/year.

7.5 Dr H. Nion (Uruguay) reported that the Uruguayan fishery takes juvenile *D. eleginoides* over the deeper shelf/slope areas 36–37°S while adults are taken at depths down to 3 000 m.

7.6 Mr L. López Abellán (Spain) noted that *D. eleginoides* taken in fisheries outside the Convention Area (Areas 47, 51) originate from inside the CCAMLR Convention Area.

7.7 The Scientific Committee thanked Spain for providing the data from catches taken in Areas 47 and 51, for which very little information exists in the CCAMLR database.

7.8 Dr Constable suggested that:

(i) IUU and other information from outside the CCAMLR Convention Area needs to be provided to WG-FSA well in advance of its meeting to allow an in-depth assessment of these data;

(ii) with respect to paragraph 8.8 of Annex 5, the Scientific Committee might be in a position to respond to the question as to what extent stocks outside the CCAMLR Convention Area have been depleted. He underlined the importance of learning how stocks inside the Convention Area and those occurring outside are linked, and that this question needs to be addressed as a matter of urgency;

(iii) all data on *D. eleginoides* collected by CCAMLR Members outside the CCAMLR Convention Area be submitted to the CCAMLR Secretariat. Trends in catch rates could assist in revealing to what extent these stocks are affected by fishing and how they may interact with fish inside the Convention Area;

(iv) harmonisation of management of the fisheries on *D. eleginoides* inside and outside the CCAMLR Convention Area may assist in the conservation of the stocks.

7.9 Mr López Abellán questioned whether and to what extent fishing on *D. eleginoides* outside the CCAMLR Convention Area could affect stocks inside the Convention Area. The situation outside CCAMLR areas generally reflects events inside the CCAMLR Convention Area.

7.10 The Scientific Committee requested that the Commission consider how estimates of the most recent IUU fishing could be considered and confirmed in time for use by WG-FSA in its assessment work.

7.11 The Scientific Committee recalled its conclusion last year that the current levels of IUU catches are unsustainable (SC-CAMLR-XXII, paragraph 7.13). Noting the view of WG-FSA that the catch rates in Areas 51 and 57 provided by Spain are much lower than the CDS records for this area would suggest (Annex 5, paragraph 8.12), the Scientific Committee reiterated its concern that catch rates in these areas are likely to be unsustainable.

7.12 On the basis of the report of WG-FSA, the Scientific Committee noted that the CDS-reported catches from outside the Convention Area, in particular in Areas 47, 51 and 57, declined this year and that this decline could be due to three reasons (Annex 5, paragraph 8.8):

- stocks may have become depleted;
- fewer CDS reports were being received because vessels are re-flagging to States which do not participate in the CDS;
- CCAMLR monitoring and compliance measures are causing a reduction in IUU fishing.

7.13 The Scientific Committee requested that the Commission consider whether the latter two reasons might have caused the decline in CDS-reported catches. With respect to the first reason, it noted that more data will be needed to assess whether that reason is plausible but this possibility could be explored by WG-FSA on the basis of trends in catch rates.

7.14 The Scientific Committee also recalled the discussion under Item 7 last year and noted the comments this year by Members regarding the likelihood of links between stocks inside and outside the Convention Area in the Indian Ocean. It agreed that data on the nature of stocks outside the Convention Area in Areas 51 and 57 would help WG-FSA determine whether those links might significantly affect the status of stocks inside the Convention Area either through fish moving between the areas or larvae or young fish moving from areas outside to areas inside the Convention Area.

7.15 At present, the information on stocks in Areas 51 and 57 is sparse and is not routinely provided to the CCAMLR Secretariat. As such, the Scientific Committee requested the Commission to consider acquiring data for these areas. In the absence of research data, fisheries-based data on locality, catch and effort, and size of fish in the catch would be useful for WG-FSA to analyse. Such data would be most useful in fine spatial resolution, such as haul-by-haul data, in order to assess the trends in catch rates. Submission of data could follow the format of data reporting already described in conservation measures and be subject to the usual rules for data access. It would be useful for such data to be provided to CCAMLR in time for use at the next meeting of WG-FSA.

7.16 Dr Shin noted that the linkages between stocks inside and outside the CCAMLR Convention Area, particularly in the Atlantic Ocean sector, have not been demonstrated, and that this discussion is proceeding without any scientific material provided to facilitate it. Therefore, he does not consider such a request justifiable.

7.17 Dr Shust noted that stocks of *D. eleginoides* from north of the Polar Front are separate from those living further south (Annex 5, paragraphs 5.106 and 5.107). He described that specimens of *D. mawsoni* from various parts of the Ross Sea are similar in genetic terms and are likely to form a single population. He emphasised that further tagging and genetic studies are needed to elucidate questions of the status of *D. mawsoni* stocks in various areas of the Southern Ocean.

7.18 Prof. Fernholm emphasised that tagging studies are urgently needed outside the CCAMLR Convention Area.

7.19 Dr Constable reported on the extensive tagging Australia is conducting on *D. eleginoides* at Macquarie Island.

7.20 Mr López Abellán suggested that CCAMLR contact fisheries organisations north of the CCAMLR Convention Area in order to harmonise research and data collection with respect to *D. eleginoides*.

7.21 Many Members requested that the Commission consider obtaining catch data for Areas 51 and 57, given that a number of Members have participated in fisheries and the absence of an RFMO with competency to manage bottom fish/*D. eleginoides*.

7.22 No new information was provided to the Scientific Committee by WG-EMM with respect to IUU fishing.

Management advice

7.23 The Scientific Committee requested that the Commission consider how estimates of the most recent IUU fishing could be considered and confirmed in time for use by WG-FSA in its assessment work (paragraph 7.10).

SCIENTIFIC RESEARCH EXEMPTION

8.1 Scientific research surveys notified to the Secretariat under Conservation Measure 24-01 are regularly updated on the CCAMLR website. Notifications of surveys in 2004/05 received by the Secretariat were also listed in CCAMLR-XXIII/BG/8.

8.2 One notification, submitted by New Zealand on 23 July 2004 (SC-CAMLR-XXIII/BG/17), was for a longline survey of *D. mawsoni* in Subarea 88.3. In providing this notification, New Zealand proposed that the survey vessel could take no more than 100 tonnes of *D. mawsoni* and no more than 35 tonnes of all other species combined.

8.3 Under Conservation Measure 24-01, Members are required to respond within two months of circulation of the notification if they wish to request a review by the Scientific Committee. The proposed research plan was circulated on 4 August 2004. No comments were received prior to the start of WG-FSA-04 on 11 October 2004.

8.4 At WG-FSA-04 some Members expressed concern at the high proposed maximum catch for *D. mawsoni* compared to the threshold value in Conservation Measure 24-01, and suggested that in future it would be useful for survey designs submitted under Conservation Measure 24-01 to be referred to WG-FSA for review prior to consideration by the Commission (Annex 5, paragraph 3.32).

8.5 Dr Sullivan explained that the nominated catch of 100 tonnes for *D. mawsoni* was not a catch target, but was an upper limit required to allow the objectives and design of the survey to be achieved. The survey design involved the use of 40 research lines. The sampling of *D. mawsoni* from Subarea 88.3 would allow genetic and non-genetic techniques to be used for stock structure analysis.

8.6 Dr Shust welcomed the New Zealand proposal, noting that it was well presented and would add to the understanding of ecosystem functioning in the region.

8.7 Dr Constable expressed his concern that it was not clear how the research proposal would lead to an assessment program for a new and exploratory fishery, and that the Scientific Committee needed to be confident that the research was not contrary to the intent of Conservation Measure 24-01. Dr Constable suggested that, should the research survey proceed, WG-FSA be given the opportunity to review the information obtained from the research to determine the basis for reviewing and approving any future research proposals and how they might contribute to future assessments for this area.

8.8 Dr Sullivan indicated that New Zealand would welcome any review of the research by WG-FSA and the Scientific Committee, and proposed that future surveys may also be scheduled if the pilot survey was successful.

8.9 The Scientific Committee supported consideration of the New Zealand research survey by WG-FSA in the future, and encouraged Members, if they wished to have research proposals reviewed by the Working Group and the Scientific Committee, to respond within the required period after submission.

COOPERATION WITH OTHER ORGANISATIONS

9.1 The Scientific Committee was chaired during this section by Dr Sushin, 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-XXIII/BG/7) outlined his participation in CEP-VII under the Madrid Protocol (Cape Town, South Africa, May–June 2004). The most important issues of relevance to CCAMLR were:

(i) CEP again addressed the issue of establishing 'Specially Protected Species'. CEP reviewed two working papers presenting different views on some issues and prepared a suggested revised text for consideration by the ATCM.

(ii) CEP's Intersessional Contact Group (ICG) on the State of the Antarctic Environment continued its work under agreed terms of reference. The Chair of the Scientific Committee monitored progress as a member of the ICG. CEP agreed to continue the ICG under modified terms of reference.

(iii) CEP reviewed progress of the Antarctic Site Inventory (ASI) to monitor and assess the effect of visitors to sites in the Antarctic Peninsula. The ASI has collected biological data and site-descriptive information in the Antarctic Peninsula since 1994. CEP agreed to establish an open-ended ICG to further address this issue.

(iv) Dr A. Press (Australia), the CEP Observer to CCAMLR-XXII and SC-CAMLR-XXII, presented an information paper which highlighted the main aspects of SC-CAMLR-XXII. Dr Press continues to serve as the CEP Observer to the Scientific Committee.

9.3 It was noted that CEP worked to a large extent through intersessional correspondence groups reporting to the regular meetings of CEP, and that many items are in an early stage of development.

SCAR

9.4 Dr Fanta, CCAMLR Observer at SCAR and SCAR Observer at CCAMLR, presented a report (CCAMLR-XXIII/BG/37) on SCAR.

9.5 SCAR presented a long-term strategic plan for the period 2004–2010, including activities to be established for the IPY (2007/08). The main program of interest to CCAMLR is 'Evolution and Biodiversity in the Antarctic (EBA)'.

9.6 The twenty-eighth meeting of SCAR was held in Bremen, Germany, from 25 to 29 July 2004.

9.7 LSSSG (www.nioo.knaw.nl/projects/scarlsssg/) was chaired by Dr S. Chown (South Africa). Topics of interest to CCAMLR are:

(i) SCAR has presented to the ATM a report on marine acoustics technology and the Antarctic environment. Apparently, and in contrast to military equipment, no research equipment has negative effects on marine mammals, and only in a few cases avoidance behaviour was observed.

(ii) The criteria for the identification of species to be especially protected under the Treaty were considered not to be consistent with modern concepts of conservation. Therefore, for the time being, the IUCN criteria for species at risk were adopted. The exclusion of fur seals and Ross seals from the list of protected species is not yet agreed.

(iii) A workshop on 'Biological Monitoring and Human Impacts in the Antarctic' will be held in 2005, and the steering committee started the definition of terms of reference for the workshop, including themes such as habitat protection and management of species.

(iv) Bioprospecting was discussed and SCAR suggested that CCAMLR pay attention to new tendencies of the world market in relation to products and molecules obtained from marine organisms. They may result in large removals of marine organisms.

(v) The plans for Cape Sheriff and San Telmo, which include a CEMP site, Edmondson Point, and Deception Island were approved. Again there was a discussion about the need for CCAMLR to revise such plans when they include a marine component. This raised the question whether SCAR would have to review plans that CCAMLR presents, when they are inside the Treaty area. There was a suggestion that SCAR could propose areas for protection, if LSSSG or any other group could identify values that would need protection. This will now be a permanent item on the group's agenda.

9.8 The following Science Programs of LSSSG were active during the past year:

(i) Evolution and Biodiversity in the Antarctic: the response of life to changes (EBA), convened by Dr G. di Prisco (Italy), will be the main scientific program of LSSSG, and will examine patterns of gene flow and their consequences for population dynamics; the patterns and diversity of organisms; ecosystems and habitats in Antarctica; and the impact of past, current and predicted environmental change on biodiversity and the consequences for Antarctic marine ecosystem functions. Two inclusions in the program were agreed:

- the Circum-Antarctic Census of Marine Life (Circum-Antarctic CoML) following a proposal by Australia that there be an international, centrally coordinated Circum-Antarctic Census of Antarctic Marine Life (CircAntCML) conducted during the Antarctic summer in 2007/08, with the aim to describe and define biodiversity of marine life in the oceans that surround the Antarctic. This will also be a significant contribution to the IPY;

- the Information Net on Marine Biodiversity of SCAR (SCAR-MarBIN), a databank to integrate and disseminate information on Antarctic marine biodiversity.

(ii) Evolutionary Biology of Antarctic Organisms (EVOLANTA), convened by Dr P. Rodhouse (UK), held a Workshop on 'Evolution and Adaptation' in Siena, Italy, in December 2003. Papers have been published this year in a special volume of *Antarctic Science*.

(iii) The program, Ecology of the Sea Ice Zone (EASIZ), convened by Dr A. Clarke (UK) and Dr W. Arntz (Germany), was formally closed with a final symposium held in Croatia in September 2004. Another significant event of the past year was a symposium held at Ushuaia, Argentina, in October 2003. The main themes of the symposium were interactions between the Magellan region and the Antarctic (IBMANT) and Antarctic benthic deep-sea diversity (ANDEEP).

9.9 Two expert groups reported on their activities during the past year:

(i) Expert Group on Seals (EGS), chaired by Prof. A. Blix (Norway), has updated information at www.fagmed.uit.no/info/imb/aab/Scar/. The group reported that Antarctic fur seals and sub-Antarctic fur seals continue to increase over their entire range, while some populations of *Arctocephalus gazella* (Bouvetøya, South Shetland and South Sandwich Islands) and *A. tropicalis* (Amsterdam Island) and all three stocks (South Georgia, Macquarie and Kerguelen Islands) of southern elephant seal populations have stabilised.

The Status of Stocks Report will be provided to the CCAMLR Scientific Committee in 2005.

(ii) Expert Group on Birds (EGB), chaired by Dr E. Woehler (Australia) met in the Netherlands in June 2004. The main topics were the ratification of ACAP, progress on the compilation of contemporary and historical data on the distribution and abundance of birds in the Southern Ocean, and specially protected species and the status of giant petrels.

9.10 Among the action groups, the following were active:

(i) Biological Monitoring, convened by Dr D. Walton (UK), includes Dr Fanta among its members to promote liaison with CCAMLR. In 2005 there will be a workshop with the aim of producing a document for the Antarctic Treaty. Some objectives of the workshop are to consider a series of biological indicators of human impact, to consider if the monitoring of key species is practicable, and to evaluate the protocols of biological monitoring that are tested and validated in other parts of the world;

(ii) Best Practices for Conservation, chaired by Dr Walton, to look at conservation related to the Antarctic;

(iii) Global International Waters Assessment (GIWA) – the Ambassador of this program is Prof. G. Hempel (Germany). The group will organise a workshop for a discussion on the terms of reference for the report on Area 66, Antarctica.

9.11 The IXth SCAR International Biology Symposium (www.pucpr.br/scarbiologysymposium) will be held in Curitiba, Brazil, from 25 to 29 July 2005. The central theme of the symposium is 'Evolution and Biodiversity in the Antarctic'. The themes of the sessions are: Evolution and adaptation, Ecological processes, Conservation and management, Patterns and processes in biodiversity, and an Open session. The final date for submission of abstracts is 1 March 2005.

9.12 The IPY is a major event in which SCAR will play a significant role. Thus, LSSSG has defined some questions to be answered, that were derived from the IPY Initial Outline Science Plan:

- How do polar ecosystem structure and function vary through space and time and how much of this variation can be attributed to anthropogenic change?
- How has polar diversity responded to long-term changes in climate?
- What are the linkages between the physical, chemical and biological systems in the polar regions?
- What is the pattern and structure of polar marine and terrestrial biodiversity, at all trophic levels?
- How does phylogenetic and functional diversity vary across extreme environments, and what are the evolutionary responses underpinning this variation?

9.13 The establishment of a SCAR/SCOR/IOC Coordinating Group on Inter-disciplinary Southern Ocean Science (ISOS) is recommended to facilitate coordination between the different discipline research groups currently active in the Southern Ocean, and to encourage an inter-disciplinary approach to Southern Ocean observational and modelling research, recognising the inter-dependence of physical, chemical and biological processes in the ocean.

9.14 In response to questions and comments it was clarified that:

(i) the time for the meeting of the Working Group on Biological Monitoring and Human Impacts in the Antarctic has not yet been decided but the second week of March is likely;

(ii) no written documentation is available regarding the Circum-Antarctic CoML which was an idea presented, discussed and accepted during the meeting;

(iii) there is no standing request for advice to CCAMLR from the two expert groups on seals and birds (EGS and EGB). The potential request envisaged in paragraph 9.9 needs to be approved by the Scientific Committee;

(iv) a more definitive plan for the IPY is expected in January 2005. At the SCAR meeting, only an Initial Outline Science Plan was presented.

9.15 Prof. Croxall thanked Dr Fanta for her presentation and explanations, and concluded that the Scientific Committee may need to develop more efficient documentary means of linking and coordinating the many overlapping areas of interest for SCAR and CCAMLR, especially relating to monitoring, management and biodiversity issues.

Reports of observers from international organisations

ASOC

9.16 ASOC drew delegates' attention to the following papers: SC-CAMLR-XXIII/BG/25 for recommendations on krill; CCAMLR-XXIII/BG/31 for ASOC's recommendations and priorities for this meeting; CCAMLR-XXIII/BG/32 on noise pollution in the Southern Ocean; and CCAMLR-XXIII/BG/33 on protection of sensitive high-seas areas.

9.17 ASOC welcomed initial efforts made by the SCAR Action Group on Noise Pollution and Acoustic Impacts on the Marine Environment. ASOC submitted that coordinated efforts by CCAMLR and CEP should be made to implement mitigation measures before ATCM-XXVIII, with the aim of reporting back to the ATCM on progress made. ASOC urged the Scientific Committee and CCAMLR Member States to endorse the recommendations developed by the IWC and SCAR, and to commit CCAMLR resources to this joint effort.

9.18 ASOC strongly encouraged CCAMLR Members to take account of different recommendations to promote the development of MPAs from relevant fora like the World Parks Congress, the Convention on Biological Diversity and the UN General Assembly.

9.19 CCAMLR's adherence to the ecosystem and precautionary approaches as integral to the management of the Convention Area, places the Commission in a unique position to take concrete action to protect critical, vulnerable and highly sensitive deep-sea habitats in the Southern Ocean, particularly cold-water corals and their associated and dependent species. Special attention should also be granted to the Ross Sea, which has been highlighted as the largest intact marine ecosystem remaining on Earth.

9.20 ASOC commended WG-FSA and the subgroup on Subarea 48.3 for its hard work on the assessment of the fishery in Subarea 48.3.

9.21 ASOC stated that this body and this fishery are recognised globally as examples of conservative, precautionary and scientific fisheries management. It is clear that there is significant uncertainty associated with this assessment. In that context, ASOC finds it extremely troubling that for the second year running, the Scientific Committee has failed to provide concrete advice to the Commission. A catch limit chosen by a political body is not conservative, precautionary or scientific.

9.22 Additionally, ASOC sought reassurance that the proposed closure to fishing in Management Area 1 (West Shag Rocks) does not preclude patrolling against IUU fishing, which could severely impact on seabird populations in the area.

FAO/Birdlife South American Workshop on Implementation of NPOA-Seabirds and Conservation of Albatrosses and Petrels

9.23 The observer, Prof. Moreno, reported on the FAO/Birdlife South American Workshop on Implementation of NPOA-Seabirds and Conservation of Albatrosses and Petrels (SC-CAMLR-XXIII/BG/7).

9.24 The workshop was held at Futrono, close to Valdivia, Chile, from 2 to 6 December 2003, with 28 participants representing the fishing industry, non-governmental organisations, governmental fishery managers, researchers and invited international experts.

9.25 The meeting reached important conclusions and the recommendations emphasise aspects that can help in practical ways to achieve the NPOAs in the whole region, recognising, *inter alia*, that:

(i) all countries concerned have started to work on the assessment of incidental mortality of seabirds in longline fisheries;

(ii) all countries have identified a set of mitigation measures and some of them have initiated studies to implement and/or improve such measures;

(iii) all countries have initiated the preparation of NPOA-Seabirds, although the degree of achievement varies from country to country;

(iv) a higher commitment – regarding the first workshop – from governmental institutions and also from the fishing industry to deal with the conservation of seabirds is observed;

(v) some progress has also been achieved in the economic assessment of interaction between seabirds and marine fisheries;

(vi) a good basis exists for regional cooperation on the reduction of incidental catch of seabirds in countries with longline fisheries in the South Pacific and South Atlantic. In this context, the cooperation between FAO and BirdLife International, which allowed the holding of this workshop, was commended.

9.26 The meeting made the following recommendations:

(i) encourage the assessment of incidental mortality of seabirds in longline fisheries and intensify the research on suitable mitigation measures for specific fisheries, as well as research oriented to improve the mitigation methods and devices.

(ii) continue the development of methodologies to assess the economic impact of incidental catch of seabirds in longline fisheries and develop methodologies to assess the economic impact of mitigation measures in longline fisheries;

(iii) encourage the development of regional research on seabird by-catch and also on the implementation and improvement of mitigation measures in longline fisheries;

(iv) continue the cooperation between FAO and BirdLife International. The next steps in this cooperation should be: (a) the publication of a technical paper on the interaction of seabirds and longline fisheries in the South American seas; and (b) the holding of a third workshop on this issue by the end of 2005;

(v) study the possible interactions of trawling fleets with seabirds in the high seas of the southeast Pacific;

(vi) encourage the adoption by concerned countries of ACAP and the participation of these countries in the research program of the agreement.

IWC

9.27 The IWC Observer, Dr Kock, reported on relevant elements from the meeting of the SC-IWC held in Sorrento, Italy, from 29 June to 10 July 2004.

9.28 The SC-IWC emphasised the importance of close collaboration between the IWC, SO GLOBEC and CCAMLR in the Southern Ocean.

9.29 The role of sea-ice will be a focus of the 'Environmental Subcommittee' of the SC-IWC in 2005, to which some experts from outside the IWC will be invited. The SC-IWC strongly recommended that a workshop on sea-ice be held prior to the annual meeting in Ulsan, Republic of Korea, in May 2005. The CCAMLR Observer recommended that CCAMLR experts should be closely involved and contribute to the workshop and sea-ice discussions within the SC-IWC.

9.30 True blue whales have been estimated to have numbered 239 000 (202 000–311 000) at the start of whaling in the Southern Ocean in 1904. They had been reduced to a low of 360 (150–840) whales by 1973, with their last estimate being 1 700 (860–2 900) in 1996. They currently increase at a rate of 7.3% (1.4–11.6%) per year.

9.31 It was not possible to completely evaluate the effectiveness of the Southern Ocean Sanctuary (SOS) of the IWC at the present time because its scientific objectives are not clear and are not associated with quantifiable performance measures. The SC-IWC requested that its Commission consider clarifying the objectives of the SOS in order to allow the SC-IWC to discriminate among designs that would, *inter alia*, protect whales, protect whale species diversity and increase whaling yields outside the SOS. The SC-IWC developed a series of recommendations that, once the overall objectives have been refined, will allow these objectives to be evaluated, and will facilitate evaluation in future reviews.

9.32 In response to questions relating to the recommendation to involve CCAMLR expertise in the planned sea-ice workshop, it was clarified that the IWC ultimately will be interested in the relationship between whales and sea-ice. However, it was envisaged that two experts covering both the physical aspects and the ecosystem-related aspects of sea-ice distribution would be appropriate. It would be valuable to receive a report from the experts to WG-EMM to elaborate on this.

Reports of CCAMLR representatives at meetings of other international organisations

CWP

9.33 The Data Manager participated in the intersessional meeting of CWP which was held at FAO, Rome, from 3 to 5 February 2004 (SC-CAMLR-XXIII/BG/2). The meeting covered issues of immediate interest to CCAMLR, including:

- data quality indicators
- field guides for species identification
- fishery data processing systems
- the implementation of the strategy on status and trend of capture fisheries

- trade document information
- vessel data exchange formats.

9.34 The benefits of CCAMLR's involvement in CWP include participation in the:

- 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.

9.35 The 21st Session of CWP will be hosted by ICES and will be held in Copenhagen, Denmark, from 1 to 4 March 2005. The Workshop on Implementation of the Strategy on Status and Trend of Capture Fisheries will be held immediately prior to the 21st Session.

ICES

9.36 The report from the 2004 ICES Annual Science Conference in Vigo, Spain, from 20 to 25 September 2004, was available as SC-CAMLR-XXIII/BG/24.

9.37 ICES is the organisation that coordinates and promotes marine research in the North Atlantic. This includes adjacent seas such as the Baltic Sea and North Sea. ICES also gives advice to international organisations on fisheries management and pollution.

9.38 The Annual Science Conference was attended by a record of almost 800 scientists from ICES member states, states outside the ICES area and a number of international organisations.

9.39 Several meetings and sessions were held to address issues of specific scientific relevance to ICES. The theme sessions were divided into: (i) functioning of marine ecosystems; (ii) human impacts on marine ecosystems; (iii) options for sustainable marine-related industries; and (iv) the sustainable use of living marine resources.

Future cooperation

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

- 4th Biennial International Fisheries Observer Conference, 8 to 11 November 2004, Sydney, Australia – Australia (SC-CAMLR-XXII, paragraph 9.22);

- Agreement on the Conservation of Albatrosses and Petrels (ACAP), 8 to 12 November 2004, Hobart, Australia – Australia (SC-CAMLR-XXII, paragraph 9.22);

- 21st Session of CWP on Fishery Statistics, 1 to 4 March 2005, Copenhagen, Denmark – Data Manager;

- 7th Indo-Pacific Fish Conference, 16 to 20 May 2005, Taipei, Taiwan – Dr Shust;

- CEP-VIII – Antarctic Treaty, 6 to 17 June 2005, Stockholm, Sweden – Chair, Scientific Committee;

- 57th Annual Meeting of the SC-IWC, 30 May to 10 June 2005, Ulsan, Republic of Korea – Dr Kock;

- SCAR International Biology Symposium, 25 to 29 July 2005, Curitiba, Brazil – Dr Fanta;

- ICES Annual Science Conference, 20 to 24 September 2005, Aberdeen, UK – Dr Collins;

- SCOR 2005 General Meeting, 29 August to 1 September 2005, Cairns, Australia – no nomination.

9.41 A question was raised whether the Scientific Committee is interested in engaging in APEC in order to provide information on tourist-related matters. It was concluded that these questions are within the realm of CEP.

Future procedure

9.42 The Scientific Committee reviewed its advice to observers to the Scientific Committee who wish to submit documents to its meetings (SC-CAMLR-XXII, paragraph 9.23). It was agreed that this advice applied to all documents submitted by observers, including observers from other international and non-governmental organisations as well as CCAMLR observers at meetings of other international organisations. In future, the Scientific Committee would only consider papers from observers which are submitted to the Secretariat by 0900 h on the opening day of the meeting.

BUDGET FOR 2005 AND FORECAST BUDGET FOR 2006

Scientific Committee budget

10.1 The agreed budget of the Scientific Committee for 2005 and the forecast budget for 2006 are summarised in Table 5.

10.2 The budget for 2005 includes:

- support for WG-FSA based on estimates established for the 2004 meeting;

- Data Manager's participation and two days of secretarial support for the 2005 meeting of WG-FSA-SAM which will be held immediately prior to the meeting of WG-EMM at the same, or nearby, location;

- participation by four staff at the 2005 meeting of WG-EMM;

- participation costs (travel and per diem) for two experts at the 2005 workshop of WG-EMM, including participation by one of these experts at the 2005 meeting of WG-FSA-SAM.

10.3 The forecast budget for 2006 includes participation of one expert at a three-day workshop on land-based predators (A$6 000 for travel and per diem) (paragraph 3.85). Additional activities scheduled for 2006, which may have budgetary implications as yet to be identified, include SG-ASAM (paragraphs 3.20 to 3.22, 3.94 to 3.96 and 13.5) and the Workshop on MPAs (paragraphs 3.46 to 3.53).

Commission budget

10.4 The Scientific Committee endorsed the following expenditures under the Commission's budget for 2005:

- preparatory work for the review of the *Scientific Observers Manual*
- level funding for language support for *CCAMLR Science*
- participation by the Chair of the Scientific Committee in the 2005 meeting of CEP
- participation of the Data Manager in the 2005 intersessional meeting of CWP.

10.5 The Scientific Committee noted that re-issuing the *Scientific Observers Manual*, following revision, would cost approximately A$20 000 (CCAMLR-XXIII/4). This amount has been included in the forecast budget for 2006.

Multi-year budgeting

10.6 From time to time, the Scientific Committee was unable to complete a task intended for a particular year and was required, under current procedures, to forfeit the funding approved and reapply for funds at a later time if such a task was required in a subsequent year. SCAF had considered this issue and recommended that the Commission establish a procedure to permit the Scientific Committee to carry forward funds under particular circumstances. Pending a decision by the Commission, the Scientific Committee has requested that funding for a review of the GYM in 2004 (A$4 500) be carried forward to 2006.

ADVICE TO SCIC AND SCAF

11.1 The Chair presented the Scientific Committee's 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:

(i) estimates of finfish catches in the Convention Area (Annex 5, paragraphs 3.12 to 3.15, Table 3.1);

(ii) estimates of finfish catch and effort from IUU fishing (Annex 5, paragraphs 3.16 to 3.19, Tables 3.2 and 3.3);

(iii) IUU estimation inside and outside the Convention Area (Annex 5, paragraphs 8.1 to 8.13);

(iv) evaluation of threats arising from IUU activities with respect to seabird mortality (Annex 5, paragraphs 7.112 to 7.122);

(v) assessment of implementation of conservation measures relevant to mitigation of incidental mortality of seabirds (Annex 5, paragraphs 7.46 to 7.61);

(vi) Scheme of International Scientific Observation (Annex 5, paragraphs 11.1 to 11.55);

(vii) the need for scientific observers on krill vessels (Annex 5, paragraphs 7.229 to 7.237);

(viii) information relevant to SCIC which included advice concerning:

    (a) the need to crosscheck cruise reports and logbooks for monitoring compliance to conservation measures (Annex 5, paragraphs 11.56 to 11.60);

    (b) the request by WG-FSA for SCIC to provide estimates of fishable seabeds in the Convention Area that are under observation by fishery patrols (Annex 5, paragraphs 8.4 to 8.6).

SECRETARIAT SUPPORTED ACTIVITIES

Data management

12.1 The Scientific Committee noted the Data Manager's report (SC-CAMLR-XXIII/BG/5) which outlined the work undertaken by the Data Centre in the 2003/04 intersessional period.

Database developments

12.2 The Secretariat has revised a number of databases used in support of the work of the working groups. The revision included simplification of the operating procedures, improving the user-friendliness and further developing the data/error checking routines.

12.3 Intersessional work also included further validation of survey data, and improvements to data form C4 used for submitting data from bottom trawl surveys. This data form is in Microsoft Access format and data may be loaded either manually using the data entry panel, or by direct transfer of data to the tables in the form.

12.4 The Secretariat has also developed detailed documentation for the CEMP database queries used to calculate indices A1 to A9 (penguins) and B1 to B5 (seabirds). It is proposed to extend this type of documentation to the fur seal indices, overlap indices and other indices considered by WG-EMM.

12.5 In addition, in 2003, the Scientific Committee recommended that the Secretariat liaise with WG-FSA-SFA, current acoustic equipment manufacturers and software developers for advice on data storage and collection. The Secretariat has begun this work in consultation with past and present conveners of WG-FSA-SFA.

Fishery Plans

12.6 In 2004, the Secretariat undertook a major reorganisation and reconstruction of the database which holds the time series of information used in the Fishery Plans (see also Section 4). The Scientific Committee noted that Fishery Plans had been developed and updated as follows:

(i) plans for all fisheries (including closed fisheries) in the Convention Area are complete for the 2003/04 season;

(ii) plans for toothfish in Subareas 48.3, 88.1 and 88.2 and Division 58.5.2 are complete for the entire time series over which management measures have been in force;

(iii) plans for icefish in Subarea 48.3 and Division 58.5.2 are complete for the entire time series over which management measures have been in force;

(iv) plans for krill in Area 48 and Divisions 58.4.1 and 58.4.2 are complete for the entire time series over which management measures have been in force.

Monitoring CCAMLR fisheries

12.7 In 2003, the Commission requested that the Secretariat develop a procedure for forecasting closures in SSRUs (CCAMLR-XXII, paragraph 9.20). This request is addressed in CCAMLR-XXIII/38; other monitoring issues of concern to the Data Centre are also examined, and several changes and improvements were proposed by the Secretariat. The Scientific Committee discussed this matter in section 5.

Rules for Access and Use of CCAMLR Data

12.8 The Scientific Committee endorsed WG-EMM's recommendation that Members making data requests should clearly indicate the nature of their proposed work with respect to distinguishing between the work indicated in paragraph 2(a) and 2(b) of the rules (Annex 4, paragraphs 7.18 and 7.19). It was also agreed that, in the case of work endorsed by the Scientific Committee or the Commission, detailed reference to the relevant sections of their annual reports should be included in the data request. This would assist the Secretariat in evaluating the nature of the proposed work and in determining the applicable process under the rules.

Publications

12.9 In addition to annual reports of CCAMLR, the following documents were also published during 2004:

(i) *CCAMLR Scientific Abstracts* cover abstracts of papers presented in 2003
(ii) *CCAMLR Science*, Volume 11
(iii) *Statistical Bulletin*, Volume 16
(iv) Revisions to *Inspectors Manual* and *Scientific Observers Manual.*

12.10 The Scientific Committee agreed that language support for *CCAMLR Science* would be required in 2005. As a result, the Commission had approved level funding in 2005 (see section 10).

12.11 The Scientific Committee noted that the special issue of *Deep Sea Research II*, dedicated to the CCAMLR-2000 Survey, was currently in press (Annex 4, paragraphs 7.20 and 7.21). The Commission had contributed A$10 000 to the costs of publishing this special issue (CCAMLR-XX, paragraph 4.42). The Scientific Committee joined WG-EMM in expressing its gratitude to the CCAMLR-2000 Survey Steering Committee and in particular to the guest editor of the species issue, Dr J. Watkins (UK).

12.12 The Scientific Committee thanked the Convener of WG-EMM (Dr Hewitt) and the former Convener of WG-FSA (Dr I. Everson, UK) for their contribution to the Fourth World Fisheries Congress. The Conveners, together with Dr Jones, had presented a paper describing CCAMLR's approach to resource management (Annex 4, paragraph 7.12). This paper will be published in the proceedings of the conference.

Submission of papers to the Scientific Committee

12.13 The Scientific Committee noted the comments of WG-EMM (Annex 4, paragraphs 7.15 to 7.17) and WG-FSA (Annex 5, paragraphs 14.4 and 14.5) in relation to the guidelines for the submission of papers to the Scientific Committee (SC-CAMLR-XXIII/5 Rev. 1; see also SC-CAMLR-XXII, paragraphs 12.32 and 12.33).

12.14 In considering the comments provided by the working groups and related matters raised by WG-FSA-SAM (WG-FSA-04/4, paragraph 3.54), the Scientific Committee agreed to the following revision of its guidelines for the submission of papers:

(i) Paragraph 1 was modified to include explicitly consideration of papers submitted by Acceding States. The paragraph was revised to read (in the context of SC-CAMLR-XXIII) 'Contracting Parties are invited to submit for consideration at the Twenty-third meeting of the Scientific Committee, working papers and background papers related to specific items of the Scientific Committee's agenda.' The Scientific Committee noted that Contracting Parties comprise Members and Acceding States.

(ii) Paragraph 6 was reworded to reflect the current practice. The paragraph was revised to 'Papers submitted after the start of the meeting will not be accepted for consideration unless specifically agreed by the Scientific Committee due to exceptional circumstances notified to the Chair prior to the meeting.'

12.15 The Scientific Committee noted the revised rules for the submission of papers to WG-FSA (Annex 5, paragraph 2.6), and that these rules also applied to SC-CAMLR and CCAMLR documents which are submitted to the working group.

12.16 The Scientific Committee agreed that it would be beneficial to have guidelines relating to the submission of documents to the Committee and those of its working groups collated into a single reference document.

12.17 The Scientific Committee considered the Secretariat's proposal regarding the submission to the working groups of published papers or papers accepted for publication (SC-CAMLR-XXIII/5 Rev. 1, Annex 1). This matter had also been considered by WG-FSA (Annex 5, paragraph 14.5).

12.18 The Scientific Committee agreed that the status quo should be maintained in relation to this matter. It was also agreed that the preferred way of dealing with published papers submitted to working group meetings was for Members to provide the reference in advance of the meeting, and for participants to source the published papers and bring these to the meeting.

12.19 The Scientific Committee also agreed that the responsibility for any copyright issue related to the submission of published papers to working group meetings rests with the authors.

INTERSESSIONAL WORK

Intersessional activities during 2004/05

13.1 The Scientific Committee accepted with great pleasure Dr Naganobu's invitation, on behalf of Japan, to host the 2005 meeting of WG-EMM (two weeks) and the meeting of WG-FSA-SAM (one week) during the period from 27 June to 22 July 2005. These meetings would be held in the Tokyo area, and the exact dates of the meetings would be announced as soon as possible. Major activities scheduled by the Scientific Committee in the 2004/05 intersessional period are listed in Annex 6.

13.2 The Scientific Committee reviewed and endorsed the intersessional work plans of WG-EMM (SC-CAMLR-XXIII, Annex 4, Table 4), WG-FSA (SC-CAMLR-XXIII, Annex 5, Table 13.1) and ad hoc WG-IMAF (Annex 5, Appendix D).

13.3 The following CCAMLR meetings are planned during the 2004/05 intersessional period:

- meeting of WG-EMM scheduled in the Tokyo area, Japan, during a two-week period between 27 June and 22 July 2005;
- meeting of WG-FSA, including ad hoc WG-IMAF, scheduled in Hobart from 10 to 21 October 2005;
- meeting of WG-FSA-SAM scheduled in the Tokyo area, Japan, during the week immediately prior to WG-EMM-05.

13.4 In addition, a second workshop on the age determination of *C. gunnari* is scheduled in 2005 (Annex 5, paragraphs 9.8 to 9.12). The dates and venue of the meeting will be determined in consultation with the subgroup members and information will be circulated to the Scientific Committee in early 2005.

13.5 Following recommendations from WG-EMM (Annex 4, paragraphs 4.89 to 4.93 and 4.123) and WG-FSA (Annex 5, paragraph 10.8) to establish SG-ASAM, Members agreed to make available experts for consultation, particularly those associated with the ICES-FAST Working Group (see also paragraphs 3.94 and 3.95). It was tentatively agreed that the first meeting of SG-ASAM would be held sometime before the 2005 meeting of WG-EMM in July. It was also agreed that the terms of reference would be restricted to issues with respect to krill surveys, namely: (i) alternative models of krill target strength and (ii) delineation of volume backscattering attributed to krill versus other taxa. The Scientific Committee endorsed a plan offered by Dr Hewitt as Convener of WG-EMM, whereby a circular announcing the meeting and specifying the terms of reference would be sent to all Members. Members could then elect to send an expert to the meeting with the understanding that recommendations with respect to the analysis of acoustic krill surveys would be forwarded to WG-EMM for consideration at their 2005 meeting.

13.6 The Scientific Committee noted Dr Hewitt's need to retire as the Convener of WG-EMM (Annex 4, paragraph 8.3). It was agreed that the incoming Chair of the Scientific Committee would canvass Members with a view of finding a new convener for WG-EMM in the coming year.

Revision of the Scientific Committee agenda
and format of the WG-FSA report

13.7 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.

13.8 The Scientific Committee reviewed the format of the WG-FSA report. The report, in the format submitted to the Scientific Committee (SC-CAMLR-XXIII/4), contained approximately 240 pages of text and 40 pages of tables. Translation of the report had pushed the Secretariat's resources to breaking point, and staff had worked very long hours in order that the report be available to the Scientific Committee, in all languages, by the second day of its meeting.

13.9 While the Scientific Committee acknowledged the significant improvements arising from the restructure of the report, it was generally agreed that the report, in its present format, had become unmanageable.

13.10 Two options were considered to improve the focus of the report and the accessibility of information to the Scientific Committee and the Commission. Both options focused on retaining management advice and information essential to the work of the Scientific Committee in the body of the report. The two options differed in the way in which the remaining text, which provided background information and advice for future work of WG-FSA, would be presented.

13.11 Under Option 1, the remaining text would be placed in an appendix to the report. This appendix would be translated during the intersessional period and published with the report of WG-FSA. Under Option 2, the remaining text would be placed in a SC-CAMLR background document. These documents are not translated and the information contained within is subject to the Rules for Access and Use of CCAMLR Data. Both options resulted in a significant reduction in the size of the WG-FSA report, as illustrated by an example prepared by the Convener of WG-FSA.

13.12 The Scientific Committee acknowledged the editorial difficulties faced by the Convener in preparing the example report. In order to facilitate this process during future meetings of WG-FSA, the Scientific Committee offered the following guidance:

- rapporteurs at WG-FSA be encouraged to remove background documentation from the main body of the report;
- in cases where consensus is not reached, the report of WG-FSA should include a balanced presentation of the various views;
- the main body of the report should include the detail necessary to understand the development of each element of management advice.

13.13 The Scientific Committee agreed that Option 1 would best suit the needs of Members, and this option should be used to guide the format of future reports of WG-FSA. Further, it was agreed that the new format should be kept under review, and that WG-FSA should strive to identify material in its reports which may be placed in documents which do not require translation.

13.14 The Scientific Committee considered the request of WG-EMM for it to consider how best to coordinate and structure its work given the overlap between the working groups and the need to give more time to consider some issues (Annex 4, paragraphs 6.28 to 6.30). The Scientific Committee agreed that the strategic planning work forecast by WG-EMM could become a general planning workshop for the Scientific Committee to consider how best to structure its work, including harmonising the work of the working groups. It invited submissions on these matters from Members to the next meeting of the Scientific Committee with the intention of facilitating discussion on the terms of reference, timing and preparation for a workshop.

Invitation of observers to the next meeting

13.15 The Scientific Committee agreed that all observers invited to the 2004 meeting, as well as ACAP, would be invited to participate in SC-CAMLR-XXIV.

Next meeting

13.16 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 24 October to 4 November 2005.

ELECTION OF THE CHAIR AND VICE-CHAIR OF THE SCIENTIFIC COMMITTEE

14.1 Dr Holt's second term as Chair ended with SC-CAMLR-XXIII and the Scientific Committee sought nominations for a new Chair. Dr Barrera-Ora nominated Dr Fanta and this nomination was seconded by Dr Constable. Dr Fanta was unanimously elected to the position for a term of two regular meetings (2005 and 2006) and the Scientific Committee extended a very warm welcome to the incoming Chair.

14.2 Dr Sushin's term as Vice-Chair also ended with this meeting and the Scientific Committee sought nominations for a new Vice-Chair. Dr Sushin nominated Dr Shin and this nomination was seconded by Dr Hewitt. Dr Shin was unanimously elected to the position for a term of two regular meetings (2005 and 2006). A very warm welcome was extended to the incoming Vice-Chair.

14.3 The Scientific Committee thanked Drs Holt and Sushin for their significant contributions to its work (see also section 17).

OTHER BUSINESS

External review of the GYM

15.1 The Scientific Committee reviewed progress in conducting an independent external review of the GYM software and manual (SC-CAMLR-XXII, Annex 5, paragraph 9.18; SC-CAMLR-XXIII, Annex 5, paragraphs 13.9 to 13.11). Although the intent of the review was to examine the implementation of the software, the identification of the work to be included in the review had led to the consideration of broader issues (see WG-FSA-04/4, paragraphs 4.1 to 4.12).

15.2 The Scientific Committee agreed that external reviews of software used to implement models, as well as evaluations of assessment methods, would be beneficial to the work of CCAMLR. It was also recognised that such review may be undertaken externally or in collaboration with invited experts at CCAMLR-sponsored workshops and meetings.

15.3 The Scientific Committee noted that the proposed external review of the GYM would be further considered at the 2005 meetings of WG-FSA-SAM and WG-FSA, with a view of undertaking a review in 2006. Funds allocated for the review in 2004 have been carried forward to 2006 (see section 10).

International Polar Year

15.4 The Scientific Committee noted the suggestions of WG-EMM regarding possible CCAMLR-related activities for the IPY (Annex 4, paragraphs 7.1 to 7.4). These activities included a large-scale synoptic survey, smaller-scale surveys, contributions to the CoML and population estimates of land-based predators.

15.5 A number of Members will be conducting activities during the IPY (2007/08) either as part of their national activities or specifically for the IPY. These include: Australia, Argentina, Brazil, Chile, France, Germany, India, Italy, Japan, Republic of Korea, Russia, New Zealand, Norway, South Africa, Sweden, UK and the USA. Activities included the CoML, large-scale surveys, small-scale surveys, predator studies and individual studies of key organisms.

15.6 The Scientific Committee recognised that a single large-scale CCAMLR activity for the IPY was most likely to win support of the IPY planning group. The Scientific Committee agreed that a synoptic acoustic survey in the South Atlantic region would be the most appropriate activity for CCAMLR in the IPY. This survey would focus on krill but would collect a range of ancillary physical and biological data including observations on marine mammals, birds and fish. An intersessional steering group was established under Dr V. Siegel (European Community) to progress the concept of a CCAMLR synoptic survey for the IPY and he would contact Scientific Committee representatives from participating Members to nominate national coordinators. This group would formulate a CCAMLR proposal for the IPY and would submit it to the IPY planning group by the deadline early in 2005.

15.7 The Scientific Committee recognised the opportunity offered by the proposed CoML to collect a synoptic series of samples of interest to CCAMLR during the IPY. The Antarctic

CoML is likely to consist of a series of meridional transects around the Antarctic using vessels from a number of Members and if this format is followed, the Scientific Committee suggested that standardised measurements were made that included scientific acoustics, krill demographics, samples for genetic analysis of populations of krill and other key pelagic organisms, standardised physical and biological oceanography and ship-based surveys for mammals and birds. WG-EMM will provide standard protocols to CoML for each of these measurements.

ADOPTION OF THE REPORT

16.1 The report of the Twenty-third Meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

17.1 The close of the meeting completed Dr Holt's term as Chair of the Scientific Committee.

17.2 In closing, Dr Holt acknowledged Dr K. Kerry (Australia, former Convener of WG-CEMP), who had retired this year, and Mr R. Williams (Australia, former Convener of WG-FSA), who will be retiring in 2005. Both scientists had made significant contributions to the work of the Scientific Committee over their distinguished careers. Dr Holt also thanked Prof. Croxall, outgoing Convener of ad hoc WG-IMAF, for his vision and perseverance in addressing and reducing the incidental mortality of seabirds and marine mammals in CCAMLR fisheries, and Dr Constable, outgoing Convener of WG-FSA-SAM, for his expertise and guidance in the development and application of assessment methods.

17.3 Dr Holt thanked all Members of the Scientific Committee, the rapporteurs, vice-chairs and conveners for their dedication and goodwill. He also thanked the Secretariat for their support as each and every staff member had worked long and hard in support of the Scientific Committee and its working groups in 2004.

17.4 Dr Constable, on behalf of the Scientific Committee, thanked Dr Holt for his tremendous contribution during his four-year term. That period had seen an expansion in the role of the Scientific Committee and Dr Holt had ushered in the changes with grace and responsibility.

17.5 On behalf of the Scientific Committee, and all those at CCAMLR, Dr Miller presented Dr Holt with a gavel in commemoration of his time in the Chair.

17.6 The meeting was closed.

REFERENCES

Hewitt, R.P., G. Watters, P.N. Trathan, J.P. Croxall, M.E. Goebel, D. Ramm, K. Reid, W.Z. Trivelpiece and J.L. Watkins. 2004. Options for allocating the precautionary catch limit of krill among small-scale management units in the Scotia Sea. *CCAMLR Science*, 11: 81–97.

Table 1: Revised WG-EMM plan of work scheduled between 2003 and 2006.

Issue	2003	2004	2005	2006
Revised Krill Management Procedure				
Further development of predator–prey–fishery–environment models	Planning session	Workshop	Steering Committee	Steering Committee
Subdivide precautionary catch limit	Initial proposals	Additional proposals Recommendation	Initial advice based on workshop below	Further advice
Evaluation of management procedures including objectives, decision rules, performance measures	Discussion	Planning session	Workshop (1) to evaluate options for the subdivision of precautionary catch limit for Area 48	Workshop (2) CEMP properties and feedback management procedures
CEMP review	Workshop (SC-CAMLR-XXII, Annex 4, Appendix D)	Consideration of further analytical work (SC-CAMLR-XXII, Annex 4, Appendix D, Table 9)	Consideration of further analytical work	Consideration of further analytical work
Monitoring requirements from CEMP	Discussion		Initial specifications	Revised specifications based on workshop above
Reporting requirements from fishery	Interim requirements adopted by Commission	Consideration of revised requirements	Initial recommendation	Further recommendation
Assessment of Predator Demand				
Large-scale surveys of land-based predators	Discussion	Consideration of pilot studies	Consideration of pilot studies at a planning session	Workshop
Subdivision of Large FAO Statistical Areas				
Establishment of harvesting units	Discussion		Discussion	Proposals for Subareas 48.6, 88.1, 88.2, 88.3 and Divisions 58.4.1 and 58.4.2 Recommendation
Strategic Planning	Discussion	Discussion	Consideration of mechanisms to consider broader issues	Planning session for a workshop

Table 2: Revised krill management procedure.

	2002	2003	2004	2005
Delineation of **SSMUs** in Area 48	workshop			
CEMP review		workshop		
Selection of an operational model that captures the relevant interactions between krill, their predators, the environment and the fishery, which can be used to test the effectiveness of alternative management procedures			workshop	
Elaboration and testing of **management procedures**, including management objectives, required observations, assessment methods and decision rules				workshop
Reporting requirements from fishery			discuss	discuss
Monitoring requirements from CEMP			discuss	discuss

Table 3: Catch (tonnes) of target species in the Convention Area for the 2003/04 season (December 2003 to November 2004). Catches reported to 24 September 2004 in the catch and effort reporting system, unless indicated otherwise.

	Species	Member Country	Subarea or Division													Total
			48*	48.1	48.2	48.3	48.6	58.4.2	58.4.3b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Toothfish	*Dissostichus eleginoides*	Argentina												1		1
		Australia						0	1		2 269					2 270
		Chile				1 542										1 542
		EC – France**								3 436		441				3 877
		EC – Spain				660										660
		EC – UK				1 392										1 392
		Japan					7									7
		Korea, Republic of				310										310
		New Zealand												1	0	1
		Norway												0		0
		Russian Federation												0		0
		South Africa				232						55	50	0		337
		Ukraine												9		9
		USA												1		1
		Uruguay				346								0		346
	Dissostichus mawsoni	Argentina												162		162
		Australia						20	6							26
		EC – Spain												114		114
		EC – UK												16		16
		Korea, Republic of												114		114
		New Zealand												729	374	1 103
		Norway												98		98
		Russian Federation												283		283
		South Africa												110		110
		Ukraine												153		153
		USA												185		185
		Uruguay												190		190
	Total (toothfish)					4 482	7	20	7	3 436	2 269	496	50	2 166	374	13 307
Icefish	*Champsocephalus gunnari*	Australia									51					51
		Chile				972										972
		EC – UK				678										678
		Korea, Republic of				1 034										1 034
		USA				2										2
	Total (icefish)					2 686					51					2 737

(continued)

Table 3 (continued)

	Species	Member Country	Subarea or Division													Total
			48*	48.1	48.2	48.3	48.6	58.4.2	58.4.3b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Krill	*Euphausia superba*	EC – UK				16										16
		Japan	33 259													33 259
		Korea, Republic of		1 608	9 506	12 473										23 587
		Poland		1 148	4 795	3 024										8 967
		Russian Federation				775										775
		Ukraine			7 787	4 367										12 154
		USA		708	1 802	5 865										8 375
		Vanuatu***				14 979										14 979
	Total (krill)		33 259	3 464	23 890	41 499										102 112

* Unspecified within Area 48
** Monthly catch summaries to August 2004
*** Fine-scale data submitted during the meeting

Table 4: Catch (tonnes) of target species in the Convention Area for the 2002/03 season (December 2002 to November 2003). 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	58.4.2	58.5.1	58.5.2	58.6	58.7	88.1	88.2	
Toothfish	*Dissostichus eleginoides*	Australia				0		2 844					2 844
		Chile			2 881								2 881
		EC – France					5 291		531				5 822
		EC – Spain			880								880
		EC – UK			1 475								1 475
		Japan			262								262
		Korea, Republic of			296								296
		New Zealand			399						26		425
		Russian Federation			606								606
		South Africa			382				39	219	0		640
		Uruguay			347								347
	Dissostichus mawsoni	Australia				117							117
		New Zealand									954	106	1 060
		Russian Federation									703		703
		South Africa									149		149
	Total (toothfish)				7 528	117	5 291	2 844	570	219	1 832	106	18 507
Icefish	*Champsocephalus gunnari*	Australia						2 345					2 345
		Chile			834								834
		EC – UK			658								658
		Korea, Republic of			494								494
	Total (icefish)				1 986			2 345					4 331
Krill	*Euphausia superba*	Japan	27 094	154	32 434								59 682
		Korea, Republic of	2 360	4 625	14 291								21 276
		Poland	2 783	1 085	5 037								8 905
		Ukraine	324	7 012	10 379								17 715
		USA	2 816	2 550	4 784								10 150
	Total (krill)		35 377	15 426	66 925								117 728

Table 5: Scientific Committee budget for 2005 and forecast budget for 2006.

2004 Budget		Item	2005 Budget		*2006 Forecast*	
		WG-FSA				
		Meeting				
5 000		Computing facilities	5 200		*5 400*	
26 000		Preparation and Secretariat support	28 300		*29 100*	
50 100		Report completion and translation	39 100		*40 200*	
	81 100			72 600		*74 700*
	3 500	Secretariat support for WG-FSA-SAM		3 600		*3 700*
	4 500	Review of GYM		0		*0*
		WG-EMM				
		Meeting				
23 400		Preparation and Secretariat support	24 100		*24 800*	
35 200		Report completion and translation	36 300		*37 400*	
	58 600			60 400		*62 200*
		Travel for Scientific Committee Program				
	49 700	WG-EMM meeting (freight, flights and subsistence)		51 200		*52 700*
	16 000	External experts		19 300		*23 000*
	1 200	**Contingency**		1 200		*1 200*
	A$214 600	**Total**		A$208 300		*A$217 500*

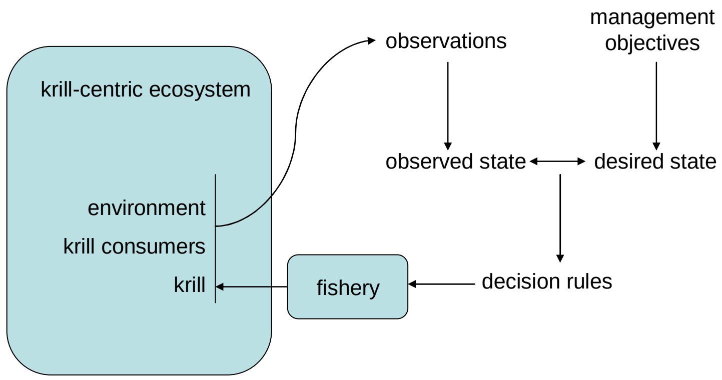

Figure 1: Krill management procedure.

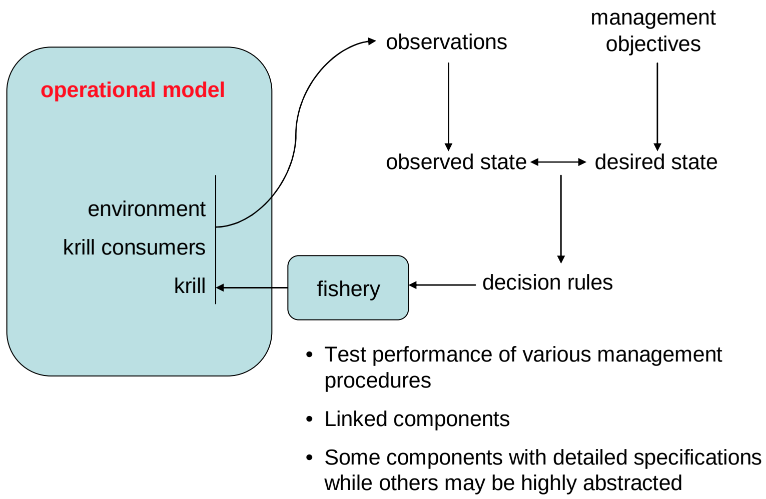

Figure 2: Testing krill management procedures.

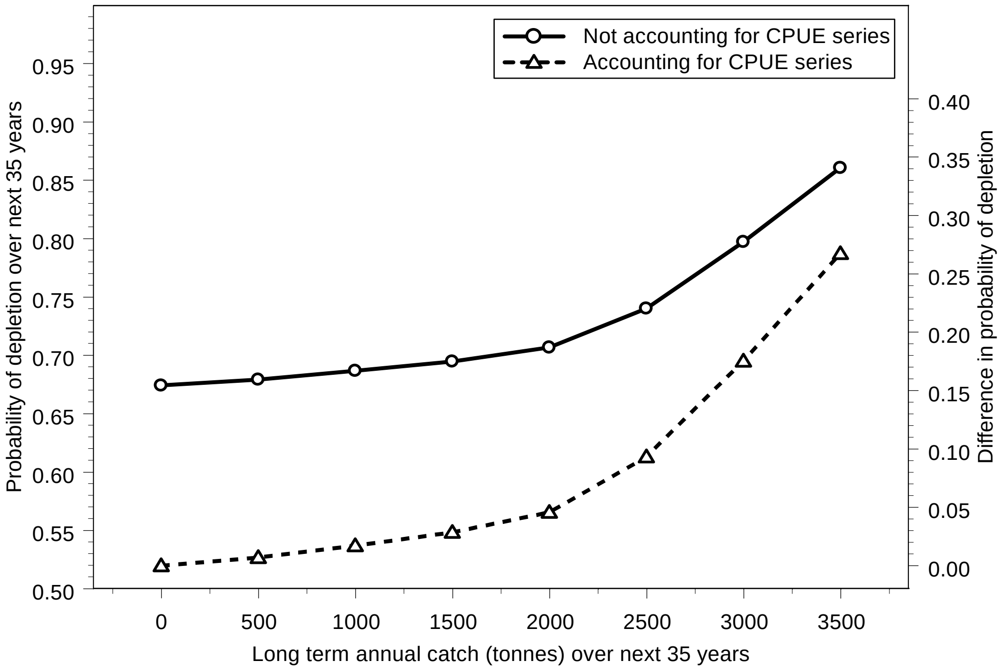

Figure 3: The probability of the spawning stock of *Dissostichus eleginoides* in Subarea 48.3 being depleted below 20% of the pre-exploitation median spawning biomass (part of the CCAMLR decision rule for assessing long-term annual yield) given an annual catch over the next 35 years. These probabilities are determined according to the parameters for the base-case scenario in Annex 5, Table 5.27. The probabilities that account for the CPUE series are those where greater emphasis is given to simulation trials that have similar trends during the historical catch series to the trends indicated by the standardised CPUE. The increase in the slope of both graphs around a catch level of 2 000 tonnes is a reflection that the base case assesses sustainable yield at 1 900 tonnes.

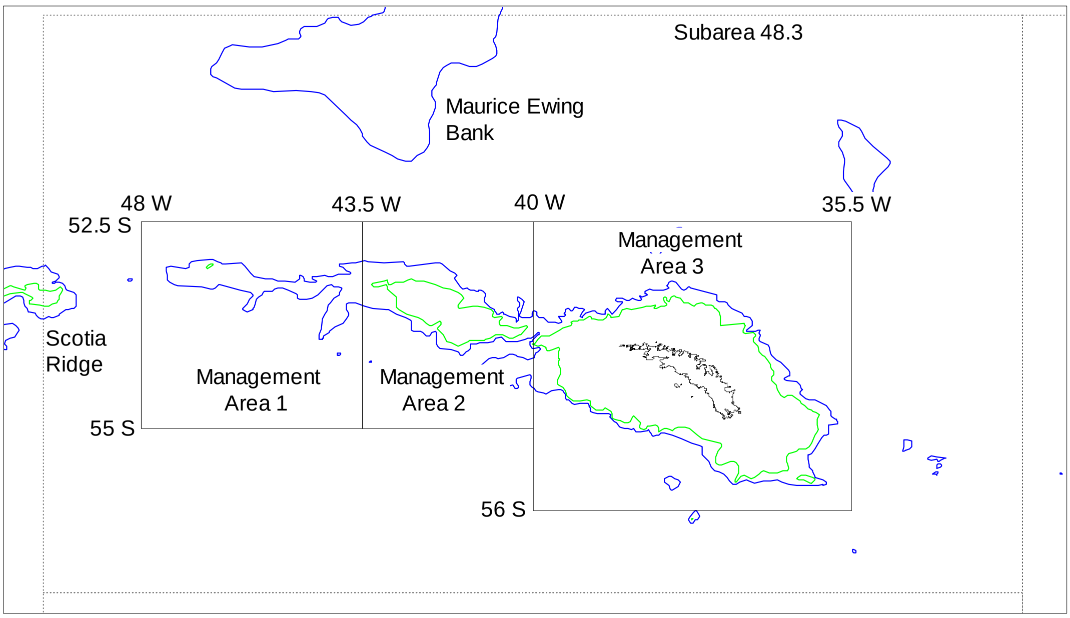

Figure 4: Map of Subarea 48.3 showing proposed management areas for *Dissostichus eleginoides* catch allocation.

ANNEX 1

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ANNEX 2

LIST OF DOCUMENTS

LIST OF DOCUMENTS

SC-CAMLR-XXIII/1	Provisional Agenda for the Twenty-third Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXIII/2	Provisional Annotated Agenda for the Twenty-third Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XXIII/3	Report of the meeting of the Working Group on Ecosystem Monitoring and Management (Siena, Italy, 12 to 23 July 2004)
SC-CAMLR-XXIII/4	Report of the Working Group on Fish Stock Assessment (Hobart, Australia, 11 to 22 October 2004)
SC-CAMLR-XXIII/5 Rev. 1	Draft rules for the submission of meeting papers to the Scientific Committee Secretariat
SC-CAMLR-XXIII/6	Budgeting issues for the work of the Scientific Committee Secretariat
SC-CAMLR-XXIII/7	On the management of exploratory toothfish fisheries: the need to amend a number of conservation measures Delegation of Ukraine

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SC-CAMLR-XXIII/BG/1	Catches in the Convention Area in the 2002/03 and 2003/04 seasons Secretariat
SC-CAMLR-XXIII/BG/2	Report on the Intersessional Meeting of the Coordinating Working Party on Fisheries Statistics (CWP) Secretariat
SC-CAMLR-XXIII/BG/3	Summary of notifications of new and exploratory fisheries in 2004/05 Secretariat
SC-CAMLR-XXIII/BG/4	Observer's Report from the 56th Meeting of the Scientific Committee of the International Whaling Commission (Sorrento, Italy, 29 June to 10 July 2004) CCAMLR Observer (K.-H. Kock, Germany)

SC-CAMLR-XXIII/BG/5	Data Management: report on activities during 2003/04 Secretariat
SC-CAMLR-XXIII/BG/6	Summary of scientific observation programmes conducted during the 2003/04 season Secretariat
SC-CAMLR-XXIII/BG/7	Observer Report on FAO/Birdlife South American Workshop on Implementation of NPOA-Seabirds and Conservation of Albatrosses and Petrels (Valdivia, Chile, 2 to 6 December 2003) CCAMLR Observer (C.A. Moreno, Chile) (Submitted in English and Spanish)
SC-CAMLR-XXIII/BG/8	Calendar of meetings of relevance to the Scientific Committee in 2004/05 Secretariat
SC-CAMLR-XXIII/BG/9	Synopses of papers submitted to WG-EMM-04 Secretariat
SC-CAMLR-XXIII/BG/10	Desechos marinos recolectados en Cabo Shirreff, isla Livingston, durante las temporadas antárticas 2002/03 y 2003/04 Delegación de Chile
SC-CAMLR-XXIII/BG/11	Review of CCAMLR activities on monitoring marine debris in the Convention Area Secretariat
SC-CAMLR-XXIII/BG/12	Entanglement of Antarctic fur seals (*Arctocephalus gazella*) in man-made debris at Signy Island, South Orkney Islands, 2003/04 Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/13	Beach debris survey, Main Bay, Bird Island, South Georgia, 2002/03 Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/14	Entanglement of Antarctic fur seals (*Arctocephalus gazella*) in man-made debris at Bird Island, South Georgia, during the 2003 winter and 2003/04 breeding season Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/15	Beach debris survey, Signy Island, South Orkney Islands, 2003/04 Delegation of the United Kingdom

SC-CAMLR-XXIII/BG/16	Fishing equipment, marine debris and oil associated with seabirds at Bird Island, South Georgia, 2003/04 Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/17	Notification for scientific research in 2004/05 Secretariat
SC-CAMLR-XXIII/BG/18	Report of the Convener of WG-EMM-04 to SC-CAMLR-XXIII
SC-CAMLR-XXIII/BG/19	On experimental approach to extend boundaries of exploratory fishery on Antarctic toothfish (*D. mawsoni*) in the Ross Sea (Subareas 88.1 and 88.2) in the meso- and bathypelagial layers Delegation of Russia
SC-CAMLR-XXIII/BG/20	Structure and distribution of the slope fish community in the vicinity of the sub-Antarctic Prince Edward Archipelago Delegation of South Africa
SC-CAMLR-XXIII/BG/21	IMAF assessment of new and exploratory fisheries by statistical area Ad Hoc Working Group on Incidental Mortality Arising from Fishing (WG-IMAF)
SC-CAMLR-XXIII/BG/22	Summary of population data, conservation status and foraging range of seabird species at risk from longline fisheries in the Convention Area Ad Hoc Working Group on Incidental Mortality Arising from Fishing (WG-IMAF)
SC-CAMLR-XXIII/BG/23	Incidental mortality of seabirds during unregulated longline fishing in the Convention Area Ad Hoc Working Group on Incidental Mortality Arising from Fishing (WG-IMAF)
SC-CAMLR-XXIII/BG/24	Report from the 2004 ICES Annual Science Conference (Vigo, Spain, 20 to 25 September 2004) CCAMLR Observer (Belgium)
SC-CAMLR-XXIII/BG/25	Management of the Antarctic krill: ensuring the conservation of the Antarctic marine ecosystem Submitted by ASOC
SC-CAMLR-XXIII/BG/26	Ad Hoc WG-IMAF Convener's summary for the Scientific Committee 2004
SC-CAMLR-XXIII/BG/27	Report of the Convener of WG-FSA to SC-CAMLR-XXIII, October 2004

SC-CAMLR-XXIII/BG/28	Summary tables of current and proposed Antarctic marine protected areas Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/29	The biology, ecology and vulnerability of seamount communities Delegation of the United Kingdom (prepared by A.D. Rogers, British Antarctic Survey and published in 2004 by the International Union for the Conservation of Nature and Natural Resources)
SC-CAMLR-XXIII/BG/30	The applicability of international conservation instruments to the establishment of marine protected areas in Antarctica Delegation of the United Kingdom
SC-CAMLR-XXIII/BG/31	Intersessional work plan for Ad Hoc WG-IMAF for 2004/05 Ad Hoc Working Group on Incidental Mortality Arising from Fishing (WG-IMAF)

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CCAMLR-XXIII/1	Provisional Agenda for the Twenty-third Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXIII/2	Provisional Annotated Agenda for the Twenty-third Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XXIII/3	Examination of the audited financial statements for 2003 Executive Secretary
CCAMLR-XXIII/4	Review of the 2004 budget, draft 2005 budget and forecast budget for 2006 Executive Secretary
CCAMLR-XXIII/5	Watching brief on the Fishery Resource Monitoring System (FIRMS) and the partnership arrangement Secretariat
CCAMLR-XXIII/6	Notification of Norway's intention to conduct an exploratory fishery for 2004/05 in Subareas 88.1 and 88.2 Delegation of Norway
CCAMLR-XXIII/7	Reports of Members' Activities Secretariat

CCAMLR-XXIII/8	Notification of Argentina's intention to conduct exploratory fisheries for *Dissostichus* spp. in CCAMLR areas Delegation of Argentina
CCAMLR-XXIII/9	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.3a for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/10	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.3b for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/11	Notification of Australia's intention to conduct an exploratory longline fishery in Statistical Subarea 88.1 for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/12	Notification of Chile to conduct an exploratory longline fishery in Division 58.4.1 for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/13	Notification of intention to conduct an exploratory longline fishery in Division 58.4.2 for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/14	Notification of intention to conduct an exploratory longline fishery in Division 58.4.3b for *Dissostichus* spp. Delegation of Chile
ADDENDUM CCAMLR-XXIII/12 CCAMLR-XXIII/13 CCAMLR-XXIII/14	Notification of Chile to conduct an exploratory longline fishery in Division 58.4.1 (CCAMLR-XXIII/12), Division 58.4.2 (CCAMLR-XXIII/13) and Division 58.4.3b (CCAMLR-XXIII/14) for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/15	Notification of Spain's proposal to conduct exploratory fisheries for toothfish (*Dissostichus* spp.) in CCAMLR Subarea 88.1 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b in the 2004/05 season Delegation of Spain
CCAMLR-XXIII/16	Notification of the intention to conduct an exploratory bottom trawl fishery for icefish in Subarea 48.3 Delegation of the United Kingdom

CCAMLR-XXIII/17	Notification by the United Kingdom of its intention to participate in the exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 during the 2004/05 season Delegation of the United Kingdom
CCAMLR-XXIII/18	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season (Subarea 48.6) Delegation of Japan
CCAMLR-XXIII/19	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3b) Delegation of Japan
CCAMLR-XXIII/20	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Subarea 48.6) Delegation of the Republic of Korea
CCAMLR-XXIII/21	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.1) Delegation of the Republic of Korea
CCAMLR-XXIII/22	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.2) Delegation of the Republic of Korea
CCAMLR-XXIII/23	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3a) Delegation of the Republic of Korea
CCAMLR-XXIII/24	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3b) Delegation of the Republic of Korea
CCAMLR-XXIII/25	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Subarea 48.6 in the 2004/05 season Delegation of New Zealand
CCAMLR-XXIII/26	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Divisions 58.4.1 and 58.4.2 in the 2004/05 season Delegation of New Zealand

CCAMLR-XXIII/27	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Subareas 88.1 and 88.2 in the 2004/05 season Delegation of New Zealand
CCAMLR-XXIII/28	Notification by Russia of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subareas 88.1 and 88.2 Delegation of Russia
CCAMLR-XXIII/29	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/30	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Division 58.4.1 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/31	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Division 58.4.2 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/32	Notification of an exploratory fishery in Subarea 88.1 Delegation of Uruguay
CCAMLR-XXIII/33	CCAMLR environmental protection measures Secretariat
CCAMLR-XXIII/34	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season Delegation of South Africa
CCAMLR-XXIII/35	Multi-year funding for tasks of the Scientific Committee Secretariat
CCAMLR-XXIII/36	Formula for calculating Members' contributions to the Commission's annual budget Secretariat
CCAMLR-XXIII/37	Executive Secretary's report to SCAF 2004 Executive Secretary
CCAMLR-XXIII/38	Monitoring CCAMLR fisheries: proposed changes and improvements Secretariat

CCAMLR-XXIII/39	Draft CCAMLR Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) Fishing Delegation of the European Community and CCAMLR Secretariat
CCAMLR-XXIII/40	Implementation of Conservation Measures 10-06 and 10-07 Draft List of IUU Vessels, 2004 Secretariat
CCAMLR-XXIII/41	Antarctic protected areas system: proposal for a new protected area at Edmonson Point, Wood Bay, Ross Sea Delegation of Italy
CCAMLR-XXIII/42	Ukraine's proposals to amend certain provisions of the conservation measures (category 'fishery regulations', subcategory 'toothfish') Delegation of Ukraine
CCAMLR-XXIII/43	Ukraine's proposals to amend certain provisions of conservation measures in order to increase the 'Transparency' of the information submitted and to prevent IUU fishing (category 'general fishery matters', subcategory 'notifications') Delegation of Ukraine
CCAMLR-XXIII/44	E-CDS trial Delegation of France
CCAMLR-XXIII/45	EC Proposal Amendments to Conservation Measure 21-02 – Exploratory Fisheries Delegation of the European Community
CCAMLR-XXIII/46	EC Proposal Amendments to Conservation Measure 10-02 Licensing and Inspection Obligations of Contracting Parties with regard to their Flag Vessels Operating in the Convention Area Delegation of the European Community
CCAMLR-XXIII/47	Withdrawn
CCAMLR-XXIII/48	Improvements to the CCAMLR Illegal, Unreported and Unregulated (IUU) Vessel Lists Delegation of Australia
CCAMLR-XXIII/49	A proposal to establish a CCAMLR Centralised Vessel Monitoring System (C-VMS) Delegations of Australia, New Zealand and the USA

CCAMLR-XXIII/50	Report of the Standing Committee on Administration and Finance (SCAF)
CCAMLR-XXIII/51	Report of the Standing Committee on Implementation and Compliance (SCIC)

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CCAMLR-XXIII/BG/1 Rev. 1	List of documents
CCAMLR-XXIII/BG/2	List of participants
CCAMLR-XXIII/BG/3	Attendance at OECD workshop on IUU fishing (Paris, France, 19–20 April 2004) Executive Secretary
CCAMLR-XXIII/BG/4	Report on attendance by the CCAMLR Executive Secretary and Science Officer at the Deep Sea 2003 Conference (Queenstown, New Zealand, 1 to 5 December 2003) Executive Secretary
CCAMLR-XXIII/BG/5	Cooperation between CCAMLR and CITES Secretariat
CCAMLR-XXIII/BG/6	Report of the CCAMLR Observer to ATCM-XXVII (Cape Town, South Africa, 24 May to 4 June 2004) Executive Secretary
CCAMLR-XXIII/BG/7	Report on attendance at the Seventh Meeting of the Committee for Environmental Protection under the Madrid Protocol Chair of the CCAMLR Scientific Committee
CCAMLR-XXIII/BG/8	Implementation of fishery conservation measures in 2003/04 Secretariat
CCAMLR-XXIII/BG/9	Summary of current conservation measures and resolutions in force 2003/04 Secretariat
CCAMLR-XXIII/BG/10	Calendar of meetings of relevance to the Commission in 2004/05 Secretariat
CCAMLR-XXIII/BG/11	Report on the Ninth Session of the COFI Sub-Committee on Fish Trade (10 to 14 February 2004, Bremen, Germany) CCAMLR Observer (H. Pott, Germany)

CCAMLR-XXIII/BG/12	Observer Report on FAO Technical Consultation on Fishing Capacity/IUU Fishing (Rome, Italy, 19 to 24 June 2004) CCAMLR Observer (Japan)
CCAMLR-XXIII/BG/13	Implementation of the System of Inspection and other CCAMLR enforcement provisions in 2003/04 Secretariat
CCAMLR-XXIII/BG/14	Report of the C-VMS trial Secretariat
CCAMLR-XXIII/BG/15	Implementation and operation of the Catch Documentation Scheme in 2003/04 Secretariat
CCAMLR-XXIII/BG/16	Report of the E-CDS trial Secretariat
CCAMLR-XXIII/BG/17	The use of trade statistics in the evaluation of total removals of toothfish and the performance of the CDS Secretariat
CCAMLR-XXIII/BG/18	CCAMLR Education Package Secretariat
CCAMLR-XXIII/BG/19	Évaluation de la pêche illicite dans les eaux françaises adjacentes aux îles Kerguelen et Crozet pour la saison 2003/04 (1er juillet 2003 – 30 juin 2004) Informations générales sur la zone 58 de la CCAMLR Délégation française
CCAMLR-XXIII/BG/20	Mise en œuvre du C-VMS Délégation française
CCAMLR-XXIII/BG/21	Withdrawn
CCAMLR-XXIII/BG/22	Towards the creation of a Marine Protected Area around South Africa's sub-Antarctic Prince Edward Islands Delegation of South Africa
CCAMLR-XXIII/BG/23	CCAMLR and seabirds in the Antarctic marine ecosystem Secretariat (To be submitted to the First ACAP Conference of Parties)
CCAMLR-XXIII/BG/24	Illegal, unreported and unregulated Patagonian toothfish catch estimate for the Australian EEZ around Heard Island and McDonald Islands Delegation of Australia

CCAMLR-XXIII/BG/25	Observer's report on the 2003 annual meeting of the International Commission for the Conservation of Atlantic Tunas (ICCAT) CCAMLR Observer (European Community)
CCAMLR-XXIII/BG/26	Further clarification and standardisation of Catch Documentation Scheme procedures Delegation of the USA
CCAMLR-XXIII/BG/27 Rev. 2	Illegal toothfish trade: introducing illegal catches into the markets Submitted by ASOC (Submitted in English and Spanish)
CCAMLR-XXIII/BG/28	Report on the FAO technical consultation to review Port State measures to combat illegal, unreported and unregulated fishing CCAMLR Observer (Norway)
CCAMLR-XXIII/BG/29	Observer's report on the WTO Committee on Trade and Environment (WTO CTE), 2004 CCAMLR Observer (New Zealand)
CCAMLR-XXIII/BG/30	Report on the vessels *Florens 1* (*Simeiz*) and *Eva 1* (*Mellas*) Delegation of New Zealand
CCAMLR-XXIII/BG/31	Priority issues and recommendations of the Antarctic and Southern Ocean Coalition (ASOC) for the XXIII Meeting of the Convention of the Conservation of Antarctic Marine Living Resources Submitted by ASOC
CCAMLR-XXIII/BG/32	Noise pollution in the Southern Ocean Submitted by ASOC
CCAMLR-XXIII/BG/33	Protection of high seas Submitted by ASOC
CCAMLR-XXIII/BG/34	Regarding the circumstances of registration of vessels *Simeiz*, *Mellas* and *Sonriza* in Ukraine and issuing to them permissions to fish in the Convention Area Delegation of Ukraine (Submitted in Russian and English)
CCAMLR-XXIII/BG/35	FAO Observer's Report FAO Observer (R. Shotton)

CCAMLR-XXIII/BG/36	Report on attendance by CCAMLR representative at the Vessel Monitoring System (VMS) Conference, Asia and Pacific (November 2003, Cairns, Australia) CCAMLR Observer (Australia)
CCAMLR-XXIII/BG/37	Report on the activities and meetings of the Scientific Committee on Antarctic Research (SCAR) 2003/04 SCAR representative in CCAMLR, CCAMLR representative in SCAR E. Fanta (Brazil)
CCAMLR-XXIII/BG/38	IWC Observer's Report to CCAMLR Annual Meeting 2004 IWC Observer (B. Fernholm, Sweden)
CCAMLR-XXIII/BG/39	A ministerially-led task force on illegal, unreported and unregulated fishing in the high seas Delegations of Australia, Chile, New Zealand and the United Kingdom
CCAMLR-XXIII/BG/40	Report on attendance at the Eleventh Annual Meeting of the Commission for the Conservation of Southern Bluefin Tuna (19 to 22 October, 2004) CCAMLR Observer (Republic of Korea)
CCAMLR-XXIII/BG/41	Report of Scientific Committee Chair to the Commission
CCAMLR-XXIII/BG/42	Ratifications of international fisheries instruments Delegation of Norway
CCAMLR-XXIII/BG/43	Eighty years of the Convention objectives Delegation of Argentina (Submitted in English and Spanish)
CCAMLR-XXIII/BG/44	Correspondence from the Republic of Vanuatu Fisheries Department (Received from the Republic of Vanuatu)

ANNEX 3

AGENDA FOR THE TWENTY-THIRD MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE TWENTY-THIRD 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 2003/04 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 2003/04 season
      (b) Notifications for new and exploratory fisheries in the 2004/05 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
   (ii) 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 2005 and forecast budget for 2006

11. Advice to SCIC and SCAF

12. Secretariat supported activities
   (i) Data management
   (ii) Publications
   (iii) Submission of papers to the Scientific Committee

13. Scientific Committee activities
   (i) Intersessional activities during 2004/05
   (ii) Revision of the Scientific Committee agenda and restructure of the WG-FSA report
   (iii) Invitation of observers to the next meeting
   (iv) Next meeting

14. Election of Chair and Vice-Chair of the Scientific Committee

15. Other business

16. Adoption of the Report of the Twenty-third Meeting of the Scientific Committee

17. Close of the meeting.

ANNEX 4

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Siena, Italy, 12 to 23 July 2004)

CONTENTS

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Siena, Italy, 12 to 23 July 2004)

INTRODUCTION

Opening of the meeting

1.1 The tenth meeting of WG-EMM was held at the University of Siena, Siena, Italy, from 12 to 23 July 2004. The meeting was convened by Dr R. Hewitt (USA).

1.2 Prof. P. Tosi (Chancellor of the University of Siena), Ambassador L. Cortese (Ministry of Foreign Affairs and CCAMLR Commissioner), Prof. C. Ricci (Chair of the Italian Scientific Committee for Antarctic Research), Prof. S. Focardi (Dean of the Faculty of Science, University of Siena) and Dr Hewitt welcomed the participants.

1.3 Dr Hewitt and Dr D. Miller, Executive Secretary, thanked the University of Siena and Prof. Focardi for hosting the tenth meeting of WG-EMM and recalled that the University had also hosted the first and very successful meeting of the Working Group in 1995.

1.4 Dr Hewitt outlined the program for the meeting. This was the fourth meeting with a mixed agenda consisting of plenary and subgroup sessions to discuss core topics, and a workshop (Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management – section 2). Much of this work was started in Siena during the 1995 meeting.

Adoption of the Agenda and organisation of the meeting

1.5 The Provisional Agenda was discussed and the Working Group agreed to expand Item 5.4 to ‘Consideration of models and analytical and assessment methods’. With this change, the agenda was adopted (Appendix A).

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

1.7 The report was prepared by Drs D. Agnew (UK), A. Constable (Australia), Prof. J. Croxall (UK), Drs D. Demer (USA), M. Goebel (USA), S. Kawaguchi (Australia), G. Kirkwood (UK), P. Penhale (USA), D. Ramm (Secretariat), K. Reid (UK), E. Sabourenkov (Secretariat), H.-C. Shin (Republic of Korea), V. Siegel (Germany), W. Trivelpiece (USA), P. Trathan (UK) and G. Watters (USA).

WORKSHOP ON PLAUSIBLE ECOSYSTEM MODELS FOR TESTING APPROACHES TO KRILL MANAGEMENT

2.1 The Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management, which was established in the program of work for WG-EMM in 2001, was held at the University of Siena, Siena, Italy, from 12 to 16 July 2004. The meeting was convened by Dr Constable. The report is attached as Appendix D.

2.2 The terms of reference for the workshop were agreed in 2003 (SC-CAMLR-XXII, Annex 4, paragraph 6.17). The Working Group agreed that excellent progress was made by the workshop on the first two terms of reference for the development of plausible models, including intersessional work by the workshop's steering committee in 2003/04 (SC-CAMLR-XXII, paragraphs 3.45 to 3.49; Appendix D, paragraph 1.2), and endorsed the report of the workshop. This work provides the foundation for technical implementation of ecosystem models under the third term of reference.

2.3 Dr B. Fulton (CSIRO, Australia) was invited for her expertise in developing models for the evaluation of management procedures (strategies). A second expert was invited but was unable to attend the workshop due to unexpected circumstances. Dr Fulton made a very valuable contribution to the workshop, including her guidance during the discussions.

2.4 The workshop had agreed that a primary aim of the workshop was to develop the specifications that will be used by programmers to produce the modelling framework in which plausible models of the Antarctic marine ecosystem can be simulated. Also, the workshop considered ecosystem and other scenarios that would need to be explored to help evaluate the potential for biases in our monitoring and in the assessment process, and whether those biases could lead to incorrect decisions that would cause the Commission to fail to meet one or more of its objectives.

2.5 In undertaking its work, the workshop noted that the discussions were to draw together information and concepts to provide a common framework for developing one or more ecosystem models for testing approaches to krill management. The workshop noted that some tables, figures or text may not be complete in their consideration or presentation of the issues. Nevertheless, the workshop agreed that the format of the workshop provided the foundation for further development and implementation of ecosystem models for the work of WG-EMM.

2.6 The workshop reported on the outcomes of intersessional activities, which included:

(i) seeking the contribution and participation from experts (Appendix D, paragraphs 1.5 to 1.7);

(ii) a review of relevant literature on ecosystem models, primarily in the Southern Ocean (Appendix D, paragraphs 2.3 to 2.5);

(iii) compilation of a catalogue of available software and other simulation environments for ecosystem modelling (Appendix D, paragraphs 2.6 and 2.7);

(iv) preliminary consideration of the requirements for datasets, estimates of parameters and other aspects related to the second term of reference (Appendix D, paragraphs 2.8 to 2.10);

(v) preliminary outline of the aims and specifications for ecosystem modelling as it relates to the development of management procedures for krill (Appendix D, paragraphs 2.11 to 2.13).

2.7 Dr Fulton presented illustrations of her use of models in CSIRO in evaluating management strategies for the marine environment. She provided background on management strategy evaluation, steps for developing ecosystem models and summary details of two models that she uses, Atlantis and InVitro. Her presentations are summarised in Appendix D, paragraphs 2.15 to 2.25.

2.8 The workshop summarised desirable attributes of ecosystem models. A review of existing models is provided in Appendix D, paragraphs 3.1 to 3.15. The general attributes of models for evaluation of management procedures and their implementation were discussed and agreed by the workshop in Appendix D, paragraphs 3.16 and 3.17.

2.9 The workshop developed conceptual representations of the ecosystem with the following points in mind (Appendix D, paragraphs 4.1 to 4.3):

(i) the aim of developing conceptual models is to provide a flexible framework for considering how each taxon might be influenced by the rest of the ecosystem, thereby providing the means to explicitly decide how best that taxon should be represented in the model to evaluate krill management procedures;

(ii) some taxa will need to be represented in some detail in order to simulate field monitoring and the local-scale effects of fishing;

(iii) other taxa might be simulated in a very general way in order to save simulation time while ensuring that ecosystem responses are realistic;

(iv) the approach is intended to provide a means for explicitly determining how to take account of structural uncertainties given the paucity of data on many aspects of the ecosystem. The approach is also designed to allow an assessment of the sensitivity of model outcomes to assumptions about the relationships between taxa;

(v) the basic elements of the model will be the lowest, indivisible quantity in the food-web model and could be a species, guild, ecological group, population, local population or life stage (not necessarily age-structured);

(vi) some consideration will need to be given to distributions of each element in space and depth, as well as the time steps required to satisfactorily model each element;

(vii) the conceptual models will require consideration of the characteristics of elements, even though each characteristic may not be explicitly incorporated as a separate part of a model.

2.10 In the first instance, the workshop agreed to undertake the following work in developing conceptual representations of key components:

(i) develop pictorial representation, as appropriate, of key population processes, primary locations of individuals relative to features in the physical environment and spatial foraging patterns;

(ii) identify key parameters and processes that will need to be considered in the representation of each element in the ecosystem model, including population dynamics, foraging behaviours and spatial and temporal distributions;

(iii) undertake initial consideration of:

(a) the interactions between taxa and between taxa and the environment;

(b) the representation of space, time, and depth in ecosystem models;

(c) the requirements for modelling field observations, which will be undertaken in the evaluation process.

2.11 The workshop noted that the major considerations for the development of operating models are with respect to:

- physical environment
- primary production
- pelagic herbivores and invertebrate carnivores
- target species
- mesopelagic species
- marine mammals and birds.

2.12 Other taxa may need to be considered in future, such as demersal and bathypelagic species, including *Dissostichus* spp., *Macrourus* spp., skates and rays. It was noted that the current framework was sufficient for initiating work on evaluating approaches to krill management.

2.13 The Working Group endorsed the body of the workshop report describing the results of discussions on conceptual representation of these components (Appendix D, paragraphs 4.9 to 4.100).

2.14 The workshop considered the types of scenarios that need to be considered in evaluating the robustness of krill management procedures to structural uncertainties of the model. This discussion focused on two broad topics. The first was concerned with the plausibility of the model (Appendix D, paragraphs 5.2 to 5.4) and the second was concerned with questions of ecosystem dynamics that could be explored with the model (Appendix D, paragraph 5.4).

2.15 After some discussion, the workshop concluded that the following scenarios should be accorded the highest priority:

(i) behaviour of the model system in response to artificial (i.e. known) forcing functions in order to better understand the properties of the model;

(ii) effects of alternative formulations of krill transport on ecosystem dynamics;

(iii) effects of climate change on primary production and/or ocean circulation.

2.16 The Working Group requested guidance from the Scientific Committee with regard to the priorities for exploring realistic scenarios and future work.

2.17 The workshop discussed a number of items that relate to the formulation and specification of ecosystem models in general (Appendix D, paragraphs 6.2 to 6.4) and to Antarctic ecosystems in particular (Appendix D, paragraphs 6.5 to 6.25).

2.18 The workshop agreed that it would be desirable to develop an ecosystem model as a set of connected modules rather than a single large piece of software. Individual modules might be used to model various oceanographic processes (e.g. separate modules for ocean currents and the seasonal development of sea-ice) and the population dynamics of individual taxonomic groups (e.g. separate modules for Antarctic krill and fur seals). The Working Group endorsed the discussion on developing these modules provided in Appendix D, paragraphs 6.2 to 6.4.

2.19 The Working Group noted that ecosystem models typically describe interactions between species and taxonomic groups in the context of predator–prey and competitive interactions (although many other types of interactions are possible), and the manner in which such interactions are characterised typically has profound effects on the behaviour of and predictions from ecosystem models. It endorsed the discussion on predator–prey interactions in Appendix D, paragraphs 6.6 to 6.20, noting that:

(i) the figures of food-web interactions (Appendix D, Figures 30 to 34) are a useful foundation for conceptualising the food webs in the Antarctic marine ecosystem;

(ii) sensitivity analyses should be done to explore how predictions from Antarctic ecosystem models change in response to different assumptions about predator–prey interactions (e.g. assuming a Type II or Type III functional response or assuming different decision criteria in individual-based foraging models) and to different ways of modelling these interactions (i.e. using functional response curves or individual (group) based foraging models);

(iii) studies should be done to determine whether, and under what conditions, functional response curves can be satisfactory approximations of individual-based foraging models. Although the latter approach may be more realistic, the former approach is likely to be more efficient in a modelling context.

2.20 The Working Group endorsed the considerations of incorporating space, time and depth into ecosystem models (Appendix D, paragraphs 6.21 to 6.24).

2.21 The Working Group noted that some consideration will need to be given to peripheral processes and boundary conditions in the context of animals that move in and out of the spatial arena described by operating models (Appendix D, paragraph 6.25).

2.22 The Working Group agreed that the workshop had achieved the goal to provide a foundation for conceptual models of the physical environment and taxa of the Southern Ocean ecosystem and how to place these into a modelling framework. It recognised that future work will entail validating the work presented here and further developing conceptual models as indicated in the body of Appendix D, sections 4, 5 and 6. As such, the Working Group recommended continued refinement of these conceptual models and encouraged their implementation in the modelling framework.

2.23 The Working Group noted that an important task is to collate the appropriate parameter values for implementing functions and model components derived from these conceptual models. In this respect it also noted that reviews of available information would be useful and that a common database of available parameters could be developed to facilitate a coordinated use of such parameters and information.

2.24 The Working Group requested WG-FSA review the details provided on fish, squid and fisheries in Appendix D, section 4, and provide component details for toothfish and demersal species and to address the issues in Appendix D, paragraph 7.2.

2.25 The Working Group noted that the development of complex models will take some time to complete (Appendix D, paragraph 7.5).

2.26 With respect to next year's Workshop Management Procedures (paragraphs 6.12 to 6.21), the Working Group noted that initial exploration of management options could be achieved using spatially structured krill population models that allow exploration of the interaction between

- the krill population
- spatial catch limits and the fishery
- krill predators
- transport of krill.

2.27 The Working Group agreed that this may be feasible next year with the further development of existing models and new basic models taking account of outcomes of this workshop. This was further discussed in preparation for next year's workshop.

2.28 The Working Group agreed that further development of the framework and the implementation of one or more ecosystem models will require coordinated work. It recommended that a steering committee be established to coordinate this work and noted the points for consideration raised by the workshop (Appendix D, paragraph 7.7).

2.29 The Working Group noted that a number of research groups of CCAMLR Members are developing ecosystem models for the Southern Ocean. It therefore agreed to establish the steering committee as quickly as possible (Appendix D, paragraph 7.8). Details for the steering committee are given in paragraph 5.62.

2.30 The Working Group noted that the development of models for next year's workshop is a different task from the longer-term work. Nevertheless, it was recommended that the conveners of next year's workshop coordinate the preparatory work for the workshop with the coordinator of the steering committee and, in the interim, with those scientists nominated in paragraph 5.63. This will help provide the opportunity for modelling work for next year to be developed in such a way that it might contribute to the longer-term modelling work.

2.31 The Working Group thanked the Convener and the steering committee of the workshop and the Secretariat for successfully facilitating a productive workshop.

STATUS AND TRENDS IN THE KRILL FISHERY

Fishing activity

3.1 In the 2002/03 season, five Member countries fished, with a total of nine vessels, only in Area 48 (WG-EMM-04/15). The total catch reported was 117 639 tonnes, a slight decrease from the previous fishing season. Japan caught approximately 60 000 tonnes, followed by the Republic of Korea and Ukraine each with approximately 20 000 tonnes, and the USA and Poland each with approximately 10 000 tonnes. Fifty-seven percent of the total catch was taken from Subarea 48.3. Within Subarea 48.1, most of the catch was taken within the Western Drake Passage SSMU; in Subarea 48.2, the western sector South Orkney SSMU; and in Subarea 48.3, the South Georgia Eastern SSMU.

3.2 In the 2003/04 season to July 2004, seven vessels from six Members had reported a catch of about 43 000 tonnes of krill, suggesting that the total catch for 2003/04 would be below 100 000 tonnes (WG-EMM-04/15).

3.3 Fishing had been undertaken by Japan, Republic of Korea, Poland, Ukraine, UK and the USA. In addition, one vessel flagged to Vanuatu had entered the fishery. However, no data had been submitted to CCAMLR to date. It was noted that Vanuatu, an Acceding State to the Convention, had notified CCAMLR of its intention to fish according to CCAMLR requirements. Dr Agnew confirmed that the Vanuatu vessel was currently fishing in Subarea 48.3. A UK observer had been deployed. The Working Group asked the Secretariat to confirm with Vanuatu that the data would be submitted to CCAMLR.

3.4 The Working Group expressed its thanks to fishing nations for the provision of notification information in Table 1 (WG-EMM-04/6). This is the first time that the Working Group had had this information. It was recognised that although the total catch in Table 1 appeared to be much higher than in previous years (226 000 tonnes) the actual catches may not meet the forecasts depending on economic and other factors. Forecasts are therefore more likely to be upper estimates of potential catch. For instance, Dr V. Bibik (Ukraine) informed the meeting that Ukrainian vessels are likely to take significantly less than notified in the table, 25 000 tonnes with two vessels. The number of vessels and potential products may provide a better indicator of trends in the fishery.

3.5 The information on the timing and areas of potential fishing is particularly useful for the work of EMM. Information on products is useful to determine trends within the market for krill that might have implications for future development. Any requests for additional data in the notifications would similarly be linked to specific questions required for the work of WG-EMM.

3.6 The Working Group emphasised that the reason for requiring these data was to satisfy the requirement of Conservation Measure 51-01. This states that once the total catch in Area 48 exceeds 620 000 tonnes, precautionary catch limits will need to be developed and applied to smaller management units. Adequate warning of the approach of this catch limit is required in order for the Working Group to recommend appropriate subdivision of the area-wide catch limit.

Description of the fishery

3.7 WG-EMM-04/39 presented an analysis of CPUE data from the former USSR. Interannual variation in CPUE for the overall fishing ground in Area 48 was found to be insignificant, and the paper suggested that krill density of 170–200 g m^{-2} is the average density within the fishing grounds of Area 48. The document concluded that the stable CPUE for Area 48 is due to krill transport between subareas. Dr P. Gasyukov (Russia) emphasised that these estimates of krill density were only relevant to the krill fishing grounds.

3.8 WG-EMM-04/52 presented CPUE and daily production analyses of haul-by-haul data from the Japanese krill fishery during the 1980–2003 seasons. Catch per searching time was used as a proxy of krill abundance in the fishing area. Searching time was defined as the sum of time between hauls within an entire continuous operational fishing period, itself defined as the period between steaming to/from fishing grounds or between non-fishing periods.

3.9 The paper was based on a working hypothesis that operational effort will be maximised as krill density increases, until a critical krill density beyond which effort will decrease as processing capacity becomes limiting. CPUE will increase linearly as krill abundance increases until the critical density is reached, at which time CPUE will be constant whilst production is maintained. The analysis was done by using linear mixed models.

3.10 In the Drake Passage and Elephant Island area, neither fishing effort, CPUE nor production showed any clear trend that could be attributed to the above hypotheses. In the South Orkney area, the production pattern behaved as hypothesised, but fishing effort appeared to increase, and CPUE to decrease, at high krill abundance. In the South Georgia area, the production pattern behaved as hypothesised, but CPUE showed an increasing trend until reaching critical abundance and thereafter decreased, whereas effort showed a decreasing pattern to some point and thereafter increased.

3.11 The observed pattern suggested that the South Orkney and South Georgia areas are both operating around the critical point which is just enough to maintain the best factory performance but they suffer low production in years of low krill density. The status of Subarea 48.1 was not clear.

3.12 The document suggested that daily production may be a suitable index for krill abundance at low krill densities. It further suggested the need to validate the use of catch per searching time as an index of krill abundance. To do so it will be necessary to undertake acoustic surveys by research vessels in the same time and areas that fishing operations are taking place. Alternatively, it may be possible to analyse quantitative echograms from the fishing vessels.

3.13 The Working Group recalled that it had asked for this sort of analysis to be undertaken in the past (SC-CAMLR-XXII, Annex 4), and therefore welcomed the paper (WG-EMM-04/52). It encouraged further research along the lines of that suggested in paragraph 3.12, and asked Members to investigate the possibility of acquiring quantitative recordings from echo sounders on fishing vessels.

3.14 The behaviour pattern of the Japanese krill fishery in Area 48 was analysed in WG-EMM-04/51, based on questionnaires sent out to skippers. More than 10 years of accumulated information showed Japanese krill fishing operations tend to utilise fishing grounds close to the southern limit within the ice-free range. This document revealed the usefulness of questionnaires to understand the behaviour of fishing vessels. Fishing patterns may vary between nations, and the document suggested the necessity of performing the same kind of analysis for all other nations' vessels to understand overall fishing strategies of the krill fishery.

3.15 The Working Group recalled that last year two Members (Poland and the USA) submitted questionnaires on krill fishing strategies. The Working Group stressed the usefulness of questionnaires for understanding behaviour of krill fishing fleets, and encouraged other Members to submit questionnaires.

3.16 WG-EMM-04/44 presented an analysis of seasonal variation in towing depth and CPUE in relation to the photoperiod using Japanese fishery data from 1980 to 2003. CPUE was highest during the day and lowest at night. Diurnal changes in fishing depth were observed at the South Shetland and South Orkney Islands, but did not occur during winter around South Georgia. Mean trawling depth was found to be shallow during summer and early autumn (in the top 60 m of the water column) but became deeper in mid-autumn, reaching a maximum average depth of 144 to 187 m in mid-winter. These changes reflect distribution of krill in relation to feeding and spawning behaviour.

3.17 WG-EMM-04/62 described the 2002 and 2003 fishing seasons in Subarea 48.3. Fishing occurred exclusively in the eastern region of South Georgia in 2002, but in 2003 part of the effort shifted to the western region. The modal size of krill in 2002 was the same in the fishery and the fur seal diet, however, in 2003, the modal size in seal diet was smaller than the mode of fishery-caught krill. During the winter period when there was a reduction in the frequency of occurrence of krill in the diet of seals, the fishery appeared to operate at greater depths suggesting a possible depth change of krill during winter. An initial analysis of krill length sampling variance suggested that significant gains in CV are not made at sample sizes greater than 400 individuals. The paper recommended that observer tasks should be restructured accordingly, to allow, especially, more time to be devoted to sampling fish by-catch.

3.18 The Working Group noted that seasonal depth changes in the distribution of krill aggregations were observed from fisheries data (WG-EMM-04/44), predator diet data (WG-EMM-04/62) and observer data (WG-EMM-04/10). All implied that krill depth distributions are shallowest during summer and autumn, deep in winter, and again shallow in spring.

3.19 WG-EMM-04/15 presented four measures of the degree of overlap between predator foraging, krill distribution and the krill fishery. The feasibility of calculating overlap indices for each of the SSMUs were investigated. It was recognised that estimated krill consumption and foraging areas for all known predator colonies are needed. This could be done by, for example, using data analysed in the SSMU Workshop.

3.20 WG-EMM-04/43 reported a relatively high rate of bacterial infection in krill in the catch. They were mainly infected in cephalothoracic segments. The infection rate was 1.93%, and the species of bacteria is yet to be determined.

3.21 WG-EMM-04/30 reviewed the USSR's fishery and scientific studies in the Atlantic sector of the Southern Ocean. Between 1961 and 1989, a total 55 scientific voyages was undertaken, and these data are all stored in a newly created database. Whale surveys commenced in 1960, and the collected data includes statistical and biological data on embryo growth rate of several baleen and toothed whale species, including physiological structure of the females which could be used for stock evaluation and understanding population dynamics. Krill surveys started in 1961, and fish surveys in 1967, with the main aims of understanding ecology, stock and recruitment assessment and searching for new resources.

Scientific observation

3.22 There has now been a total of 14 international scientific observer cruises on krill vessels (WG-EMM-04/15). Three of these were in Subarea 48.1 in the 1999/2000 and 2000/01 fishing seasons (observers from the USA, Japan and Ukraine). Five were in Subarea 48.3 in the 2001/02 fishing season (four UK observers, one Ukraine observer) and six in Subarea 48.3 in the 2002/03 fishing season (all UK observers).

3.23 WG-EMM-04/31 reported incidental entanglements of seals in krill trawls in Subarea 48.3 recorded by UK observers in the 2002/03 fishing season. A total of 27 dead, 15 alive and 1 unknown seal entanglements were reported. Entanglements were noted only on vessels where the crews had no or limited previous experience in the krill fishery. Simple mitigation measures, involving the introduction of seal escape panels in the net, substantially reduced the problem. The observers reported that Antarctic fur seals were always present around the vessel during fishing operations.

3.24 The Working Group recalled the request of the Scientific Committee for information on this topic (SC-CAMLR-XXII, paragraphs 5.42 and 5.43). The Working Group regarded the issue of design of mitigation measures to avoid fur seal by-catch to be very important. All vessels should have some means of mitigation for fur seals and other affected species. The Working Group solicited the prompt submission to WG-IMAF of descriptions of mitigation measures and devices that have been developed in krill fisheries. This information may come from observers and the fishing industry. This will enable the development of advice on mitigation measures.

3.25 The Working Group agreed that when such advice has been developed, it would expect to recommend that mitigation devices be deployed on all krill vessels.

3.26 WG-EMM-04/10 reported the observations of the national observer on board a Ukrainian commercial krill vessel which fished from 25 March to 7 May 2003 in Subarea 48.2 and from 25 May to 23 June 2003 in Subarea 48.3. In Subarea 48.2, krill size ranged between 24 and 58 mm, comprising three size groups. Krill were slightly smaller than those observed in the previous season. Salps were not recorded. Only one small fish by-catch was recorded from this area. In Subarea 48.3, the krill size ranged between 32 and 60 mm, dominated by the 2000 and 1999 year classes. Juvenile icefish were recorded as by-catch in five samples. In Subarea 48.2, average sea-surface temperature at the fishing ground in April was abnormally low, possibly because of high abundance of icebergs in 2003. The Subarea 48.3 fishing ground also had below-normal sea-surface temperature in May and June. The average CPUE for the period was 22.5 $t.h^{-1}$ and 163.3 $t.day^{-1}$ for Subarea 48.2, and 22.8 $t.h^{-1}$ and 170.8 $t.day^{-1}$ for Subarea 48.3.

3.27 The Working Group drew the attention of WG-FSA to these records of juvenile icefish in catches from the krill fishery.

3.28 WG-EMM-04/42 reported the activities of a national observer on board the Japanese krill trawler *Chiyo Maru No. 5* from 4 August to 21 September 2003. The fishing area was around South Georgia, and 451 tows were performed during this observation. The average number of daily tows was 11.6 and the average duration was 27.5 minutes. By-catch sampling, biological measurements of krill, vessel sightings and marine mammal observations were reported. It was not possible to undertake conversion factor analysis from the meal plant since this would have required disruption of the operations. The observer suggested sampling from the conveyer belt is safer than working on deck, however, it is essential to ensure that sampling is not biased.

3.29 The Working Group recalled that there were a number of types of data that it required from the fishery: catch data, data on skipper behaviour, vessel decisions, biological properties of target species, information on fish by-catch and dependent and related species. Some of these types of data are best collected and reported by fishing vessels, and some are best collected by observers. The Working Group asked WG-FSA to consider if it is possible for WG-FSA-SAM to consider what observer coverage and sampling techniques would be appropriate to collect relevant data in the krill fishery.

3.30 In the meantime, the Working Group recommended that international scientific observers continue to be placed on as many krill vessels as possible. Some participants considered that a high level of observation would be required to acquire the information necessary to determine sampling protocols, and that this ought to apply equally to all krill fisheries.

Possible dialogue between fishing operators and WG-EMM

3.31 The Working Group recognised that information from the fisheries, particularly relating to the type, structure and density of aggregations which the fishing vessels target, may help increase the understanding of fishing operations and also greatly contribute to a better understanding of krill biology (e.g. overwintering biology) and the interactions between fisheries and predators.

3.32 The reason for the paucity in this kind of information is due to spatial and/or temporal mismatch between fishing operations and scientific surveys. This is largely because fishing operations occur throughout the year, whereas surveys are mostly limited to snapshots during summer months.

3.33 The Working Group identified a number of questions, for example, related to:

(i) the commercial significance of different forms of fish and krill aggregations;

(ii) properties of such aggregations and their significance to the fleet;

(iii) catchability of different types of fishing gear;

(iv) behaviours of fleets and individual fishing vessels in relation to the distribution of the fishable biomass;

(v) how changes in the spatial distribution of krill may influence fishing behaviours.

3.34 The Working Group agreed to establish a dialogue with the fishing operators to obtain the necessary information, such as:

(i) fisheries information, including:

- haul-by-haul data
- type of vessels and their technical characteristics
- type of post-harvest processing;

(ii) information on krill distribution patterns;

(iii) visual information on predators;

(iv) by-catch data;

(v) biological data on krill and fish.

3.35 The Working Group noted that the information contained in paragraph 3.34(i), (iii), (iv) and (v) is available through the CCAMLR Scheme of International Scientific Observation if the forms are fully completed (paragraph 3.43(i)). The data which could not be obtained through scientific observation relate to information on the form of aggregation (paragraph 3.34(ii)).

3.36 Logging acoustic data voluntarily from a fishing vessel's echo sounder was suggested as a way to obtain information on the structure of aggregations at the fishing ground. The Working Group considered that this should involve minimum disruption to the fishing operation.

3.37 Several types of electronic interfaces are commercially available which allow logging of acoustic data from the ship's echo sounder.

3.38 The Working Group noted that there have been trials in the North Atlantic, which assessed the possibility of using echo sounders installed on fishing vessels to collect data on biomass (ICES-FAST report, 2004, www.ices.dk).

3.39 Another option considered by the Working Group was for fishing vessels to voluntarily undertake specific targeted and non-targeted tows at different times of the year at the fishing grounds to help understand the differences in krill population characteristics between those tows. This option may affect routine fishing to some extent, and these issues need to be carefully addressed.

3.40 Dr M. Naganobu (Japan) expressed his deep concern that collecting this information may violate the right to protect commercial confidentiality, and impose some unwanted, complicated duties.

3.41 The Working Group agreed to request further information on the acquisition of quantitative electronic echograms from fishing vessels, including on issues relating to equipment (and its installation) and data acquisition, access and analysis.

3.42 In the meantime, Members with an interest in collaborating on this topic were encouraged to develop appropriate proposals.

Recommendations for the attention of the Scientific Committee

3.43 The Working Group recommended the following:

(i) The review of the *Scientific Observers Manual* should include:

(a) consideration of the number of samples that are required for estimation of krill biological properties and by-catch estimation on krill vessels;

(b) a requirement for vessel owners and skippers to give access to the factory decks for observers to undertake conversion factor analysis and to allow samples for the assessment of by-catch to be made before any sorting of the catch has taken place;

(c) consideration of the level of observer coverage (at vessel, season, haul and within-haul levels) required to acquire unbiased data required by WG-EMM.

(ii) The review of the *Scientific Observers Manual* should be coordinated by the Secretariat (WG-EMM-04/21) and should include a meeting and/or correspondence involving practising observers and observer coordinators.

(iii) In the interim, while considering the observer coverage required, WG-EMM recommended that international scientific observers continue to be placed on krill vessels where possible.

(iv) Members be encouraged to submit fishery behaviour questionnaires in accordance with the *Scientific Observers Manual*.

(v) Members investigate the possibility of acquiring quantitative electronic echograms from fishing vessels.

(vi) WG-IMAF be requested to review seal mortality mitigation measures, noting that the Working Group would expect that mitigation devices would be deployed on all krill vessels, if necessary.

STATUS AND TRENDS IN THE KRILL-CENTRIC ECOSYSTEM

Status of predators, krill resource and environmental influences

Predators (pinnipeds)

4.1 WG-EMM-04/4 reported on male fur seal diet at Stranger Point, King George Island, from February to April 1996. Krill was the primary prey and occurred in 97% of scats, while myctophid fish occurred in 69% of scats (only 3% contained fish only) and cephalopods occurred in 12% of scats. Although there were no differences in proportions of prey between summer and autumn, the modal length class of myctophids increased over the time period sampled. The authors reported a decrease in the nototheniid fish *Pleuragramma antarcticum* compared to studies in 1992 and 1994.

4.2 WG-EMM-04/9 presented three tables of non-CEMP data registered with the Secretariat in response to the request from this Working Group (SC-CAMLR-XXII, Annex 4, Appendix D, paragraph 96). Tables 1 and 2 listed biological and environmental datasets, most of which were submitted as part of the 2003 CEMP Review Workshop. Table 3 listed other data of potential utility to CEMP.

4.3 In WG-EMM-04/33, labelled water methods were used to measure energy expenditure during lactation and energy gain during the post-breeding/pre-moult foraging trips for southern elephant seals. Total energy expenditure and energy gain were similar to measures made on animals breeding at South Georgia, however, because of shorter trip duration, the rate of energy gain in South Shetland females was greater. The authors attributed this to a potentially shorter transit time to primary foraging areas than seals making trips from South Georgia. Because information on diet in elephant seals is so limited and confined primarily to a few onshore lavaging studies, the authors used a range of squid and fish proportions to calculate an estimate of the total biomass consumed. In spite of assumptions about at-sea metabolic rates and diet, this is a valuable contribution and has potential for use in ecosystem models of squid- and fish-centric food webs.

4.4 WG-EMM-04/49 tested the hypothesis that there is no difference in krill length frequencies between predators and nets using net data collected only in fur seal foraging habitat and scat samples collected concurrently on land. As with studies at South Georgia (Reid et al., 1999) there was broad coherence with overall krill demographic trends from year to year. Significant differences in krill length frequencies occurred between predator diet and scientific net samples when the entire dataset for the west area of the US AMLR survey grid is used. However, when only net samples collected at survey stations in the area used by fur seals foraging from the scat-collection areas, no differences in krill length-frequency distributions for the two datasets resulted.

4.5 The Working Group asked whether fur seals foraging from Cape Shirreff bypass large krill occurring over the continental shelf to forage in the slope region northwest of the cape. If so, does the spatial distribution of krill inshore versus offshore differ in some way such that offshore krill aggregations were easier for fur seals to exploit?

4.6 Dr Goebel pointed out that data on the diet and foraging locations of penguins would suggest that larger krill are indeed exploited by penguins foraging much closer to Cape

Shirreff. He also pointed out that throughout a period of changing krill demographics (1999–2004, which includes two years of substantial recruitment) fur seals consistently foraged in the continental slope region northwest of Cape Shirreff.

4.7 WG-EMM-04/67 reported on the ecological implications of body composition and thermal capabilities in young Antarctic fur seals. Juvenile survival is important for sustaining predator populations and is the least understood phase of predator life cycles. This paper uses measures of body composition and metabolic rates for moulted pups and yearling fur seals to model post-weaning metabolic rates and thermoregulation to provide evidence that foraging habitat near natal rookeries may be important for post-weaning survival. It suggested that there is potential overlap between fishing areas and recently weaned foraging fur seals.

Predators (seabirds)

4.8 WG-EMM-04/5 reported on the 2004 breeding season at Cape Shirreff, Livingston Island. The chinstrap penguin population continued to decline as it has over the past four seasons; however, results for all other breeding and foraging indices found 2004 to be an average year for the chinstrap and gentoo penguins at this site. For the first time in seven years of study the size of krill taken by chinstrap penguins was significantly smaller than for gentoo penguins during their concurrently sampled chick-rearing periods.

4.9 WG-EMM-04/29 provided updates to a series of papers presented to the Working Group meeting last year by Dr R. Crawford (South Africa). Populations of gentoo, macaroni and eastern rockhopper penguins and Crozet shags continued to decrease at Marion Island in 2003/04. The decreases are thought to be due to a reduced availability of prey to birds foraging near the island. Populations of three albatross species (wandering, grey-headed and light-mantled sooty), two tern species (Antarctic and Kerguelen) and northern giant petrels appear stable at Marion Island, albeit with large annual fluctuations in breeding numbers. Numbers of dark-mantled sooty albatrosses, southern giant petrels and kelp gulls have shown a long-term decrease, although the count for dark-mantled sooty albatrosses was higher in 2003/04 than for several seasons.

4.10 WG-EMM-04/36 presented a list of publications for information only. It comprised a set of papers that were produced by two BAS core-funded science programs. The bibliography was tabled to ensure that Members are aware of the ongoing research programs that have relevance to the work of WG-EMM, but are not directly related to the current agenda.

4.11 WG-EMM-04/38 presented the results of diet sampling of Adélie penguins at two colonies in the Ross Sea, at Edmonson Point during five seasons (1995–1997, 1999 and 2001) and at Inexpressible Island in 2001. Mean diet composition varied from year to year and between the two locations in 2001. Results show the relative importance of krill and fish as principal resources in the summer diet of this species in the Ross Sea. *Euphausia crystallorophias* and *E. superba* varied from year to year, with the latter particularly abundant in 2001 at both colonies. These differences in the diet composition between two colonies in close proximity suggest that several factors, including environmental factors, colony location and colony size, should be considered before reaching conclusions on prey availability from diet data.

4.12 WG-EMM-04/57 described temporal changes in foraging range throughout the breeding season of Adélie penguins nesting at Béchervaise Island in Eastern Antarctica. Penguins ranged furthest north during incubation and used a recurrent polynya to forage in the early season. They made their shortest trips during the guard stage of chick rearing and penguins foraged most intensively at the continental shelf break and over submarine canyons, particularly whilst feeding chicks. Birds foraging prior to their annual moult travelled hundreds of kilometres to both the west and east of their breeding sites. Foraging ranges increased as the chick-rearing period progressed, consistent with hypotheses of prey depletion and intra-specific competition. Projection of the foraging ranges derived from this study onto other Adélie penguin colonies in the Prydz Bay region indicated varying degrees of overlap depending on the stage of the breeding season and the distance between populations. On the basis of the foraging areas described in the paper, two management units could be defined between longitudes 51°–71°E and 71°–81°E and extending as far north as 65°S.

Krill

4.13 WG-EMM-04/39 highlighted that, due to the scarcity of comparable scientific long-term data, the nature of interannual fluctuations of krill biomass for the entire Scotia Sea is uncertain. The authors noted that the extensive dataset collected from the former Soviet krill fishery might fill this gap, because long haul duration across krill patches may be considered as an appropriate sampling strategy. This would allow the use of CPUE indices for direct monitoring of 10-day, monthly and longer-term fluctuations in krill biomass. Haul-by-haul data were used for the period from 1977 to 1991 and CPUE indices were calculated for all vessel types.

4.14 For the period from 1986 to 1991 the average CPUE was 6.3 $t.h^{-1}$ for all vessel types, ranging between 5.6 $t.h^{-1}$ and 6.4 $t.h^{-1}$ depending on the vessel type. Interannually, CPUEs in Area 48 varied from 4.9 to 6.4 $t.h^{-1}$ for all vessel types. In Subarea 48.1, the average CPUE was 5.2 $t.h^{-1}$, in Subarea 48.2 it was 7.3 $t.h^{-1}$, and in Subarea 48.3 it was 6.0 $t.h^{-1}$. Interannual CPUE variations were rather small for Area 48 as a whole. The average CPUE values for the period from 1978 to 1986 were 6.1 $t.h^{-1}$ for the whole of Area 48 and for all vessel types.

4.15 The authors of WG-EMM-04/39 concluded that despite the variable interannual biomass estimates from acoustic surveys in subareas, the average annual CPUE values did not vary significantly for the whole of Area 48 as well as for Subareas 48.1, 48.2 and 48.3. The authors suggested that a mean biomass density of about 170–200 g m^{-2} may be considered as an average characteristic value for fishing grounds in Area 48 (see paragraph 3.7).

4.16 The Working Group emphasised that analyses of krill stock stability/fluctuations from fishery CPUE data should consider the kind of krill aggregations from which these data were derived. It was further noted that CPUE data should be standardised. In particular, changes in variances should be considered in addition to the means to facilitate consideration by the Working Group (such as those described in WG-EMM-04/39) that would allow inferences to be drawn on whether the krill population was variable or stable.

4.17 WG-EMM-04/27 described results from two net sampling surveys across the Scotia Sea in the summers of 1984 and 1988. Three size groups of krill were identified: a large group of 48–50 mm modal size was associated with the southern branch of the ACC, while medium- and small-sized krill (40–44 and 30–35 mm respectively) were linked to the Weddell Sea water mass. An additional bimodal size group was observed in the summer of 1988.

4.18 The authors noted that in the study area the considerable variability in the distribution of these size groups, and the boundaries between them, was dependent on the high interannual dynamics of the water masses in the area, reflecting the relative influence of water from the west as well as from the Weddell Sea. The authors suggested that in 1988 the water dynamic conditions were close to the climatic norm with Weddell Sea water transport to the eastern shelf of South Georgia and cold-water intrusion to the far north. Comparing their results with those obtained during the CCAMLR-2000 Survey, the authors suggested a high degree of similarity in krill stock distribution and composition between the two years. The situation in 1984 was thought to be anomalous; during a warm period the transport of the cold Weddell Sea waters into the eastern part of the Scotia Sea decreased due to ACC intensification. This scenario might provide an explanation as to why during this type of hydrological regime the small krill group was not transported to South Georgia, though it did occur further south in the Drake Passage.

4.19 The authors summarised that the observed regular occurrence of the three basic size groups, their spatial distribution and the association with water mass dynamics justifies the conclusion that the general structure of the krill population in the southwestern Atlantic sector has not changed during the past 20 years. The observed dynamics of the spatial distribution of krill size groups, and the variability in the structure and source of krill stocks at individual fishing grounds, is determined by interannual peculiarities of the hydrological regime.

4.20 The Working Group noted the potentially important influence of the Weddell Sea stock for krill stock composition in the Scotia Sea and at South Georgia, which may vary considerably between years. The Working Group felt that the potentially critical role of the Weddell Sea warrants further detailed consideration. However, the Working Group could not agree on a common view about the long-term stability of the krill population in Area 48. Some members interpreted the results of WG-EMM-04/27 as an indication that the ecosystem of the Atlantic sector has been stable for the past 20 years. Other members felt that the results may be regarded as a signal, but results came from three years only and it is difficult to interpolate these points to draw inference over a longer time period, especially in the light of results obtained from several long-term mesoscale scientific surveys.

4.21 WG-EMM-04/66 Rev. 1 presented the results of acoustic surveys from the summer months of 2000 and 2002 around South Georgia and reported significant distinctions in krill aggregation structures in the northwestern and northeastern parts. The northwestern part, where foraging grounds for predators are, is not attractive to the krill fishery. Potential fishing grounds with krill density exceeding the threshold value of 100 g m^{-2} were observed in the northeastern part.

4.22 It was assumed that a dispersed aggregation (layers and irregular forms) is suitable for predators and dense swarms are more attractive to the fishery. The author of the paper concluded that investigations of the foraging tactics of predators and comparison of the availability of different structures of krill aggregations to fishing vessels and predators are important for understanding how the interaction between upper-trophic level predators and krill biomass might be used to manage levels of krill fishing.

4.23 Dr Reid noted that both of these areas are used by the krill fishery during the winter and this may indicate that there were changes in the characteristics of the krill distribution between summer and winter. Dr Trathan suggested that at South Georgia during the winter period, when fur seals are not constrained to return to their breeding beaches, their foraging areas include areas that are also utilised by krill fishing vessels. This is evident, given the incidental mortality of fur seals (paragraph 3.23).

4.24 WG-EMM-04/44 examined seasonal variation in CPUE data from Japanese trawling operations during different seasons and in different parts of Area 48. During summer and winter, average trawling depth showed a marked diurnal change around the South Shetland and South Orkney Islands, i.e. trawling operations were deepest during the day and shallowest at night. At South Georgia in winter, the average depth was deepest at dawn and shallowest at dusk. Trawling depth was relatively shallow in summer (20–60 m) and deepened gradually until autumn (40–160 m), attained the maximum depth in winter (100–300 m) and rapidly decreased again in early spring. The depth range over which trawling occurred increased from summer to winter. Diurnal changes also occurred in CPUE data. In summer largest catch rates were obtained at night, while in autumn and winter largest CPUE values were observed during the day. The authors concluded that the observed seasonal variation patterns in trawling depth and CPUE can be explained by diel vertical migration behaviour of Antarctic krill triggered by the light regime.

4.25 The Working Group noted that such patterns of seasonal changes in vertical distribution of krill were also observed in other areas (Lazarev Sea, WG-EMM-04/23), predator diet studies (WG-EMM-04/63) as well as in other CCAMLR fishing operations (WG-EMM-04/10). This indicated that the described seasonal vertical distribution pattern might be a more general pattern than just for the described area or years.

4.26 WG-EMM-04/62 presented an initial analysis of the characteristics of Antarctic krill taken by the fishery and fur seals during the winters of 2002 and 2003 at South Georgia. There was considerable overlap in the size composition of krill taken by the fishery and in the diet of fur seals. During winter, the occurrence of krill in the diet of fur seals was reduced and the fishery was apparently operating at greater depths. This may suggest a possible depth change of krill during winter.

4.27 Dr Constable indicated that it might be useful to ask krill fishing vessels to undertake research trawls at given times, depths and locations to further the understanding on the interactions between krill distribution and foraging behaviour of predators.

4.28 WG-EMM-04/63 described data on the population size composition of krill from the diet of predators at Bird Island, South Georgia, over the past decade. This analysis has provided a re-evaluation of population demographics of krill at South Georgia, and has provided evidence for a relationship between sea-surface temperature and the level of krill recruitment in Subarea 48.3. The Working Group noted that using predators as samplers of krill can help provide information on the life-history parameters of krill used in assessments.

4.29 WG-EMM-04/23 introduced results of krill net sampling surveys from Subareas 48.1 and 48.6 in the 2004 season. It was noted that the Lazarev Sea survey is located in the high-latitude part of the distribution range of *E. superba*. During April 2004 krill in the Lazarev Sea were distributed inside and outside the pack-ice zone. More than 90% of the day samples had zero or less than one krill per 1 000 m^{-3}, whereas more than 90% of all night samples were larger than one krill per 1 000 m^{-3}. A possible explanation for day–night catch differences could be a different krill vertical migration behaviour during this late autumn period and/or in these high latitudes. Krill abundance estimates from night samples only were 31.1 krill per 1 000 m^{-3}. This level of density is below the long-term average observed in the Antarctic Peninsula region. Mean abundance of krill larvae in the Lazarev Sea was low compared to the FIBEX 1981 survey and the CCAMLR-2000 Survey indicating that absolute recruitment and stock density will not greatly increase in the next year.

4.30 Krill length-frequency data from the Lazarev Sea survey showed recognisable size groupings with medium-sized immature krill dominating north of the pack-ice. A second group was characterised by bimodal length frequencies consisting of immature stages and large adults inside the pack-ice zone. Recruitment indices for the 2004 Lazarev Sea survey were low for the 2003 year class (R1 = 0.039) and very high for the 2002 year class (R2 = 0.762).

4.31 Krill numerical density indices in Subarea 48.1 for the Elephant Island survey were around 50 krill per 1 000 m^{-3}. This was below the long-term average and a substantial drop since the high level of krill abundance in the 2001 and 2002 seasons. Recruitment indices for the Elephant Island survey showed a very poor recruitment success of the 2003 year class (R1 = 0.0001), while values from earlier years indicate good recruitment for the 2000 to 2002 year classes which caused the interim increase in density values after a long period since the mid-1980s with rather low stock abundance.

4.32 WG-EMM-04/72 presented results on krill demography and zooplankton composition in Subarea 48.1 during the summer of 2004. Mean krill densities in the Elephant Island area were similar during two consecutive surveys with values quite close to the 1992–2004 means (52.1 and 54.4 krill per 1 000 m^{-3}). In January, lengths were distributed around 42 mm modal size with >75% of individuals over 35 mm in length; in February–March length distribution was polymodal around 33–35, 43–45 and 50 mm lengths.

4.33 The conclusion of the paper was that the overall krill length-frequency distributions from January to March 2004 (predominantly >35 mm individuals) reflected strong recruitment success of the 2000, 2001 and 2002 year classes and minimal representation from 2003. It is also concluded that the presence of relatively advanced furcilia larval stages in January indicated an extremely early initiation of spawning and that the combination of prolonged reproductive efforts and abundant larvae provide a basis for good recruitment success the following year, however, other factors such as advective regimes and overwintering conditions may also be critical determinants.

4.34 January 2004 was characterised by relatively sparse zooplankton catches. Total zooplankton abundance one month later was an order of magnitude greater. This was due to increases in copepods, chaetognaths and larval *Thysanoessa macrura*. After 1998, the dominance of salp and copepod and their relative abundance changed dramatically. This has been associated with a significant order of magnitude increase in mean copepod abundance. Other zooplankton taxa such as *E. frigida* and chaetognaths also demonstrated significant abundance increases. In the light of increases in certain zooplankton taxa and increased frequency of strong krill year classes, the author suggested that after the 1998 El Niño the Antarctic Peninsula region may have experienced the same regime shift that is affecting the entire Pacific Ocean basin. Most significant of these changes to CCAMLR is the build-up of krill stocks in Subarea 48.1 that had declined significantly during the past 20 years.

4.35 The Working Group realised that currently three quite different scenarios are suggested to describe the state of krill stocks in Area 48:

- stable population over the past 20 years (WG-EMM-04/27, 04/39)
- fluctuation with an eight-year cycle (Hewitt et al., 2003)
- regime shift since 1998 (WG-EMM-04/72).

The Working Group noted that the simulation models currently under development by WG-EMM may help address this question in future, taking into account the physical environment, and indicate which of the scenarios might be more realistic.

4.36 Dr Constable voiced his concern that the terms 'oscillation', 'fluctuation', 'changes in state' and 'regime shift' should be used carefully, and that there is a need for WG-EMM to discuss these terms and come to a common understanding and use of these terms.

4.37 Dr Kawaguchi noted that the distribution of krill larvae described in WG-EMM-04/23 may be a good indication of a southward movement of krill larvae in autumn. This would support the concept of the seasonal aspects of krill distribution summarised in WG-EMM-04/50 which will form part of the ecosystem modelling approach of WG-EMM.

4.38 Dr Naganobu highlighted the importance to investigate other zooplankton species such as *E. frigida*, because dynamics of their distribution might help to explain a southward shift or changes in the transport rate of the ACC.

4.39 WG-EMM-04/10 described the results of scientific observations on a krill fishing vessel around the South Orkneys and South Georgia in autumn (March to June) 2003, and comparison with data from previous seasons. The paper presented data on catch, biological state of krill, size groups of krill and analysis of weather and ice conditions. Sea-surface temperature around the South Orkneys from March to April was lower than in normal years, and ice was formed earlier, resulting in a fishing season 1.5 to 2.5 months shorter than usual. Hydrometeorological conditions around South Georgia were closer to the long-term average. Fishing conditions (in terms of CPUE) in Subarea 48.2 were generally favourable, and fishing conditions in Subarea 48.3 from May to September were very favourable.

4.40 WG-EMM-04/35 reported near-shore acoustic surveys for Antarctic krill that were conducted using a small vessel at South Georgia in January 2004. These surveys obtained estimates of krill biomass from areas where no such data have been available so far, but are important for foraging to some species of land-based predators (e.g. penguins). Mean krill densities were 5.9 to 7.1 g m^{-2}, and this low density was not unexpected in line with cyclical patterns, but may have been exacerbated by the presence of large icebergs. The Working Group noted that this is a new attempt, and combination of data from small vessels operating near the shore with data collected over more extensive, offshore areas by large ocean-going research vessels would provide a more comprehensive understanding of the prey field available to krill predators.

4.41 WG-EMM-04/71 presented a preliminary result of the interdisciplinary survey conducted in the Ross Sea from December 2003 to January 2004. Two krill species (*E. superba* and *E. crystallorophias*) moved with different spatial and temporal scales. Distribution centres of the two species were different – the centre of *E. superba* was further north than that of *E. crystallorophias*. The distribution centre of *E. superba* in this survey was found in the northernmost position (70°–69°S) and, as in previous surveys, this was where the greatest number of whales was observed.

Physical environment in Subarea 48.3

4.42 WG-EMM-04/34 explored temporal variability in the physical environment at South Georgia. The paper showed how time-series analysis of sea-surface temperatures highlight the presence of high levels of autocorrelation, with periodicity evident in temperature anomalies at lag periods of approximately three to four years. The authors presented cross-correlation analyses of temperature series from South Georgia with temperature anomaly data for the El Niño 4 region in the Pacific; these analyses showed that variability at South Georgia reflects temperature fluctuations in the Pacific, with the Pacific leading South Georgia by approximately three years. The Working Group recalled that similar relationships had been presented previously at the Workshop on Area 48 (SC-CAMLR-XVII, Annex 4, Appendix D).

4.43 WG-EMM-04/34 also explored biological variability at South Georgia, with variability evident in data from a suite of top predators. The paper showed how periods of reduced predator breeding performance are strongly correlated with warm anomaly periods, but lagged by a number of months. For some predators the most critical periods appear to be prior to the breeding season during the summer and early autumn of the preceding year. The analyses showed that gentoo penguins exhibit a strong negative relationship between the number of chicks fledged and sea-surface temperature in the preceding February some 12 months earlier. Antarctic fur seals also show a similar negative relationship between the number of pups surviving at birth and the temperature 14 months earlier in the preceding November.

4.44 WG-EMM-04/34 suggested that the observed relationships most likely reflect prey (krill) availability. WG-EMM-04/63 explored this relationship further and showed a relationship between sea-surface temperature and the level of krill recruitment.

Physical environment in the southwest Atlantic

4.45 WG-EMM-04/46 used spectral analysis to explore an updated Drake Passage Oscillation Index. These analyses showed periodicity at scales of approximately 20, 35 and 55 months. These scales are consistent with the periodicity in sea-surface temperature anomalies reported by WG-EMM-04/34.

4.46 WG-EMM-04/45 compared oceanographic structures in the southwest Atlantic during the 1981 FIBEX survey and the CCAMLR-2000 Survey. The paper suggested that the distribution of cold Antarctic Surface Water during the 1981 FIBEX survey was more extensive than during the CCAMLR-2000 Survey. The author suggested that this is consistent with the interannual variability. However, the author also suggested that this is consistent with environmental warming.

4.47 In contrast to this, WG-EMM-04/72 suggested that a regime shift (paragraph 4.36) affecting the entire Pacific Ocean basin has occurred following the 1998 El Niño and that this shift has resulted in dramatic ecological changes in the AMLR survey area around Elephant Island. The author suggested that these results now raise questions about the validity of previous conceptual models of how krill, salp and sea-ice dynamics operate in the Antarctic Peninsula region.

4.48 WG-EMM-04/72 also suggested that should this regime shift persist, it is likely that it will have profound effects on the Antarctic Peninsula ecosystem; the most significant of these changes is likely to be a build up of krill stocks in Subarea 48.1 following an increased frequency of years with successful krill recruitment and apparently increasing population size.

4.49 All these papers (WG-EMM-04/34, 04/45, 04/46, 04/63 and 04/72) suggested that large-scale climate variability has a potentially profound effect on the dynamics of the marine ecosystem in the southwest Atlantic. Consistent signals are reported by some of these papers (WG-EMM-04/34, 04/46 and 04/63); however, some effort is still required before it is possible to have a conceptual model that also includes the hypotheses outlined by others (WG-EMM-04/72). The Working Group therefore recognised that important challenges remain before large-scale climate signals, sea-ice dynamics, polynya formation and other physical processes influencing the Southern Ocean are fully understood.

CEMP parameters

4.50 Dr Ramm presented the annual report of trends and anomalies in CEMP indices in WG-EMM-04/14 provided by the Secretariat. The report included all data submitted up to the 18 June 2004 deadline and provided a summary of intersessional progress in data validation and checking.

4.51 WG-EMM-04/14 also included a new index of Antarctic fur seal pup growth rates (SC-CAMLR-XXII, Annex 4, paragraph 4.110). The Working Group noted that the new index was currently calculated for both sexes combined and asked that the index be calculated individually for male and female pups.

4.52 Following the recommendation of the Working Group last year (SC-CAMLR-XXII, Annex 4, paragraph 4.4) the Secretariat had investigated the feasibility of calculating predator–fishery overlap indices for each of the SSMUs. Whilst it may be relatively straightforward to allocate krill catch to SSMUs on the basis of STATLANT data, the calculation of overlap indices would require estimates of krill consumption and foraging areas for all known predator colonies within each SSMU. Currently this data only exists for penguins in Subarea 48.1, however, WG-EMM-04/14 suggested that the data prepared and analysed during the SSMU Workshop (SC-CAMLR-XXI, Annex 4, Appendix D) may be useful in developing this approach further.

4.53 WG-EMM-04/17 contained correspondence relating to the collection of CEMP data on gentoo penguins in a collaborative project involving Ukraine and Bulgaria. The Working Group thanked Ukraine and Bulgaria for providing the information that it had requested (SC-CAMLR-XXII, Annex 4, paragraph 7.14) and noted that the data arising from this research would be difficult to integrate into CEMP at this time.

4.54 WG-EMM-04/17 also contained details of the methods used by Norway when collecting CEMP data at Bouvetøya that highlighted the difficulties of working at this site. The Working Group asked that these details be archived by the Secretariat in order that they be available to advise future analyses of CEMP data.

4.55 WG-EMM-04/60 presented preliminary analyses of approaches which may be used to evaluate the sensitivities of CEMP indices to sampling procedure. The methods and presentation of CEMP parameters A1 (penguin arrival mass), A5 (penguin foraging trip duration) and A7 (penguin fledging mass) were evaluated using simulated time-series data.

4.56 Analysis of the effects of the intensity and timing of sampling during five-day periods for measures of arrival and fledging mass suggested that situations where sampling is distributed unevenly around the peak arrival/fledging date may introduce substantial bias in CEMP parameters A1and A7.

4.57 The analysis of parameter A5 addressed the concern that the description of foraging trip duration using the mean arising from a bimodal distribution of trip durations from individual penguins may not provide a useful index of foraging performance. The analysis presented in WG-EMM-04/60 suggested that although the mean may provide a useful index, the use of the 90th percentile of the cumulative foraging effort may provide a more sensitive measure of variability arising from changes in foraging strategies of penguins.

4.58 The Working Group agreed that these preliminary analyses represented an important development in the understanding of the properties of CEMP indices and recognised that the continuation of such analyses would be an important part of the future work of the Working Group.

4.59 Following the advice of the Working Group in 2003 (SC-CAMLR-XXII, Annex 4, paragraphs 4.9 to 4.18), WG-EMM-04/61 suggested a potential alternative to the current approach to providing advice on the status of the krill-centric ecosystem which relies on the evaluation of statistical anomalies in the CEMP database. This approach uses an ordination of variables according to functional groupings to summarise the variability in CEMP parameters, following the outline in WG-EMM-03 (SC-CAMLR-XXII, Annex 4, paragraph 4.15) based on the methodology developed by WG-EMM to produce composite standardised indices (CSIs) from data matrices containing missing data. Examples of the approach were provided using data from Subarea 48.3 (see WG-EMM-03/43) together with a potential procedure for identifying anomalous years with respect to the rest of the time series.

4.60 Dr Constable noted that the analysis of CEMP data should identify when there is a significant departure from a normal situation and that it was important to evaluate: (i) the properties of the constituent parameters for inclusion in combined indices in order to identify appropriate functional groups for inclusion in such analyses; and (ii) the statistical properties of the indices themselves. He further noted that the use of ordination approaches to facilitate decision-making had received considerable attention in the environmental impact literature of the 1990s.

4.61 The Working Group agreed that the approach developed in WG-EMM-04/61 was useful and encouraged further exploration using data from other regions. The Working Group agreed that further work was required both to develop: (i) a quantitative mechanism by which to evaluate the properties of methods to summarise CEMP parameters; as well as (ii) a process of decision-making based on those summaries. In so doing, it recalled its agreement in 2000, that further development of the interpretation of CEMP indices would need to include a consideration of the issues described in SC-CAMLR-XIX, Annex 4, paragraph 3.51.

Further approaches to ecosystem assessment and management

4.62 The Working Group considered two papers which raised issues potentially relevant to other aspects of CCAMLR's approaches to the management and conservation of marine systems, species and stocks.

4.63 WG-EMM-04/28 described approaches in South Africa to manage interactions between fishery target species and dependent species, arising from new South African legislation incorporating principles of sustainable use and precautionary and ecosystem approaches, giving effect to obligations under a variety of international agreements (e.g. FAO's Code of Conduct and Reykjavik Declaration on Responsible Fishing, World Summit on Sustainable Development's Implementation Plan).

4.64 In respect of providing protection for dependent species, WG-EMM-04/28 discussed the topic of setting target population levels, particularly for restoration of depleted populations, such as African penguins. The paper suggested that some of the criteria used in determining the conservation status of species in the IUCN system may be useful in this context. It noted some of the issues involved in converting estimates of extinction probability (and associated estimates of Minimum Viable Populations (MVP)) to population level targets which incorporate appropriate levels of precaution for rebuilding depleted populations. The paper also discussed possible management approaches in South Africa for restoring depleted populations of dependent species, potentially involving consideration of closed areas and prey-escapement levels based on predator–prey functional relationships, taking account of density-dependence considerations.

4.65 The Working Group welcomed this information and noted some similarities with management approaches developed within CCAMLR. It was observed, however, that target population levels for recovery of depleted populations would be very different from population target levels associated with fisheries, including those currently assessed by CCAMLR. Even in respect of restoring populations of krill-dependent species (even those within the same IUCN category of threat) within the Convention Area, target levels would need to reflect the different trajectories of populations and species. Thus, for instance: (i) Antarctic fur seals are increasing in most areas, and possibly exceeding pre-exploitation levels in some of these – in other areas populations are still recovering to former (historical) levels; (ii) populations of many species of baleen whales (several in IUCN globally threatened categories) may be increasing but are still in need of substantial restoration; (iii) some macaroni penguin (IUCN Vulnerable category) populations have been declining for 20 to 30 years.

4.66 It was recommended that WG-FSA be consulted to determine if any models or methods relating to the estimation of target population levels could be evaluated by WG-FSA-SAM.

4.67 Management measures to achieve desired population levels would have to take account, at least in the case of krill, of the need to manage simultaneously different targets associated with krill-dependent species with different population trends and functional relationships. Some of the modelling initiatives, particularly multispecies predator–prey interactions involving krill considered by the Workshop on Plausible Ecosystem Modelling, may assist with investigating the feasibility of this.

4.68 In reviewing WG-EMM-04/20, concerning the marine ecosystem in the Ross Sea, it was noted that this paper was a development of ideas and concerns last considered by the Working Group in WG-EMM-02/60.

4.69 In WG-EMM-04/20, the author argued that the Ross Sea Shelf Ecosystem (RSShelfE) is:

(i) of the world's 'Large Marine Ecosystems' (LME), the one least affected by direct anthropogenic alteration;

(ii) a highly distinct ecosystem within the Antarctic by virtue of its physical and biological characteristics;

(iii) the subject of the Antarctic's most intensive programs of long-term multidisciplinary scientific research, involving notable multinational collaboration and cooperation;

(iv) through its unique attributes and the intensive research, providing some of the clearest evidence of climate forcing and top-down controls – and that there are few, if any, other marine ecosystems where both processes are important, still extant and accessible for study.

4.70 The paper discussed the potential for top-down control of ecosystem processes with examples from current research on Adélie penguin and minke whales (key consumers of *P. antarcticum* and *E. crystallorophias*), and on orcas (killer whales) and Weddell seals in relation to interactions with *Dissostichus mawsoni*.

4.71 The paper also noted that CEMP is relatively undeveloped in the RSShelfE (and focused exclusively on Adélie penguins) and that CCAMLR may receive little information on, for instance, the increasing knowledge of the key role that toothfish may play in respect of dependent species such as seals and whales.

4.72 WG-EMM-04/20 concluded by suggesting that the recent initiation and rapid expansion of the fishery for *D. mawsoni* and the continuing removal of large numbers (in terms of potential ecosystem effects) of minke whales may have the potential for:

(i) prejudicing the scientific research programs directed at studying fundamental processes (including relevance to regional and global climate change) in this system;

(ii) creating unforseen (and currently unmonitored) effects for dependent species, including their potentially critical role in ecosystem processes.

It noted that reviewing the effects of current levels of exploitation in the RSShelfE would require collaboration between CCAMLR and the IWC.

4.73 In relation to some of the points raised by WG-EMM-04/20, Dr K. Shust (Russia) observed that:

(i) the paper did not provide a full understanding of the functioning of the RSShelfE. In particular, it did not accurately reflect the development of the fishery, including the conservation measures implemented to ensure that any expansion remained consistent with CCAMLR's principles of precautionary management for new and exploratory fisheries;

(ii) the area has complicated topography, especially in relation to benthic habitats, which might warrant consideration of the most appropriate types of fishing gear to be used, including for longline fisheries;

(iii) he had concerns about the apparent presumption, in the absence of adequate scientific data, that conservation issues, including the use of marine protected areas, should be given greater emphasis than the maintenance of sustainable fisheries;

(iv) there was considerable additional information, relevant to the high-latitude Pacific sector, including the RSShelfE, especially on climate change and physical forcing functions, in Maslennikov (2003).

4.74 Dr S. Olmastroni (Italy) believed that WG-EMM-04/20, taken in conjunction with the references cited therein, did provide an accurate appraisal of many aspects of current thinking on ecosystem interactions in the region. She noted that time series of data on many species and processes were very extensive and that the understanding of many of the predator–prey–environment links in this specialised system was at least as good as anywhere else in the Southern Ocean. She believed that, on the basis of the scientific data currently available, there was a good case for CCAMLR considering the direct and indirect effects of removals of whales and toothfish in relation to:

(i) complicating existing multinational collaborative investigations into fundamental physical and biological processes in the region's systems;

(ii) the nature of existing management by CCAMLR and the IWC of the magnitude and distribution of exploitation.

Several members supported this view.

4.75 Dr Shust noted that additional data, including appropriate models of relevant interaction processes involving components of the high-latitude ecosystems of the Pacific sector, including Subareas 88.1 and 88.2, would be essential in any such evaluations.

4.76 Dr Kirkwood cautioned against incautious acceptance of statements (e.g. WG-EMM-04/20, p. 12) concerning the reasons underlying decisions made by the IWC and patterns of whale harvesting in, or adjacent to, the RSShelfE.

4.77 Dr Constable welcomed the synthesis of information contained in WG-EMM-04/20 and recognised that it posed some important questions for CCAMLR. These included:

(i) How can we provide advice, in the future, on natural ecosystem processes, if fisheries are occurring everywhere?

(ii) Therefore, how can we ensure that the ability to predict/detect the impacts of fishing is not affected by the fishing process itself?

(iii) How best to coordinate conservation and management initiatives between CCAMLR and other international instruments and organisations with responsibilities relevant to the RSShelfE and adjacent areas.

(iv) The possible need for data on by-catch of benthos, especially fragile species and communities, in longline fisheries within the RSShelfE.

4.78 Dr Naganobu noted the particular importance of the RSShelfE for existing and projected scientific research, notably recent research on marine environmental variability. He indicated that the Japanese research vessel *Kaiyo Maru* would collect data simultaneously on environment–Antarctic krill–whale interactions in the Ross Sea and adjacent waters during a survey in 2004/05 (WG-EMM-04/47). Transects along 180°E, 175°E and 165°E will cover hot spots such as the Scott Seamounts, the Balleny Islands, the shelf off Victoria Land and the Bay of Whales where high concentrations of krill and whales are suggested to occur. The 175°E transect will be surveyed in particular detail from the surface to near the sea bottom in relation to physical, chemical and biological processes.

4.79 Dr Penhale indicated likely increased US interest in regional and global process studies involving data collected from the RSShelfE and that such projects were, like SO GLOBEC, increasingly likely to include data collection from all trophic levels. She noted that modern protected-area concepts were readily applicable to the Southern Ocean and that the RSShelfE, as well as other areas, might benefit from such approaches.

Other prey species

4.80 WG-EMM-04/22 reported a study of within- and between-year variation in foraging patterns in the Antarctic blue-eyed shag. It concluded that before such variation could be used in monitoring programs as indicators of fish prey availability, considerable additional research is needed to understand the influence of other associated behaviour patterns that have potentially confounding effects.

4.81 WG-EMM-04/68 reported analyses of the cephalopod diet of gentoo penguins and Antarctic fur seals at Laurie Island, South Orkney Islands, in the March–May periods of 1988 (fur seals) and 1993, 1995 and 1996 (gentoo penguins). The occurrence of squid, particularly *Psychroteuthis glacialis*, in penguin and fur seal diets at this time of year may be fairly typical (albeit that krill was still the dominant prey category), especially in years of low local krill availability (1995).

4.82 It was noted, however, that, relative to krill, squid tends to be over-represented in such studies of penguin diet, because squid beaks have long residence times in stomachs. In addition, sample sizes for Antarctic fur seals were very small (39 seal scats and 35 squid beaks).

4.83 Some publications reporting research on other prey species of potential general interest to CCAMLR are listed in WG-EMM-04/36. In addition, several papers tabled for the Workshop on Plausible Ecosystem Models contained, or summarised, considerable information on the role of squid and fish in Antarctic marine ecosystems.

4.84 The Working Group requested the Scientific Committee to reconsider how it wishes to treat matters relating to ecosystem interactions involving fish and squid.

Methods

Acoustics

4.85 WG-EMM-04/18 reported on progress on the development of an 'event driven' archive of acoustic surveys compiled by the Secretariat; the archive contains ek5, EV and csv files from the CCAMLR-2000 Survey. Further work is required to import to the CCAMLR database the CTD and plankton net data from CCAMLR-2000 Survey data, and the Working Group noted that this work is scheduled as low priority and will be completed as resources allow.

4.86 WG-EMM-04/35 provided an assessment of the krill biomass at South Georgia in January 2004 conducted on a small vessel in near-shore waters. In respect of the methods of this study, the discussion related to the platform from which the survey was conducted rather than the details of the acoustic methodology. The Working Group agreed that the ability to survey areas within the foraging range of predators, that are not readily accessible to large research vessels, may be important to identify small-scale distribution of krill and local-scale foraging interactions.

4.87 WG-EMM-04/40 presented evidence that animal shape is an important determinant of sound scatter from crustaceans. Therefore, crustaceans cannot be expected to have a single target strength (TS) versus animal length relationship. Thus, the Greene et al. (1991) TS versus animal length model, developed from measurements of a variety of crustaceans, may be inaccurate for Antarctic krill. Broad bandwidth measurements of sound scatter from both northern and Antarctic krill support the Stochastic Distorted Wave Born Approximation model (SDWBA) derived with the same krill shape (WG-EMM-02/49, 02/50 and 04/41). For that reason, acoustic measurements of northern krill and the SDWBA model versus animal size, shape and orientation can be used to improve the techniques for species delineation and TS estimation for surveys of Antarctic krill.

4.88 WG-EMM-04/41 demonstrated that use of the Greene et al. (1991) TS versus animal length model is inappropriate for *E. superba* because: (i) the empirical TS model is only valid in the geometric scattering regime (where the acoustic wavelength is small relative to the animal dimensions); (ii) it does not account for animal shape, and was over-simplistically derived from measurements of a variety of crustaceans, excluding Antarctic krill; and (iii) it incorrectly predicts that sound scatter from crustacean zooplankton is dependent on the animal's volume (versus area for the SDWBA model; see WG-EMM-02/49, 02/50 and 04/40). A simplified version of the SDWBA model, derived with an appropriate distribution of krill orientations (the 'Demer and Conti distribution'), is provided for convenient use in acoustic survey analyses. As an example, a reanalysis of the acoustic data using the SDWBA TS model solved with appropriate distributions of krill lengths and orientations, and a mean krill shape, results in a minimum increase in the CCAMLR-2000 Survey estimate of B_0 for Area 48 from 44.3 to 109.4 million tonnes. This analysis was requested by the Working Group (SC-CAMLR-XXI, Annex 4, paragraphs 3.108 to 3.110), and has been accepted for publication in the *ICES Journal of Marine Science*.

4.89 The Working Group agreed that there is a need for expert re-evaluation of the acoustic protocols used in the determination of target strength of *E. superba*. In particular how the use of methods that determine the target strength as a function of animal shape relates to the estimation of biomass. There was discussion of how the data presented in WG-EMM-04/40 and 04/41 could be incorporated into the work of the Working Group. Although there was a clear history of development of the SDWBA approach with papers presented to this Working Group over the last two to three years, the Working Group noted that there was insufficient expertise present at the meeting and recommended the work be reviewed in the upcoming intersessional period by a group of experts (paragraph 4.92).

4.90 The Working Group noted the parallel work on acoustic delineation of *E. superba* and *Champsocephalus gunnari* and suggested that it might be beneficial to coordinate the work of WG-EMM and WG-FSA in order to review these issues common to both working groups.

4.91 The Working Group agreed that it is important to develop a process by which such data/methodological advances are incorporated into the work of this group and that this should not become a protracted process where there is inactivity in the absence of appropriate feedback. To this end the Working Group agreed that the approaches to determine target strength of krill outlined in WG-EMM-04/40 and 04/41 would be reviewed at its meeting next year, based on reviews and information received and the Working Group will provide advice to the Scientific Committee next year.

4.92 The Working Group recommended that a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) be established to advise the Scientific Committee in a timely fashion on protocols in acoustic surveys and analyses. SG-ASAM should address issues related to acoustic surveys for both WG-FSA and WG-EMM.

4.93 To that end, the Working Group recommended that the Scientific Committee consider the following terms of reference:

(i) to develop, review and update as necessary, protocols on:

(a) the conduct of acoustic surveys to estimate biomass of nominated species;

(b) the analysis of acoustic survey data to estimate the biomass of nominated species, including estimation of uncertainty (bias and variance) in those estimates.

4.94 Immediate issues to be addressed are acoustic protocols for assessing:

- *E. superba* in Area 48
- *C. gunnari* in Subarea 48.3.

4.95 The Working Group also recognised that acoustic assessment of other taxa (e.g. myctophid fishes), and the conduct of surveys in other areas (e.g. Ross Sea) could be considered by SG-ASAM.

4.96 The Working Group requested that WG-FSA consider this proposal and the implications for its work in time for consideration at the meeting of the Scientific Committee.

CEMP

4.97 At the meeting of WG-EMM in 2003, including the CEMP Review Workshop, several areas of intersessional work that related to the analysis and interpretation of CEMP data were identified (SC-CAMLR-XXII, Annex 4, paragraphs 4.1 to 4.18, Table 3, and Appendix D, Table 9).

4.98 In order to make progress with this work an informal workshop attended by Drs J. Clarke, L. Emmerson and C. Southwell (Australian Antarctic Division), and Drs Ramm, Reid and Watters was held at the CCAMLR Secretariat from 18 to 27 February 2004. The aims of the workshop were to:

(i) examine the performance of the CEMP standard methods in delivering the data to the CEMP database;

(ii) examine the sources of variance, including the statistical and logistical implications of different sampling methodologies;

(iii) consider different approaches to the presentation of CEMP data to WG-EMM.

4.99 A decision was taken by the participants to contribute papers arising from the informal workshop to the meeting of WG-EMM in 2004 (WG-EMM 04/60, 04/61 and 04/70) rather than a report of the workshop.

4.100 The Working Group thanked the participants of the informal workshop and recognised the considerable amount of intersessional work presented in the three papers.

4.101 WG-EMM-04/70 contained recommendations for actions and analyses aimed at refining and improving the CEMP standard methods and their delivery to the CEMP database. It also contained a number of recommendations that relate to changes in CEMP methods that are presented in Table 2 (Table 7 of WG-EMM-04/70) and the responses of the Working Group are outlined below.

Collection of CEMP parameter A2

4.102 The current methods for the collection of CEMP parameter A2 (incubation shift) meant that it was difficult to interpret prey availability as this index refers to two distinct time periods (pre-breeding versus breeding season). Therefore the Working Group agreed that any new entrants to CEMP would be advised that the collection of this parameter was no longer a requirement.

4.103 Dr Trivelpiece outlined work in progress to investigate sources of variance and the interpretation of this parameter based on data from the South Shetland Islands.

Collection of environment indices by the Secretariat

4.104 The Working Group agreed that the Secretariat should no longer produce environmental indices (F1 to F4) as there had been no requests for these data by Members, despite several papers that have been presented to the Working Group that used indices of the physical environment from a range of data sources. This reflects a substantial increase in the ease of availability of time series of physical data at a range of spatial scales since the collection of these indices by the Secretariat was initiated.

Collection of data on population size

4.105 The Working Group agreed that it would be useful to provide an operational definition of a colony for the purposes of reporting an index of changes in population size. This should include an assessment of existing counts from sub-colonies within a site to examine representativeness and consistency. In addition, consideration should be given to amending the CEMP standard methods for counting numbers of birds in a colony such that there is no feedback between observers until repeat counts are completed.

4.106 In order to progress this work further it was agreed that these issues might be best considered by the correspondence group on land-based predator surveys led by Dr Southwell.

Data analysis

4.107 The Working Group agreed that the examination of the distributional and variance characteristics of raw data for CEMP parameters, including a review of requirements for sample sizes to detect change, is an important component of future work. Such work would be guided by the definition of the statistical power required to detect changes in CEMP parameters.

4.108 Further analysis of the serial dependence and summary statistics for penguin foraging trip duration that was initiated in WG-EMM-04/60 should be undertaken by Members collecting these data.

CEMP methods

4.109 There was a clarification that the presence of an occupied nest was appropriate for the measurement of population size and for observations of chronology as the requirement to determine the presence of an egg had the potential to introduce an unwarranted level of disturbance.

4.110 The Working Group asked Australia to provide details of the cloacal examination techniques for sexing Adélie penguins that may provide a more suitable alternative to the existing method of the discrimination using detailed biometrics (*CEMP Standard Methods*, Part IV, Section I).

4.111 The Working Group encouraged Members to provide reviews of the implications of the use of fixed chronological reference points as an alternative to five-day periods with respect to the breeding chronology of penguins.

Future surveys

4.112 WG-EMM-04/37 contained a proposal for an Australian acoustic survey of the krill biomass in Division 58.4.2, the southwest Indian Ocean, from January to March 2006. The goal is a new estimate of B_0 to support a revised CCAMLR precautionary catch limit for this division. The plan for a single-ship survey includes 15 parallel transects between 30°E and 80°E, and similar data collection and analysis methods to those of the CCAMLR-2000 Survey. Throughout the next year, Australia will consider constructive criticisms to the proposed survey design and analysis methods.

4.113 Australia extended an invitation to experts from WG-EMM to participate in the survey. Also, as Australia intends to define an ecological-based harvesting unit, they are soliciting additional ship resources to expand the proposed ecosystem investigation. The final survey plan is to be presented at WG-EMM-05.

4.114 WG-EMM-04/47 contained a proposal for a Japanese survey of the Ross Sea and adjacent waters from December 2004 to February 2005 to characterise the influences of long-term changes in the environment on krill and whales. The RV *Kaiyo Maru* will be used to sample the physical, chemical and biological oceanographic conditions in areas expected to have high krill and whale concentrations. These data will provide the environmental context to a concurrent JARPA (Japanese Whale Research Program under special permit in the Antarctic) survey.

4.115 WG-EMM-04/40 and 04/41 were discussed as they relate to analyses of future acoustic surveys for estimating B_0 of *E. superba*. WG-EMM-04/40 recommended that analyses of future acoustic surveys of *E. superba* should use the SDWBA TS model solved with appropriate distributions of krill lengths, shapes and orientations. A simplified version of the SDWBA model is provided in WG-EMM-04/41 for convenient use in future survey analyses. The Working Group recalled its recommendation to the Scientific Committee that SG-ASAM (see paragraphs 4.92 and 4.93) should consider whether the simplified SDWBA TS model should replace the Greene et al. (1991) TS model as the CCAMLR-endorsed standard and provide comments in time for consideration at the 2005 meeting of WG-EMM.

Key points for consideration by the Scientific Committee

4.116 Estimates of krill recruitment in Subarea 48.1 indicate good recruitment in both 2001 and 2002, that resulted in a substantial increase in the local krill population abundance, and poor recruitment in 2003 (paragraphs 4.31 and 4.32).

4.117 Data from the krill fishery and from the diet of krill-dependent predators suggest that krill are found at greater depths during winter than in summer. Asking krill fishing vessels to undertake appropriate research trawls would help understand krill distribution and its relationship with the foraging behaviour of predators (paragraphs 4.23 to 4.27).

4.118 The Working Group considered three quite different scenarios to describe the state of krill stocks in Area 48:

(i) stable population over the past 20 years (WG-EMM-04/27, 04/39)
(ii) fluctuation with an eight-year cycle (Hewitt et al., 2003)
(iii) regime shift since 1998 (WG-EMM-04/72).

It noted that the operational models currently under development by WG-EMM would be useful to evaluate the implications of each of these scenarios in the work of the Working Group (paragraph 4.35).

4.119 The Working Group agreed that the ordination of variables according to functional groupings to summarise the variability in CEMP parameters was useful and encouraged further exploration using data from other regions. It agreed that further work was required both to develop a quantitative mechanism by which to evaluate the properties of methods to summarise CEMP parameters, as well as to the development of a process of decision making based on those summaries taking account of SC-CAMLR-XIX, Annex 4, paragraph 3.51 (paragraph 4.61).

4.120 The attention of the Scientific Committee was drawn to the discussion of the RSShelfE (paragraphs 4.68 to 4.79).

4.121 The Scientific Committee should reconsider how it wishes to treat matters relating to ecosystem interactions involving fish and squid (paragraph 4.84).

4.122 Reanalysis of the acoustic data from the CCAMLR-2000 Survey using the SDWBA TS model, that was requested by the Working Group in 2002 (SC-CAMLR-XXI, Annex 4, paragraph 3.105), suggested the estimate of B_0 for Area 48 may increase substantially (paragraphs 4.88 and 5.76).

4.123 SG-ASAM should be formed to address the terms of reference in paragraph 4.93, including whether the simplified SDWBA TS model or alternative models should replace the Greene et al. (1991) TS model as the CCAMLR-endorsed standard and provide their comments in time for consideration at the 2005 meeting of WG-EMM (see paragraphs 4.92 and 4.93).

4.124 The Working Group agreed that in respect to the collection and analysis of CEMP parameters:

(i) the Secretariat should no longer produce environmental indices (F1 to F4);

(ii) any new entrants to CEMP would be advised that the collection of CEMP parameter A2 was no longer a requirement;

(iii) the correspondence group on land-based predator surveys led by Dr Southwell be asked both to provide an operational definition of a colony for the purposes of reporting an index of changes in population size and to review the level of feedback between observers until repeat counts are completed;

(iv) the number of occupied nests in penguin colonies is appropriate for the assessment of population size;

(v) Australia should provide details of the cloacal examination techniques used in its program for sexing Adélie penguins.

STATUS OF MANAGEMENT ADVICE

Protected areas

5.1 Dr Penhale presented the report of the Advisory Subgroup on Protected Areas. Tasks that were assigned for the intersessional period included:

(i) review of the membership, circulation of tasks and background information, and development of a page on the CCAMLR website;

(ii) preparation of a draft revision of guidelines for the production of maps of protected areas;

(iii) request for review by Brazil and the USA of the status of CEMP sites for which updated maps have not yet been submitted and to provide maps, if appropriate;

(iv) review of the management plan for ASPA No. 145 (Port Foster, Deception Island, South Shetland Islands) which is concurrently undergoing review by the ATCM.

5.2 Additional agenda items for discussion during WG-EMM included:

(i) review of the management plan for ASPA No. 149, Cape Shirreff and San Telmo Island, Livingston Island, South Shetlands Islands, which is concurrently undergoing review by the ATCM;

(ii) discussion of a series of papers relating to the subgroup's term of refence (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 purposed of scientific study or conservation, including special areas for protection and scientific study.'

5.3 Dr Penhale noted that the development of the web page provided an excellent forum for conducting work during the intersessional period as it contained a list of members with contact information, a list of tasks, relevant documents, and correspondence amongst the subgroup. Subgroup members thanked Dr Sabourenkov and the Secretariat staff for producing this excellent web page.

5.4 Dr Penhale reported that outreach to the CCAMLR membership has resulted in an increase in membership and expertise of the subgroup. Membership presently includes 13 members from 11 countries.

5.5 Dr Penhale reported on the discussion of WG-EMM-04/19, which was a draft revision of Conservation Measure 91-01, Annex 91-01/A 'Information to be included in management plans for CEMP sites'. This measure had been updated with more detailed guidance for the production of maps, consistent with map guidelines produced by the CEP.

5.6 Subgroup members had agreed that this revised conservation measure provided excellent guidance for map production for CEMP sites and noted that in the future, additional guidance for map production could be required for marine protected areas to be considered under Article IX.2(g) of the Convention.

5.7 WG-EMM agreed to forward this revised conservation measure with a recommendation for approval by the Scientific Committee.

5.8 With regard to the status of maps, Dr E. Fanta related that Brazil no longer conducted CEMP research at Elephant Island; thus, there was no plan to produce a map of the site. Dr Penhale announced that since CEMP research had ceased at both Seal Island and Anvers Island, there was no plan to update maps of those sites. A map of the US CEMP research site at Admiralty Bay was currently being produced.

5.9 Dr Penhale asked subgroup members whether updated maps would be useful for sites where CEMP research had ceased, but for which data existed in the CCAMLR database. Prof. Croxall noted that maps that allowed the existing CEMP data to be associated with colony locations would be relevant to those who may utilise the data.

5.10 Dr Penhale reported on the discussion of the first of two protected area management plans containing marine areas which were submitted to the ATCM (WG-EMM-04/8). Each would thus require approval by CCAMLR. It was noted that the Cape Shirreff and San Telmo Island site is also protected as a CEMP site.

5.11 Subgroup members noted that due to the shallow nature and small size of marine area, the plan would not affect CCAMLR-related activities and thus recommended approval.

5.12 WG-EMM agreed to forward this revised management plan with a recommendation for approval by the Scientific Committee.

5.13 The second ATCM management plan included two small marine sites at Port Foster, located in the enclosed body of water within the caldera of Deception Island (SC-CAMLR-XXII/BG/14). Members noted that due to the shallow nature of the site and the location within the caldera, the plan would not affect CCAMLR-related activities and thus agreed that WG-EMM should recommend approval by the Scientific Committee.

5.14 Members noted that in terms of the management plan as a whole, there was insufficient scientific information to determine whether the site continues to require protection. Description of physical and biological features was minimal, with no rationale for the location and size of the two sites included in the plan. Also, there was no information on recent research being conducted in the area. While not central to the CCAMLR review, members wished to transmit these comments as advice for improvements to the plan.

5.15 WG-EMM agreed to forward this revised management plan with a recommendation for approval by the Scientific Committee. The additional review comments will be forwarded as advice to the originators of the plan.

5.16 Prof. Croxall introduced three papers, which the UK intended to submit to the Scientific Committee. These papers relate to the role of CCAMLR as an organisation with the attributes of a regional fishery organisation but with a wider conservation mandate, in the international discussion of marine protected areas as management tools for the world's oceans. He recognised that some of the content of these papers reflects and raises issues which require consideration of general principles by the Commission and/or the Scientific Committee. However, it was felt appropriate to solicit initial views and comments from WG-EMM and the Subgroup on Protected Areas.

5.17 WG-EMM-04/11 presented a table of protected areas that are partially or fully marine and are located within the Convention Area. The entries included areas that have been designated as, or proposed to be, protected under various instruments of the Antarctic Treaty or other appropriate regimes. Members found the document very useful in understanding the range and extent of various sites afforded protection.

5.18 Members suggested that additional information in the tables could prove useful; these included the application of the IUCN protected area classification system, information on which areas were most central to the interests of CCAMLR, which areas have already been approved by CCAMLR, and complete information on the size of the marine component of the plans. Prof. Croxall thanked members for this advice, which he will transmit to the authors. He would also welcome being informed of any errors in the paper.

5.19 Prof. Croxall introduced WG-EMM-04/32 which was a review of conservation instruments that have potential relevance to the topic of marine protected areas in the Antarctic Treaty System area. He noted that there is currently worldwide activity within bodies responsible for the management of the world's oceans to investigate how best to use marine protected areas as one of a suite of tools for the management of marine ecosystems within the areas of their jurisdiction and responsibilities.

5.20 Dr Shust noted that the Commission has had 22 years of experience in marine ecosystem management, using the conservation measure as the primary instrument for affording protection to species and sites. He felt that these means were sufficient for the purposes of CCAMLR and he noted that the tasks of the working groups and the Scientific Committee are strictly scientific and these groups must respond to the direction of the Commission. He cautioned against becoming involved in any political aspects of the topic. With regard to the information in WG-EMM-04/32, Dr Shust felt that the paper did not contain sufficient scientific data to justify further discussion by WG-EMM.

5.21 Dr Constable welcomed the overview paper and recommended that the inclusion of information from other conventions would be useful with respect to other conservation mandates that potentially have overlap with CCAMLR, such as CMS and CITES. He further noted that the Scientific Committee is regarded as having the most complete scientific expertise for providing management advice on the Southern Ocean. He felt that it was important for the Scientific Committee to establish the mechanisms for considering the global issues of marine ecosystem management in its future work.

5.22 Prof. Croxall called attention to subgroup term of reference (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 the purpose of scientific study or conservation, including special areas for protection and study’. He believed that it would be useful and timely to consider the best way for CCAMLR to draw upon the scientific experience and expertise of its Members, including consideration of new developments within the international arena in relation to protection and management of marine habitats. Several members expressed agreement with this view.

5.23 In relation to the emerging worldwide issue of the negative impact of bottom trawling on benthic communities, Prof. Croxall introduced WG-EMM-04/12 which highlighted the importance and vulnerability of seamounts as a habitat for marine fish and benthic invertebrates.

5.24 Dr Shust noted that this overview paper did not present data relevant to CCAMLR and felt that further discussion should be based on scientific information from the Convention Area. He noted that there are examples of seabed protection already in place within the conservation measures. Prior to selecting seamounts as marine protected areas, detailed research including fishing methodology, is required.

5.25 Dr P. Wilson (New Zealand) informed the Working Group that New Zealand planned to submit a new management plan for protection within the Balleny Islands area and that the New Zealand committee responsible for producing the management plan will meet later this year. New Zealand welcomes information from and discussion with Members on how best to proceed with development of the plan for the archipelago to become an important contribution to the Antarctic system of marine protected areas in accordance with the provisions of Article IX.2(g) of the Convention.

5.26 It was suggested that as information on the scope and content of the new management plan became available, New Zealand might consider placing such material on the CCAMLR website in order to receive comments.

5.27 Dr Olmastroni informed the Working Group that Italy had submitted a management plan for a new protected area at Edmonson Point, Wood Bay, Ross Sea, to the ATCM in May 2004. Since it contains a marine area, it must be approved by CCAMLR. Due to bureaucratic reasons, Italy was not able to submit this plan in time for consideration at the 2004 meeting of WG-EMM. The plan, which has now been submitted to the Scientific Committee, is currently undergoing review in an ATCM intersessional group which will report to the June 2005 ATCM meeting.

5.28 Dr Olmastroni reported that the area includes an important CEMP research site, which is not protected through the CCAMLR system for CEMP sites. The marine component is a small area which extends approximately 200 m offshore, so there should be no issues related to harvesting in the Convention Area. Dr Olmastroni, on behalf of the Italian Antarctic Program, asked if there were a means for the subgroup to conduct its review intersessionally and provide a recommendation to be received by the Scientific Committee during its meeting in October 2004.

5.29 Dr Hewitt noted that it was unfortunate that the plan was not submitted to WG-EMM by the deadline, because the rules of procedure are that the subgroup reports directly to WG-EMM and not directly to the Scientific Committee. He asked the Chair of the subgroup whether it would even be possible for the subgroup to conduct a review prior to the meeting of the Scientific Committee.

5.30 Dr Penhale reported that with the increased efficiency afforded through the establishment of the subgroup web page, there would be time for the subgroup to make a recommendation on the management plan in time for discussion at the Scientific Committee.

5.31 Dr Constable indicated that the proposition for the subgroup to work intersessionally was a welcome means to provide the Scientific Committee with advice throughout the year. He also noted that consideration of such proposals might be expedited by developing a 'general rule' for proposals in coastal areas so that CCAMLR only focused on protected areas with marine components that are of central interest to CCAMLR, rather than addressing areas only metres offshore coastal sites. Such a rule would endeavour to identify the type of marine sites, such as coastal areas, for which there would be no conflict with CCAMLR activities.

5.32 Dr Holt, in his role as Chair of the Scientific Committee, stated that the current rules of procedure are that the subgroup reports to WG-EMM which reports to the Scientific Committee. He noted that any modification of established procedures would set a precedent that might present future difficulties.

5.33 Dr Wilson noted that there was a will among many members for the review and recommendation on the Edmonson Point management plan to go forward through intersessional review by the subgroup and subsequent discussion at the Scientific Committee. He noted that the rules do not allow the subgroup autonomy, but there should be some flexibility, due to the unique and overarching role of this subgroup, in terms of reporting pathways.

5.34 Prof. Croxall expressed sympathy with the dilemma posed by the situation. He noted that whether a recommendation from the subgroup subsequent to this meeting of WG-EMM could be considered by the Scientific Committee was entirely up to the Scientific Committee. He recommended that the subgroup continue its work intersessionally and make appropriate recommendations in time for the Scientific Committee to make a decision at its meeting in October 2004 as to whether it would review the proposed plan or refer it to the 2005 meeting of WG-EMM.

5.35 Dr Fanta suggested that the Scientific Committee consider reviewing the current procedures for the work of the Subgroup on Protected Areas, to allow more flexibility, possibly involving reporting via both WG-EMM and the Scientific Committee. This would take advantage of the possibility of interaction of all members of the group by correspondence, and of the access that Members have to the documents at the subgroup's web page. The Subgroup on Protected Areas needs to be particularly flexible because it not only gives advice, via WG-EMM to the Scientific Committee and Commission of CCAMLR, but is also involved in advice which relates to the procedures and timetables of meetings of the CEP and ATCP.

5.36 Dr Constable noted that an overarching issue is how CCAMLR could best conduct its business and provide advice in a timely manner. He felt that issues such as review of management plans from the ATCM or issues arising from the Subgroup on Methods were ideally suited to intersessional work. He recommended that the Scientific Committee address the issue of how and when such advice could be delivered to the Scientific Committee.

5.37 Dr Hewitt summarised the consensus arising from the discussion by noting that the subgroup could continue to work intersessionally, although the Working Group would not be able to review its recommendations prior to the 2004 meeting of the Scientific Committee. Furthermore, the Scientific Committee would have to decide as to whether it will accept advice on the Edmonson Point management plan directly from the subgroup at its October meeting.

Harvesting units

5.38 Dr Naganobu informed the meeting that discussions between him and Dr S. Nicol (Australia) on the delineation of harvesting units were continuing and he indicated that it would be at least next year before any results of their considerations would be reported to WG-EMM.

Small-scale management units

5.39 Dr Trathan introduced the recent history relating to SSMUs for the krill fishery; this is outlined in paragraphs 5.40 to 5.43.

5.40 Three years ago at WG-EMM-01, the Working Group considered proposals for subdividing the Area 48 precautionary catch limit and establishing SSMUs, it elected to define ‘predator units’ based on consideration of land-based predator foraging ranges, krill distribution and the behaviour of krill fishing vessels. This approach was subsequently endorsed by the Scientific Committee and also by the Commission (SC-CAMLR-XX, paragraphs 6.15 to 6.19).

5.41 Two years ago at WG-EMM-02, the Working Group held a workshop with a view of defining SSMUs for Area 48. The recommendations made by that workshop were subsequently endorsed by the Scientific Committee (SC-CAMLR-XXI, paragraphs 3.16 and 3.17) and adopted by the Commission which then directed the Scientific Committee to provide advice on how the precautionary catch limit for krill in Area 48 should be subdivided among the agreed SSMUs (CCAMLR-XXI, paragraph 4.6). The Commission also adopted a requirement that krill catches should be reported at a scale of 10 by 10 n mile squares by 10-day periods at the end of the fishing season. In making this recommendation, the Scientific Committee noted that this requirement should be considered to be an interim measure and that haul-by-haul data by 10-day periods should be required when the precautionary catch limit was subdivided among SSMUs.

5.42 Last year at WG-EMM-03, a paper was presented (WG-EMM-03/36) that outlined various methods to subdivide the precautionary catch limit for krill among the SSMUs adopted by the Commission. The purpose of WG-EMM-03/36 was primarily to stimulate discussion on general approaches rather than to advocate any specific proposal. During its discussions the Working Group requested that other alternative proposals for subdividing the precautionary catch limit should be submitted to WG-EMM-04.

5.43 WG-EMM-03/36 has now been extended and revised by the authors and accepted for publication in *CCAMLR Science* (Hewitt et al., 2004); the revised paper has also been tabled for information at this meeting. Hewitt et al. (2004) considers five options; the first four options may be considered to be static allocations of the precautionary catch limit, the fifth may be considered to be a dynamic allocation. Briefly these are:

(i) subdividing the precautionary catch limit in terms proportional to the historical catch in each SSMU;

(ii) subdividing the catch limit in terms proportional to the estimated predator demand in each SSMU;

(iii) subdividing the catch limit in terms proportional to the estimated standing stock of krill in each SSMU;

(iv) subdividing the catch limit in terms proportional to the standing stock less predator demand in each SSMU;

(v) subdividing the catch limit using a dynamic allocation based on land-based predator monitoring conducted just prior to, or early in, the fishing season.

5.44 The Working Group noted that the Commission has also agreed that the krill fishery shall not expand above 620 000 tonnes per annum until the precautionary catch limit had been subdivided among SSMUs. It also noted that no additional papers describing potential methods for subdividing the precautionary catch limit had been tabled at this meeting.

5.45 In this context and in order to evaluate the five options, Dr Trathan suggested that the Working Group should examine closely some of the assumptions that underpin the different options described in Hewitt et al. (2004). Such assumptions include:

(i) harvesting methods will remain the same as currently employed
(ii) mitigation measures to reduce fishery by-catch are adequate
(iii) the current seasonal and geographic pattern of catches remains the same
(iv) transport of krill between SSMUs remains constant
(v) climate-induced changes to the ecosystem are negligible.

5.46 In the ensuing discussion and in relation to allocating the precautionary catch limit of krill among SSMUs in the Scotia Sea, Dr V. Sushin (Russia) reiterated the objections he expressed at the WG-EMM-03 meeting (SC-CAMLR-XXII, Annex 4, paragraphs 5.22(ii) and 5.26). He noted that operational objectives and relevant biological reference points for krill predator populations have still not been developed. In this respect it is difficult to develop objective management advice that is connected with or includes krill predators.

5.47 It was noted that last year several Members had responded to Dr Sushin's concerns (SC-CAMLR-XXII, paragraphs 5.21 and 5.23 to 5.25).

5.48 In relation to biological reference points, Prof. Croxall noted the discussion this year on target population sizes (paragraphs 4.62 to 4.67), which indicates some of the problems associated with deriving these for krill-dependent species.

5.49 It was recognised that, while estimates of target population sizes could doubtless be derived using various methods and approaches, these were of limited use unless accompanied by suggestions for appropriate and feasible management measures. Such measures would need not only to address restoration of depleted populations but also to be applicable to simultaneous management of krill-dependent species with different population status, including those currently increasing.

5.50 Once appropriate measures could be evaluated by WG-EMM, it might then be feasible to consider their incorporation into the management of SSMUs. It would be inappropriate to delay managing SSMUs until measures to manage target population sizes of dependent species could be developed and agreed.

5.51 Dr Sushin then outlined specific remarks regarding the allocation options described in Hewitt et al. (2004); these were as follows:

(i) Allocation of the precautionary catch limit on the basis of the standing stock (option (iii)) is not possible without consideration of oceanographic flux (both within and between SSMUs). Taking into account factors relating to oceanographic flux allows an assessment of the turnover of krill biomass within an SSMU and thus a more realistic evaluation of krill availability. For example, as a result of flux through the Antarctic Peninsula Drake Passage West SSMU and through the Antarctic Peninsula Drake Passage East SSMU (see Hewitt et al., 2004, Figure 1), the standing stock of krill could to be replaced 2.7 times during the December–March period (Hofmann et al., 1998; Ichii and Naganobu, 1996; Sushin, 1998; Sushin and Myskov, 1992). Consequently, the biomass of krill during that period (important for populations of dependent species) would be approximately 2.7 times higher than that indicated by the CCAMLR-2000 Survey. Dr Sushin considered that as a consequence of flux, krill could be replaced at a rate dependent on the water movement. Dr Sushin added that such considerations also affected other options described in Hewitt et al. (2004), specifically options (iv) and (v).

(ii) Estimates for the subdivided catch limit within some of the SSMUs (calculated on the basis of options (iv) and (v)) are considerably lower than the historical krill catch levels within those SSMUs (e.g. South Georgia West and South Georgia East (see Hewitt et al., 2004, Figure 1) are approximately three to four times lower than the annual catch in the 1980–1991 period). As there are no signals that the former catches had a negative influence on predator populations or on the status of the pelagic ecosystem, such low catch allocations appear to be an unnecessarily strong restriction on the krill fishery.

(iii) Bearing in mind the above remarks, it is not possible to conclude, at this stage of development, how the allocation of the precautionary catch limit of krill could be accomplished.

5.52 Dr Naganobu indicated that he also shared the concerns of Dr Sushin and that it was difficult to formulate management advice at this moment.

5.53 With respect to Dr Sushin's specific comments, Dr Trathan suggested that understanding the relative level of in situ krill production and oceanographic transport was important and needed further evaluation; further that there were likely to be temporal and spatial differences in the way that such processes operated and that as a consequence, issues relating to flux should be explicitly considered when evaluating the different options (iii, iv and v). Dr Trathan also emphasised that part of the process to evaluate subdivision of the precautionary catch limit must be to examine the underlying assumptions; these should include modelling of production, flux and predation and the potential impacts on dependent species.

5.54 Drs Trathan and Constable emphasised that the Working Group already provides advice about uncertainty to the Scientific Committee and the Commission and that such concerns should form part of any evaluation of the different options for subdividing the precautionary catch limit. Further, that uncertainty about the level of the standing stock, the demand for krill from dependent species, the importance of oceanographic transport, and the need for appropriate monitoring studies (such as at CEMP sites), were each important components when considering the various options.

5.55 Dr Constable suggested that the modelling framework outlined in WG-EMM-04/73 provides opportunities to explore the consequences of different options for subdividing the precautionary catch limit. It may be advantageous to establish a subdivision, in the first instance, to obtain knowledge about how the ecosystem works and/or will respond to different levels of fishing at the scale of land-based predator colonies and the areas in which those predators forage. To that end, pulse fishing may be an option. Following the acquisition of new information, a revision to the subdivision may be in order. If a subdivision is established then it may be important to consider what monitoring may be required to establish that no problems arise with respect to predators in the future.

5.56 An ad hoc subgroup comprising Drs Trathan, Sushin and Naganobu met to further consider the ideas discussed by the Working Group. During their discussions the subgroup agreed that it was not possible at this time to select between the five different options laid out in Hewitt et al. (2004); this was because there was ecological (and therefore management) uncertainty associated with each of the options and that some of the assumptions underpinning the options were not fully evaluated.

5.57 The ad hoc subgroup agreed that modelling the various assumptions and options contained in Hewitt et al. (2004) would allow progress to be made. The subgroup therefore agreed that this should form the focus of future investigations and that use of a modelling framework, such as that described in WG-EMM-04/73, would allow the different options to be evaluated.

5.58 Dr Sushin considered that options (i) and (iii) (paragraph 5.43) would potentially enable progress to be made most rapidly. Both of these options contain just one component as the basis for calculating the subdivision of the catch limit (the historical catch or the standing stock) and as a consequence they potentially have a lower level of uncertainty than other options, for example options (iv) or (v).

5.59 However, other Members emphasised the importance of giving particular attention to those options that involved more direct consideration of the requirements of dependent species than options like (i) and (iii) which were based solely on utilising historical krill catch data and estimates of standing stock.

5.60 The Working Group recommended carrying forward the appropriate modelling work needed to support the subdivision of the precautionary catch limit amongst SSMUs through the proposed Workshop on Management Procedures in 2005 (paragraphs 6.12 to 6.21).

Consideration of models and analytical and assessment methods

5.61 The Working Group noted the outcomes of the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management described in section 2.

5.62 In order to continue the development of plausible ecosystem models, the Working Group agreed to establish a Steering Committee on Antarctic Plausible Ecosystem Modelling Efforts (APEME) with the following terms of reference:

1. The Steering Committee should promote and coordinate the development of suitable models, analyses and publication of results, and the review of appropriate candidate models.

2. Specifically, the Steering Committee should:

   (i) Science tasks –

   (a) Ensure development of suitable frameworks to include the management and/or implementation of:

   - data, parameters, database availability
   - required code, platforms, components and protocols
   - validation process of the models.

   (b) Ensure coordination and collaboration occurs including:

   - timetables for model development, analyses, estimation of input parameters, model verification and validation;

   - as far as possible, have all work coordinated prior to its commencement;

   - promote, coordinate and define workshop(s) to advance the work program;

   - coordinate analyses of data not undertaken at workshops;

   - identify and coordinate outputs and products.

(c) Act as a two-way information conduit such that Steering Committee members are made aware of individual analyses being conducted by Members, and that individual scientists are made aware of this information.

(ii) Publication –

(a) act as arbitrator/mediator in any conflict relating to authorship of publications;

(b) ensure that all manuscripts are brought to the attention of the Steering Committee prior to submission;

(c) maintain a register of all publications relating to the modelling task.

(iii) Role of the Secretariat –

(a) ensure resources required from the Secretariat are clearly identified in advance.

(iv) Maintain coordination with the conveners of WG-EMM workshops.

5.63 The Working Group requested that Members consider representation on the Steering Committee and that the structure of that committee, including its convener, be determined by the time of the meeting of the Scientific Committee. To that end, Dr Holt agreed to coordinate the process.

5.64 The Working Group agreed that it would be useful to progress the work of the Steering Committee, following the Workshop on Plausible Models and the need to provide input to the development of models for the workshop next year. Dr Constable offered to assist Dr Holt in ensuring that work is progressed amongst nominated members of the Steering Committee until such time as its organisation is completed.

5.65 Dr Constable presented a summary of the report of WG-FSA-SAM (WG-FSA-04/4). The key outcomes and points of discussion included:

(i) methods to estimate recruitment of toothfish, including resolving issues arising at WG-FSA in 2003;

(ii) the evaluation of the design of trawl surveys using simulation studies;

(iii) developing assessments for exploratory fisheries;

(iv) long-term management procedures for *C. gunnari*;

(v) the combining of trawl and acoustic survey information in estimating the abundance of *C. gunnari*;

(vi) methods for estimating mortality and total removals of skates and rays;

(vii) development of assessment and estimation procedures, including survey design, parameter estimation, estimating IUU activities, and alternative assessment methods for *Dissostichus* spp.;

(viii) plausible operating models for *Dissostichus* spp.;

(ix) software;

(x) assessment timetable for WG-FSA at its 2004 meeting.

5.66 The attention of the Working Group was drawn to the following issues:

(i) Estimates of predator consumption of icefish need to be accompanied by the statistical error in those estimates, allowing better comparisons between different estimators (WG-FSA-04/4, paragraph 2.34).

(ii) WG-FSA-SAM requested that WG-EMM consider the issues associated with discriminating between *C. gunnari* and krill in acoustic surveys in Subarea 48.3 and whether the estimates of density and abundance of krill in this area may need to be revised given the difficulty in discriminating krill from icefish using acoustics highlighted in WG-FSA-04/4, paragraph 2.36 (WG-FSA-04/4, paragraph 7.10(i)).

(iii) A need to determine whether the diet of gentoo penguins in Subarea 48.3 is a consequence of diet selectivity or availability (WG-FSA-04/4, paragraph 2.37).

(iv) WG-FSA-SAM agreed that a combination of bottom trawl and acoustic survey will provide the best information on the *C. gunnari* stock in Subarea 48.3 by estimating both the demersal and pelagic components and, to that end, the following areas need to be addressed (WG-FSA-04/4, paragraph 2.39):

(a) discrimination of *C. gunnari* from other acoustic scatterers
(b) further improvements in target strength estimates for *C. gunnari*
(c) age-specific patterns in daily vertical distribution of *C. gunnari*.

(v) In addition, experimental and simulation studies will be useful in determining the appropriate design of trawl and acoustic surveys, including the use of target trawls, for use in assessments of biomass of *C. gunnari* (WG-FSA-04/4, paragraph 2.40).

(vi) Like WG-EMM, WG-FSA has begun work programs to develop plausible ecological models and simulation operating models in order to provide the simulation framework for evaluating management methods and procedures (WG-FSA-04/4, section 3 and paragraph 4.7).

(vii) The subgroup recalled its discussion last year on plausible models for toothfish and continued this discussion with an emphasis on the need to develop operating models to assist in the evaluation of assessment methods and management procedures (WG-FSA-04/4, paragraphs 3.34 to 3.53). It encouraged Members to further develop intersessionally the ideas developed during the meeting and to submit papers elaborating on potential functional forms and/or components of plausible models to WG-FSA-04 and WG-FSA-SAM-05 (WG-FSA-04/4, paragraph 7.7(iii)).

(viii) WG-FSA-SAM agreed that external reviews of CCAMLR software were important to provide transparency as well as a wider acceptance in the use of the software (WG-FSA-04/4, paragraph 4.5). However, such reviews would need to be clearly specified.

(ix) WG-FSA-SAM (WG-FSA-04/4, paragraph 4.8) agreed that the term 'Generalised Yield Model' (GYM) now had two meanings, the first of which is in reference to the assessment method for *D. eleginoides*, while the second is in reference to the software used to implement the assessment method. It was noted that the GYM is the current tool to implement the toothfish, icefish and krill assessments. As such, it would be preferable to refer to the assessment of *D. eleginoides* by some other term, perhaps 'recruitment-based long-term yield assessment', which is used in the Standard Methods Descriptions (SC-CAMLR-XXI/BG/28). This would mean that the term 'GYM' refers to the implementation software for these assessments.

(x) With respect to validation of the GYM software (WG-FSA-04/4, paragraphs 4.9 and 4.10) and to be confident that it correctly implements the assessments and is able to be used effectively and correctly by members of WG-FSA in its assessment work, a substantial amount of work had already be undertaken to validate the GYM computing code. The subgroup agreed that the primary task, in terms of the software, now would be in reference to its 'user-friendliness' and the degree to which users will be able to undertake the existing CCAMLR assessments using the GYM. It noted that the versatility of software may be evaluated through the use of questionnaires, surveys or small projects where 'novice' users, such as first-time users at WG-FSA or graduate students, may be asked to implement the software using available user manuals and operating instructions. This approach could be used to answer questions such as:

- Is the manual explicit and well written?
- Is the software easy and robust to use by novices?
- Are the model runs reliable and are the results consistent on all platforms?
- Are there sufficient diagnostic tools and features available to check that the assessments have worked as expected and is there sufficient detail provided to explain how to use the diagnostic tools?

(xi) WG-FSA-SAM agreed that it would be helpful to obtain general information on the approaches used by other regional organisations such as RFMOs for adopting assessment software (WG-FSA-04/4, paragraph 4.11).

(xii) WG-FSA-SAM discussed other software (WG-FSA-04/4, paragraphs 4.15 to 4.24), including AD Model Builder, Fish Heaven, CASAL, recommending that WG-FSA consider purchasing a single-user licence of AD Model Builder for use by the Data Manager and requested the Data Manager investigate whether it would be within the licence agreement for the software to be borrowed by members of the subgroup for short, non-overlapping periods to enable familiarisation with the software and development of models (WG-FSA-04/4, paragraph 4.19).

(xiii) WG-FSA-SAM requested that the Scientific Committee consider how papers from non-Members be received and utilised by its Working Groups (WG-FSA-04/4, paragraph 7.10(ii)).

5.67 The Working Group noted that the discrimination of krill from icefish and other taxa in the acoustic estimation of krill and icefish abundance is a general question worth considering in more detail by a group of acoustic experts (see paragraph 4.92). Although WG-FSA-SAM considered the problem in relation to the impact on estimates of icefish, the Working Group noted that the same question could be made with respect to the impact of mis-identification of the targets on estimates of krill. It was also noted that the problem will largely concern the discrimination of icefish of the same size as krill rather than for larger icefish.

5.68 Dr Trathan indicated that the UK was currently undertaking field trials with a new echo sounder that should be able to investigate some of the issues surrounding acoustic estimation using the equipment from the CCAMLR-2000 Survey. He also indicated that krill and young icefish might be spatially segregated, which would reduce the impact of mis-identification of young icefish and krill on acoustic estimates.

5.69 With respect to the consumption of icefish by predators, the Working Group noted the need to consider the variance in the estimates of consumption and requested Members to consider undertaking work in this regard.

5.70 The Working Group noted the overlap in consideration of methods under this item and under Item 4.4. It agreed that Item 4.4 was largely concerned with field methodologies. There was also an opportunity for introducing and discussing statistical methods more generally but these were usually those undertaken by individuals or research groups.

5.71 The Working Group agreed that a mechanism needs to be established to validate models and analytical and statistical methods, in a similar way to WG-FSA and its Subgroup on Assessment Methods, in order to agree to their general use in providing advice to the Scientific Committee from the Working Group. Prof. Croxall noted that this would involve developing linkages with other organisations and groups, e.g. in order to have information on the development of methods for modelling the population dynamics of vertebrate species, such as matrix population models.

5.72 The Working Group agreed that it needs to appropriately review within a reasonable timeframe the modelling, statistical and assessment methods underpinning advice to the Scientific Committee before the advice is given, such as through the establishment of subgroups, the initiation of expert review or other procedures considered appropriate. This process is illustrated by the steps agreed for the review of target strengths of krill and icefish (paragraphs 4.92 and 4.93).

Existing conservation measures

5.73 Conservation Measure 51-01 sets precautionary catch limits for *E. superba* in Statistical Area 48 (4 000 000 tonnes), consisting of a limit of 1 008 000 tonnes in Subarea 48.1, 1 104 000 tonnes in Subarea 48.2, 1 056 000 tonnes in Subarea 48.3 and 832 000 tonnes in Subarea 48.4. The catch limits apply to all seasons until the total catch in any season exceeds 620 000 tonnes. In 2002, the Commission endorsed a Scientific Committee work plan that included development of advice on how the precautionary catch limit for krill in Area 48 could be subdivided among the established SSMUs (CCAMLR-XXI, paragraph 4.29).

5.74 The precautionary catch limits for Area 48 and its subareas were set based on analyses of the results of the CCAMLR-2000 Survey. WG-EMM-04/41 presented a reanalysis of the CCAMLR-2000 Survey data for the Scotia Sea, which suggested that the krill biomass in the Scotia Sea may be substantially higher than previously estimated and that therefore a revision of the precautionary catch level for krill in the Scotia Sea may be warranted.

5.75 This paper was considered by the Subgroup on Methods. In subsequent discussion by WG-EMM, it was concluded that there is a need to establish a standing subgroup on acoustics (SG-ASAM) to consider and review protocols in acoustic surveys and analysis. A series of tasks was identified for this group, including a review of the analysis in WG-EMM-04/41 (see paragraphs 4.92 and 4.93). The Working Group therefore does not propose any changes at this stage to Conservation Measure 51-01.

5.76 Several members noted that, following the deliberations of SG-ASAM, it was likely that the current estimate of B_0 for Area 48 may change. This may, in turn, lead to a consequential revision of the precautionary catch limits for this area and its constituent subareas. The Working Group noted that at this stage of development of krill management procedures, it would be undesirable for there to be frequent alterations of the precautionary catch limits. It also noted that annual adjustments may be necessary in a feedback management procedure in the future.

5.77 Dr Constable recalled that it is some time since the current krill management procedure had been reviewed, particularly the input parameters, and that there were several issues that deserved further consideration. These included whether we have fully accounted for all the uncertainties and the extent to which the calculated catch limits are likely to be sufficiently precautionary given the types of biases in the acoustic methodologies. He noted that with the work of the Subgroup on Acoustics and the modelling initiatives proposed by the Working Group, including examination of alternative krill management strategies, it is likely in the next year or two that substantial progress could be made in reviewing the precautionary catch limits, including taking account of new information.

5.78 The possible subdivision of the precautionary catch limit for krill in Area 48 among SSMUs was discussed in paragraphs 5.39 to 5.60. A program of future work was recommended to study this issue further, and no new conservation measures are proposed at this stage for subdivision of the subarea catch limits.

5.79 It was noted that work on subdivision of catch limits among SSMUs should be considered regardless of parallel work on possible revision of the overall precautionary catch limit. In this context, there would be merit in pursuing approaches that, where possible, may allow the subdivided catch limits to be calculated relative to the overall precautionary catch limit.

Key points for consideration by the Scientific Committee

5.80 Following consideration by the Subgroup on Protected Areas, WG-EMM recommended that the Scientific Committee (paragraphs 5.1 to 5.37):

(i) approve revised Conservation Measure 91-01, Annex 91-01/A 'Information to be included in Management Plans for CEMP sites' (WG-EMM-04/19);

(ii) approve the management plan for ASPA No. 149, Cape Shirreff and San Telmo Island, Livingston Island, South Shetlands Islands, which is currently undergoing review by the ATCM (WG-EMM-04/8);

(iii) approve the management plan for ASPA No. 145, Port Foster, Deception Island, South Shetland Islands which is currently undergoing review by the ATCM (SC-CAMLR-XXII/BG/14).

5.81 The Scientific Committee should note the advice of the Working Group concerning:

(i) the development of a proposed new management plan for the Balleny Islands (paragraphs 5.25 and 5.26);

(ii) the status of the management plan for the new protected area at Edmonson Point (paragraphs 5.27 to 5.37).

5.82 Work is continuing on the delineation of harvest units, but it will be next year at least before the results are considered by WG-EMM (paragraph 5.38).

5.83 A program of further work was recommended to enable the subdivision of the precautionary catch limit in Area 48 amongst SSMUs through the proposed Workshop on Management Procedures (paragraph 5.60), taking account of the comments in paragraphs 5.58 and 5.59.

5.84 Key points of relevance to WG-EMM from the WG-FSA-SAM report and subsequent discussion are contained in paragraphs 5.65 to 5.69. In particular, the Working Group recommended the establishment of mechanisms to validate models and analytical and statistical methods relevant to the work of WG-EMM, in order to have an agreed basis for providing advice to the Scientific Committee (paragraphs 5.70 to 5.72).

5.85 Noting the outcomes of the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management (see section 2) and the need to continue development of these models, the Working Group agreed to establish an APEME Steering Committee. Terms of reference for the Steering Committee are given in paragraph 5.62.

5.86 No change is proposed to Conservation Measure 51-01, pending a review of acoustic survey protocols and analyses, to be carried out by a Subgroup on Acoustics, and further modelling initiatives proposed by the Working Group, including examination of alternative krill management strategies (paragraphs 5.74 to 5.79).

FUTURE WORK

Predator surveys

6.1 A correspondence group was established in 2001 to consider the feasibility of broad-scale predator surveys. The group comprised Drs Southwell (coordinator), Trathan, Trivelpiece, Goebel and Wilson. Subsequent discussions by the correspondence group have focused on developing a framework for standardising surveys and on the usefulness of new technology such as satellite remote sensing and unmanned aircraft capable of carrying high-resolution photographic equipment (SC-CAMLR-XXII, Annex 4, paragraphs 6.1 to 6.12).

6.2 Four papers considering issues important to land-based predator surveys were received by the Working Group.

6.3 WG-EMM-04/54 modelled availability bias using existing time-series count data and developed the approach using an Adélie penguin case study. Preliminary modelling suggested that adjusting counts of adult Adélie penguins for availability bias to estimate the breeding population will have large associated uncertainty if counts are undertaken prior to late November or after early January. Modelling availability bias is constrained by limited time-series count data in the literature. The paper indicated that further modelling work could be facilitated by using any additional published or unpublished datasets to those used in this paper.

6.4 WG-EMM-04/55 assessed the accuracy of Adélie penguin breeding abundance estimates at regional scales in Antarctica from existing count data as a case study for penguins generally. The paper concluded that there are likely regional differences in the accuracy of regional-scale estimates of Adélie penguin breeding populations, with estimates from the Antarctic Peninsula/Scotia Sea likely to be less precise than from the Ross Sea or East Antarctic regions. This is largely because the uncertainty in adjusting counts to a standard date, when only the breeding population is present has not been taken into account.

6.5 WG-EMM-04/56 developed and applied a general abundance estimator for Adélie penguins as a case study for developing such estimators for general use in land-based predator surveys. A general estimator of abundance is applied to a range of hypothetical logistic scenarios and related survey designs. It was recommended that the adoption of a general estimator would facilitate standardisation of any future surveys of land-based predators.

6.6 WG-EMM-04/64 reported on an evaluation of assumptions in shipboard line transect surveys of crabeater seal abundance in the pack-ice off East Antarctica. There were some minor violations to assumptions of line transect methods applied to pack-ice seals off East Antarctica as part of the APIS Program. Bias in abundance estimation resulting from assumption violation was minimised through analysis, in particular spatial modelling to address non-random transect placement.

6.7 Dr Trivelpiece welcomed these papers noting that Dr Southwell and his group have provided useful analyses to help progress the practical implementation of region-wide land-based predator surveys.

6.8 In addition to these papers, the Working Group also recalled the paper from 2002 (WG-EMM-02/45) on assessing the feasibility of regional surveys of land-based predator abundance in the Southern Ocean. That paper presented a framework for decision-making and planning of such surveys.

6.9 During the Working Group meeting, the correspondence group met briefly (with Dr Constable representing Dr Southwell). The group noted that there was a continued need to undertake a synoptic survey of land-based predators; it also highlighted the following important points:

(i) the need for a continued consideration of broader issues relating to the planning of surveys, especially with respect to a standardised approach;

(ii) the need to encourage Members to start considering the level and nature of logistic support required for future survey work;

(iii) the necessity of a standardised or general framework (as opposed to standardised methods), e.g. different methods may be necessary for the same species in different locations, but these methods should be consistent with a general framework;

(iv) a need to convene a short planning session in the near future (prior to WG-EMM-05 or in 2006) to progress the work of the group;

(v) with respect to (iv), the correspondence group suggested that the proposed planning session should examine a variety of existing field data and existing analyses methods that would help contribute towards planning a synoptic survey;

(vi) consider options for field methods, survey design and analyses, based on discussions last year (SC-CAMLR-XXII, Annex 4, paragraphs 6.43 to 6.45), papers submitted this year and any further work in the future, including work undertaken under existing or planned programs that Members may be undertaking;

(vii) consider logistic arrangements for undertaking the work.

6.10 The Working Group noted the discussions from the correspondence group and agreed that:

(i) it would be useful to establish a program of preparatory work, proposed field schedules and analyses as soon as is practicable and encouraged the correspondence group to help formulate this over the next year;

(ii) in so doing, field work may not be feasible prior to the International Polar Year (IPY) and most field work would likely be undertaken following that time;

(iii) there was a need to encourage Members to consider participating in these preparations, in particular to consider when they may be able to provide logistic support for this work.

6.11 The Working Group supported the suggestion to hold a planning session (principally for the correspondence group, though possibly with other interested experts) and encouraged the correspondence group to develop a suitable proposal (including terms of reference) in time for the next Scientific Committee meeting; this would then enable any budgetary implications to be considered. The Working Group recognised that it would be valuable to hold the meeting prior to the next meeting of WG-EMM.

Workshop on Management Procedures

6.12 The Working Group initiated its discussion on the Workshop on Management Procedures by recalling that:

(i) the Commission has asked for advice on how the precautionary catch limit for krill in Statistical Area 48 might be subdivided among SSMUs (CCAMLR-XXI, paragraph 4.6);

(ii) candidate management procedures for creating such a subdivision were discussed both at the 2003 meeting of WG-EMM (SC-CAMLR-XXII, Annex 4, paragraphs 5.13 to 5.30) and at this meeting (section 3);

(iii) advice about these candidate procedures could not be provided to the Scientific Committee until the candidates were evaluated under a range of alternative hypotheses that characterise important sources of structural and functional uncertainty in the dynamics of the predator–prey–fishery system (section 3);

(iv) such evaluations should occur in the near future, be model-based, and build on the work of the Workshop on Plausible Ecosystem Models (section 3).

6.13 The Working Group agreed that the objective of the 2005 Workshop on Management Procedures should be to evaluate candidate management procedures that subdivide the precautionary catch limit in Area 48. These procedures should include subdivisions developed according to:

(i) the spatial distribution of catches by the krill fishery;

(ii) the spatial distribution of predator demand;

(iii) the spatial distribution of krill biomass;

(iv) the spatial distribution of krill biomass minus predator demand;

(v) spatially explicit indices of krill availability that may be monitored or estimated on a regular basis;

(vi) pulse-fishing strategies in which catches are rotated within and between SSMUs.

6.14 The Working Group further agreed that these candidates should be evaluated by quantifying the degree to which they are robust or sensitive both to a range of assumptions about the structure and function of the predator–krill–fishery system and to the data or conditions that are used to initialise the candidate procedures. Robustness/sensitivity will be determined by measures of performance of important attributes of the krill–predator–fishery system, which could include factors such as catch rates and predator survival.

6.15 The Working Group recognised that each of the four items of work should be completed as far as is necessary in advance of the workshop:

(i) Data that initialise the candidate procedures should be updated and provided to the workshop. Alternative conditions for initialising the candidate procedures might also be specified during this work. For example, catch data might be updated and data from different time periods might be used to initialise the procedure that evaluates a subdivision based on the spatial distribution of catches by the krill fishery.

(ii) Alternative structural and functional assumptions about the dynamics of the predator–krill–fishery system should be considered and, where possible, specified. These alternatives should include assumptions related to the transport of krill through Area 48.

(iii) Important measures of performance should be identified. These measures will be used to determine whether the candidate procedures are likely to produce results that are robust or sensitive both to the initialisation data and conditions, and to the alternative structural assumptions. Performance measures should be considered with respect to the different components of the predator–krill–fishery system.

(iv) Models that explicitly consider the alternative structural assumptions and predict the important performance measures should be constructed and validated.

6.16 It was agreed that correspondence groups would be formed to advance the first three work items intersessionally. It was also agreed that the fourth work item will be addressed by Members as they see fit. It was, however, emphasised that there would be time to construct models at the workshop.

6.17 Three individuals agreed to organise correspondence groups related to krill (Dr Hewitt), the krill fishery (Dr Kawaguchi) and krill predators (Dr Trathan). Membership in the correspondence groups will be open to all interested parties, and participation in one group will not exclude interested parties from participating in the other groups.

6.18 All three correspondence groups will have similar terms of reference and will address the first three work items listed in paragraph 6.15. That is, each group will identify, and possibly provide, updated data that can be used to initialise the candidate procedures; specify some alternative structural and functional assumptions that can be addressed in the evaluations; and identify performance measures that would be useful to consider. Although each group will conduct this work with reference to their specific focus (i.e. to krill, the fishery or predators), it will be important for the work of all three groups to be coordinated. The workshop conveners will, therefore, coordinate communication between the groups.

6.19 The Secretariat was asked to further facilitate communication within and among the correspondence groups by developing and providing a correspondence web page. The Working Group agreed that such a web page should be placed in the secure 'Members Only' section of the CCAMLR website.

6.20 The Working Group agreed that the correspondence groups will advise the workshop conveners of the results from the intersessional work by the end of the 2004 meeting of the Scientific Committee. The advice will be distributed to WG-EMM soon after it is received from the correspondence groups, and will serve two functions. First, the advice will provide initial guidance to the conveners about those datasets, hypotheses and performance measures that WG-EMM would like to consider at the workshop. Second, it will inform those Members who are constructing models to advance work under the fourth item listed in paragraph 6.15.

6.21 Dr Kawaguchi pointed out that, given the time line identified in paragraph 6.20, it will be important to identify, as soon as possible, the kinds of data available to the fishery correspondence group and the analyses that can be done with these data. Dr Kawaguchi suggested that two informal meetings of the fishery correspondence group may, therefore, be useful. One meeting might occur some time during 2004 as appropriate after WG-FSA, and a second might occur just prior to the workshop. Discussion during the first meeting might focus on available datasets and analyses to be done during the intersessional period. Discussion during the second informal meeting might focus on synthesising results from intersessional analyses and finalising advice that is provided to the workshop.

6.22 The Working Group recognised that intersessional work to construct models for evaluating the candidate management procedures will be critical to the success of the workshop. Members undertaking such work were encouraged to:

(i) utilise the data to address the hypotheses and the performance measures identified by the correspondence groups;

(ii) build on the concepts developed during the Workshop on Plausible Ecosystem Models, paying particular attention to the interactions between the krill population, the krill fishery, krill predators and the transport of krill (see paragraph 2.27);

(iii) develop their computer code in ways and on platforms that will facilitate its use by other Members;

(iv) provide the conveners of the workshop with a report on the nature and status of their work by the end of April 2005.

6.23 The conveners will use the status reports identified in point (iv) of paragraph 6.22 to plan the work that will be conducted at the workshop. The status reports will also be distributed to WG-EMM so that work can be coordinated as far as possible.

6.24 The Working Group further recognised that it would be useful if the models developed for use in the workshop were generally compatible with the goals and objectives of the larger, long-term modelling effort to develop operating models of Antarctic ecosystems. Along these lines, those Members developing models for the workshop and the workshop conveners were advised to correspond with the APEME Steering Committee (see paragraphs 5.62 to 5.64).

Long-term work plan

6.25 The Working Group reviewed its long-term work plan and recognised that substantial progress is being made. Nevertheless, the work plan that was presented in the last report of WG-EMM (SC-CAMLR-XXII, Annex 4) does not adequately describe how that progress is being made.

6.26 The long-term work plan is an important communication tool. It provides the Scientific Committee an opportunity to understand and comment on how the Working Group envisions it can meet its obligation to provide useful advice.

6.27 It was agreed that the long-term work plan should be revised to more clearly reflect how progress is being made and take the following points into consideration:

(i) The workshop planned for the next meeting of the Working Group (paragraphs 6.12 to 6.24) should be viewed as the first workshop to evaluate management procedures for the krill fishery.

(ii) Plans for assessing predator demand are on schedule. Such assessments depend on the eventual conduct of regional-scale predator surveys; the development of such surveys is discussed in paragraphs 6.1 to 6.11.

(iii) Discussions on the subdivision of large FAO statistical areas and the establishment of harvesting units should continue in 2005.

(iv) Many aspects of work are converging, and, in the future, the Working Group will be conducting work that is more integrative.

(v) Following from this attempt to integrate various work items, it may be useful to convene a workshop in 2006 that considers CEMP in the context of operating models of Antarctic ecosystems. Such a workshop could be used in a second evaluation of management procedures for the krill fishery.

A revised work plan for the Working Group is presented in Table 3.

6.28 The Working Group also discussed other strategic planning issues. It was agreed that advice should be sought from the Scientific Committee regarding mechanisms for:

(i) consolidating work that overlaps with WG-FSA and WG-IMAF;

(ii) reviewing broader biological and ecological information that is of interest to the Working Group but, due to time constraints at the annual meetings, receives limited consideration;

(iii) making quantitative expertise available to the Working Group;

(iv) responding to broader conservation issues that may be tangential to the topics identified in the Working Group's long-term work plan.

6.29 The Working Group noted proposals for various new subgroups and recommended that the Scientific Committee consider how best to coordinate and structure the work of its working groups and subgroups.

6.30 Similarly, noting the great deal of work being asked of the Secretariat, the Working Group recommended that the Scientific Committee, in consultation with the Secretariat, consider how the work of the Secretariat may best be coordinated across the work of the Scientific Committee, its working groups and subgroups.

6.31 Dr Hewitt also suggested that the Working Group consider discussing how it might develop its work beyond 2006. He envisioned that such a discussion might take one to two days and require participants to develop and table strategic planning documents that would provide useful talking points. Ultimately, such a discussion might develop a new work plan to replace that presented in Table 3.

6.32 In concluding the discussion on work planning, Dr Sabourenkov introduced document WG-EMM-04/13. This document was tabled to provide a historical perspective of the work that has been accomplished by the Working Group since the development of its five-year work plan in 2001. The Working Group thanked the Secretariat for preparing the document and agreed that it would be useful for a similar document to be tabled at its next meeting.

6.33 Tasks identified by the Working Group for the 2004/05 intersessional period are listed in Table 4.

Key points for consideration by the Scientific Committee

6.34 The Working Group agreed that plans for conducting synoptic surveys of land-based predators should continue (paragraphs 6.10 and 6.11). In particular, the planning will consider field methods, survey design, logistical requirements and methods of data analysis. For the moment, the Working Group recommended that this work should be done through intersessional correspondence and by informal meetings during the annual meeting of the WG-EMM (paragraphs 6.10 and 6.11).

6.35 The Working Group agreed to hold a workshop to evaluate candidate management procedures for subdividing the precautionary catch limit for krill among SSMUs in Area 48. The Workshop on Management Procedures will evaluate candidate procedures by quantifying the degrees to which they are robust or sensitive to key sources of uncertainty (paragraphs 6.13 and 6.14). To enable this:

(i) three correspondence groups, organised by Drs Hewitt, Kawaguchi and Trathan will prepare background and scoping information. Their terms of reference and other operational details are in paragraphs 6.15 to 6.20;

(ii) Members will be responsible, intersessionally, for constructing models that can be used to evaluate candidate management procedures at the workshop (paragraphs 6.16 and 6.20) taking account of the points presented in paragraphs 6.21 to 6.23.

6.36 The Working Group discussed its long-term work plan and determined that it did not adequately describe the ways in which progress was being made on its main work items (paragraphs 6.25 to 6.27). Therefore, the work plan was revised, and it is presented in Table 3.

6.37 The Working Group also discussed a number of strategic planning issues. It was agreed that advice should be sought from the Scientific Committee on the topics presented in paragraphs 6.28 to 6.30.

OTHER BUSINESS

Possible CCAMLR research activities during the IPY

7.1 During its meeting in 2003, the Commission encouraged the Scientific Committee and its working groups to consider plans for a research program during the IPY (2007/08). Such an initiative would serve the needs and objectives of CCAMLR and would at the same time provide an excellent opportunity for wider recognition of CCAMLR's role in research on the Antarctic marine ecosystem and the rational use of marine living resources.

7.2 The Working Group discussed the potential participation of CCAMLR during the IPY in 2007/08 and welcomed the willingness of Members to support this initiative. Currently some Members hope to contribute ship time for sea-going cruises or contribute scientific expertise in specialist research fields. The main research objectives were seen to be in the management context, recognising that process studies would also be valuable. Surveys similar to the CCAMLR-2000 Survey, as well as land-based predator studies, would be welcome.

7.3 At this stage, the Working Group sought guidance from the Scientific Committee, as to whether future planning of a CCAMLR program should centre around, e.g.:

(i) a large-scale survey similar to the CCAMLR-2000 Survey in support of the development of krill management procedures including oceanography and shipboard observations of seabirds and marine mammals (and including phytoplankton and zooplankton studies and studies related to the evaluation of biodiversity or genetic diversity); or

(ii) smaller-scale surveys around key marine areas that could be used as reference areas in the modelling initiative currently under development by CCAMLR (WG-EMM-04/73) to manage the Antarctic marine ecosystem; or

(iii) the Census of Antarctic Marine Life, as presented and discussed at the Commission last year (CCAMLR-XXII, paragraphs 18.1 to 18.4) to assist in considering benthic habitat issues; or

(iv) population estimation of Antarctic land-based predators (though the Working Group noted that it may not be feasible to undertake such a complex survey prior to the IPY (see also paragraphs 6.1 to 6.11)).

7.4 The Working Group considered that the planning phase for such a coordinated international exercise would take about three years. It therefore sought advice from the Scientific Committee and asked that it consider this item during its 2004 meeting; that it take into account proposals developed at the SCAR meeting in Bremen, Germany, held during July 2004, as well as any deliberations resulting from the next meeting of WG-FSA. Following discussion by the Scientific Committee, the Commission may then wish to establish an ad hoc planning group to develop and standardise sampling methodologies and protocols. This group should coordinate CCAMLR activities, but also establish contact with other groups such as the steering committee of CoML (Census of Marine Life) and CircAntCML (Circum-Antarctic Census of Antarctic Marine Life).

SO GLOBEC

7.5 Dr Penhale reported that the US National Science Foundation is inviting grant applications for a special funding competition on SO GLOBEC synthesis and modelling in early 2005. The competition is also open to proposals using other Antarctic marine ecosystem datasets of relevance to SO GLOBEC. While funding is limited to scientists from US institutions, this competition provides an opportunity for collaborative work within the international scientific community.

SCAR

7.6 Dr Fanta advised that SCAR will hold its Ninth International Antarctic Biology Symposium in Curitiba, Brazil. The theme will be 'Evolution and Biodiversity in Antarctica'. This theme was chosen because it encompasses all possible research approaches to Antarctic organisms, and because it establishes a link to global and local events, from the past to the present, and looking into the future. The theme includes all environments, plants and animals, from microbes to vertebrates, from biomolecular approaches to ecosystems, from pure to applied science. This is also the theme of a future umbrella program within SCAR, and will be discussed with the Antarctic Biology Community at a workshop during this symposium.

7.7 The symposium will be held from 25 to 29 July 2005 at Pontifícia Universidade Católica do Paraná. Meetings of SCAR groups (e.g. Seals, Birds, Evolanta, RiSCC) might be held between 20 and 23 July 2005.

Research in the Ross Sea

7.8 Dr Wilson advised that an informal meeting had been held during WG-EMM-04 between various CCAMLR Members involved and interested in research in the Ross Sea.

The meeting was attended by Drs S. Corsolini, Olmastroni, M. Azzali, M. Vacchi and B. Catalano (Italy), M. Naganobu and K. Taki (Japan), Watters (USA), Fanta (Brazil), S. Hanchet and Wilson (New Zealand).

7.9 The aim of the meeting was to informally investigate how the various groups conducting research in the Ross Sea might collaborate further, with a particular focus on the further understanding of the Ross Sea ecosystem.

7.10 Dr Hanchet advised that New Zealand was planning to develop a preliminary ecosystem model of the Ross Sea in the coming year. The proposed work will proceed along similar lines to the CCAMLR modelling workshop with a view to evaluation of various models, identification of components and determination of parameter values. If time is available, a trial energy budget model will be assembled and data needs evaluated, identifying the focus for future research.

7.11 All attendees of the informal meeting were interested in providing data and collaborating on this work. They also considered the Ross Sea area as unique with respect to the importance of key components (e.g. *E. crystallorophias* and *P. antarcticum*). They also agreed that in the longer term it was important to include the Ross Sea within the larger CCAMLR ecosystem model currently under development under the auspices of the Steering Committee on APEME (paragraph 5.62).

Fourth World Fisheries Congress

7.12 The Working Group noted that Dr Hewitt had participated in the Fourth World Fisheries Congress and had chaired a session on 'Reconciling fisheries with conservation in polar seas'. Drs Hewitt, Everson and C. Jones (USA) had presented a paper entitled 'Reconciling fisheries with conservation: three examples from the Southern Ocean' (WG-EMM-04/48) which has been submitted for publication in the proceedings of the congress.

Living Planet Index

7.13 Dr Ramm advised on correspondence between the Secretariat and the UNEP World Conservation Monitoring Centre (UNEP-WCMC) arising from a query about the availability of time-series data on vertebrates from CEMP (WG-EMM-04/16). UNEP-WCMC was working on developing further the approach for measuring and communicating trends in biodiversity that was developed for the Living Planet Index (www.panda.org/news_facts/publications/general/livingplanet/index.cfm). Initiated in 1998, this index combines data on population trends for a wide range of vertebrate species from many locations; the data are assembled from a wide variety of published and unpublished sources.

7.14 The Working Group noted that, despite the appropriate cautions expressed in the Data Manager's response to WCMC, the CEMP data contained time-series trend data of potential relevance to the Living Planet Index. It suggested that Members might wish to make these data available to WCMC, including via published papers where available. To avoid potential duplication of effort, involving similar data that may be discussed during the SCAR meeting in Bremen, Germany, members of WG-EMM attending that meeting were asked to publicise and discuss the WCMC request.

Guidelines for the submission of papers to SC-CAMLR

7.15 In 2003 the Scientific Committee requested that its working groups review the existing guidelines for the submission of papers to SC-CAMLR (SC-CAMLR-XXII, paragraphs 12.31 to 12.34).

7.16 The Working Group noted SC-CAMLR-XXIII/5 prepared by the Secretariat. This was a matter for the Scientific Committee. However, the Working Group agreed that this paper, which would be considered by the Scientific Committee at its next meeting, may provide an opportunity to consider issues related to the submission of Working Group papers, and particularly:

(i) whether the present deadline for the submission of papers (two weeks prior to the meetings) may be extended for certain types of papers which require specialised technical consideration;

(ii) clarification regarding the consideration of unpublished papers from non-Members.

7.17 The Working Group proposed that the conveners of the working groups and other interested parties meet with the Chair of the Scientific Committee immediately prior to SC-CAMLR-XXIII to consider these matters and to develop a proposal for consideration by the Scientific Committee.

Implementation of the revised Rules for Access and Use of CCAMLR Data

7.18 The Working Group noted that the Commission had agreed to a revised set of Rules for Access and Use of CCAMLR Data (CCAMLR-XXII, paragraphs 12.1 to 12.6, see also www.ccamlr.org/pu/e/e_pubs/bd/toc.htm).

7.19 The Working Group discussed recent experiences with the rules. It was agreed that Members making data requests should clearly indicate the nature of their proposed work with respect to distinguishing between the work indicated in paragraphs 2(a) and 2(b) of the Rules of Access and Use of CCAMLR Data, including in the case of work endorsed by the Scientific Committee or the Commission, detailed reference to the relevant sections of their annual reports. This would assist the Secretariat in evaluating the nature of the proposed work and in determining the applicable process under the rules.

Publication of results of the CCAMLR-2000 Survey

7.20 The Working Group noted that the special issue of *Deep-Sea Research* II reporting the results of the CCAMLR-2000 Survey was with the printer and proofs will be sent to authors very soon. CCAMLR will contribute A$10 000 to the costs of publishing this special issue (CCAMLR-XX, paragraph 4.42).

7.21 The Working Group expressed its gratitude to the CCAMLR-2000 Survey steering committee and in particular to the guest editor of the special issue of *Deep-Sea Research* II, Dr J. Watkins (UK).

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

8.1 The report of the tenth meeting of WG-EMM was adopted.

8.2 In closing the meeting, Dr Hewitt reflected on the Working Group's long-term plan and the work undertaken during the meeting. WG-EMM had made significant progress in developing operational models of the ecosystem, developing scenarios for subdividing the catch limit for krill in Area 48, and outlining further work on management procedures.

8.3 Although the work of WG-EMM has been, and remains, of great interest to Dr Hewitt, he advised that he would need to step down as Convener of the Working Group some time in 2005 due to his new job and a new set of work commitments. He asked that members of WG-EMM consider the convenership of the group over the next 12 months.

8.4 Dr Hewitt thanked all participants for contributing to the meeting and the workshop. He also thanked the Secretariat for their work in support of WG-EMM, both at the meeting and during the intersessional period.

8.5 Dr Holt, on behalf of the Working Group, thanked Dr Hewitt for his significant and dedicated contribution to the work of WG-EMM, and for leading another successful meeting.

8.6 Dr Holt joined Dr Hewitt in thanking Prof. Focardi and his team, particularly Drs Corsolini and Olmastroni and Ms Luanna Bonelli, for hosting the meeting at the University of Siena and for providing outstanding support. Their very generous hospitality has been greatly appreciated by all.

8.7 Dr Carrada, on behalf of Prof. Focardi, thanked the Working Group for meeting in Siena.

8.8 The meeting was closed.

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Table 1: Krill fishery plans notified for the 2004/05 fishing season.

Member	Date of notification	No. of vessels	Expected level of catch (tonnes)	Months during which fishing will proceed	Subareas where fishing will take place	Products to be derived from catch
Japan	8 June 2004	2	45 000	8 months	48.1, 48.2, 48.3	raw (crude) 42% boiled 9% peeled 5% krill meal 44%
Korea, Republic of	18 June 2004	2	30 000	6–8 months	48.1, 48.2, 48.3	processed 73% krill meal 27%
Poland	7 June 2004	1	10 500	Feb–Aug	48.1, 48.2, 48.3	frozen 48.5% krill meal 51.5%
Russia	19 June 2004	1	20 000	Mar–Nov	48.1, 48.2, 48.3	frozen 15% krill meal 85%
Ukraine	7 June 2004	4	84 000	Mar–Aug	48.2, 48.3	processed 20% krill meal 60% frozen 20%
UK	15 June 2004	1	1 500	Dec–Feb	48.3	frozen 100%
Uruguay	18 June 2004	1	10 000	to be advised	48.1, 48.2	krill meal
USA	18 June 2004	1	25 000	Feb–Oct	48.1, 48.2, 48.3, 48.4	processed 70% krill meal 30%
Total		13	226 000			

Table 2: Summary recommendations for actions and analyses aimed at refining and improving the CEMP standard methods and their delivery to the CEMP database arising from an informal workshop held at the CCAMLR Secretariat in February 2004 (WG-EMM-04/70).

General topic	Issue	Parameter	Recommendation for further work or action
Scales over which CEMP parameters integrate processes	Integration and measurement over a mixture of scales	A2	• Cease measurement of incubation shift durations unless continuation can be justified.
		A3	• Analysis of the degree of concurrence of breeding population size trends within a range of scales and determination of the representativeness of population trends from single sites.
		F2, F5	• Discontinue collation of sea-ice cover data by the Secretariat.
Spatial extent of data	Regional differences in monitoring intensity	All parameters	• Consider regional differences in monitoring intensity in relation to management outcomes.
Temporal extent of data	Missing data	All parameters	• Documentation of data gaps and analysis of the effects of missing data on calculation and interpretation of indices.
Statistical properties and summaries of raw data	Distribution of raw data	All	• Examine the distributional form of raw data.
	Independence of sampling units	A5	• Assess the extent of dependence between trips for a bird, between birds, or between pair members in penguin foraging trip duration data.
		A3	• Examine submitted penguin breeding population size data for consistency in their interpretation and application of the colony as the sampling unit across programs, and correct any inconsistencies. • Reconsider the definition of the colony as a sampling unit for penguin breeding population size.
		A3, A6a, A6c	• Amend the standard method for penguin breeding population size such that observers are required not to communicate their counts to each other until repeat counts are completed.
	Sources and magnitude of variability	All	• Model the sources and magnitudes of variability in CEMP parameters from first principles using raw data.
	Summary statistics	A5	• Undertake simulation studies to investigate the properties of alternative summary statistics for penguin foraging trip data that are non-normal in distribution at the trip level.

(continued)

Table 2 (continued)

General topic	Issue	Parameter	Recommendation for further work or action
Covariates and qualifiers to summary statistics	Nest contents as a qualifier	A2, A5	• Determine the extent of compliance across all programs to the standard method's requirement for information on the presence/absence of eggs and chicks as a qualifier to calculation of summary statistics for penguin incubation shift and foraging trip duration.
	Five-day periods and breeding chronology as covariates	A1, A5, A7 A9	• Undertake simulation studies to examine the effect of variable sample size over five-day periods for parameters using five-day periods as a covariate. • Depending on the outcome of related work, assess whether alternative covariates or qualifiers to five-day periods may be appropriate (e.g. guard and crèche stages for foraging trip duration, or peak arrival and fledge for arrival and fledgling weights). • Investigate the use of 'chronological anchor points' as an alternative to continued collection of breeding chronology data for programs still collecting breeding chronology data.
	Spatial and temporal scale of environmental parameters	F2	• Discontinue collation of sea-ice cover data by the Secretariat. • The Secretariat provides background information on the sources and forms of available environmental data to assist Members using those data for analyses.
Sample size	Variability and sample size	All	• Sample size requirements are reassessed in the light of data now available. Such a reassessment should be undertaken in conjunction with previously recommended modelling of sources of variability.
	Effect size	All	• Consider an appropriate effect size for detection of change in each parameter.
	Compliance with recommended sample size	All	• The Secretariat determines the extent to which current sample size recommendations have been met.
Representativeness and biased detection of change	Size criterion for selecting colonies, and the number of colonies monitored	A3	• Review the issues of a criterion for the size of colony to measure, and the scale at which inferences on population size are to be made.

(continued)

Table 2 (continued)

General topic	Issue	Parameter	Recommendation for further work or action
Measurement error	Sex determination	A1	• Determine the optimal strategy with regard to the accuracy of available sex determination methods as a covariate to penguin arrival weight.
	Occupied and incubating nest counts	A3	• Use occupied nest counts rather than incubating nest counts for breeding population and breeding success.
	Drainage methods	A8	• Reconsider the recommendation on drainage methods made in Clarke (1995) as an amendment to the standard methods.
Comparability of multiple procedures for a single parameter	Concurrence in time series	A1, A6, A7, C1, C2	• Examine time series data at sites where multiple procedures for the same parameter have been applied over several years for concurrence or otherwise. If possible, determine the cause of any non-concurrence.
	Non-concurrence due to small sample size	A1, A7	• Examine non-concurrence due to variable sample size through simulation.
New or alternative predator parameters	Reproductive output	A6, A7	• Investigate the properties of penguin reproductive output as a new parameter through simulation.
Disturbance caused by monitoring activities		A9 A2, A5	• Assess the benefits of continuing nest observations against the possible cost of disturbance. • The use of 'chronological reference points' is investigated as an alternative to continued collection of penguin breeding chronology data for programs still collecting breeding chronology data. • Investigate whether presence/absence of nest contents can be inferred from the joint behaviour of pair members.
Data processing by the Secretariat	Definition and measurement of 'change'	All parameters	• Reassess the process of identifying statistical differences between years and anomalous years in the light of improved knowledge of long-term variability.

Table 3: Revised plan of work scheduled between 2003 and 2006.

Issue	2003	2004	2005	2006
Revised Krill Management Procedure				
Further development of predator–prey–fishery–environment models	Planning session	Workshop	Steering Committee	Steering Committee
Subdivide precautionary catch limit	Initial proposals	Additional proposals Recommendation	Initial advice based on workshop below	Further advice
Evaluation of management procedures including objectives, decision rules, performance measures	Discussion	Planning session	Workshop (1) to evaluate options for the subdivision of precautionary catch limit for Area 48	Workshop (2) CEMP properties and feedback management procedures
CEMP review	Workshop (SC-CAMLR-XXII, Annex 4, Appendix D)	Consideration of further analytical work (SC-CAMLR-XXII, Annex 4, Appendix D, Table 9)	Consideration of further analytical work	Consideration of further analytical work
Monitoring requirements from CEMP	Discussion		Initial specifications	Revised specifications based on workshop above
Reporting requirements from fishery	Interim requirements adopted by Commission	Consideration of revised requirements	Initial recommendation	Further recommendation
Assessment of Predator Demand				
Large-scale surveys of land-based predators	Discussion	Consideration of pilot studies	Consideration of pilot studies at a planning session	Preparation for surveys
Subdivision of Large FAO Statistical Areas				
Establishment of harvesting units	Discussion		Discussion	Proposals for Subareas 48.6, 88.1, 88.2, 88.3 and Divisions 58.4.1 and 58.4.2 Recommendation
Strategic Planning	Discussion	Discussion	Consideration of mechanisms to consider broader issues	Planning session for a workshop

Table 4: List of tasks identified by WG-EMM for the 2004/05 intersessional period. The paragraph numbers (Ref.) refer to this report unless stated otherwise. √ – general request, √√ – high priority.

No.	Task	Ref.	Priority	Action required	
				Members	Secretariat
	Status and trends in krill fisheries				
1.	Request Vanuatu to provide the required krill catch data for the 2004 season.	3.3	√√		Implement
2.	Encourage further analysis of krill fishery operational parameters.	3.13	√	Krill fishing Members	Remind
3.	Encourage submission of completed questionnaires on krill fishing strategies.	3.15	√	Krill fishing Members	Remind
4.	Solicit urgent submission to WG-IMAF of descriptions of mitigation measures and devices developed to avoid fur seal by-catch.	3.24	√	Krill fishing Members	Remind
5.	Consider what observer coverage and sampling techniques would be appropriate to collect the required krill fisheries data.	3.29	√	WG-FSA (Convener)	Provide support as required
6.	Implement, as required, recommendations for the revision of the *Scientific Observers Manual.*	3.43	√	National coordinators of scientific observation programs (Conveners of WG-EMM and WG-FSA)	Coordinate the work on the proposed revision
7.	Request further information on the acquisition of quantitative electronic echograms from fishing vessels, including on issues relating to equipment (and its installation) and data acquisition, access and analysis.	3.41	√	WG-EMM (Convener)	
	Status and trends in the krill-centric ecosystem				
8.	Calculate the new index of Antarctic fur seal pup growth rates individually for male and female pups.	4.51	√		Implement
9.	Archive details of methods used by Norway when collecting CEMP data on Bouvetøya.	4.54	√		Implement
10.	Conduct further work on developing methods to summarise CEMP parameters.	4.61	√	Members involved in CEMP	Remind
11.	Consider how any models or methods relating to the estimation of target population levels could be evaluated.	4.66	√	WG-FSA	
12.	Establish a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) and address issues related to acoustic surveys for both WG-FSA and WG-EMM.	4.89, 4.92–4.95, 4.115	√√	WG-FSA, subject to approval by SC-CAMLR	Provide support as required

(continued)

Table 4 (continued)

No.	Task	Ref.	Priority	Action required	
				Members	Secretariat
13.	Request WG-FSA to consider the establishment of SG-ASAM and its implication for the work of WG-FSA.	4.96	√√	Conveners of WG-EMM and WG-FSA	
14.	Advise new entrants to CEMP that the collection of incubation shift parameter A2 is no longer a requirement of CEMP.	4.102	√	Implement	Advise
15.	Discontinue production of environmental indices F1 to F4.	4.104	√		Implement
16.	Develop operational definition of a colony, amend CEMP standard methods for counting numbers of birds in a colony.	4.105, 4.106	√	Subgroup on Land-based Predator Surveys (Convener)	
17.	Undertake further analysis of the serial dependence and summary statistics for penguin foraging trip duration.	4.108	√	Implement (Members who collect these data)	Provide support as required
18.	Provide details of the cloacal examination techniques for sexing Adélie penguins.	4.110	√	Australia	
19.	Provide reviews on the implication of the use of chronological reference points with respect to the breeding chronology of penguins.	4.111	√	Implement (Members who collect these data)	Remind Members
	Status of management advice and future work				
20.	Accomplish tasks for 2005 as agreed in the revised long-term work plan.	6.26, 6.27, Table 3	√	Implement (WG-EMM Convener, Members)	Participate, provide support as required
21.	Establish Steering Committee on Antarctic Plausible Ecosystem Modelling Effort (APEME) and accomplish the tasks assigned.	2.29, 5.62–5.64, 5.71, 5.73, 5.85	√√	Nominate participants (Dr Holt to coordinate), coordinate development of suitable models	Participate, provide support as required
22.	Conduct the 2005 Workshop on Management Procedures.	5.60, 5.83, 6.13, 6.14, 6.35	√√	Conveners to organise and conduct the workshop	Provide support as required
23.	Continue intersessional work on constructing models.	6.16, 6.21–6.23, 6.35	√√	Urged to implement (Members developing models)	
24.	Convene correspondence groups, accomplish the tasks assigned, report to the convener of the workshop by the end of the 2004 meeting of the Scientific Committee, inform Members who are involved in constructing models.	6.15–6.18, 6.20, 6.35	√√	Coordinator of correspondence groups	Participate, provide support as required

(continued)

Table 4 (continued)

No.	Task	Ref.	Priority	Action required	
				Members	Secretariat
25.	Establish a webpage on the CCAMLR website to assist the work of the correspondence group.	6.19	√√		Implement
26.	Establish a program of preparatory work to undertake a synoptic survey of land-based predators; consider conducting a planning session prior to the next meeting of WG-EMM.	6.10, 6.11	√√	Correspondence group (Coordinator, Dr Southwell)	Provide support as required
27.	Consider Edmonson Point Management Plan.	5.37	√	Coordinator ASPA	

APPENDIX A

AGENDA

Working Group on Ecosystem Monitoring and Management
(Siena, Italy, 12 to 23 July 2004)

1. Introduction
   - 1.1 Opening of the meeting
   - 1.2 Adoption of the agenda and organisation of the meeting

2. Workshop on plausible ecosystem models for testing approaches to krill management

3. Status and trends in the krill fishery
   - 3.1 Fishing activity
   - 3.2 Description of the fishery
   - 3.3 Scientific Observation
   - 3.4 Regulatory issues
   - 3.5 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 Protected areas
   - 5.2 Harvesting units
   - 5.3 Small-scale management units
   - 5.4 Consideration of models and analytical and assessment methods
   - 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 Procedures
   - 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.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Ecosystem Monitoring and Management
(Siena, Italy, 12 to 23 July 2004)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Siena, Italy, 12 to 23 July 2004)

WG-EMM-04/1	Provisional Agenda and Provisional Annotated Agenda for the 2004 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-04/2	List of participants
WG-EMM-04/3	List of documents
WG-EMM-04/4	The diet of Antarctic fur seals, *Arctocephalus gazella*, at King George Island, during the summer–autumn period G.A. Daneri, A.R. Carlini, C.M. Hernandez and A. Harrington (Argentina) (*Polar Biology,* submitted)
WG-EMM-04/5	Seabird research at Cape Shirreff, Livingston Island, Antarctica, 2003–2004 M. Antolos, A.K. Miller and W.Z. Trivelpiece (USA) (*AMLR 2003/2004 Field Season Report*, in press)
WG-EMM-04/6	Summary of notifications of krill fisheries in 2004/05 Secretariat
WG-EMM-04/7	Vacant
WG-EMM-04/8	Draft Revised Management Plan for ASPA 149, Cape Shirreff and San Telmo Island, Livingston Island, South Shetland Islands Delegations of Chile and USA
WG-EMM-04/9	Register of non-CEMP time-series data Secretariat
WG-EMM-04/10	Results of scientific observation on board RKT-S (cannery fishing super trawler) *Konstruktor Koshkin* in Statistical Area 48 in March–June 2003 as compared with previous seasons V.A. Bibik and S.A. Klementiev (Ukraine)
WG-EMM-04/11	Summary table of current and proposed Antarctic marine protected areas S. Grant (United Kingdom)

WG-EMM-04/12	The biology, ecology and vulnerability of seamount communities A.D. Rogers (United Kingdom) (Published in 2004 by the International Union for the Conservation of Nature and Natural Resources)
WG-EMM-04/13	History of development and completion of tasks put forward by WG-EMM (2001–2003) Secretariat
WG-EMM-04/14	CEMP indices 2004: analysis of anomalies and trends Secretariat
WG-EMM-04/15	Krill fishery information Secretariat
WG-EMM-04/16	The living planet index Secretariat
WG-EMM-04/17	CEMP-related correspondence Secretariat
WG-EMM-04/18	Development of the acoustic survey database Secretariat
WG-EMM-04/19	Revision of Conservation Measure 91-01 (2000), Annex 91-01/A 'Information to be included in Management Plans for CEMP sites' Chair, Subgroup on Protected Areas
WG-EMM-04/20	Acquiring a 'base datum of normality' for a marine ecosystem: the Ross Sea, Antarctica D. Ainley (USA)
WG-EMM-04/21	CCAMLR Scheme of International Scientific Observation: Review of the *Scientific Observers Manual* Secretariat
WG-EMM-04/22	Foraging patterns in the Antarctic shag (*Phalacrocorax bransfieldensis*) at Harmony Point, Antarctica R. Casaux and A. Baroni (Argentina)
WG-EMM-04/23	Demography of Antarctic krill in the Lazarev Sea (Subarea 48.6) and the Elephant Island area (Subarea 48.1) in 2004 V. Siegel (Germany), V. Loeb (USA), B. Bergström (Sweden), S. Schöling (Germany), M. Haraldsson (Sweden), J. Kitchener (Australia), M. Vortkamp (Germany)

WG-EMM-04/24	A possible framework in which to consider plausible models of the Antarctic marine ecosystem for evaluating krill management procedures A. Constable (Australia) (*CCAMLR Science*, submitted)
WG-EMM-04/25	Report of the Steering Committee for the WG-EMM Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management
WG-EMM-04/26	Developing conceptual models of the Antarctic marine ecosystem: squid K. Phillips (Australia)
WG-EMM-04/27	Biotopic and spatial distribution of krill *Euphausia superba* Dana (Crustacea, Euphausiacea) length groupings in the Atlantic sector of Antarctic in summer 1984 and 1988 V.V. Lidvanov, A.V. Zimin, K.E. Shulgovsky (Russia) (*Collected Papers AtlantNIRO*, 2004, in press)
WG-EMM-04/28	Accounting for food requirements of seabirds in fisheries management – the case of the South African purse-seine fishery R.J.M Crawford (South Africa) (*African Journal of Marine Science*, Vol. 26, in press)
WG-EMM-04/29	Counts of surface-nesting seabirds at Marion Island in 2003/04 R.J.M Crawford, N. de Bruyn, B.M. Dyer, B. Hanise, N.T.W. Klages, P.G. Ryan, L.G. Underhill and L. Upfold (South Africa)
WG-EMM-04/30	The brief review of the AtlantNIRO's investigations of living marine resources: whales, krill and fish, in the Atlantic sector of the Antarctic F. Litvinov, D. Tormosov, Zh. Frolkina (Russia) (*History of Oceanography*. Abstracts of the VII International Congress on the history of Oceanography. Museum of the World Ocean, Kaliningrad, 8–12 September 2003: 273–278)
WG-EMM-04/31	Incidental seal entanglements on trawl vessels fishing for krill in CCAMLR Subarea 48.3 J. Hooper, K. Reid and D. Agnew (United Kingdom)
WG-EMM-04/32	The applicability of international conservation instruments to the establishment of marine protected areas in Antarctica S. Grant (United Kingdom)

WG-EMM-04/33	Food consumption estimates of southern elephant seal females during their post-breeding aquatic phase at South Shetland Islands A.R. Carlini, G.A. Daneri, M.E.I. Márquez (Argentina), H. Bornemann (Germany), H. Panarello, R. Casaux (Argentina), S. Ramdohr and J. Plötz (Germany)
WG-EMM-04/34	Physical forcing in the southwest Atlantic: ecosystem control P.N. Trathan, E.J. Murphy, J. Forcada, J.P. Croxall, K. Reid and S.E. Thorpe (United Kingdom) (*Management of Marine Ecosystems: Monitoring Change in Upper Trophic Levels*. Boyd, I.L. and S. Wanless (Eds). (submitted to the Zoological Society of London Symposium))
WG-EMM-04/35	Near-shore acoustic surveys for Antarctic krill at South Georgia, January 2004 A.S. Brierley, P.N. Trathan, J. Poncet and A. Morton (United Kingdom)
WG-EMM-04/36	Dynamoe and albatross papers 2003–2004 British Antarctic Survey (United Kingdom)
WG-EMM-04/37	Proposal for an acoustic krill biomass survey in CCAMLR Division 58.4.2 S. Nicol, S. Kawaguchi, T. Jarvis and T. Pauly (Australia)
WG-EMM-04/38	Interannual variation in the summer diet of Adélie penguin (*Pygoscelis adeliae*) at Edmonson Point S. Olmastroni, F. Pezzo, I. Bisogno and S. Focardi (Italy)
WG-EMM-04/39	CPUE values derived from Soviet fishery statistics as indicators of Antarctic krill density fluctuations in 1977–1991 F.F. Litvinov, A.Z. Sundakov and G.N. Andrianov (Russia)
WG-EMM-04/40	Broadbandwidth sound scattering and absorption from krill (*Meganyctiphanes norvegica*), Mysids (*Praunus flexuousus* and *Neomysis integer*) and shrimp (*Crangon crangon*) S.G. Conti, D.A. Demer (USA) and A.S. Brierley (United Kingdom) (*Journal of the Acoustical Society of America*, submitted)
WG-EMM-04/41	Sounds like more krill D.A. Demer and S.G. Conti (USA) *ICES Journal of Marine Science* (submitted)

WG-EMM-04/42	Report of scientific observations of commercial krill harvest aboard the Japanese stern trawler *Chiyo Maru No. 5* 2 August 2003–21 September 2003 T. Hayashi, M. Naganobu and K. Taki (Japan)
WG-EMM-04/43	Short note: report of bacterial infectious Antarctic krill *(Euphausia superba)* in South Georgia T. Hayashi and M. Naganobu (Japan)
WG-EMM-04/44	Characteristics of seasonal variation in diurnal vertical migration and aggregation of Antarctic krill (*Euphausia superba*) in the Scotia Sea, using the Japanese fishery data K. Taki, T. Hayashi and M. Naganobu (Japan) (*CCAMLR Science*, submitted)
WG-EMM-04/45	Comparison of 1981 FIBEX survey and 2000 CCAMLR survey on oceanographic variability in the Scotia Sea, Antarctica M. Naganobu and Y. Yoda (Japan) (*CCAMLR Science*, submitted)
WG-EMM-04/46	Spectra analysis of Drake Passage Oscillation Index (DPOI) from 1952 to 2003, Antarctica M. Naganobu and K. Kutsuwada (Japan)
WG-EMM-04/47	A survey plan of Japanese RV *Kaiyo Maru* in 2004/05 for the Ross Sea and adjacent waters, Antarctica M. Naganobu, K. Taki and T. Hayashi (Japan)
WG-EMM-04/48	Reconciling fisheries with conservation: three examples from the Southern Ocean R.P. Hewitt (USA), I. Everson (United Kingdom) and C.D. Jones (USA) (*Proceedings of the Fourth World Fisheries Congress*, submitted)
WG-EMM-04/49	Krill caught by predators and nets revisited: interpreting prey selection in proper temporal–spatial scales M.E. Goebel, V. Loeb, D.P. Costa, S.N. Sexton, A.R. Banks, J.D. Lipsky and A.C. Allen (USA)
WG-EMM-04/50	Developing conceptual models of elements of the Antarctic marine ecosystem: Antarctic krill (*Euphausia superba*) S. Nicol and S. Kawaguchi (Australia)
WG-EMM-04/51	A conceptual model of the krill fishery S. Kawaguchi, S. Nicol (Australia), K. Taki and M. Naganobu (Japan)

WG-EMM-04/52	Analysis of trends in Japanese krill fishery, and its implication S. Kawaguchi, S. Candy, S. Nicol (Australia), K. Taki and M. Naganobu (Japan) (*CCAMLR Science*, submitted)
WG-EMM-04/53	Developing conceptual models of elements of the Antarctic marine ecosystem: Adélie penguins L.M. Emmerson, J. Clarke, M. Tierney and L. Irvine (Australia)
WG-EMM-04/54	Modelling availability bias using existing time series count data: Adélie penguins as a case study L. Emmerson, B. Raymond and C. Southwell (Australia)
WG-EMM-04/55	Assessing the accuracy of penguin breeding abundance estimates at regional scales in Antarctica from existing count data: a review using Adélie penguins as a case study C. Southwell (Australia) (*CCAMLR Science*, submitted)
WG-EMM-04/56	Developing and applying a general abundance estimator for land-based predator surveys: Adélie penguins as a case study C. Southwell (Australia) (*CCAMLR Science*, submitted)
WG-EMM-04/57	Changes in the foraging range of Adélie penguins as the breeding season progresses J. Clarke and L. Emmerson (Australia) (*Journal of Animal Ecology*, submitted)
WG-EMM-04/58	Conceptual model of Antarctic epi- and mesopelagic fish R. Williams (Australia)
WG-EMM-04/59	Conceptual model of icefish (*Champsocephalus gunnari*) R. Williams (Australia)
WG-EMM-04/60	Approaches to evaluating and testing of CEMP methods for parameters A1, A5 and A7 G. Watters (USA) and K. Reid (United Kingdom) (*CCAMLR Science*, submitted)
WG-EMM-04/61	Approaches to the simplification of the summary and presentation of CEMP data K. Reid (United Kingdom) and G. Watters (USA) (*CCAMLR Science*, submitted)

WG-EMM-04/62	An initial analysis of the characteristics of Antarctic krill taken by the commercial fishery and Antarctic fur seals during the winters of 2002 and 2003 at South Georgia K. Reid, D.J. Agnew, N.L. Warren and E. Owen (United Kingdom)
WG-EMM-04/63	Monitoring krill population variability using seabirds and seals at South Georgia – new samplers provide new insights K. Reid, E.J. Murphy, J.P. Croxall and P.N. Trathan (United Kingdom) (*Proceedings of the Zoological Society of London Symposium, March 2004*, submitted)
WG-EMM-04/64	Shipboard line transect surveys of crabeater seal abundance in the pack-ice off East Antarctica: evaluation of assumptions C. Southwell, W. de la Mare (Australia), D. Borchers and L. Burt (United Kingdom) *(Marine Mammal Science*, in press)
WG-EMM-04/65	Developing conceptual models of elements of the Antarctic marine ecosystem: marine mammals N. Gales and C. Southwell (Australia)
WG-EMM-04/66 Rev. 1	The structure and spatial distribution of Antarctic krill aggregations from acoustic observation in the South Georgia area S.M. Kasatkina (Russia) (*CCAMLR Science*, submitted)
WG-EMM-04/67	A review of models of Southern Ocean ecosystems: krill, ecosystems and the impacts of harvesting S.L. Hill, E.J. Murphy, K. Reid, P.N. Trathan (United Kingdom), A. Constable (Australia)
WG-EMM-04/68	Predation on cephalopods by *Pygoscelis papua* and *Arctocephalus gazella* at South Orkney Islands M.M. Libertelli, G.A. Daneri (Argentina), U. Piatkowski (Germany), N.R. Coria and A.R. Carlini (Argentina) (*Polish Polar Biology*, submitted)
WG-EMM-04/69	Ecological implications of body composition and thermal capabilities in young Antarctic fur seals (*Arctocephalus gazella*) M.R. Rutishauser, D.P. Costa, M.E. Goebel and T.M. Williams (USA) *(Physiological and Biochemical Zoology*, accepted)

WG-EMM-04/70	Review of the CEMP standard methods and their delivery to the CEMP database C. Southwell, J. Clarke (Australia), K. Reid (United Kingdom), G. Watters (USA) and D. Ramm (CCAMLR Secretariat)
WG-EMM-04/71	Preliminary results of a survey on krill, environment and predators in CCAMLR Subarea 88.1 carried out in December 2003 and in January 2004 (Project 8.4) M. Azzali, A. Russo, A. Sala, A. de Felice, B. Catalano (Italy)
WG-EMM-04/72	Krill and zooplankton populations monitored during AMLR 2004 surveys (Subarea 48.1) with respect to the long-term Elephant Island area datasets V.J. Loeb (USA)
WG-EMM-04/73	Report of the Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management (Siena, Italy, 12 to 16 July 2004)
Other Documents	
	Options for allocating the precautionary catch limit of krill among small-scale management units in the Scotia Sea Hewitt, R.P., G. Watters, P.N. Trathan, J.P. Croxall, M.E. Goebel, D. Ramm, K. Reid, W.Z. Trivelpiece and J.L. Watkins (*CCAMLR Science*, 11: 81–97)
	Climatic Variability and Marine Ecosystem of the Antarctic VNIRO, Moscow, 2003: 295 pp.
	Competition between marine mammals and fisheries – can we successfully model this using ECOPATH with ECOSIM? É. Plagányi and D. Butterworth (South Africa) (*Proceedings of the Fourth World Fisheries Congress,* in review)
	The global eco-modelling epidemic: a critical look at the potential of Ecopath with Ecosim to assist in fisheries management É. Plagányi and D. Butterworth (South Africa) (*African Journal of Marine Science*, Vol. 26, in press)
	Consideration of multispecies interactions in the Antarctic: a preliminary model of the minke whale–blue whale–krill interaction M. Mori and D.S. Butterworth (South Africa) (*African Journal of Marine Science,* in press)

	Examining natural population growth from near extinction: the case of the Antarctic fur seal at the South Shetlands, Antarctica R. Hucke-Gaete, L.P. Osman, C.A. Moreno (Chile) (*Polar Biol.*, 27: 304–311 (2004))
	Feeding ecology of Antarctic fur seals at Cape Shirreff, South Shetlands, Antarctica L.P. Osman, R. Hucke-Gaete, C.A. Moreno, D. Torres (Chile) (*Polar Biol.,* in press)
WG-FSA-SAM-04/4	Further development of the fishery plans Secretariat
WG-FSA-SAM-04/4 Attachment	Draft fishery plans sections 1, 2 and 3 CCAMLR Secretariat
WG-FSA-04/4	Report of the Subgroup on Assessment Methods (Siena, Italy, 5 to 9 July 2004)
SC-CAMLR-XXIII/5	Draft rules for the submission of meeting papers to the Scientific Committee Secretariat
SC-CAMLR-XXII/BG/14	Management plan for ASPA No. 145 [SSSI No. 27] Delegation of Chile

APPENDIX D

REPORT OF THE WORKSHOP ON PLAUSIBLE ECOSYSTEM MODELS FOR TESTING APPROACHES TO KRILL MANAGEMENT
(Siena, Italy, 12 to 16 July 2004)

CONTENTS

REPORT OF THE WORKSHOP ON PLAUSIBLE ECOSYSTEM MODELS FOR TESTING APPROACHES TO KRILL MANAGEMENT
(Siena, Italy, 12 to 16 July 2004)

INTRODUCTION

1.1 The Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management, which was established in the program of work for WG-EMM in 2001, was held at the University of Siena, Siena, Italy, from 12 to 16 July 2004. The meeting was convened by Dr A. Constable (Australia).

1.2 In 2003, the terms of reference for the workshop were agreed to be (SC-CAMLR-XXII, Annex 4, paragraph 6.17):

(i) to review the 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' models[1];

  (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 the parameters used in the models;

(iii) to advance a program of work to develop and implement operating models 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;

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[1] 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.

(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.

1.3 A steering committee was established in 2003 and comprised Drs Constable (Coordinator) and C. Davies (Australia), P. Gasyukov (Russia), S. Hill (UK), Prof. E. Hofmann (USA), Drs G. Kirkwood and E. Murphy (UK), M. Naganobu (Japan), D. Ramm (Secretariat), K. Reid (UK), C. Southwell (Australia), P. Trathan (UK) and G. Watters (USA). Drs R. Hewitt (Convener, WG-EMM) and R. Holt (Chair, Scientific Committee) have been *ex officio* members of the steering committee (SC-CAMLR-XXII, Annex 4, paragraph 6.16).

1.4 Intersessional activities of the steering committee are reported in Item 2.

1.5 The Scientific Committee agreed to fund the attendance of two invited experts at the workshop, as well as providing some funding so that the invited experts could undertake some preparatory work which would at least involve reviewing the contributions to the workshop.

1.6 The workshop steering committee agreed to invite two external experts who could advise on important areas where sufficient expertise is not available from within the CCAMLR community, and who could help with the following key questions:

- To what extent is it necessary to represent all interactions in a food web?
- How can minimally realistic models be used safely?

1.7 Dr B. Fulton (CSIRO, Australia) was invited for her expertise in considering these questions in the context of the evaluation of management procedures (strategies). A second expert was invited but was unable to attend the workshop due to unexpected circumstances.

1.8 Dr Constable introduced the work of the workshop and provided a summary of the background to the workshop along with some expectations as to the outcomes to be achieved. These points were based on Part I of WG-EMM-04/24, and included:

(i) A discussion on how observations are the basis of making decisions.

(ii) A management procedure is a combination of observations, assessments, and decision rules that adjust harvest controls to achieve operational objectives.

(iii) Long-term planning is improved if the rules surrounding decisions are known and understood.

(iv) Assessments may comprise statistical estimation of a parameter/indicator, statistical comparisons, or more complex development of models and projections.

(v) Key questions about the assessments are:

(a) Are there sufficient samples to make the correct decision? This often relates to precision of the estimates, which could lead to statistical Type I and II errors (Andrew and Mapstone, 1987).

(b) Could the estimates be biased and/or confounded by variables or processes unrelated to the assumed cause of effects?

(vi) Precision can be handled by analyses of statistical power, such as those being done in the CEMP review.

(vii) The effect of bias and/or potential confounding on making decisions consistent with the precautionary approach can be addressed by building scenarios and determining whether the bias could lead to incorrect decisions. The issues of bias and confounding in relation to parameter estimation and in relation to the processes that link ecosystem elements to krill, either as food for krill or predators of krill, are more difficult to address. While some relationships could be explored using scenarios of logic, others will need to use more complicated simulations to explore the effects of different types of plausible relationships (structural uncertainty) as well as the effects of natural variation (system uncertainty).

(viii) A task of the workshop is to develop scenarios in order to help evaluate the potential for biases in our monitoring and in the assessment process and whether those biases could lead to incorrect decisions that would cause the Commission to fail to meet one or more of its objectives.

(ix) The primary aim of the workshop was to develop the specifications that will be used by programmers to produce the modelling framework in which plausible models of the Antarctic marine ecosystem can be simulated.

1.9 Dr Constable introduced the draft agenda (in WG-EMM-04/25) and the workshop agreed to add another item 'Plausible scenarios for Antarctic marine ecosystems'. With this addition the agenda was adopted (Attachment 1).

1.10 In adopting the agenda, the workshop noted that the discussions would be drawing together information and concepts to provide a common framework for developing one or more ecosystem models for testing approaches to krill management. As such, the workshop acknowledged that the common framework developed in its report may not be using all of the information, concepts or understanding necessary for implementing ecosystem models. For example, the estimation and summary of parameters is not one of the intended outcomes of the workshop. As a result, some tables, figures or text may not be complete in their consideration or presentation of the issues. Nevertheless, the workshop agreed that the format of the workshop should provide the foundation for further development and implementation of ecosystem models for the work of WG-EMM.

1.11 The work was divided into the major sections of the agenda and coordinated by Dr Constable.

1.12 The report was prepared by Dr Constable, Prof. J. Croxall (UK), Drs Davies, Hill, Hewitt, S. Kawaguchi (Australia), Ramm, Reid, K. Shust (Russia), V. Siegel (Germany), Trathan, W. Trivelpiece (USA) and Watters. Workshop participants are listed in Attachment 2.

REPORT OF THE STEERING COMMITTEE ON INTERSESSIONAL ACTIVITIES

2.1 As agreed at WG-EMM in 2003, intersessional activities included:

(i) provision of 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 Murphy and Prof. Hofmann);

(ii) a review of relevant literature and information on the development of ecosystem models elsewhere as per the first term of reference (Prof. Hofmann and Dr Murphy);

(iii) compilation of a catalogue of available software and other simulation environments for ecosystem modelling (Drs Ramm, Watters and Gasyukov);

(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).

2.2 The results of this work are outlined in the report from the steering committee (WG-EMM-04/25).

Literature review on ecosystem models

2.3 A review of relevant literature and information on the development of ecosystem models elsewhere as per the first term of reference was prepared by Drs Hill, Murphy, Reid, Trathan and Constable. It was submitted as WG-EMM-04/67 and presented to the workshop under Item 3 (see also paragraphs 3.1 and 3.15).

2.4 The workshop had also been informed of other research and publications relevant to its evaluation of ecosystem models and processes.

2.5 The workshop requested that the recent evaluations of fishery management models (e.g. Plagányi and Butterworth, in press; Plagányi and Butterworth, in review) and of multispecies interactions in the Antarctic (Mori and Butterworth, in press) be submitted for the consideration of WG-EMM.

Available software and other simulation environments

2.6 A catalogue of available software and other simulation environments for ecosystem modelling was compiled by Drs Ramm, Gasyukov and Watters. It is summarised in Appendix A of WG-EMM-04/25.

2.7 Dr Gasyukov further outlined the availability of models through the Internet but noted that it would be preferable to develop software specifically for use by CCAMLR.

Data and parameter requirements

2.8 In preparation for the workshop, Drs Naganobu, Reid and Trathan were asked to make a preliminary consideration of the requirements for datasets, estimates of parameters and other aspects related to the second term of reference.

2.9 The workshop recognised that defining the data requirements for models that are not yet specified meant that there was a limit to the progress that could be made. Nevertheless there are a number of key areas of data that are likely to form the basic requirements of an ecosystem model of the Southern Ocean. In WG-EMM-04/25, a background synopsis of the availability of basic data is provided in the following categories:

- models of the physical environment
- food-web linkages and their relative importance
- dynamics of the krill fishing fleet.

2.10 The workshop noted that there was considerable information available with which to parameterise ecosystem models. However, the workshop also recognised that the availability and utility of data were not synonymous; for example, there are a large number of datasets of physical processes but the utility of these to ecosystem models was not yet defined. In order to progress the development of plausible ecosystem models for use in the management of the krill fishery, it would be necessary to ensure that adequate validated information was available to properly describe both food-web linkages and the dynamics of the krill fleet.

Aims and specifications for ecosystem modelling

2.11 Drs Constable, Davies, and Kirkwood undertook to consider aims and specifications for ecosystem modelling. Much of the discussion occurred at the Scientific Committee meeting last year, which was distributed in the first and second Scientific Committee circulars concerning the workshop.

2.12 Dr Kirkwood described his involvement in a project funded by the European Community developing fisheries-related models to evaluate management strategies. That work is being coordinated by Dr L. Kell (CEFAS) with much of the code being developed in the free-ware statistical language, R. A central theme of this work is to integrate many different kinds of operating and assessment models in a single framework, an approach similar to the one needed by WG-EMM. It was agreed that this work may provide some useful tools in the future.

2.13 Dr Constable described work undertaken at the Australian Antarctic Division to assist the workshop in initiating discussions on modelling different components of the Antarctic marine ecosystem. This work formed the basis of WG-EMM-04/24 as well as a number of working papers provided to WG-EMM to help initiate discussions.

Invited experts

2.14 Dr Constable welcomed Dr Fulton to the workshop and invited her to present illustrations of her use of models in CSIRO in evaluating management strategies for the marine environment. The following paragraphs summarise her presentation.

Management strategy evaluation (MSE)

2.15 The MSE approach is made up of a model of the biophysical system (or operating model); submodels of each of the important anthropogenic exploitation or impact activities; submodels for any monitoring activities; and submodels of the decisions process associated with management of each sector. The combined dynamics of these models are used to evaluate how the potential real system might respond to natural events and any human activities. The MSE models must be capable of reproducing historical trends and responses to major events, but they must also be capable of projecting the outcomes of a range of management strategies that have not been used in the past. This is done by ensuring that the main features of the natural system, including uncertainty, are captured in the model, as well as by realistic depiction of sector responses to management strategies. MSE is particularly useful for: (i) determining effective monitoring schemes; (ii) identifying management procedures robust to sampling and model uncertainty; (iii) finding effective compromises between different sectors (or interests) within the system; and (iv) identifying unanticipated problems, issues or dynamics.

2.16 MSE is a tool that has been used at the Australian CSIRO Marine Research (CMR) for nearly 20 years (e.g. Sainsbury, 1988). Over the last six years the approach has been extended from single and multispecies applications to ecosystem-level, multiple-use management MSE. The two marine ecosystem models currently used in this role by CMR are Atlantis and InVitro. Atlantis has been used to consider the effects of model complexity on model performance, and, in MSE, to test potential ecological indicators of the ecosystem effects of fishing (Fulton et al., in press). InVitro is currently being used as the basis of MSE for a range of multiple-use management procedures for the northwest shelf of Australia (Fulton et al., in prep.).

Atlantis

2.17 The Atlantis framework was developed from the ‘Bay Model 2’ ecosystem model (Fulton et al., 2004). It is a deterministic model that tracks the nutrient (nitrogen and silica) flow through the main biological groups (vertebrate and invertebrate) found in temperate marine ecosystems and three detritus groups (labile detritus, refractory detritus and carrion). The invertebrate and primary producer groups are simulated using aggregate biomass pools, while the vertebrates are represented using age-structured models. The primary processes considered in Atlantis are consumption, production, waste production, migration, predation, recruitment, habitat dependency, and natural and fishing mortality.

2.18 Atlantis is spatially resolved, with a polygonal geometry that matches the major geographical features of the simulated marine system (Figure 1). The size of each polygon reflects the extent of spatial homogeneity in the physical variables represented in the model (depth, seabed type (reef or flat), canyon coverage, porosity, bottom stress, erosion rate, salinity, light and temperature). Atlantis is also vertically structured. For the simulations of this study, there is one sediment layer and up to five water column layers within each box (Figure 1). The biological components mentioned above are replicated in each layer of each box, with movement among boxes and layers dealt with explicitly (for the migration of higher trophic levels), or by a simple transport model (for advective transfer).

2.19 The harvesting submodel in Atlantis allows for multiple fleets, each with differing characteristics (gear selectivity, habitat association, target, by-product and by-catch groups, effort dynamics and management structures). While not as sophisticated as fleet dynamic models that model the behaviour of individual vessels (e.g. Little et al., 2004), Atlantis does represent the dynamics of aggregate fleets and allows for behavioural responses to effects such as effort displacement due to the depletion of local stocks or the creation of marine protected areas.

2.20 The sampling model generates data with realistic levels of measurement uncertainty (bias and variance) based on the outputs from the operating model, given specifications for the precision of the data and how they are collected temporally and spatially. For example, fisheries-dependent data are aggregated spatially and temporally (e.g. total catch over the entire area per quarter), whereas fisheries-independent data (such as surveys or diet composition) are only available infrequently (annually to once every decade) from 'snap shots' taken at certain 'sampling locations' (Figure 1).

InVitro

2.21 The biophysical model that forms the operating model in InVitro reproduces the main physical and biological features of the natural marine ecosystem (e.g. bathymetry, currents, waves, seabed types, habitat-defining flora and fauna, and local and migratory populations of marine animals). The InVitro model also includes a representation of the impact of natural forces and activities by the various human sectors found on the northwest shelf of Australia (petroleum exploration and extraction, conservation, fisheries and coastal development). In the management submodel the relevant agencies observe the system produced by the biophysical model (imperfectly) and make decisions about the location and magnitude of the sector activities.

2.22 InVitro is a three-dimensional agent-based, or i-state-configuration, model (Caswell and John, 1992; DeAngelis and Gross, 1992). This form of model provides a convenient framework for dealing with many types of entities (e.g. individuals, populations and communities) – also known as agents. The behaviour of the various kinds of agents in the model can be either passive or on the basis of decision rules, depending on the form of the agent. A summary of the major agent types and the behaviours modelled for each type is given in Table 1. Mobile agents are represented as either individuals (turtles and fishers) or as aggregates (e.g. subpopulations of finfish, schools of sharks and prawn boils), while habitat-defining biological groups are all represented by more aggregate agents (e.g. entire seagrass beds and reefs). Functional and physical attributes are detailed for each of these agents and rules are specified for growth (at the appropriate scale), as well as for passive and active movement. This intertwining of classical age-structured population and typical agent-based models into hybrid form allows for an efficient representation of all critical spatial and interaction scales.

2.23 The environment of an agent is based on the bathymetry, currents, temperature, light intensity, chemical concentrations, habitat type and resident communities. The environmental attributes are updated so that active agents can evaluate their surroundings and take the appropriate (temporal and spatial) responses. A scheduler (which functions in much the same way as a multi-tasking operating system – assigning priorities to agents and splitting available time to give the illusion of concurrency) handles the timing of the agents' activities (and any interactions among the agents). This allows each agent to work at the time step best suited to its activities while ensuring temporal consistency (no agent may re-live the same instant), maintaining synchronicity (preventing the 'subjective' time of an agent straying far from that of its neighbours), and avoiding any potential for systematic advantage of a particular agent (or agent type) due to internal ordering of processes.

Model development

2.24 Ecosystem model development is an iterative, but largely two-stage process. Firstly the ecosystem must be scoped. The following list of checkpoints gives a good sense of the critical processes, components and scales in marine ecosystems:

- oceanography and climate;
- biogeochemistry;
- biogeography;
- biological components (dominant, keystone, vulnerable groups, age or size structuring required);
- links (trophic and otherwise, weights, multiple pathways);
- ecological processes;
- anthropogenic pressures and activities.

2.25 Once a conceptual model of the ecosystem has been sketched out (via multiple classification of the components and processes to allow for discernment of natural groupings), then the most critical step of model development commences – determination of the spatial, temporal and biological scales. Based on previous experience in a number of ecosystem modelling exercises around the world, it is likely that models incorporating mixed scales (with detail focused where it is needed rather than being applied homogeneously throughout the model) will prove to be the most effective.

DESIRABLE ATTRIBUTES OF ECOSYSTEM MODELS

Attributes of models in the literature

3.1 Dr Hill presented WG-EMM-04/67. This paper reviewed approaches to modelling ecosystems in the CCAMLR region with the aim of identifying issues and approaches of relevance to the development of models for evaluating approaches to the management of the krill fishery.

3.2 Models of krill population dynamics have generally addressed the causes of interannual variability in abundance in the Scotia Sea and around South Georgia. Both changes in large-scale distribution and local production seem to play a role. The krill yield model, which is used to set catch limits, uses a Monte Carlo approach to simulate fished krill populations. Parameter values for each year, including recruitment are independently drawn from statistical distributions but there is evidence of autocorrelation in krill recruitment.

3.3 There are various putative effects of environmental variables on aspects of krill biology, including recruitment dynamics and mortality. Most are modelled as simple correlations. A more complex model suggests that hatching of krill embryos on the continental shelf is limited by depth and presence of warm water (Hofmann and Hüsrevoğlu, 2003). Passive drift on ocean currents might be important in determining the large-scale distribution of krill, though active swimming could influence local distribution.

3.4 Early predator–prey models of the Southern Ocean were largely developed in response to the proposition that total krill consumption was reduced with the depletion of the baleen whale stocks. Laws (1977) estimated that this released a krill surplus of 147 million tonnes. The models of May et al. (1979) and others considered a multispecies system with exploitation of both krill and whales. They assumed that prey abundance was driven by predation and that competition and prey consumption were linearly proportional to predator abundance. Among the results of these models were illustrations of multispecies modelling issues.

3.5 Murphy (1995) developed a spatially resolved model of predator and prey dynamics in which krill recruitment was decoupled from predator abundance. The model showed the potential influence on predator dynamics of overlapping foraging ranges and krill concentration. It also illustrated the importance to land-based predators of the retention of krill around islands.

3.6 Butterworth and Thomson (1995) and Thomson et al. (2000) attempted to construct realistic models of the response of the best-studied predators to krill availability. These included non-linear performance responses to prey abundance. The models considered whether krill catch limits could be set on the basis of a target predator population size. There were biases in results due to parameter estimates or model structure. The workshop considered that such models were not sufficient to determine the level of krill escapement required to meet the conservation requirement for predators because they do not represent the overall krill requirement of all predators.

3.7 The models of Mangel and Switzer (1998) and Alonzo et al. (2003a, 2003b) considered the potential influence of behaviour on the dynamics of populations of krill and their predators. These models suggested that krill behaviour can amplify negative effects of krill harvesting on penguins. The authors suggested that predator behaviour might be used to indicate ecosystem status.

3.8 Models of krill fisheries were constructed by Mangel (1988) and Butterworth (1988a) to investigate the relationship between krill abundance and CPUE from the former Soviet and Japanese krill fisheries respectively. These incorporated the hierarchical structure of krill aggregations as patches within patches as described by Murphy et al. (1988). Marín and Delgado (2001) represented the fishery using a spatial automata model implemented in a GIS.

3.9 The earliest attempt to quantify biomass flow through a simplified food web was made by Everson (1977). Many of the pathways which could not be quantified remain data poor. Croxall et al. (1984) used detailed consideration of energy requirements to model prey consumption by predators. Three detailed ecosystem models have been constructed by Green (1975), Doi (1979) and Bredesen (2003), the latter using ECOSIM software. These models are limited by the availability of data. However they highlight the importance of pathways that do not involve krill or well-studied consumers. They also highlight the need for improved data on energy transfer and assimilation rates.

3.10 Constable (2001) presented a model to integrate ecosystem effects through summing biomass production in predator species arising from consumption of harvested species. This could be summed across predators to give an index of ecosystem status, which could be used to set ecosystem reference points. It could also be summed across prey species within predators to set reference points for individual predator populations.

3.11 Early models of long-term dynamics assumed the system was at equilibrium before harvesting. However, the past status of the ecosystem is likely to be impossible to establish. Also, the assumption of equilibrium in the past or the future might be unrealistic.

3.12 Krill is clearly of central importance, but the food web has pathways that do not include krill.

3.13 There is a need to improve the data available on important trophic interactions. Also, the question of how to manage fisheries when some parts of the ecosystem are difficult to observe needs to be addressed. Other important questions to consider are how to represent important environmental effects in models of the ecosystem, and how to integrate different models when they may give output at different scales.

3.14 Dr Hill requested workshop members to supply details of any relevant literature that was currently missing from the review. Dr Shust suggested the volume on krill distribution and oceanography (Maslennikov, 2003).

3.15 Dr Shust suggested that the estimation of unexploited krill biomass remains a problem. Dr V. Sushin (Russia) commented that there may be other ways to manage the ecosystem than through managing the krill fishery.

General attributes of models for evaluation of management procedures

3.16 Dr Constable presented discussion points on the general attributes of models for evaluating management procedures. This presentation was based primarily on Part II of WG-EMM-04/24. He noted that operating models are not intended to capture all of the dynamics of the physical and biological systems but should capture the important properties of the system as they relate to the effects of fishing and the possible monitoring programs (ecology, physical environment, fishery) that can be employed. The important properties to consider and discuss in more detail in WG-EMM-04/24 are:

(i) the potentially important direct and indirect effects of fishing, thereby defining the characteristics of the ecosystem that may need to be measured in the simulations, whether or not they can be measured in the field;

(ii) the types of field observations and monitoring programs that could be employed;

(iii) the biological scales (taxonomic grouping and population subdivision into life stages – which may not be the same for each taxonomic group) required to promulgate the important interactions between species and to provide for monitoring;

(iv) the spatial scales of interactions, taking account of differences in interactions between different types of locations as well as the potential for biogeographic differences, thereby influencing the degree to which space will need to be explicitly accommodated in the modelling framework and whether spatial units need to be uniform geographic units or may be implied by being represented as compartments accommodating different spatial areas and extents;

(v) the temporal scales of interactions, taking account of differences in important interactions over time and the duration of different events, such as reproduction or other life stage characteristics, thereby influencing the duration of the time steps necessary to be accommodated;

(vi) the degree to which interactions (cause and effect) are approximated or explicitly modelled, which may be influenced by the types of measurements able to be achieved in a monitoring program;

(vii) the degree to which processes peripheral to the central processes concerned with the effects of fishing are simulated;

(viii) the manner in which the boundaries of the model system are simulated, recognising that the system is unlikely to be a closed system and that processes occurring outside of the model system might impact on the function of that system.

3.17 The workshop agreed that these attributes are important to consider during the workshop and in the implementation of models for use by WG-EMM.

CONCEPTUAL REPRESENTATION OF ECOSYSTEM MODELS

General approach

4.1 As indicated in Item 2, Dr Constable had undertaken an exercise with scientists in the Australian Antarctic Division to develop conceptual models of various components of the Antarctic marine ecosystem. He introduced this item by summarising Part III of WG-EMM-04/24. The major points were:

(i) the aim of developing conceptual models is to provide a flexible framework for considering how each taxon might be influenced by the rest of the ecosystem, thereby providing the means to explicitly decide how best that taxon should be represented in the model to evaluate krill management procedures;

(ii) some taxa will need to be represented in some detail in order to simulate field monitoring and the local-scale effects of fishing;

(iii) other taxa might be simulated in a very general way in order to save simulation time while ensuring that ecosystem responses are realistic;

(iv) the approach is intended to provide a means for explicitly determining how to take account of structural uncertainties given the paucity of data on many aspects of the ecosystem. The approach is also designed to allow an assessment of the sensitivity of model outcomes to assumptions about the relationships between taxa.

4.2 Figure 9 in WG-EMM-04/24 illustrated the components/functions of a single element in a food-web model discussed in that paper. An element was defined as the lowest, indivisible quantity in the food-web model and had the following attributes:

(i) taxon – the group to which the element belongs, which could be a population, species, guild, ecological group, sex or some other category;

(ii) stage – the life stage of the element, whether it be age, life stage or some other subdivision of the taxon needed to provide for distinguishing ecological characteristics (below) from other stages;

(iii) units – the type of units used to measure/monitor the quantity of the element, such as number, biomass, area or some other measure;

(iv) location – if needed, the spatial compartment or cell in which the element resides;

(v) depth – if needed, the depth stratum in which the element resides.

4.3 The state of an element is largely governed by its magnitude (abundance) but some knowledge of its age may be important if the proportion of animals of a certain life stage advancing to another life stage is not constant and governed by the present age structure.

4.4 The workshop noted that the conceptual models will require consideration of the characteristics of elements, even though each characteristic may not be explicitly incorporated as separate parts of a model.

4.5 In the first instance, the workshop agreed to undertake the following work in developing conceptual representations of key components:

(i) develop pictorial representation, as appropriate, of key population processes, primary locations of individuals relative to features in the physical environment and spatial foraging patterns;

(ii) identify key parameters and processes that will need to be considered in the representation of each element in the ecosystem model, including population dynamics, foraging behaviours and spatial and temporal distributions;

(iii) undertake initial consideration of:

(a) the interactions between taxa and between taxa and the environment;

(b) the representation of space, time and depth in ecosystem models;

(c) consideration of the requirements for modelling field observations, which will be undertaken in the evaluation process.

4.6 The workshop noted that the major considerations for the development of operating models are with respect to

- physical environment
- primary production
- pelagic herbivores and invertebrate carnivores
- target species
- mesopelagic species
- marine mammals and birds.

4.7 Other taxa may need to be considered in future, such as demersal and bathypelagic species, including *Dissostichus* spp., *Macrourus* spp., skates and rays. It was noted that the current framework was sufficient for initiating work on evaluating approaches to krill management.

4.8 The remainder of this section sets out the results of discussions on conceptual representation of these components.

4.9 The Antarctic marine ecosystem considered at the workshop is primarily that ecosystem south of the Sub-Antarctic Front (SAF), including most of the Polar Frontal Zone (PFZ) and the ocean south of that zone, which comprises the west–east flow of the Antarctic Circumpolar Current (ACC) and the east–west flow of the Antarctic coastal current. This is primarily contained within the CCAMLR Convention Area, although some features of the

PFZ occur to the north of the CCAMLR Convention Area (Figures 2 and 3). The workshop noted that the boundaries of the ACC described by Orsi et al. (1995) are also important features to consider. In that respect, the subtropical front, which is to the north of the primary area of interest, was also considered important for flying birds.

4.10 The other main feature of the Antarctic marine ecosystem is the annual progression and retreat of the pack-ice zone (Figure 4). In this respect, the MIZ at the edge of the pack-ice as well as the role of pack-ice to predators needing haul out locations and as a substratum for productivity need to be considered.

4.11 A view of the biological productivity of the Southern Ocean can be viewed using SeaWifs data (Figure 5).

4.12 The main biotic components considered by the workshop were primary production, pelagic herbivores and invertebrate carnivores, target species (*Euphausia superba* and *Champsocephalus gunnari*), mesopelagic species (myctophid fish and squid) and widely distributed and migratory species, the marine mammals and birds (Table 2).

Physical system

4.13 The workshop considered those elements of the physical environment that it noted were of potential importance in the operation of the Southern Ocean marine ecosystem and that would also be of considerable utility in a coupled ecosystem model. The workshop considered these various elements from a number of perspectives.

4.14 Firstly, it considered a range of environmental factors each with a set of properties and each with a set of motivating forces; secondly, it considered a set of dynamic processes and how these structure the environment; thirdly, it considered seasonality and how this affects a number of the environmental factors; and finally it considered the natural spatial properties of the ecosystem. The results of these deliberations are contained in Tables 3 to 6. The workshop agreed that considerably greater detail could be included, but it recognised that, for a first attempt, the identified elements were sufficient to scope the modelling process.

4.15 The workshop noted that, conceptually, the physical environment provides four main ecological functions in the Antarctic marine ecosystem:

(i) a substratum for production, with the attendant physical conditions in space, depth and time;

(ii) stratification of the physical environment into natural units, including oceanic zones, depth zones, bathymetric features and ice;

(iii) substratum for transport between areas and depths;

(iv) sources of mortality, such as extreme atmospheric conditions.

4.16 At each stage of the process, the workshop identified which of these ecological functions and processes was affected; examples of potential functional impact are identified in square brackets ([ ]) in Tables 3 and 4.

4.17 The workshop considered physical factors in different seasons (Table 5). It recognised that the division of the calendar year into seasons depended on latitude. Initially it decided to focus on two seasons, winter and summer.

4.18 The workshop also recognised that the Southern Ocean had a number of natural spatial divisions (Table 6).

4.19 The workshop attempted to develop a conceptual model of the environment and how the various factors and processes interacted. This is illustrated in Figure 6.

4.20 The workshop recognised that there were a number of areas where environmental models would be of considerable utility in a coupled ecosystem model. These included:

(i) Delineating two-dimensional areas and three-dimensional polygons of spatial operation; these would potentially delineate a framework of habitats for use elsewhere in the ecosystem framework. The workshop recognised that direct coupling of a physical general circulation model may not be necessary, so long as inputs and outputs could be defined at appropriate spatial and temporal scales. These outputs would need to encompass the ecosystem functions described in paragraph 4.15.

(ii) The delineated habitats and processes should relate to the intended biological complexity of the model.

(iii) There could be utility in considering separate frameworks for each of continental, island and low-latitude situations.

Primary production

4.21 As part of its deliberations the workshop considered primary production, recognising that there was only general (and not specific) expertise within the group. Some consideration of primary production is given in WG-EMM-04/24. It noted that the formation of particulate matter for secondary producers could arise from primary production, particulates in the microbial loop as well as particulate detritus (Figure 7). The workshop also considered the factors that might influence primary production discussed in that paper (Figure 8, Table 7). It noted that remotely sensed ocean colour data, such as from SeaWiFS or MODIS, had the potential to help partition the Southern Ocean for the purposes of building an ecosystem model coupled with a physical oceanographic model. An example of summer Chl-*a* distribution from SeaWiFS is shown in Figure 5.

4.22 The workshop noted that future work will be needed in developing models of primary production, including reviews of the forcing functions provided in WG-EMM-04/24 as well as alternative formulations available in other models. The workshop recognised that, at some future point, it would also need to consider more detailed primary production models that included successional elements and seasonal elements.

Invertebrate herbivores and carnivores

4.23 Five taxonomic groups were considered as important pelagic herbivores and carnivores: salps, copepods, mysids, amphipods and euphausiids (other than *E. superba*).

4.24 Salps are open-water pelagic filter feeders and include several species, the most important of which is *Salpa thompsoni*. Copepods include approximately 60 species, of which 10 to 15 are common. Mysids include three common epibenthic species associated with continental shelves, shelf breaks and canyons. Hyperiid amphipods include approximately six common species, the most important of which may be *Themisto gaudichaudii*. Important euphausiids other than *E. superba* include *E. crystallorophias* and *Thysanoessa macrura*.

4.25 Attributes that were considered to be important with regard to the functioning of the pelagic ecosystem included spatial distribution, diet, generation time and depth distribution.

4.26 With regard to spatial distribution, it was recognised that distinct zooplankton communities were difficult to identify in the Southern Ocean, that there was a general decline in the number of species and their abundance progressing from north to south. Nevertheless, three non-exclusive species groupings were recognised: namely oceanic, island shelf and high-latitude shelf groups with large overlaps between them. Species indicative of the ocean group include salps; species indicative of the island shelf group include mysids; and species indicative of the high-latitude shelf group include *E. crystallorophias*.

4.27 With regard to diet, salps were considered to be primarily herbivores. Copepods, depending on species, were considered to include herbivores, carnivores and omnivores. Mysids and amphipods were considered to be carnivores. Euphausiids were considered to be omnivores.

4.28 With regard to generation time, salps and copepods were considered to be capable of responding the fastest to favourable conditions with generation times of 0.5 to 1 year. Mysids were considered to have a generation time in the order of 2 years; amphipods 1 to 2 years and euphausiids 2 years.

4.29 With regard to depth distribution, three depth zones were defined: the epipelagic from 0 to 400 m depth, the mesopelagic greater than 400 m depth, and the epibenthic within 50 m of the bottom in water depths of 100 to 400 m. During the summer months all taxa were considered to occupy primarily the epipelagic zone, with the exception of mysids, which occupy the epibenthic zone. Little is known of the winter-time depth distribution of these zooplankton.

4.30 The above attributes are summarised in Table 8.

Target species

4.31 The workshop considered WG-EMM-04/24, 04/50 and 04/59 for its deliberations to define elements of target species to be used in ecosystem models for testing approaches to krill management. Discussions concentrated on two species, the icefish (*C. gunnari*) and krill (*E. superba*). It considered that *Dissostichus* species might be incorporated in the modelling framework in the future but these species were not considered further at this workshop.

Icefish

4.32 The properties of *C. gunnari* for inclusion in the general structure of the Antarctic ecosystem model are summarised in Table 9.

4.33 *C. gunnari* is one of the key components in the sub-Antarctic marine ecosystem in the Scotia Sea and northern Kerguelen Plateau areas. *C. gunnari* has a high biomass within its distribution range, although this can vary widely between locations and over time. The workshop noted that the species has a disjunct distribution within the sub-Antarctic region; a population in the South Atlantic region around South Georgia and Shag Rocks, South Orkney and South Shetland Islands and the tip of the Antarctic Peninsula (Figure 9); and populations on the northern part of the Kerguelen Plateau around Kerguelen and Heard Islands.

4.34 Within its distribution range *C. gunnari* is restricted to shelves around islands. Subpopulations in each major distribution area show distinct biological properties, e.g. maximum size, growth, fecundity, spawning season and fluctuations in abundance. Abundance is highly variable at any location, and fluctuations are not synchronised between areas. The variability in abundance in this species appears to derive both from large variations in recruitment strength as well as changes in abundance of adult fish between years. The documented high degree of variability in year-class strength in all populations is presumably driven by environmental factors. These may include:

- poor feeding conditions leading to a low proportion of mature fish reaching spawning condition, e.g. in the South Georgia area;

- low hatching rate of eggs due to sub-optimal temperatures or predation;

- low larval survival due to inadequate food supply, advection by currents from nursery grounds, or predation.

Although the processes behind this are not well understood, the workshop felt it necessary that variability in recruitment should be included in the modelling framework.

4.35 *C. gunnari* could be modelled as length- and age-structured populations, the methods of which are well described in the literature. While there is sufficient information to develop length-structured dynamic models that could be overlayed on bathymetric features, the workshop indicated that this species could be modelled as three life stages – early life-history stages, juveniles and adults (Figure 10).

4.36 It was recognised that icefish is a component of two different prey environments:

- In the South Atlantic area, the principal food item is *E. superba*. Larval as well as juvenile and adult icefish feed on various stages of krill from furcilia larvae to adult individuals. During times when krill is scarce, all stages of *C. gunnari* can switch prey to *T. macrura* or amphipods and mysids.

- On the Kerguelen Plateau, where *E. superba* does not exist, the principal diet component is *E. vallentini* with *T. gaudichaudii* being a secondary component.

4.37 In the Atlantic sector predators include other fish species, albatross in certain years and penguins. Fur seals increase the proportion of *C. gunnari* in their diet in those years when krill is scarce. In the Kerguelen Plateau area, predation appears to be less intense.

4.38 Since the late 1990s, fisheries have resumed for this species at South Georgia and Heard Island. It has been suggested that the nature of the ecosystem may have changed since the period of intensive fishing in such a way as to reduce the carrying capacity of *C. gunnari*. Whether this phenomenon is a result of unsustainable fishing in the past or of environmental change or other ecosystem change has not been established. A decline in the *C. gunnari* fishery at Kerguelen during the last 10 years has been attributed to a southward shift of the Polar Front (WG-EMM-04/59).

4.39 Regular surveys of *C. gunnari* around South Georgia suggest a highly heterogeneous distribution, which may be important to include in models.

4.40 The workshop considered that in each geographic location *C. gunnari* should be considered as at least three elements (larvae, juveniles and adults). It was also considered that it may be worth considering eggs as an additional element if there was reason to believe that predation on eggs is an important factor to consider.

Krill

4.41 The properties of *E. superba* for inclusion in the general structure of the Antarctic ecosystem model are summarised in Table 10.

4.42 The workshop noted that, although krill has a circumpolar distribution, the highest concentrations of the species and the broadest latitudinal distribution range are found in the Southwest Atlantic (Figures 11 and 12). Two different views were expressed on the distribution of krill size groups/developmental stages (the juvenile and spawning adult component):

(i) Existing concepts of krill distribution on the onshore–offshore separation of juveniles, the breeding stock and larvae were generalised as a conceptual life-history model in WG-EMM-04/50. The model attempted to take into account the observed relationships between properties of Antarctic krill and its biotic and abiotic environment, focusing on the effect of environmental forces such as sea-ice properties and gyre systems (Figures 13 and 14). The workshop recognised that there is some debate as to whether the South Georgia region should be regarded as an area where successful spawning of krill does not occur and the degree to which the source of recruitment is from outside South Georgia.

(ii) An alternative view was also presented for the South Orkney Islands and considered (Figure 15).

4.43 For the purposes of the model, the workshop agreed that krill could be modelled as four life stages – eggs, larvae, juveniles, adults – because of their spatial separation and that the fishery targets primarily adult krill. The life-history strategy of krill places the developing embryos and larvae in locations distinct from the adult population which avoids competition for food, but also prevents predation on larval krill by adults.

4.44 Two alternative conceptual horizontal distributions were discussed:

(i) The first alternative described krill distribution as a coherent flow across large scales including some high-density retention areas where local production was important.

(ii) The second alternative described krill distribution as a set of discrete populations restricted to the major gyre systems of the Southern Ocean (WG-EMM-04/50).

4.45 The workshop discussed alternative hypotheses regarding seasonality in the horizontal movement of krill in the Southwest Atlantic; the workshop concluded that an operating model of the krill-centric ecosystem could be useful to explore the possible alternatives:

(i) The first hypothesis suggests that krill are advected from west to east with the flow of the ACC during the summer. Further, that transport of krill slows (or ceases) as the sea surface freezes during the early winter. Krill are then distributed within 50 m of the underside of the ice where they utilise ice algae as a food source and experience reduced predation. When the ice retreats the following spring, krill are again exposed to advection by the ACC.

(ii) An alternative hypothesis would be that over shelf areas with little sea-ice cover, krill move to the bottom and reside there during the winter months.

4.46 Additional to the two-dimensional dispersion of krill, plausible ecosystem models must also account for the diel vertical migration (DVM) pattern. This DVM has a seasonal and latitudinal component which is probably linked to the prevailing light regime (evolutionary), but may also reflect a response to predators (avoidance behaviour).

4.47 DVM behaviour of *E. superba* during the summer appears to vary with latitude. In the northern part of their distribution (South Georgia) krill migrate between 0 and 150 m. Further south krill appear to migrate less, and in the southern part of their distribution (Ross Sea, Weddell Sea) krill do not appear to migrate at all. It is hypothesised that the tendency to migrate vertically is related to summertime changes in daylight (greatest at lower latitudes, least at high latitudes). A general picture of DVM behaviour during the winter is less obvious. During the winter months krill trawlers set their nets deeper at South Georgia and krill have been observed in swarms close to the bottom, although it is not known how typical this behaviour may be. Diel variation in krill catches during a recent wintertime research cruise to the Weddell Sea suggests vertical migration between 0 and at least 200 m.

4.48 Interannual abundance and recruitment vary substantially. The population is driven by reproductive output and larval survival over winter. The important key variable is sea-ice, which is probably an indicator for food resources in winter (ice-algal) and spring (ice-edge bloom).

4.49 Adult krill are viewed as indiscriminate feeders on suspended matter in the pelagic zone, consuming autotrophs, small heterotrophs and detrital material, and because of their aggregating nature, they can have the effect of locally clearing particulate material from the euphotic zone. The critical feeding periods for krill larvae are in the late summer through until spring whereas for adults it is in spring through to late summer. This further avoids competition for food resources between the life-history stages.

4.50 The workshop noted that sufficient data are available to characterise the population to implement the conceptual model summarised in Tables 3 and 4. This includes the life cycle, the interaction between ice and oceanographic features and the different life stages, as well as important components in demography and food-web linkages.

4.51 The hierarchical structure of krill aggregations is understood to consist of individuals within swarms within patches within concentrations. This structure will influence the interactions between krill, their predators and the fishery (see also paragraph 4.94).

Mesopelagic species

Mesopelagic fish

4.52 The workshop had WG-EMM-04/24 and 04/58 on which to base considerations of how to structure mesopelagic fish in an operating model for the Antarctic ecosystem.

4.53 For the purposes of the operating model the workshop considered that mesopelagic fish could be divided into four elements based on:

- the distributions of taxa between those associated with the PFZ and those distributed from the PFZ to the south;
- the differences between distributions on the shelves of islands and the Antarctic continent and those associated with high-productivity frontal features in offshore waters.

A summary of the rationale for the division is provided in Table 11. The properties of each element are provided in Tables 12(a) to 12(c).

4.54 This categorisation was considered to be appropriate given the information and expertise available to the workshop. It may be that future consideration may elaborate on this categorisation in terms of taxon included (e.g. species), distribution, size classes, sexual maturity, or other considerations. The workshop suggested that this task (reviewing this categorisation) could usefully be referred to WG-FSA.

Questions for further consideration

4.55 Should we include benthic fish, e.g. notothenids and *Dissostichus* spp. as a separate component in the model?

4.56 The extent to which predators based on the Antarctic Continent, e.g. breeding birds and seals tend to consume squid, notothenioid fish and krill over or near the continental shelf (WG-EMM-04/59).

Squid

4.57 The workshop had WG-EMM-04/24 and 04/28 on which to base considerations of how to include squid in an operating model for the Antarctic ecosystem.

4.58 For the purposes of the operating model the workshop considered that squid could be divided into five elements based on:

1. Onychoteuthid squid – juveniles
2. Onychoteuthid squid – adults
3. Ommastrephid squid – juveniles
4. Ommastrephid squid – adults
5. Small to medium nektonic squid.

The properties of each element are provided in Tables 13(a) to 13(c).

4.59 In the case of both onychoteuthid and ommastrephid squid, the workshop considered that it was necessary to have juvenile and adult elements, given the size differences, the spatial separation and the different prey and predators of each of the life-history stages.

4.60 In the case of the ommastrephid squid it was noted that the spawning grounds and distribution of juveniles from the dominant species in the Southwest Atlantic are on the Patagonian shelf, outside the CCAMLR Convention Area. Consideration will need to be given to how this spatial separation is modelled. It was also noted that there was research suggesting that some species of onychoteuthid squid may have a two-year life cycle, rather than an annual cycle.

4.61 The workshop noted that there is generally thought to be a high degree of cannibalism in squid, although there is little data available to determine the extent. The workshop suggested that it would be important to include predation functions that allow the implications of different assumptions about cannibalism to be explored.

4.62 The workshop also noted that the larger species of squid, such as *Mesonychoteuthis hamiltoni*, may represent a functional equivalent to large pelagic vertebrate predators in temperate and tropical systems, such as the Scombridae. The workshop considered that it would be important to explore the implications of assuming different functional roles for such squid in trophic pathways.

4.63 While the above categorisation of squid was considered to be appropriate given the information and expertise available to the workshop, further review of the roles of psychroteuthid, galiteuthid and cranchid squid would be appropriate. The role of epibenthic cephalopods might also warrant consideration.

Marine mammals and birds

4.64 Marine mammals and birds potentially forage widely in the Southern Ocean. This large group of animals was divided into two broad categories associated with the degree of distributional constraint imposed by breeding:

(i) those that have a part of their life cycle in which they are constrained to be central-place foragers (i.e. they have a requirement to breed on land where the dependent offspring remains until independence; one or both parents make repeated foraging trips from that point to provision the offspring), e.g. Antarctic fur seals, penguins and flying birds;

(ii) those that have pelagic distribution (i.e. cetaceans) or come on land or ice to pup, such as phocid seals.

4.65 The life-history characteristics of these two groups also reflect the extent to which species are income breeders, those species that acquire the resources required to provision offspring during the offspring rearing period (e.g. Antarctic fur seal), or capital breeders, those species for which the resources required to provision offspring are acquired prior to offspring birth (e.g. Southern elephant seal).

4.66 The workshop considered WG-EMM-04/22 (shags), 04/24 (general and migratory species), 04/53 (Adélie penguins) and 04/65 (marine mammals) to help describe the elements of these taxa.

4.67 The workshop concentrated on:

(i) identifying the important elements/components of each of the major groups;

(ii) developing visual representations of the conceptual models of the dynamics of each group, including the functions that might cause transition from one life stage to another and the locations of the main foraging areas relative to the main oceanographic and topographic features of the Southern Ocean. Examples of these are given in Figures 16 to 20;

(iii) developing the framework for considering the estimation of parameters and functions required in population transition matrices and in the spatial and temporal foraging activities of the predators;

(iv) identifying future work to validate the conceptual models and for obtaining appropriate parameters.

4.68 These were considered for the following species/taxa:

1. Central-place foragers:

   (i) Adélie, chinstrap, gentoo, macaroni, emperor and king penguins
   (ii) Antarctic fur seal
   (iii) black-browed, grey-headed, wandering and light-mantled sooty albatrosses
   (iv) giant petrels
   (v) large petrels (white-chinned, cape, snow, Antarctic, Antarctic fulmar etc.)
   (vi) small petrels (prions, diving petrels, storm petrels)
   (vii) skuas, gulls, terns, shags.

2. Non-central-place foragers:

(i) baleen whales
(ii) toothed whales (sperm whale and small cetaceans)
(iii) killer whale
(iv) pack-ice seals (crabeater, Ross and leopard seals)
(v) Weddell seal
(vi) southern elephant seal.

Life-history characteristic and demography

Birds

4.69 The workshop noted that the conceptual model provided in WG-EMM-04/53 provided the basis for describing transitions between the different elements in a generalised life cycle of a bird. The generalised model is shown in Figure 21. Further consideration may be needed for some birds as to whether pre-breeders might become non-breeders (either in good or poor condition) as a result of having a different size, foraging behaviours or factors influencing survivorship.

Penguins

4.70 Adélie, chinstrap, gentoo, macaroni, emperor and king penguins were considered by the workshop to have a period during breeding when they are central-place foragers (Figure 22). Some pre-breeders and non-breeders may also be central-place foragers for a period. This is because they can be found in colonies along with the breeders, however, the costs/constraints are unlikely to be equivalent to those of breeding birds (WG-EMM-04/53). The demography of these populations could be summarised in a manner shown in Figure 23. The workshop considered that these attributes may need to be further refined for Adélie penguins in areas other than Béchervaise Island and for other penguins.

4.71 For Adélie penguins, the workshop reviewed the conceptual model in WG-EMM-04/53 and developed some options for the various functions that might influence the dynamics of Adélie penguin populations. To that end, the transition matrix in Table 14 provided the basis for these discussions.

4.72 Points for consideration in respect of the transition matrix for Adélie penguin are:

(i) survival in first winter is low:

(a) where $S_{1,t}$ = f(FA, biomass of population and other competitors, condition, predation), where FA is food availability;

(b) the relationship between $S_{1,t}$ and FA is sigmoidal and with biomass of the population and competitors is a sigmoidal decay;

(ii) survival up to breeding, which may be over a period of three to five winters, has an expectation of an increased survivorship compared to the first year;

(iii) transition from pre-breeder to breeder is governed by the condition after winter and FA;

(iv) transition from non-breeder to breeder is likely to be high because few birds are non-breeders for two consecutive years;

(v) winter survival of breeders is likely to be higher than that of fledglings;

(vi) summer survival of the breeders is influenced by leopard seal predation, energetic costs and other factors, with the breeders expected to have a lower survivorship than non-breeders;

(vii) breeding success is influenced by age and experience of the breeders (step function), FA (increasing sigmoidal), predation by skuas (exponential decrease) and weather (step function).

4.73 A number of potential functions were also considered by the workshop concerning the impacts of various factors on survivorship and reproductive success. These included those related to:

(i) fledgling survival in the first winter; these functions may be related to:

(a) condition at fledging (possibly a skewed distribution)
(b) food availability (possibly a positive sigmoidal function)
(c) predation (possibly a negative sigmoidal function);

(ii) ice extent and density (may increase food availability, alternatively it may reduce foraging habitat, therefore associated functions may take various forms).

Flying birds

4.74 Similar principles and processes will affect the transition matrices of the different groups of flying birds. Additional factors of particular (or potential) relevance to the group might include effects of incidental mortality (both within and outside the Convention Area), and availability of supplementary food through waste and/or discards from the fisheries.

4.75 The workshop noted that the following factors might influence different life stages of flying birds, including:

(i) effects on chick survivorship include disease in the sub-Antarctic, exposure, provisioning, scavengers, other predators and, primarily, starvation;

(ii) fledglings will be influenced by food supply, which could result in mortality from starvation;

(iii) immatures and adults at sea will be influenced by predation, as well as anthropogenic effects from longlining (especially large species and white-chinned petrels) and pollutants, but scavengers will also benefit from discards and waste.

4.76 Following the example given in Table 14, a matrix of taxonomic categories and their potential states was developed to provide a basis for developing appropriate transition matrices for these taxa (Table 15).

Marine mammals

4.77 Seals have a similar process of transition between states to that depicted in Figure 22, however, they differ from birds in respect of sexual size dimorphism and the relative contribution of the different sexes to the costs of offspring rearing. In the case of Antarctic fur seals, there is a similar constraint of central-place foraging for breeding females, however, in the case of phocid seals and cetaceans these particular constraints will not apply.

4.78 Following the example given in Table 14, a matrix of taxonomic categories and their potential states was developed to provide a basis for developing appropriate transition matrices for these taxa (Table 15).

Trophic dynamics

4.79 Representation of trophic dynamics is required for all the relevant species/species-groups and will include characterisation of:

(i) diet
(ii) distribution (horizontal and vertical as appropriate).

Both of these may vary by time of year and region.

Diet

4.80 Table 16 provides an example of various potential levels of detail required to characterise the main prey types in the diet of predators. Table 17 provides a qualitative illustration of how diet categories might be allocated at the level of predator species and other species groups. Consideration of diet, including relating it to the desired levels of temporal and spatial subdivision, is an important element of future work.

Spatial scales of distribution and foraging movements by depth

4.81 A generalised model of the vertical foraging distribution of air-breathing predators was developed for several taxonomic groups (Figure 24). In general, those predators found in the upper 100 m are predominantly krill-feeding species, whilst those that consume fish and squid are predominantly found at greater depth.

4.82 With respect to the conceptual diving model in Figure 24 the penguins, seals (other than southern elephant seal) and flying birds, i.e. groups 1–7, can be characterised as surface-dwelling species that make excursions from the surface to feed. Southern elephant seals and odontocete whales can be characterised as species that live and feed at depths of 500–1 500 m and make excursions to the surface to breathe. The arrows on the figure indicate the direction of movement from the primary location in which the foragers spend the greater part of their time budget.

4.83 The horizontal distribution of the species/taxa considered at different life-history stages is considered for breeding and non-breeding periods in Tables 18 and 19. The workshop also considered the importance of boundary conditions for any operational model to allow for the dispersal and seasonal migrations of marine mammals and birds that takes account of the time spent inside/outside the Convention Area.

Fisheries

4.84 The workshop considered WG-EMM-04/24 and 04/51 during its deliberations to define elements of fisheries that can be used in ecosystem models for testing approaches for ecosystem management. The discussion focused on two fisheries: the krill fishery and the icefish fishery.

Krill fishery

4.85 The nature of the krill fishery was considered based on the behaviour of the Japanese krill fishery reported in WG-EMM-04/51. The workshop recognised that the kind of information provided, such as the decision-making processes made by the skipper according to changing circumstances during the course of the fishing season (Table 20), is an important factor when considering the development of a model of the krill fishery.

4.86 In Area 48, fishing areas usually occur adjacent to the islands. Some of these fishing areas are further divided into local fishing grounds (Figure 25).

4.87 Throughout the fishing season, there is a preference by the Japanese fleet for using fishing areas closer to the ice edge rather than using any of the other areas available (Figure 26). The fishing patterns were further characterised according to seasonal succession of physical and biological properties at the fishing grounds (Figure 27).

4.88 Individual vessels moved frequently between local fishing grounds, and sometimes moved to different fishing areas seeking suitable aggregations (e.g. density, structure, krill condition etc.) to fish.

4.89 Properties of the krill fishery were considered by the workshop; firstly, by identifying possible options for taxon, stage and units as outlined in WG-EMM-04/24. Following this exercise, the options for basic model elements, the types of decision made, and the different factors affecting fishery behaviour, were discussed.

4.90 Although krill fishing vessels tend to operate in national fleets, the behaviour of each vessel is strongly influenced by individual skippers. The 'taxon' should be defined at the level of individual vessels to reflect these behavioural differences between vessels. This is particularly appropriate as there are few vessels (5–10) and some of the observation data are available at vessel level. These properties are detailed in Table 21.

4.91 The fishing patterns examined by the workshop were derived from data from the Japanese krill fishery. Given the fact that there may be national/fleet differences in preference for fishing area as well as strategies for fishing operations (Figure 28) (CCAMLR-XXI), the workshop agreed that such differences may need to be included in any model of the krill fishery. The workshop recommended that this type of analysis should be undertaken for krill fisheries of other nations.

4.92 Overall, the workshop recognised that the fishing patterns considered were related to fishing under current fishery levels and regulations. Recalling that the aim of plausible models of the Antarctic marine ecosystem would be to evaluate krill management scenarios, the workshop thought it essential that any model should be capable of testing management scenarios by reproducing fisheries behaviour under various regulation scenarios, including catch limits set at smaller spatial and/or temporal scales than those defined by the conservation measures presently in force.

4.93 In order to achieve this, the fishery model may need to simulate individual vessels fishing under different operational strategies and requirements (see paragraphs 4.22 and 4.51). Therefore, the operational model may need to:

(i) generate regional concentrations of krill that would constitute the 'local fishing grounds' including:

   (a) concentrations corresponding to 'known' fishing grounds
   (b) concentrations in currently unfished areas;

(ii) characterise the types and distributions of aggregations within local fishing grounds well enough to allow discrimination between the results of the different fishing strategies of the different fleets;

(iii) model the effect of fishing on aggregations (e.g. reduced abundance and size of aggregations resulting from removals or dispersion; reforming of swarms after catching/dispersal, flux etc.) in order to:

   (a) be able to handle the effects of different fleet fishing strategies
   (b) describe the effects on predator feeding success;

(iv) model factors which affect catch quality such as phytoplankton and salp distributions at the level of resolution that allows the model to represent vessel behaviour in response to these properties.

4.94 With respect to 4.93(iii), the workshop noted that some work has captured the properties of krill aggregations to examine catch per unit effort in krill fisheries (Butterworth, 1988b; Mangel, 1988; Kasatkina and Latogursky, 1990; Kasatkina and Ivanova, 2003; Litvinov et al., 2002; Litvinov et al., 2003, WG-EMM-03/31), as discussed in WG-EMM-04/24 and 04/67. A number of studies have also been carried out on the effects of predation on krill concentrations, including WG-EMM-96/20, WG-EMM-96/67, Boyd et al. (1997), WG-EMM-97/28, 97/64, Murphy et al. (1988), Miller and Hampton (1989) and Alonzo et al. (2003a, 2003b). The Workshop agreed that it may be possible to examine the effects of fishing activities on predator foraging by integrating these approaches. It also recognised that further work was needed on these aspects and noted also that issues of model detail, complexity and scale would need to be considered when incorporating these interactions into the overall ecosystem model.

Icefish fishery

4.95 The Data Manager described general properties of this fishery drawing on his knowledge of CCAMLR data holdings.

4.96 It was recognised that fishing in Area 48 is currently permitted only around South Georgia and that the size of the current fishing fleet is small (<5 vessels in any season). However, in the past, the icefish fishery was larger (>80 000 tonnes), and was also present around the South Orkney Islands and the South Shetland Islands. The use of bottom trawling is prohibited in this fishery and icefish are largely taken by pelagic trawl (Figure 29).

4.97 Icefish fisheries have also operated in Area 58 and the fishing in Division 58.5.2 is regulated under Conservation Measure 42-02.

4.98 One of the significant differences between icefish fisheries and krill fisheries is that icefish fisheries are assessed annually by WG-FSA and strict management regulations are in place. In Subarea 48.3, these regulations include a temporal spatial closure during the spawning season, a move-on rule to minimise the catch of fish <240 mm in length and catch limits for by-catch species (Conservation Measures 33-01 and 42-01).

4.99 Properties of the icefish fishery were considered following the procedure for the krill fishery. These properties are detailed in Table 22.

4.100 In order to be able to model the icefish fishery operations, the operational model may need to be able to:

(i) generate realistic age structure and distribution in relation to the bottom topography;

(ii) model the dynamics of by-catch species.

PLAUSIBLE SCENARIOS FOR THE ANTARCTIC MARINE ECOSYSTEM

5.1 The workshop considered the types of scenarios that need to be considered in evaluating the robustness of krill management procedures to structural uncertainties of the model. This discussion focused on two broad topics. The first was concerned with the plausibility of the model and the second with questions of ecosystem dynamics that could be explored with the model.

5.2 With regard to model plausibility, several questions were raised. These include:

(i) How sensitive is the model to alternate hypotheses regarding critical processes?

(ii) What data and/or research are required to distinguish between important alternatives?

(iii) How closely should model ecosystem behaviour match observations?

(iv) What level of detail will be required to make a plausible model?

5.3 Examples of the above questions include consideration of:

(i) various hypotheses on interactions between species (e.g. whales and seals)
(ii) various hypotheses on trophic pathways
(iii) use of different life-history parameter values (e.g. demographies)
(iv) use of alternate component formulations.

5.4 With regard to questions of ecosystem dynamics, it was recognised that it was important to limit the number of scenarios to be explored. The possible scenarios were organised into a series of topics. These include:

(i) Response of the model system to changes in environmental forcing factors. This would require a choice of forcing factors, the degree and direction of change. For example, the response of the model to gradual climatic change versus a more abrupt regime shift could be explored. More specific examples include system response to a change in formation of Antarctic bottom water or change in Antarctic surface circulation; rapid reduction of winter ice extent or large changes in primary production occurring over decadal time scales; enhanced ultraviolet radiation and its subsequent effect on epipelagic organisms such as krill larvae.

(ii) Sensitivity and dynamics of the model system to various starting conditions and/or artificial forcing functions. For example, different starting population sizes of baleen whales and fur seals, or an initial excess krill production could be explored. The effects of random noise or periodic cycles in forcing functions could be explored.

(iii) The effects on the model system of external processes and boundary conditions. Examples of this include processes affecting the population dynamics of whales, squid and birds outside the CCAMLR Convention Area. Another possible class of examples includes the invasion of temperate species due to ocean warming and/or changes in currents.

(iv) The required behaviour of the model system to achieve a specified state. For example, recovery of depleted whale or seal populations.

(v) Effects on the model system of developments in various fisheries. These might include expansion of the krill fishery, overfishing of toothfish, expanded harvest of icefish, as well as developments in fisheries external to CCAMLR.

(vi) Effects of system feedback on modelled populations. Examples include changes over time in life-history traits, genetic selection, spatial distribution and other density-dependent population effects.

5.5 After some discussion, the workshop concluded that the following scenarios should be accorded the highest priority:

(i) behaviour of the model system in response to artificial (i.e. known) forcing functions in order to better understand the properties of the model;

(ii) effects of alternative formulations of krill transport on ecosystem dynamics;

(iii) effects of climate change on primary production and/or ocean circulation.

5.6 The workshop also requested guidance from the Scientific Committee with regard to the priorities for exploring realistic scenarios and future work.

MODEL FORMULATION AND SPECIFICATION

6.1 The workshop discussed a number of items that relate to the formulation and specification of ecosystem models in general (paragraphs 6.2 to 6.4) and to Antarctic ecosystems in particular (paragraphs 6.5 to 6.25).

6.2 The workshop agreed that it would be desirable to develop an ecosystem model as a set of connected modules rather than a single, large piece of software. Individual modules might be used to model various oceanographic processes (e.g. separate modules for ocean currents and the seasonal development of sea-ice) and the population dynamics of individual taxonomic groups (e.g. separate modules for Antarctic krill and fur seals). The modular approach described here would facilitate:

(i) the development of population dynamics models that are consistent with the data and knowledge available for each taxonomic group (e.g. to simultaneously use an age-structured model for one group and a biomass-dynamics model for another group);

(ii) the construction and implementation of modules that describe processes differently (e.g. comparing foraging models that are based on functional relationships or individual decision making);

(iii) the construction and implementation of modules that describe alternative hypotheses (e.g. regional variations in krill biomass being determined by advection or local population dynamics);

(iv) the implementation, where appropriate and helpful, of existing models;

(v) the progress of model development regardless of whether modules describing the dynamics of all taxonomic groups or forcing mechanisms are complete.

6.3 Although a modular approach to model building has distinct advantages, the workshop recognised that such an approach would introduce specific technical issues that will need to be addressed. These issues include:

(i) the need to reconcile processes that are modelled on different scales using accepted ecosystem structuring rules like thermodynamic laws and particle-size distributions;

(ii) the need to manage overall model complexity by ensuring that individual modules are developed with reasonable intuition and a focus that relates to specific questions of interest;

(iii) the need to develop protocols, software, and database architectures that link and manage the flow of information among modules.

6.4 The workshop recognised that linking modules describing oceanographic process and population dynamics to observation models will also be necessary. These links can be developed by ensuring that various modules within the operating model describe variation in state variables that are typically (or might eventually be) observed in the field. For example,

(i) a module describing the dynamics of Antarctic krill should describe spatial variation in the distribution of swarms, concentrations etc. with sufficient detail to provide reasonable linkage to observation models describing hydroacoustic surveys and krill fisheries;

(ii) modules describing the dynamics of some predator populations should describe variation in reproductive performance with sufficient detail to link to observation models describing data collection under CEMP;

(iii) a module describing ocean currents might characterise variation in the contribution of different water masses to a region of particular interest and thereby link to observation models describing the results of an oceanographic survey within that region;

(iv) modules describing the dynamics of fish populations might describe variation in the size (or age) composition of the population and thereby link to observation models describing the size (or age) composition of trawl survey or fishery catches.

Modelling interactions between species

6.5 Ecosystem models typically describe interactions between species and taxonomic groups in the context of predator–prey and competitive interactions (although many other types of interactions are possible), and the manner in which such interactions are characterised typically has profound effects on the behaviour of, and predictions from, ecosystem models.

6.6 The workshop focused its discussion on predator–prey interactions, but recognised that competitive interactions should also be considered during future developments of Antarctic ecosystem models. In this regard, the workshop drew a distinction between competition that might occur within and among taxonomic groups and competition that might occur among krill predators and krill fisheries. The processes by which such competitive interactions might occur, if they occur at all, would potentially be different. In the first case, some animals might, for example, use aggressive behaviours to compete with other animals for food. In the second case, substantive localised removals of krill by a fishery might limit availability of food for predators. Developing appropriate models of competition will also be important for understanding the degree to which krill 'surpluses' caused by the removal of one predator can result in the expansion of another predator population.

6.7 The workshop summarised the predator–prey interactions described throughout Section 4 of this report by developing conceptual illustrations of various Antarctic food webs. These webs are presented in Figures 30 to 34. Each of the arrows illustrated in these figures represents a possible predator–prey interaction that might need to be modelled, and the workshop recognised that the interactions illustrated in these figures might increase or decrease after further review and consideration. The workshop further recognised that modelling all of the predator–prey interactions illustrated in these figures may not be necessary to describe how most energy flows through the food web. Care needs to be taken that the dynamics of any taxonomic group are not necessarily dominated by weak predator–prey links.

6.8 The easiest way to consider the trophic linkages is to subdivide them based on geographic location and central prey type. The workshop discriminated two major web-types based on geographical area: continental (including high-latitude seamounts) and island based (which includes the Scotia Sea). This split is also reflected in the respective taxonomic composition of these webs. The continental shelf webs are further subdivided into krill-centric and squid-centric subwebs. Similarly, the island-based webs are subdivided into krill-centric, squid-centric and fish-centric subwebs. The workshop was less confident in its ability to characterise the squid- and fish-centric subwebs than in its ability to characterise the krill-centric subwebs, and the group 'other fish' reflects a recognition that many predator groups probably consume a fish fauna that is less well described. Despite increased uncertainty regarding the structure of the squid- and fish-centric subwebs, it will be important to consider these alternative energy pathways because they are likely to have a marked effect on model predictions.

6.9 The age and size-dependent links included in the food webs illustrated in Figures 30 to 34 indicate two processes. The first is ontogenetic shifts in the spatial distributions of predator or prey. The second is when predators take only a certain size range of prey resulting in prey outside this range (either smaller or larger) being safe from that predator. If these food webs were redrawn with the life stages for each group explicitly represented, such age- and size-dependent links might be clearer.

6.10 Depth structuring is a potentially important aspect of the trophic links in Antarctic food webs that is not illustrated in Figures 30 to 34. The trophic structure shown in these figures has greater resolution at the surface and in mid-water than in deep water. This is not an issue if the focus of the study and the dynamics of the ecosystem do not change. However, predictions by models developed from the links illustrated in Figures 30 to 34 may be misleading if the research and management focus or system dynamics become dominated by processes that occur in deep water (e.g. demersal or benthic groups and processes). It would be worthwhile to consider whether any of the ecological, environmental, or fisheries scenarios identified in Section 5 of this report would be affected by this potential problem.

6.11 With respect to Figures 30 to 34, the workshop also noted that some food webs which are not presented in this report (e.g. entirely pelagic webs or webs associated with deep seamounts like those in the Ross and Weddell Seas which are dominated by toothfish, rajids and oceanic squids) may need to be developed to completely represent the full range of major food webs in the Antarctic.

6.12 The workshop considered two methods of modelling predator–prey interactions: functional response curves and individual foraging models. Functional response curves describe the relationship between prey abundance (or density) and the per capita consumption of that prey by a group of predators. Individual foraging models describe predator–prey relationships by modelling the decisions that predators and prey make in response to the abundance (or density) and distribution of each other and to variations in environmental conditions.

6.13 It was agreed that both methods of describing predator–prey interactions should be investigated and the workshop commented on each approach.

6.14 Two types of functional response curves might be useful for describing many predator–prey interactions in Antarctic ecosystems: Type II and Type III response curves. These two types of curves are illustrated in Figure 35. For those predators whose foraging is based on interactions with individual prey organisms (e.g. a killer whale that forages on a seal), Type II response curves might be appropriate. For those predators whose foraging is based on interactions with prey organisms that must be aggregated into some threshold density (e.g. a baleen whale that forages on krill), Type III curves might be appropriate. When considering Type III curves, the workshop recognised that prey abundance (or density) might need to be measured on different scales. For example, foraging by baleen whales might be influenced more by the density of swarms within an area of relatively high krill concentration than by the density of krill within a swarm, but this might be reversed for other predators.

6.15 The workshop noted that a single functional response curve might not be appropriate for any given species or taxonomic group. Functional responses might change over the course of a reproductive cycle, be dependent on an animal's condition, age, or sex, and vary in response to the predator's perceived risk of themselves becoming prey. Although such refinements to functional response models will complicate this approach to modelling predator–prey interactions, they may be more realistic.

6.16 Foraging models based on individual decision making have previously been developed for penguins and krill fisheries (Alonzo and Mangel, 2001; Alonzo et al., 2003a, 2003b;

Mangel and Switzer, 1998). The predictions from this work were reviewed in WG-EMM-04/67, and the workshop considered that such models might, after additional review and modification, be useful dynamic modules to include in operational models of Antarctic ecosystems.

6.17 The workshop noted that multiple cues can be used by predators to make individual foraging decisions. These cues are not necessarily related to the absolute abundance or density of prey and probably include, but are not likely limited to, habitat features (e.g. the shelf break), previous experience (e.g. travelling back to the last location where prey were successfully captured and eaten) and variation in the local retention of prey. It might be particularly important to recognise when foraging decisions are based on group dynamics (e.g. when animals adopt foraging strategies like their neighbours or when they cue on aggregations of other predators).

6.18 The workshop noted that foraging models based on individual decision making are often generated from data collected during foraging trips, and some care should be taken in making inferences from these data. Animals that forage in the Antarctic adopt a variety of foraging strategies. As a result of these strategies, foraging events might be uniformly or randomly distributed in space and time. Alternatively, foraging events might be aggregated in space and time, and such aggregation might occur over a range of scales (e.g. at both diurnal and annual scales). For example, diving behaviours might occur in bouts when animals are foraging on shoaling/swarming species, and a single foraging trip might include several periods with and without dive bouts. Inferences from data collected during foraging trips can be facilitated by considering the physiological and ecological context in which the data were collected (e.g. time-energy budgets can be useful for understanding the foraging behaviour of animals that are provisioning offspring).

6.19 Unfortunately, data on foraging behaviours are not available for many species in the Antarctic, and this lack of information will make it difficult to construct decision-based models. The workshop noted that it may be possible to alleviate this problem by looking for information on analogous species outside the Antarctic.

6.20 In concluding its discussion of predator–prey interactions, the workshop agreed that two items of future work would be useful. First, sensitivity analyses should be done to explore how predictions from Antarctic ecosystem models change in response to different assumptions about predator–prey interactions (e.g. assuming a Type II or Type III functional response or assuming different decision criteria in individual-based foraging models) and to different ways of modelling these interactions (i.e. using functional response curves or individual (group) based foraging models). Second, studies should be done to determine whether, and under what conditions, functional response curves can be satisfactory approximations of individual-based foraging models. Although the latter approach may be more realistic, the former approach is likely to be more efficient in a modelling context.

Modelling space

6.21 The workshop had considerable discussion regarding appropriate spatial resolution for operating models of Antarctic ecosystems. It was agreed that spatially explicit models would be appropriate in many circumstances. The workshop considered that, at a minimum, it would be useful to resolve differences between high-Antarctic and sub-Antarctic areas and between pelagic areas and areas on or near the continental shelf (e.g. Figures 30 to 34). It was noted, however, that substantially greater spatial resolution might be appropriate in many instances. Cases in which greater spatial resolution might be warranted are identified throughout section 4 of this report.

6.22 The workshop recognised that spatial resolution can vary among the modules that are developed as components of operating models of the Antarctic ecosystem (i.e. a fixed spatial resolution is not required by the envisioned approach). It was also recognised that having module-specific spatial resolution would further increase the need to address the issues identified in paragraph 6.3. The workshop noted that modules with varying spatial resolution have successfully been implemented in the Atlantis and InVitro models (see section 2).

6.23 The workshop also considered the degree to which depth should be resolved in operating models of Antarctic ecosystems. In contrast to the minimum horizontal resolution identified in paragraph 6.21, the workshop did not identify a minimum vertical resolution. This was difficult because there is considerable overlap in the depths used by animals that spend time in Antarctic waters. Nevertheless, resolving processes across depths may be critical for describing the spatial overlap of predators and prey. Information on depth distributions is provided throughout section 4 of this report.

Modelling time

6.24 The workshop considered that the temporal resolution of the operating model should, at a minimum, discriminate summer from winter. Such discrimination is sensible for a variety of reasons, including the resolution of breeding/spawning seasons and seasons in which most observational data are collected. Finer temporal resolution might, however, be required to adequately describe the dynamics of various oceanographic processes and taxonomic groups. Thus, temporal resolution can also be module-specific, and the workshop reiterated the points that were raised in paragraph 6.22.

Peripheral processes and boundary conditions

6.25 The workshop discussed peripheral processes and boundary conditions in the context of animals that move in and out of the spatial arena described by operating models. How such processes and conditions are modelled must be case-specific because operating models of Antarctic ecosystems might cover a range of spatial arenas, potentially varying on scales from the entire CCAMLR Convention Area down to SSMUs. Nevertheless, the workshop noted that the key to dealing with such processes and conditions is to recognise:

(i) how much time animals spend outside a model's spatial arena (e.g. see Tables 18 and 19);

(ii) what processes (e.g. recruitment) occur when animals are outside the spatial arena;

(iii) how both physical and biological conditions outside the spatial arena might contribute to variation in processes that ultimately occur inside the arena.

Dealing with peripheral processes and boundary conditions will require future work.

FUTURE WORK

Further development of plausible models

7.1 The workshop agreed that its work has achieved a foundation for conceptual models of the physical environment and taxa of the Southern Ocean ecosystem and how to place these into a modelling framework. It recognised that future work will entail validating the work presented here and further developing conceptual models as indicated in sections 4, 5 and 6. As such, the workshop recommended continued refinement of these conceptual models and encouraged their implementation in the modelling framework.

7.2 An important task is to collate the appropriate parameter values for implementing functions and model components derived from these conceptual models. In this respect, the workshop noted that reviews of available information would be useful and that a common database of available parameters could be developed to facilitate a coordinated use of such parameters and information.

7.3 The workshop also recognised that there was a lack of expertise and time at the meeting to fully develop the components concerned with fish, squid and fisheries. The workshop therefore requested WG-FSA to review the details provided and develop component details for toothfish and demersal species. These include:

(i) check the existing details on icefish life history as listed in paragraphs 4.32 to 4.40 providing changes where appropriate;

(ii) check that the existing details listed in paragraphs 4.95 to 4.100 have correctly captured the dynamics of the icefish fishery;

(iii) check the existing details on mesopelagic fish and squid life history as listed in paragraphs 4.52 to 4.63, providing changes where appropriate;

(iv) develop similar profiles (tables, figures and text) for *D. eleginoides* and *D. mawsoni* as target species (i.e. as for species in paragraphs 4.52 to 4.63);

(v) develop similar profiles (tables, figures and text) for the *D. eleginoides* and *D. mawsoni* fisheries (i.e. as for fisheries in paragraphs 4.84 to 4.100);

(vi) develop a new key component of the ecosystem which includes the other demersal fish species (e.g. macrourids, rajids, other nototheniids etc.);

(vii) check food webs for interactions including toothfish, icefish, other demersal fish, myctophids and *Pleuragramma antarcticum*.

7.4 The workshop recommended that the Working Group seek guidance from the Scientific Committee with regard to the priorities for exploring realistic scenarios and future work (paragraph 5.6).

Further development of a modelling framework

7.5 The workshop agreed that the it has provided a suitable framework to continue the development of plausible ecosystem models for testing approaches to krill management. It recognised that the development of complex models will take some time to complete.

7.6 With respect to next year's workshop on evaluating candidate management procedures, the workshop noted that initial exploration of management options could be achieved using spatially structured krill population models that allow exploration of the interaction between

- the krill population
- spatial catch limits and the fishery
- krill predators
- transport of krill.

This may be feasible next year with the further development of existing models and new basic models taking account of outcomes of this workshop.

7.7 The workshop noted that further development of the framework and the implementation of one or more ecosystem models will require coordinated work. It recommended that the Working Group consider establishing a steering committee to coordinate this work. Such a committee will need to consider, among other things,

(i) framework
 data, parameters, database
 code, platforms, components, protocols
 model architecture, modularity, flexibility
 the process of validation of the models to ensure appropriate application;

(ii) collaboration
 timetable
 authorship and ownership issues
 components;

(iii) role of the Secretariat;

(iv) coordination with the conveners of next year's workshop.

7.8 The workshop noted that a number of research groups of CCAMLR Members are developing ecosystem models for the Southern Ocean. It recommended that the Working Group establish the steering committee as quickly as possible in order to have the work coordinated among groups as far as is practicable as well as taking advantage of the momentum generated from this workshop.

7.9 It was noted that the development of models for next year's workshop is a different task from the longer-term work. Nevertheless, it was recommended that the conveners of next year's workshop coordinate the preparatory work for the workshop with the coordinator of the steering committee. This will help provide the opportunity for modelling work for next year to be developed in such a way that it might contribute to the longer-term modelling work.

ADOPTION OF THE REPORT

8.1 The report, with figures, tables and attachments, was adopted.

CLOSE OF THE WORKSHOP

9.1 The Convener of WG-EMM, Dr Hewitt, thanked Dr Constable for his hard work in convening the workshop and his guidance throughout in ensuring its success.

9.2 Dr Constable thanked all the participants, rapporteurs and members of the workshop steering committee for their contributions to the workshop. He also thanked Dr Fulton, the invited expert, for her valuable contribution and for her guidance during the discussions. Dr Constable thanked the Secretariat for their support both intersessionally and at the workshop, and Prof. S. Focardi (Italy) and his team for hosting the workshop.

9.3 The workshop closed on 16 July 2004.

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Table 1: InVitro: Summary of the major agent types and behaviours that may be modelled in the InVitro Northwest Shelf (Australia) management strategy evaluation model. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Agent type	Description	Instances (species or groups)	Behaviours and characteristics
Population	Age-structured sub-populations of mobile species	Finfish (small and large lutjanids, lethrinids, nemipterids and saurids)	Ageing through age classes, growth, feeding, mortality, movement to preferable habitat, spawning and recruitment to age class zero.
Animal	Individuals or schools of mobile species	Prawns (banana and king prawns), turtles, sharks, dugongs, seabirds	Ageing, growth, mortality, feeding, evasion, movement to preferable habitat, spawning and recruitment of new individuals or schools.
Larva	Larval (or infant) and juvenile stages of other agent types	Finfish (small and large lutjanids, lethrinids, nemipterids and saurids)	Advection, settling, growth, mortality, consumption, movement to recruiting sites, recruitment.
Polyorganisms	Large patches (or mean field representations) of high turnover rate species or groups	Oyster leases, ponyfish schools	Movement, feeding, mortality, reproduction, advective and dispersive growth.
Benthic	Mosaic of habitat-defining patches	Macrophytes (seagrass and macroalgae), reefs (sponge and coral), mangroves	Mortality, depth and sediment-type dependent reproduction and patch growth (may be resource limited), vertical growth into larger size/age classes.
Vessel	Ore carriers	Cargo vessels	Route following, cargo content, fuel load, state (port operations, steaming, dithering).
Boat	Fishing vessels	Trawlers, trappers, fishing survey boats	Cargo content, fuel load, state (port operations, steaming, dithering), licences, past fishing sites, effort allocation, gear types.
Recfisher	Recreational fisher area of influence	Recreational fishers	Access points, fishing pressure (dependent on human population size and distance to port).
Catastrophe	Infrequent, large-scale events	Cyclones, spills, dredging	Damage (potentially fatal) to all appropriate agents in the path of impact (dependent on intensity and type of event).
Environment	Physical environmental characteristics	Temperature, light, depth, seabed type, currents	Current flow, advection, diffusion, absorption, erosion.
Tracker	Monitoring or sampling bodies	Buoy, monitoring sites, random samples of catch	Drift (if appropriate), monitoring.
Fixtures	Fixed locations	Ports, rigs, pipelines	Production, capacity, population size.
Fisheries management authority	Fisheries assessment and management body	FMA	Stock assessment, decision procedures, management rules, enforcement, monitoring.

(continued)

Table 1 (continued)

Agent type	Description	Instances (species or groups)	Behaviours and characteristics
Environmental protection agency	Water quality and contamination assessment and management body	EPA	Monitoring, decision procedures, management rules, enforcement.
Port Authority	Port capacity and vessel traffic assessment and management body	Department of Transport Department of Primary Industries	Monitoring, decision procedures, management rules, enforcement.

Table 2: List of taxa considered at the workshop (* represents suitable future work). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

General grouping	Taxa		
Primary production	Phytoplankton	Microbial loop	
Pelagic herbivores and invertebrate carnivores	Microzooplankton * Copepods Euphausids (excluding *E. superba*)	Mysids Amphipods	Salps Jellyfish *
Target species	*Euphausia superba* *Champsocephalus gunnari*	*Dissostichus eleginoides* * *Dissostichus mawsoni* *	
Mesopelagic species	*Pleuragramma antarcticum* Myctophid species	Squid – ommostrephids Squid – onychoteuthids	Squid – other *
Demersal fish species *	Skates * Other demersal species	Rays *	*Macrourus* spp. *
Penguins	Adélie Chinstrap	Macaroni Gentoo	Emperor King
Seals	Antarctic fur Southern elephant	Crabeater Ross	Leopard Weddell
Baleen whales	Minke Humpback Other baleen whales – high latitudes	Southern right Fin Other baleen whales – sub-Antarctic	
Toothed whales	Sperm	Orca	Other small cetaceans
Large flying birds	Wandering albatross Light-mantled sooty albatross	Grey-headed albatross Black-browed albatross	Giant petrel
Small flying birds	White-chinned petrel Cape petrel Antarctic petrel	Snow petrel Diving petrel Storm petrel	Antarctic fulmar Antarctic prion Other prions
Other birds	Skuas, gulls etc.	Shags	

Table 3: Factors in the physical environment that are of potential importance in the operation of the Southern Ocean marine ecosystem and that would also be of considerable utility in a coupled ecosystem model; each factor has a set of properties and a set of motivating forces. Roman numerals in square brackets ([ ]) refer to the subparagraphs in paragraph 4.15 outlining the main ecological functions of the physical environment. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Factor	Properties	Motivating forces
Sea-ice [i, ii, iv]	Ice texture, e.g. brine channels Ice cover – aerial density Ice extent Ice duration	Temperature Salinity Wind stress Ocean currents Local geography
Ocean currents [i, ii, iii]	Magnitude (volume flow) Magnitude (spatial dimensions) Direction Eddies (variance) Fronts (dimensions)	Temperature Salinity Bathymetry Wind stress
Light [i]	Magnitude Duration – daily/seasonal Wavelength	Latitude Water column depth Ice cover Cloud cover Season
Nutrients [i]	Micronutrients (Fe etc.) Macronutrients (N, P etc.) Form (NH_4, NO_3 etc.)	Distance from land Biological cycling
Bathymetry [ii]	Depth – pressure	

Table 4: Processes in the physical environment that are of potential importance in the operation of the Southern Ocean marine ecosystem and that would also be of considerable utility in a coupled ecosystem model; each process has a set of motivating forces. Roman numerals in square brackets ([ ]) refer to the subparagraphs in paragraph 4.15 outlining the main ecological functions of the physical environment. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Processes	Motivating forces
Vertical exchange in water column [ii, iii]	Upwelling/down-welling/mixing
Atmospheric deposition [i]	Wind Precipitation
Stratification [ii]	Wind Ocean currents
Ekman transport [ii]	Wind
Polynya formation [i, ii]	Upwelling Wind Ocean currents
Local processes [i, ii, iv]	Glacial rock flour Ice scour Land run off – rivers, nutrients, pollution
Nutrient depletion/enrichment [i]	Biological cycling Run off from predator breeding colonies
Climatic forcing [iv]	El Niño Southern Oscillation Antarctic Circumpolar Wave Drake Passage Oscillation Index
External boundaries [i, ii, iii, iv]	Land Water mass Atmosphere

Table 5: Potential variation in some physical factors between winter and summer seasons. Seasons may vary in time with latitude. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Seasonality		
Winter months April–November		Summer months December–March
Low	Temperature	High
High	Ice cover	Low
Low intensity	Light	High intensity
Short day	Day length	Long day
Higher at surface	Salinity	Lower at surface
Magnitude/breadth/shifts	Ocean currents	Magnitude/breadth/shifts
Change in patterns (latitude)	Wind	Change in patterns (latitude)

Table 6: Natural spatial divisions in the Southern Ocean that may affect the operation of the Southern Ocean marine ecosystem. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

NATURAL SPATIAL DIVISIONS	
Latitude	High ←---------------------------------------→Low
Land	Continent vs Islands and peninsulas
Sea	Nearshore vs Shelf vs Slope vs High Sea vs Fronts Depth Bottom ←---------------------------------------→Surface
Ice cover	Land vs Ice shelf vs Permanent ice vs Seasonal ice vs MIZ vs Never freezes

Table 7: Factors related to primary productivity that are of potential importance in the operation of the Southern Ocean marine ecosystem and that would also be of considerable utility in a coupled ecosystem model; each factor has a set of properties and a set of motivating forces. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Factor	Properties	Motivating forces	
Size fractionation	Species composition	Micronutrients (e.g. Fe)	Temperature
		Macronutrients (e.g. N, Si)	Salinity
		Distance from land	Light regime
		Water mass	Light wavelength
		Proximity to fronts	Ice cover
		Winds	Ice retreat
		Stratification	Grazers
Species distribution	Species composition	Micronutrients (e.g. Fe)	Temperature
		Macronutrients (e.g. N, Si)	Salinity
		Distance from land	Light regime
		Water mass	Light wavelength
		Proximity to fronts	Ice cover
		Winds	Ice retreat
		Stratification	Grazers

Table 8: Summary of attributes of the main pelagic invertebrate herbivores and carnivores in the Southern Ocean, excluding *Euphausia superba*. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Taxa	Habitat	Diet	Generation time (years)	Summer depth zone
Salps	Oceanic	Herbivore	0.5–1	Epipelagic
Copepods	Oceanic	Herbivore Carnivore Omnivore	0.5–1	Epipelagic
Mysids	Island shelf	Carnivore	2	Epibenthic
Hyperiid amphipods	Oceanic, Island shelf	Carnivore	1–2	Epipelagic
Euphausiids				
e.g. *Thysanoessa macrura*	Oceanic	Omnivore	2	Epipelagic
Euphausia crystallorophias	High-latitude shelf	Omnivore	2	Epipelagic

Table 9: Properties of *Champsocephalus gunnari* for inclusion in the general structure of the Antarctic ecosystem model. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Parameter		Stage		
		Larvae	Juveniles	Adults
Geographic distribution			South Georgia to Antarctic Peninsula, Kerguelen/Heard	South Georgia to Antarctic Peninsula, Kerguelen/Heard
Spatial distribution	Features of the physical environment that are important to this life stage		Pelagic in near-shore waters	Benthopelagic in shelf waters to about 350 m depth
	Factors/functions influencing spatial coverage, including temporal changes to distribution		Prey availability and oceanic variability likely to influence spatial coverage, but no relationships have yet been determined. Ontogenetic descent down slope influences temporal distribution.	Prey availability and oceanic variability likely to influence spatial coverage, but no relationships have yet been determined. Ontogenetic descent down slope influences temporal distribution.
	Depth		0–150 m	150–350 m
	Factors/functions influencing depth distribution, including temporal changes to distribution		Gradually spreads over inner plateau in pelagic zone and occupies lower position in water column.	Arrives at feeding grounds when about 2 years old. Diurnal vertical migrations from bottom during day into water column at night.
Age structure			0–2 years	2–5 years

(continued)

Table 9 (continued)

Parameter		Larvae	Juveniles	Adults
		Stage		
Condition	Size		<240 mm	240–>350 mm
	Reproduction		Immature	Mature
Input	Reproduction		-	Generally autumn/winter spawners but spawning season varies with locality. Estimated total fecundity 1 294–31 045.
	Mortality		Highly variable juvenile population, which is a result of variable spawning success and juvenile survival.	Mortality probably relatively low in 2 and 3 year olds, then rising abruptly in 4 year olds. Few fish remain after 5 years.
Output	Predators		Larval stages probably prey for a wide range of planktonic (e.g. Chaetognaths) and nektonic (e.g. fish) predators, but no direct data. Later stages same as for adults.	Fur seals, king penguins are main predators but rate varies between years, depending on abundance of icefish and/or of krill. Other fish, birds and mammals prey on icefish to some extent.
	Exploitation		By-catch of trawl fisheries but rate limited by conservation measures.	Target of trawl fisheries.
	Death (other sources of mortality)		-	Rapid disappearance of 4+ year olds not attributable to fishing or completely top predation.
Consumption	Classification, e.g. generalist or specialist feeders		Specialist feeder on aggregating zooplankton.	Specialist feeder on aggregating zooplankton.
	Food types		Crustaceans (in particular euphausiids and amphipods). *Euphausia superba* in Atlantic sector.	Crustaceans (in particular euphausiids and amphipods). *E. superba* in Atlantic sector.

Table 10: Properties of *Euphausia superba* for inclusion in the general structure of the Antarctic ecosystem model. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

			Stage			
			Eggs	Larvae	Juveniles/Immatures	Adults
Spatial distribution	Features of the physical environment that are important to this life stage	Intrusion of upper CDW Water depth Water temperature		Ice cover Intrusion of upper CDW Water temperature	Ice cover Water temperature Position of frontal systems	Circulation Water temperature Position of frontal systems
	Spatial extent of distribution	Position of frontal systems Water temperature		Position of frontal systems Water temperature	Position of frontal systems Water temperature	Position of frontal systems Water temperature
	Spatial area of distribution			Extent of water masses Sea-ice extent	Extent of water masses Sea-ice extent	Extent of water masses Sea-ice extent
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Water mass intrusions Advection Displacement		Extent of water masses Sea-ice extent Water mass intrusions Advection Displacement	Extent of water masses Sea-ice extent Water mass intrusions Advection Displacement	Extent of water masses Sea-ice extent Water mass intrusions Advection Displacement
	Depth (if applicable)	0–1 500 m		<500 m	<500 m	<500 m
	Factors/functions influencing depth distribution, including temporal changes to distribution	Spawning locations Developmental descent		Spawning locations Developmental ascent	DVM with latitudinal and temporal changes (predator escapement – evolutionary or behavioural reaction) Ontogenetic migrations	DVM with latitudinal and temporal changes (predator escapement – evolutionary or behavioural reaction Ontogenetic migrations

(continued)

Table 10 (continued)

			Stage			
			Eggs	Larvae	Juveniles/Immatures	Adults
Condition	Size	Function or estimate of size for the stage (e.g. growth curve or set size)		Developmental pathway known, size at stage structure thought to be fixed (Ikeda, 1984). Effect of food supply and temperature (Ross et al., 1988; Yoshida et al., 2004).	Growth curves published (Ikeda, 1985; Hofmann and Lascara, 2000). Question of shrinkage. Age structure still problematic. Length/weight, seasonal differences (Siegel, 1992). Effect of food supply and temperature on growth.	Growth curves published (Rosenberg et al., 1985; Siegel, 1987; Hosie, 1988). Question of shrinkage (Ikeda and Dixon, 1982). Effect of food supply and temperature on growth.
	Reproduction	Function relating, as appropriate, food availability (carrying capacity), environmental conditions, abundance of conspecifics and other competitors				Female reproduction dependent on very high food intake, length of season and conditions in winter/spring.
	Health	Function relating, as appropriate, the effect of food consumption		After critical point larvae die.	Reduced food can lead to cessation of growth or shrinkage.	Reduced food can lead to cessation of growth or shrinkage.
	Waste	As appropriate, function defining the production of waste based on activity, consumption and environment		Excretion, defecation and moulting rates estimated (Quetin and Ross, 1991).	Excretion, defecation and moulting rates estimated (Ikeda and Thomas, 1987).	Excretion, defecation and moulting rates estimated (Ikeda and Mitchell, 1982; Clarke et al., 1988).

(continued)

Table 10 (continued)

			Stage			
			Eggs	Larvae	Juveniles/Immatures	Adults
Input	Reproduction	Function relating to reproductive condition, environment and abundance of breeding individuals, e.g. stock-recruitment relationship modified by condition, or fecundity modified by feeding condition.				See above
	Physical movement	Relative locations in space and rates of movement between locations, including movement over the course of a year.	Eggs spawned offshore	Larvae must move inshore as they metamorphose into juveniles.	Generally found inshore.	Distribution centred on shelf break, gravid females move offshore to spawn, all adults may move inshore in winter.
		Relative locations in depth and rates of movement between depths, including movement over the course of a year.	Eggs laid at surface, embryos sink	Early larvae swim upwards as they develop, later larvae stay in surface waters and probably under ice in winter.	Undergo DVM in summer.	Undergo DVM in summer. May vary between regions (daylight length?).

(continued)

Table 10 (continued)

			Stage			
			Eggs	Larvae	Juveniles/Immatures	Adults
Output	Predators	Identify predators, including, as appropriate, relative importance at different locations, depths and times.			Land-based predators restricted to foraging area, seabirds and pelagic predators less restricted in range.	Land-based predators restricted to foraging area, seabirds and pelagic predators less restricted in range.
	Exploitation	Identify, as appropriate, the degree of exploitation at different locations, depths and times and by which types of methods.				Along shelf break-slope, close to ice edge. In summer exploitation by midwater trawl at 20–80 m depth, in autumn 30–150 m depth and in winter ~400 m depth.
Consumption	Food types	Identify prey, including, as appropriate, relative importance at different locations, depths and times.		Phytoplankton, zooplankton and under ice microbial community. First feeding stage calyptopis, 30 days after spawning.	Most particles >5 µm in diameter in surface 200 m. In deeper water probably detrital food. Under-ice feeding in late winter.	Most particles >5 µm in diameter in surface 200 m. In deeper water probably detrital food. Under-ice feeding in late winter.
	Functional feeding relationships for different prey	Include, as appropriate, variations in the feeding relationships likely to be experienced in different locations, depths and/or times or influenced by environmental features (e.g. ice).			Maximum retention efficiency >30 µm. Functional response curves described for different food types and concentrations (Ross and Quetin, 2000).	Maximum retention efficiency >30 µm. Functional response curves described for different food types and concentrations (Quetin and Ross, 1985; Ross et al., 2000).

Table 11: Rationale and characterisation of elements for mesopelagic fish. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Element	Description	Dominant species	Questions/Issues
Sub-Antarctic shelf	Restricted to insular shelves of sub-Antarctic islands.	*Champsocephalus gunnari*	May be equivalent to *C. gunnari* element. Question of whether it is important to consider taxa other than *C. gunnari*.
Sub-Antarctic mesopelagic	Broadly distributed in off-shelf pelagic environment north of the southern boundary of the ACC.	*Electrona carlsbergi* *Krefftichthys anderssoni*	Other species may be important depending on location. Is it necessary to include *Nototheniops larseni*?
Antarctic neritic	Restricted to insular shelves of the Antarctic continent.	*Pleuragramma antarcticum* *Chaenodraco wilsoni*	Suggested as functional alternative to icefish for Antarctic continental shelf. Question of whether other taxa need to be considered.
Antarctic mesopelagic	Broadly distributed in off-shelf pelagic environment south of the southern boundary of the ACC.	*Electrona antarctica* *Gymnoscopelus nicholsi*	

Table 12: Properties of pelagic fish for inclusion in the general structure of the Antarctic ecosystem model. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

(a) Sub-Antarctic mesopelagic fish (e.g. *Electrona carlsbergi*, *Krefftichthys anderssoni*).

Geographic distribution		Circumpolar
Spatial distribution	Features of the physical environment that are important to this life stage	Broadly distributed in off-shelf pelagic environment north of the southern boundary of the ACC.
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Spatial, seasonal and depth distribution influenced by water temperature/water mass. Main feeding grounds in the Polar Front. Greatest abundances associated with Polar Front.
	Depth	50–200 m depth in areas south of 50°S depending on DVM. Progressively deeper to the north of the Polar Front (500–600 m) towards the STC (>1 000 m).
	Factors/functions influencing depth distribution, including temporal changes to distribution	Water temperature/water masses (i.e. position of the Polar Front). DVM: migrates from 80–140 m to the surface at 18:00h. Found at 200–250 m during the day.
Age structure		Unknown, <5–6 years maximum age
Condition	Size	70–100 mm maximum size, growth thought to be approximately 30 mm per year for first 2–3 years.
	Reproduction	Size at maturity ~75mm Age at maturity ~2–3 years Serial spawning in late winter/early spring or summer/autumn to the north of the Polar Front.
Input	Reproduction	Suggest lognormal distribution with potential for correlation with environment.
	Mortality	-
Output	Predators	Primary: king, royal/macaroni, rockhopper and gentoo penguins, Antarctic fur seals depending on geographic location, squid (?), *Dissostichus eleginoides*. Secondary: *C. gunnari* at Heard Island and other fish species (?).
	Exploitation	Historical commercial trawl fishery.
	Death (other sources of mortality)	Unknown
Consumption	Classification, e.g. generalist or specialist feeders	Generalist (?)
	Food types	Principal components copepods with smaller amounts of hyperiids, euphausiids, pteropods and ostracods. Two main feeding periods: an extended evening period and a shorter morning period.

(continued)

Table 12 (continued)

(b) Antarctic neritic fish (e.g. *Pleuragramma antarcticum*, *Chaenodraco wilsoni*)

Geographic distribution		Circumpolar (?)
Spatial distribution	Features of the physical environment that are important to this life stage	Restricted to insular shelves of the Antarctic continent. Suggest that *P. antarcticum* may represent a functional alternative to *C. gunnari* for Antarctic continental shelf. Question of whether other taxa need to be considered.
	Factors/functions influencing spatial coverage, including temporal changes to distribution	-
	Depth	100–500 m
	Factors/functions influencing depth distribution, including temporal changes to distribution	DVM: yes 100 (night) to 200 m (day)
Age structure	maximum of 10 years	Unknown
Condition	Size	Adult size = 120–250 mm
	Reproduction	Mature at 3–4 years Spawning period October–December
Input	Reproduction	Suggest lognormal distribution with potential for correlation with environment.
	Mortality	-
Output	Predators	*D. mawsoni,* other fish, seals (?)
	Exploitation	Historical trawl fishery for *C. wilsoni.*
	Death (other sources of mortality)	Unknown
Consumption	Classification, e.g. generalist or specialist feeders	Generalist zooplankton feeder (?)
	Food types	*E. superba* (?), other krill (?), copepods (?)

(continued)

Table 12 (continued)

(c) Antarctic mesopelagic fish (e.g. *Electrona antarctica*, *Gymnoscopelus nicholsi*).

Geographic distribution		Circumpolar
Spatial distribution	Features of the physical environment that are important to this life stage	Abundant south of the Polar Front to the shelf of the continental slope.
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Concentrated along shelf and the Polar Front during spring–summer.
	Depth	Upper 250 m during spring and summer, 350–700 m during winter.
	Factors/functions influencing depth distribution, including temporal changes to distribution	Suggested that there is a seasonal pattern of: (i) concentration in surface 100–200 m at shelf break, or Polar Front during spring and summer; (ii) movement to deeper water (350–700 m) in winter. Suggested that the seasonal movement is in response to movement of invertebrate food sources.
Age structure	Maximum of 5–6 years	Unknown
Condition	Size	Size range of species (*E. antarctica, G. nicholsi*) 100–200 mm TL with *G. nicholsi* being at the upper end of the range. 15–51 g <5 years Growth rate 27–34 mm per year May be worth considering having two classes based on size and maturity.
	Reproduction	Winter spawners
Input	Reproduction	Suggest lognormal distribution with potential for correlation with environment.
	Mortality	-
Output	Predators	Primary: king penguin, Antarctic fur seals. Secondary: royal/macaroni and gentoo penguins, Antarctic fur seals, black-browed and grey-headed albatrosses, white-chinned and snow petrels, *D. eleginoides*, cormorants at Heard Island.
	Exploitation	Historical trawl fishery
	Death (other sources of mortality)	
Consumption	Classification, e.g. generalist or specialist feeders	Generalist
	Food types	Feeds on any abundant organisms, principally copepods and euphausiids, but also includes amphipods, pteropods, ostracods. Proportion of euphausiids increases in larger fish.

Table 13: Properties of the five elements of squid for inclusion in the general structure of the Antarctic ecosystem model. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

(a) Onychoteuthid squid

		Juveniles	Adults
Geographic distribution		Circumpolar in the sub-Antarctic and Antarctic.	Circumpolar in the sub-Antarctic and Antarctic.
Spatial distribution	Features of the physical environment that are important to this life stage	Shelves and slopes of landmasses in the sub-Antarctic and Antarctic.	Slopes of landmasses in the sub-Antarctic and Antarctic.
	Spatial extent or area of distribution	Shelf/slope (see above)	Slope (see above)
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Prey availability and oceanic variability likely to influence spatial coverage, but no relationships have yet been determined. Ontogenetic descent down slope influences temporal distribution.	Prey availability and oceanic variability likely to influence spatial coverage, but no relationships have yet been determined. Ontogenetic descent down slope influences temporal distribution.
	Depth (if applicable)	0–1 000 m	400 – ≥ 2 000 m
	Factors/functions influencing depth distribution, including temporal changes to distribution	Undergoes ontogenetic descent down slope over time with increasing size/maturation. Diurnal vertical migrations have not been recorded. Clarify whether DVM occur in other species (e.g. Rodhouse and Clarke, 1986), and/or include as an alternative to no DVM.	Undergoes ontogenetic descent down slope over time with increasing size/maturation. Diurnal vertical migrations have not been recorded.
	Does pack-ice affect distribution?	Distribution includes pack-ice zone; relationship with pack-ice extent and retreat unknown.	Distribution includes pack-ice zone; relationship with pack-ice extent and retreat unknown.
Age structure (if applicable)		-	-
Units		Biomass	Biomass
Condition	Size	See WG-EMM-04/26, Figure 8	See WG-EMM-04/26, Figure 8
	Reproduction	-	-
	Health	-	-
	Waste	-	-

(continued)

Table 13(a) (continued)

		Juveniles	Adults
Input	Reproduction	-	Two spawning peaks per year (late summer and late winter). Estimated total fecundity (i.e. ovarian egg number estimates) for *Moroteuthis ingens*: 84 379–286 795.
	Physical movement	Ontogenetic descent down slope over course of life stage.	Ontogenetic descent down slope over course of life stage.
	Movement between life stages	All juveniles (minus those lost to predation, by-catch and natural mortality) move into adult life stage after 6–7 months (approximately 200 days).	100% natural mortality of all adults (minus those lost to predation and by-catch) after approximately 1 year. Possibility of two-year life-cycle for some species of Antarctic squid (see Ommastrephids below)
Output	Predators	Cephalopod and vertebrate predators foraging in epipelagic and upper mesopelagic in shelf/slope environments from the sub-Antarctic to the Antarctic.	Cephalopod and vertebrate predators foraging in the mesopelagic and bathypelagic in slope environments from the sub-Antarctic to the Antarctic.
	Exploitation	By-catch of trawl fisheries in shelf/slope environments.	By-catch of trawl fisheries in shelf/slope environments.
	Death (other sources of mortality)	-	-
Consumption	Classification, e.g. generalist or specialist feeders	Opportunistic, generalist predator.	Opportunistic, generalist predator.
	Food types	Crustaceans (in particular euphausiids, also amphipods and copepods), small cephalopods and juvenile fish. Important to consider potential for higher predation (via cannibalism) on second cohort by first cohort within a season and, in the case of a two-year life-cycle, one year class on the following year class.	Myctophids, other mesopelagic fish, e.g. *Bathylagus antarcticus*, cephalopods including juvenile onychoteuthids.

(continued)

Table 13(a) (continued)

		Juveniles	Adults
Consumption (continued)	Functional feeding relationships for different prey	Minimum prey size >10 mm; maximum prey size <200 mm. Will only take pelagic, mobile prey.	Minimum prey size >10 mm; maximum prey size = approx. size of the (mantle length? of) individual squid. Will only take pelagic, mobile prey.

(b) Ommastrephid squid

Geographic distribution			Circumpolar in the sub-Antarctic and Antarctic but not high Antarctic.
Spatial distribution	Features of the physical environment that are important to this life stage	Shelves	Shelves (for spawning) and slopes of landmasses and in the open ocean for feeding.
	Spatial extent or area of distribution	In the southwest Atlantic juvenile distribution is largely outside the area (Patagonian shelf). Distribution outside the southwest Atlantic not known/uncertain.	Large proportion of biomass associated with the Polar Front.
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Spawning occurs on the (Patagonian) shelf where juveniles develop.	Feeding and spawning migrations influence spatial distribution. Aggregations often associated with oceanic frontal systems. Distribution varies significantly over time and space.
	Depth (if applicable)	0–200 m	0–≥ several hundred metres.
	Factors/functions influencing depth distribution, including temporal changes to distribution	DVM on shelf	Diurnal vertical migrations to approach surface during darkness.
	Does pack-ice affect distribution?	No, because juveniles occur elsewhere.	Not known to be distributed in the high Antarctic, pack-ice unlikely to affect distribution.
Age structure (if applicable)			-
Units		Biomass	Biomass

(continued)

Table 13(b) (continued)

		Juveniles	Adults
Condition	Size		See WG-EMM-04/26, Figure 9
	Reproduction	-	-
	Health	?	-
	Waste	?	-
Input	Reproduction	Spawns throughout the year, potential fecundity per individual female estimated at 115 000–560 000 (from ovarian egg number estimates).	Incoming juveniles, minus consumption.
	Physical movement	Juveniles passively migrate with current systems away from spawning grounds to feed.	Adult population actively migrates to spawning ground to spawn, which in the southwest Atlantic is the Patagonian shelf.
	Movement between life stages	Size-based progression between juvenile and adult.	Die/consumed
Output	Predators		Cephalopod and vertebrate predators foraging in epipelagic and upper mesopelagic in shelf/slope environments and in the open ocean. Total predation in the Scotia Sea estimated at 326 000–381 000 tonnes per year.
	Exploitation	-	By-catch of other squid jig fisheries around Falkland/Malvinas Islands and on Patagonian shelf, is occasionally a direct target for commercial jiggers in Subarea 48.3.
	Death (other sources of mortality)		100% natural mortality of remaining adult population after spawning.
Consumption	Classification, e.g. generalist or specialist feeders	Opportunistic, generalist predator.	Opportunistic, generalist predator.

(continued)

Table 13(b) (continued)

		Juveniles	Adults
Consumption (continued)	Food types	?? assume smaller zooplankton and larval fish, conspecifics.	Myctophids (particularly *Krefftichthys anderssoni*), cephalopods including cannibalism on conspecifics, crustaceans including *E. superba* and amphipod *T. gaudichaudii*.
	Functional feeding relationships for different prey	Will only take pelagic, mobile prey. An individual squid may take prey as large as itself while continuing to take smaller prey??	Will only take pelagic, mobile prey. An individual squid may take prey as large as itself while continuing to take smaller prey.

(c) Small to medium nektonic squid

Geographic distribution		Uninterrupted circumpolar distribution throughout the sub-Antarctic and Antarctic.
Spatial distribution	Features of the physical environment that are important to this life stage	Shelves and slopes of landmasses and in the open ocean from the sub-Antarctic to the high Antarctic. Ubiquitous distribution throughout.
	Spatial extent or area of distribution	See above
	Factors/functions influencing spatial coverage, including temporal changes to distribution	Until further data are available, the spatial coverage of this model group should remain static throughout the sub-Antarctic to the high Antarctic. (For species-specific differences see WG-EMM-04/26, Figure 8.)
	Depth (if applicable)	0 – ≥ 2 000 m
	Factors/functions influencing depth distribution, including temporal changes to distribution	Until further data are available, the depth distribution of this model group should remain static throughout the sub-Antarctic to the high Antarctic. (For species-specific differences see WG-EMM-04/26, Figure 8.)
	Does pack-ice affect distribution?	Distributed within pack-ice zone, pack-ice not known to affect distribution.
Age structure (if applicable)		-
Units		Biomass
Condition	Size	See WG-EMM-04/26, Figure 1
	Reproduction	-
	Health	-
	Waste	-
Input	Reproduction	Spawns throughout the year, on shelf breaks/slopes in the sub-Antarctic and high Antarctic and in the open ocean.
	Physical movement	-
	Movement between life stages	-

(continued)

Table 13(c) (continued)

Output	Predators	Important dietary component for many vertebrate predators in the southwest Atlantic; ≥ 3 squid species co-occur in the diets of 11 predators including penguins, albatrosses, seals, whales and fish. Also preyed on by other cephalopods.
	Exploitation	Occasional by-catch, discarded.
	Death (other sources of mortality)	100% natural mortality of remaining adult population after spawning.
Consumption	Classification, e.g. generalist or specialist feeders	Opportunistic, generalist predators.
	Food types	Small mesopelagic fish, small cephalopods, zooplankton including euphausiids, copepods and amphipod *T. gaudichaudii*.
	Functional feeding relationships for different prey	Will only take pelagic, mobile prey. An individual squid may take prey as large as itself while continuing to take smaller prey.

Table 14: Possible transition matrix for Adélie penguins. Numbers refer to functions and discussion in the text. (X represents a transition probability; Time represents the amount of time spent in the stage on the left; Function represents the ecological or physical function that results in the transition probability.) Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

	Fledgling	Pre-breeder (Itinerant)	Pre-breeder (Colony)	Non-breeder (Itinerant)	Non-breeder (Colony)	Breeder
Chick	X Time: Function:					
Fledgling		X Time: 1 year Function: 1	X Time: 1 year Function: 1			
Pre-breeder (Itinerant)		X Time: Function:	X Time: Function:			X Time: 3–5 winters Function: 2, 3
Pre-breeder (Colony)		X Time: Function:	X Time: Function:			X Time: 3–5 winters Function: 2, 3
Non-breeder (Itinerant)				X Time: annual Function:	X Time: annual Function:	X Time: annual Function:
Non-breeder (Colony)					X Time: annual Function:	X Time: annual Function:
Breeder					X Time: annual Function:	X Time: annual Function:

Table 15: Potential transition matrix categories for other taxa of marine mammals and birds. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Albatrosses and large petrels	Small petrels	Antarctic fur seals	Pack-ice seals (crabeater, Ross and leopard seals)	Weddell seals	Southern elephant seals	Baleen whales	Toothed whales
Chick	Chick	Pup	Pup	Pup	Pup	Calves	Calves
Fledgling	Fledgling	Juvenile	Juvenile	Juvenile	Juvenile	Juvenile	Juvenile
Juvenile	Juvenile	Sub-adult male	Non-breeder	Non-breeder	Sub-adult male	Non-breeder	Non-breeder
Breeder	Breeder	Non-breeder male	Breeder	Breeder	Non-breeder male	Breeder	Breeder
Failed breeder	Failed breeder	Breeder male			Breeder male		
Non-breeder	Non-breeder	Breeder female			Breeder female		
		Failed breeder female			Failed breeder female		

Table 16: Classification of components of the diet of seabirds and marine mammals. [ ] show general guide but these will need to be refined further. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Diet category	Level of classification	
Copepod	[large, small]	
Amphipod	Themisto, other	
Mysids	[taxon]	
Krill	[sex, status, size]	
Squid	[large, small; alive, dead]	Onychoteuthid Ommastrephid Other
Fish	[adult, juvenile]	Toothfish Icefish Myctophid Other [large, small]
Carrion	[taxon]	
Birds	[taxon]	
Marine mammals	[taxon]	

Table 17: Qualitative analysis of prey of marine mammals and birds in the Atlantic sector of the Southern Ocean. Predators are listed in the left column. Other columns represent prey groups based on the classification in Table 4.16. The number of X's corresponds to potential importance of prey. (X) means present occasionally. L – large, S – small. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

	Copepods	Amphipods	Krill	Squid		Icefish	Myctophids	Other fish		Carrion	Seals	Seabirds
				S/live	L/dead			L	S			
Large flying birds												
Wandering albatross					XX			X		XX		
Light-mantled sooty albatross			X	X	X			X		X		(X)
Grey-headed albatross			X	XX			X					
Black-browed albatross			XX	X			X			X		
Giant petrel			X		X					XXX		X
Small flying birds												
White-chinned petrel			XX	XX			XX		X			
Antarctic prion	XX	X	XX									
Cape petrel			XX				X	XX				
Antarctic fulmar			XX	X				X				
Antarctic petrel			XX	X				X				
Snow petrel			XX					X				
Diving petrel	XX	X	XX									
Storm petrel	XX	X	X				X					
Penguins												
King				X			XXX					
Emperor			X	X				XXX				
Gentoo			XX			XX		X	X			
Adélie/chinstrap			XXX				X					
Macaroni		X	XXX									
Marine mammals												
Whales:												
Baleen			XXX									
Toothed				XX				XX				
Sperm				XXX								
Killer								X			XXX	
Seals												
Fur			XXX			XX	X		X			
Crabeater			XXX									
Weddell				XX				XXX				
Leopard			XX					XX			XX	
Ross				XX	X			XX				
Elephant				XX	XX			XX				

Table 18: Foraging locations for marine mammals and birds during the respective breeding seasons. A – adult, M – male adult, F – female adult, PB – pre-breeder, NB – non-breeder, I – incubation, B/G – brood/guard, R – rearing, S – shelf, SB – shelf break, O – offshore, SBACC – southern boundary of the ACC, SACCF – southern Antarctic Circumpolar Current Front, PF – Polar Front, SAF – sub-Antarctic Front, STF – sub-tropical front. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Group	Taxon	Life stage	Part of year/ breeding cycle	Sea-ice				Coastal current			Antarctic Circumpolar Current														
											Antarctic Zone						Polar Frontal Zone					Sub-Antarctic Zone			
				Polynya	Pack	MIZ	Off-MIZ	S	SB	O	Shore	SBACC	SACCF	S	SB	O	PF	SAF	S	SB	O	STF	S	SB	O
Large flying birds	Wandering albatross	A	I													X					X	X		X	X
		A	B/G																X	X	X				
		A	R				X									X				X	X	X		X	X
	Light-mantled sooty albatross	A	I										X			X					X				
		A	B/G													X					X				
		A	R													X									
	Grey-headed albatross	A	I										X		X	X	X			X	X				
		A	B/G										X		X		X			X	X				
		A	R										X		X	X									
	Black-browed albatross	A	I										X	X	X	X	X				X				
		A	B/G										X	X	X	X	X				X				
		A	R										X	X	X	X	X				X				
	Giant petrel	M	I								X			X	X	X									
			B/G								X			X	X				X	X					
			R								X			X	X	X									
	Giant petrel	F	I								X			X	X	X									
			B/G								X			X	X	X									
			R				X				X			X	X	X									
Small flying birds	White-chinned petrel	A	I										X		X	X	X			X					
			B/G										X	X	X	X	X								
			R				X						X		X	X	X			X					
	Antarctic prion	A	Breeding										X	X	X	X									
	Other prions	A	Breeding				X							X	X	X	X		X	X	X				
	Cape petrel	A	Breeding			X	X			X			X	X	X	X									

(continued)

Table 18 (continued)

Group	Taxon	Life stage	Part of year/ breeding cycle	Sea-ice				Coastal current			Antarctic Circumpolar Current														
											Antarctic Zone						Polar Frontal Zone					Sub-Antarctic Zone			
				Polynya	Pack	MIZ	Off-MIZ	S	SB	O	Shore	SBACC	SACCF	S	SB	O	PF	SAF	S	SB	O	STF	S	SB	O
Small flying birds (cont.)	Antarctic fulmar	A	Breeding	X	X	X			X	X			X	X	X	X									
	Antarctic petrel	A	Breeding	X	X	X			X	X			X												
	Snow petrel	A	Breeding						X	X			X												
	Diving petrel	A	Breeding											X		X									
	Storm petrel	A	Breeding		X	X		X	X	X			X	X	X	X									
Penguins	Adélie – Peninsula	A	I						X	X															
		A	B/G						X	X															
		A	Crèche						X	X															
		NB			X	X			X	X															
		PB			X	X			X	X															
	Adélie – East Antarctic	A	I		X	X	X	X	X	X															
		A	B/G		X	X	X	X	X																
		A	Crèche		X	X		X	X																
		NB			X	X		X	X	X															
		PB			X	X		X	X	X															
	Adélie – Ross Sea	A	I		X	X	X	X	X	X															
		A	B/G		X	X	X	X	X																
		A	Crèche		X	X		X	X																
		NB			X	X		X	X	X															
		PB						X	X	X															
	Chinstrap	A	I					X	X	X		X	X												
		A	B/G					X	X	X															
		A	Crèche					X	X	X															
		NB						X	X	X		X	X												
		PB						X	X	X		X	X												
	Gentoo – Peninsula	A	I					X																	
		A	B/G					X																	
		A	Crèche					X																	
		NB						X																	
		PB						X																	

(continued)

Table 18 (continued)

Group	Taxon	Life stage	Part of year/ breeding cycle	Sea-ice				Coastal current			Antarctic Circumpolar Current														
											Antarctic Zone						Polar Frontal Zone					Sub-Antarctic Zone			
				Polynya	Pack	MIZ	Off-MIZ	S	SB	O	Shore	SBACC	SACCF	S	SB	O	PF	SAF	S	SB	O	STF	S	SB	O
Penguins (cont.)	Gentoo – sub-Antarctic	A	I											X											
		A	B/G											X											
		A	Crèche											X											
		NB												X											
		PB												X											
	Macaroni	A	I													X	X	X			X				
		A	B/G										X	X	X										
		A	Crèche										X	X	X	X									
		A	Premoult											X	X	X	X								
		NB														X	X	X			X				
		PB														X	X	X			X				
	King	A	Breeding													X	X	X			X				
		NB														X	X	X			X				
		PB		X	X	X										X	X	X			X				
	Emperor	A	Breeding	X	X	X																			
		NB		X	X	X																			
		PB																							
Seals	Antarctic fur	F	Breeding			X	X	X	X	X		X	X	X	X	X	X	X		X					
		M	Breeding					X	X	X		X	X	X	X	X	X	X		X					
	Southern elephant	A	Breeding		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X				X
	Crabeater	A	Breeding		X																				
	Ross	A	Breeding		X	X																			
	Weddell	A	Breeding		X	X	X																		
	Leopard	A	Breeding																						
Baleen whales	Minke	?	?																						
	Humpback	?	?																						
	Southern right	?	?																						
	Fin	?	?																						
Toothed whales	Sperm	?	?																						
	Orca	?	?																						
	Other small cetaceans	?	?																						

Table 19: Foraging locations for marine mammals and birds during the respective non-breeding seasons (see Table 18 for explanation of abbreviations). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Group	Taxon	Life stage	Part of year/ breeding cycle	Sea-ice				Coastal current			Antarctic Circumpolar Current														
											Antarctic Zone					Polar Frontal Zone					Sub-Antarctic Zone				
				Polynya	Pack	MIZ	Off-MIZ	S	SB	O	SACCB	SACCF	S	SB	O	PF	SAF	S	SB	O	STF	S	SB	O
Large flying birds	Wandering albatross	Adult	Sabbatical													X			X	X			X	X
	Light-mantled sooty albatross	Adult	Winter				X					X			X	X				X				
	Grey-headed albatross	Adult	Sabbatical													X	X			X	X			X
	Black-browed albatross	Adult	Winter																	X		X	X	
	Giant petrel	Adult	Winter															X		X		X		X
Small flying birds	White-chinned petrel	Adult	Winter												X	X	X			X	X	X	X	X
	Antarctic prion	Adult	Winter											X	X									
	Other prions	Adult	Winter													X	X			X				
	Cape petrel	Adult	Winter				X								X	X	X	X	X	X		X	X	X
	Antarctic fulmar	Adult	Winter				X								X	X	X	X	X	X		X	X	X
	Antarctic petrel	Adult	Winter	X		X	X								X									
	Snow petrel	Adult	Winter	X		X	X								X									
	Diving petrel	Adult	Winter										X	X	X									
	Storm petrel	Adult	Winter									X			X			X	X	X	X	X	X	X
Penguins	Adélie	Adult	Winter		X	X		X	X	X														
	Chinstrap	Adult	Winter			X	X	X	X	X	X	X												
	Gentoo	Adult	Winter	X			X	X					X											
	Macaroni	Adult	Winter													X	X			X				
	King	Adult	Sabbatical													X	X			X				
	Emperor	Adult	Winter		X																			

(continued)

Table 19 (continued)

Group	Taxon	Life Stage	Part of Year/ Breeding Cycle	Sea-ice				Coastal Current			Antarctic Circumpolar Current													
											Antarctic Zone					Polar Frontal Zone					Sub-Antarctic Zone			
				Polynya	Pack	MIZ	Off-MIZ	S	SB	O	SACCB	SACCF	S	SB	O	PF	SAF	S	SB	O	STF	S	SB	O
Seals	Antarctic fur	Female	Winter			X	X	X	X	X	X	X	X	X	X	X	X			X		X	X	X
		Male	Winter			X	X	X	X	X	X	X	X	X	X									
	Southern elephant	Adult	Winter					X	X	X	X	X	X	X	X	X	X	X	X	X				X
	Crabeater	Adult	Winter		X	X																		
	Ross	Adult	Winter		X																			
	Weddell	Adult	Winter		X	X																		
	Leopard	Adult	Winter		X	X	X						X	X										
Baleen whales	Minke	?	?																					
	Humpback	?	?																					
	Southern right	?	?																					
	Fin	?	?																					
Toothed whales	Sperm	?	?																					
	Orca	?	?																					
	Other small cetaceans	?	?																					

Table 20: Seasonal succession of reasons to decide on fishing locations by skippers across months in Subareas 48.1, 48.2 and 48.3 (WG-EMM-04/51). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

	Reasons for the decision						
	Month	Density	Change in krill size	Krill too green	Too many salps	Ice conditions	Transhipping
South Shetland Islands Subarea 48.1	December	16	0	1	0	0	0
	January	34	2	14	1	0	3
	February	19	2	9	5	0	0
	March	37	1	6	2	0	2
	April	46	4	4	0	0	2
	May	32	2	0	0	4	1
	June	10	1	0	0	2	0
	July	5	0	0	0	2	1
South Orkney Islands Subarea 48.2	December	3	0	2	0	0	0
	January	0	0	2	0	0	1
	February	2	0	1	0	1	0
	March	7	0	1	0	2	0
	April	4	1	1	0	0	0
	May	3	1	0	0	3	0
	June	4	1	0	0	7	0
South Georgia Subarea 48.3	May	1	0	0	0	0	0
	June	4	0	0	0	0	0
	July	0	0	0	0	0	0
	August	1	1	0	0	0	0
	September	3	0	0	0	0	0

Table 21: Properties of the krill fishery. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Taxa	Krill fishing vessels in general Nations Fleets Individual vessels Vessel size Factory type (products) Factory capacity (raw krill basis) Type of gear
Stage	Learning, established
Units	Numbers (vessel), number of hauls (effort), catch (tonnes), length of operation (days, hours)
Fishing ground formation	Relation to environmental features • ice edge • bottom topography (distance relative to the shelf edge) • hydrodynamic characteristics of the area → complex currents around islands together with topographically induced effects; • krill flux, krill spatial distribution pattern Area 48 fishing areas South Georgia, South Orkney Islands, Elephant Island, King George and Livingston Islands, Antarctic Peninsula and within these fishing areas, there are several local fishing grounds
Decision making	Skippers Based on experience and accumulation of information (biological, environmental, regulation, physical, logistics) Company (market demand, price, remaining stocks, economy, logistics)
Factors affecting behaviour	Physical aspects • Non-seasonal → bottom topography (depth and space) • Seasonal → weather Biological • Krill → distribution, colour (green, red/white), size, maturity, aggregation size, type • Other species → salp, fish, predators Communication with other vessels, or monitoring Logistics → cargo transfer, emergencies

Table 22: Properties of icefish fishery. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

Taxa	Icefish fishing vessels in general
	Nations
	Fleets
	Individual vessels
	Vessel size
	Factory type (products)
	Type of gear
Stage	Learning, established
Units	Numbers (vessel), number of hauls (effort), catch (tonnes), length of operation (days, hours)
Fishing ground formation	Relation to environmental features
	bottom topography (shelf area)
	Biological features
	aggregation
	Area 48 fishing area
	Subarea 48.3
	Area 58 fishing area
	Divisions 58.5.1 and 58.5.2
Decision making	Skippers
	Based on experience and accumulation of information
	(Biological, environmental, regulation, physical, logistics)
	Company (market demand, price, remaining stocks, economy, logistics)
Factors affecting behaviour	Physical aspects
	• Non-seasonal → bottom topography (depth and space)
	• Seasonal → ice, weather
	Biological
	• Icefish → distribution, size, maturity
	• Aggregation → size, type
	• Other species → by-catch species
	Communication with other vessels, or monitoring
	Logistics → cargo transfer, emergencies
	Regulations → temporal spatial closure, minimum size, by-catch.

Figure 1: Example of the horizontal and vertical spatial geometries used to define an ecosystem in Atlantis. Vertically, if the depth of the polygon is less than the maximum vertical depth, the water column layer(s) are truncated to match (e.g. a box in B that is 100 m deep would have 2 x 50 m water column layers). Any open ocean cells in B that are >1 800 m deep have no epibenthic or sediment layers, and are treated as having an open boundary under the deepest water column layer. Note that fine black lines indicate the boundaries of model boxes, thick black lines mark the edges of management zones, and sampling locations (used in the observation model) are indicated by black dots (reproduced from Fulton et al., in press). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

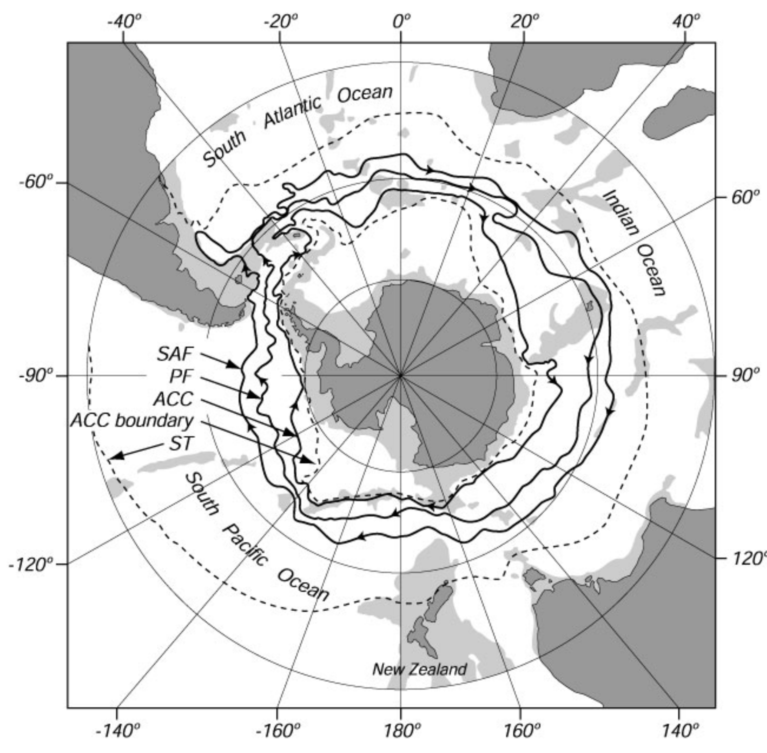


Figure 2: Main frontal features in the Southern Ocean (Orsi et al., 1995) and the CCAMLR boundaries (figure obtained from http://oceanworld.tamu.edu/resources/ocng_textbook/chapter13/Images/Fig13-13.htm). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

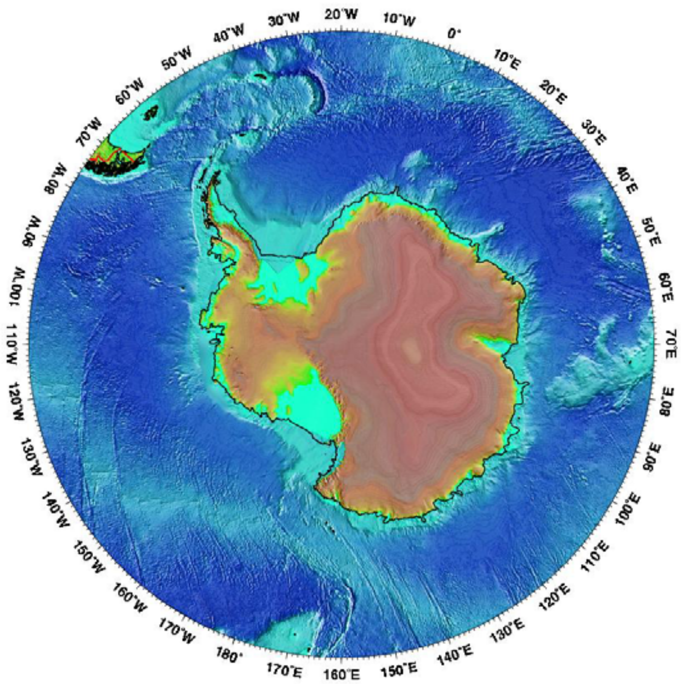


Figure 3: Main topographic features of the Southern Ocean (figure obtained from http://oceancurrents.rsmas.miami.edu/southern/img_topo2/antarctic-coastal2.jpg). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

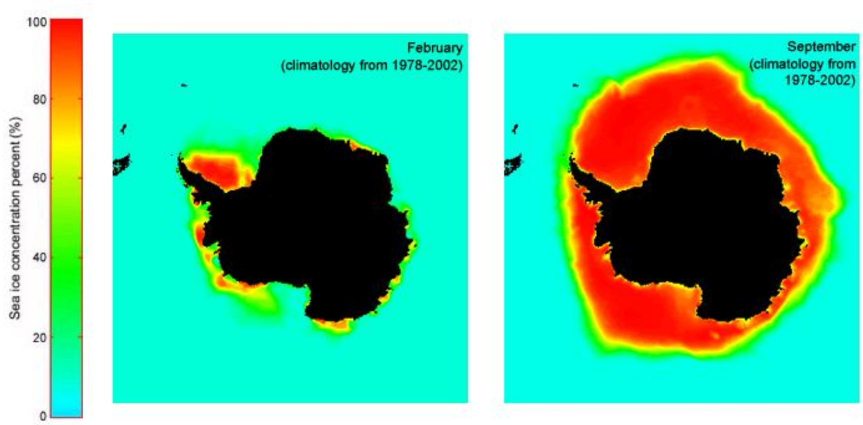


Figure 4: Seasonal extent of pack-ice around Antarctica in summer and winter (figures obtained from http://nsidc.org/sotc/sea_ice.html). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

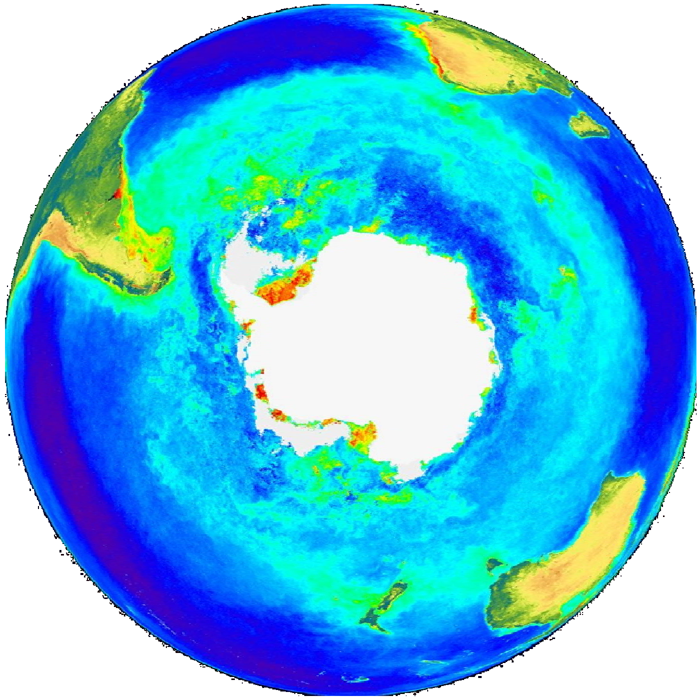


Figure 5: Average chlorophyll distribution in the polar region from SeaWiFS September 1997–July 1998 (figures obtained from http://seawifs.gsfc.nasa.gov/SEAWIFS.html). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

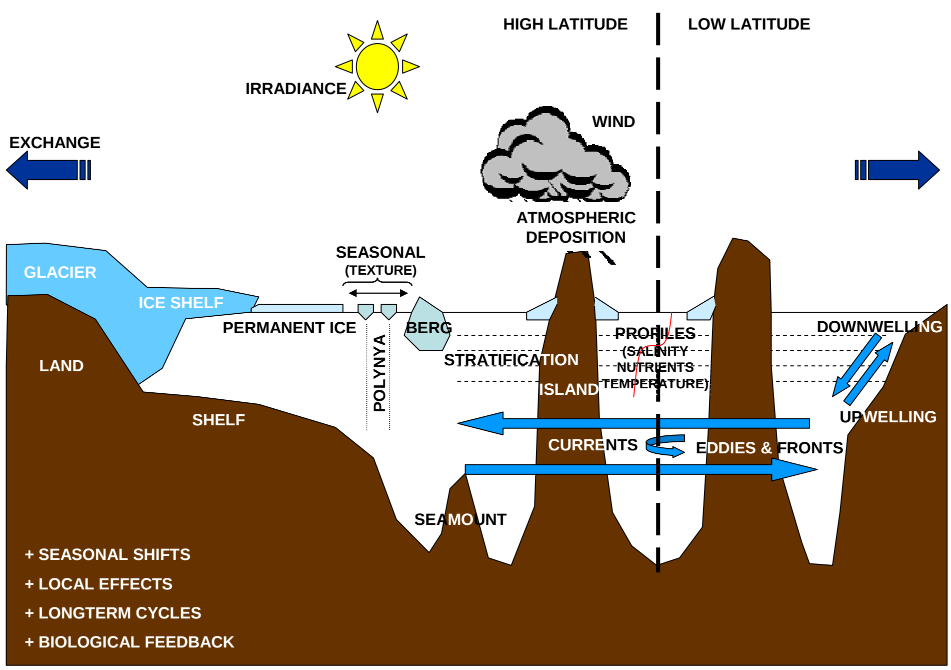


Figure 6: Conceptual diagram of major physical factors and processes affecting the Southern Ocean marine ecosystem. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

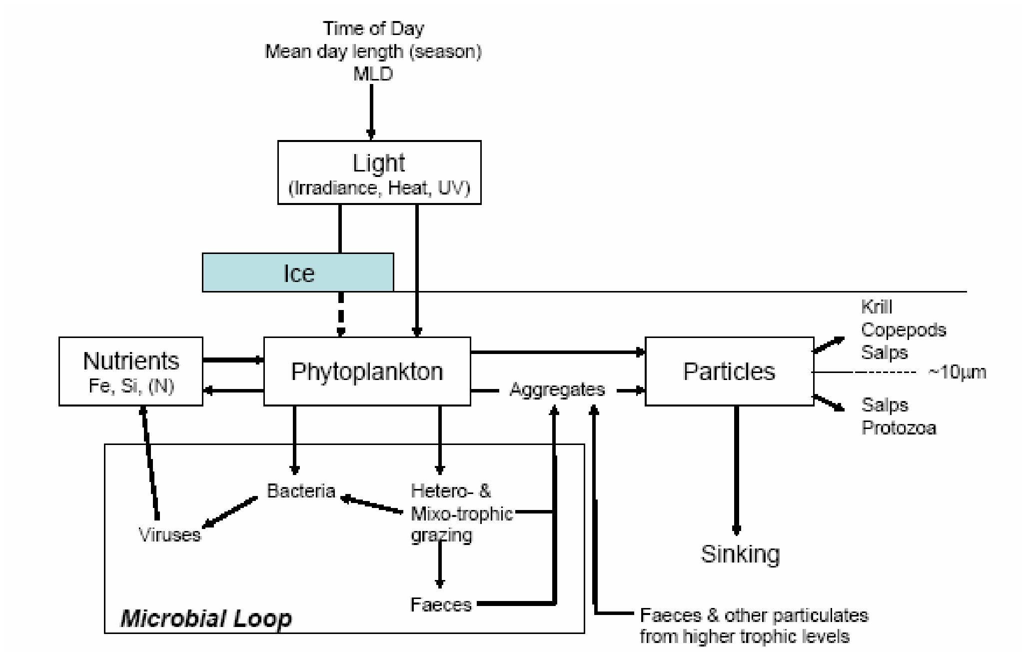


Figure 7: Conceptual model of the important linkages influencing production of particulates used as food by zooplankton. MLD – mixed layer depth. Note that Dissolved Organic Matter (DOM) is a waste product from all organisms, and DOM and Particulate Organic Matter are an important source of carbon in winter (from WG-EMM-04/24). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

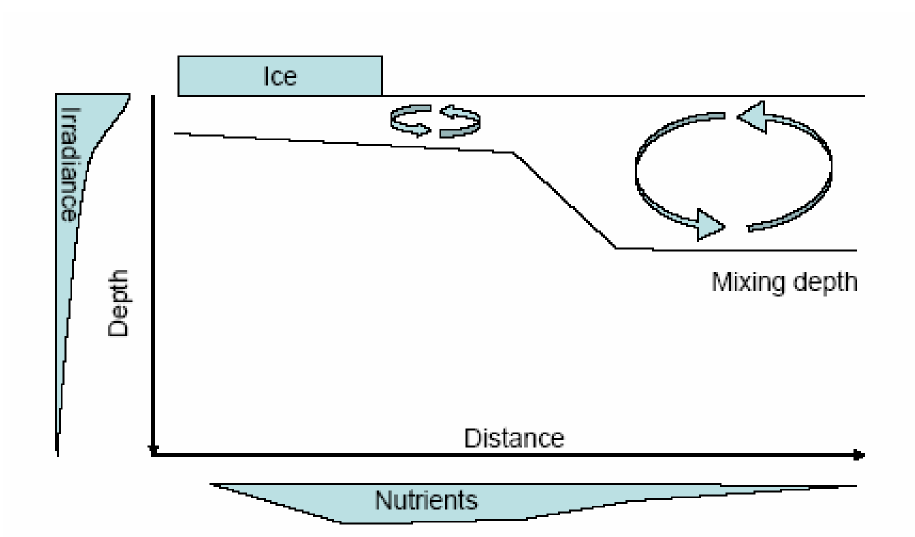


Figure 8: Diagrammatic representation of how the spatial characteristics of the environment might influence primary production in the ice-edge region. Arrows indicate possible mixing. The width of the shapes surrounding nutrients and irradiance indicate the quantities that might be available to phytoplankton given proximity to ice and the depth of the mixing layer (from WG-EMM-04/24). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

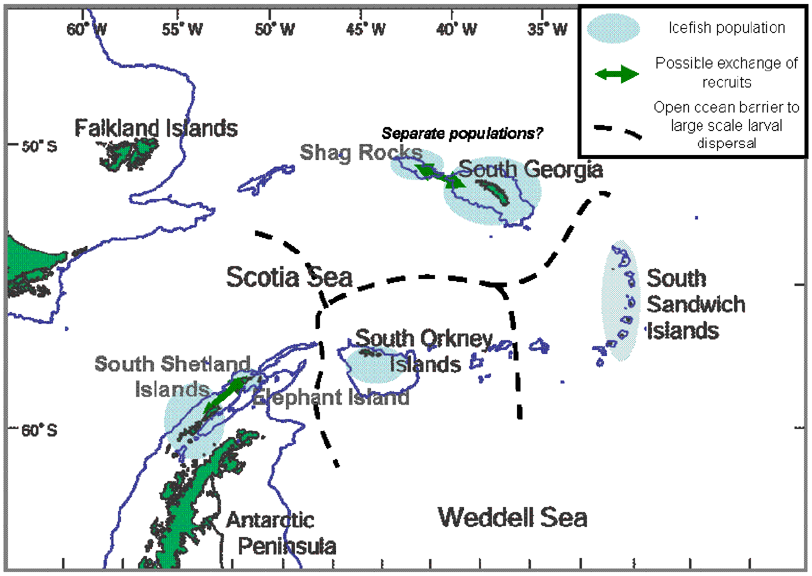


Figure 9: Conceptual model of the distribution of *Champsocephalus gunnari* in the southwest Atlantic. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

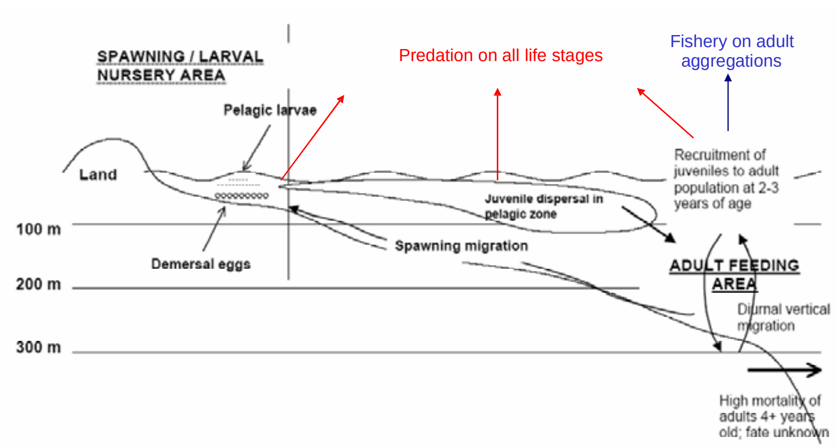


Figure 10: Summary of life history of *Champsocephalus gunnari* (modified from WG-EMM-04/59). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

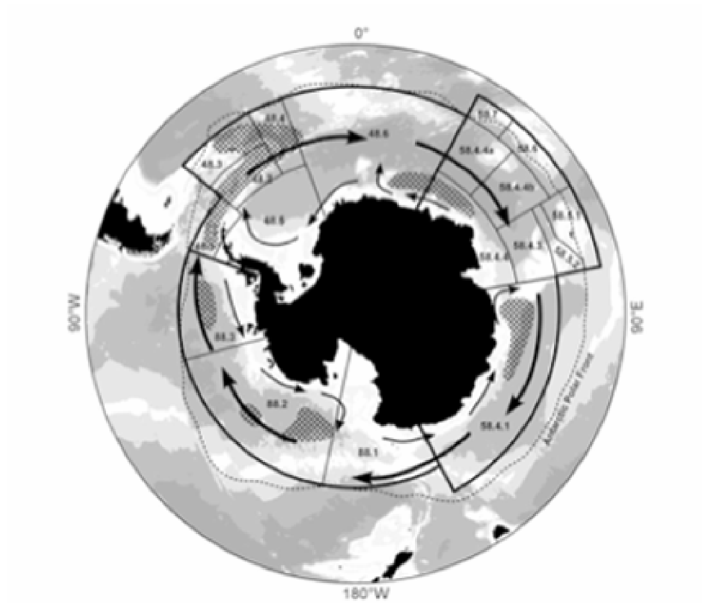


Figure 11: Antarctic Polar Front, CCAMLR boundaries, FAO statistical areas, areas of high krill densities (cross-hatched), ACC (West Wind Drift) and East Wind Drift (sources: CCAMLR, Hobart, Australia; Laws, 1985; Amos, 1984; Mackintosh, 1973). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

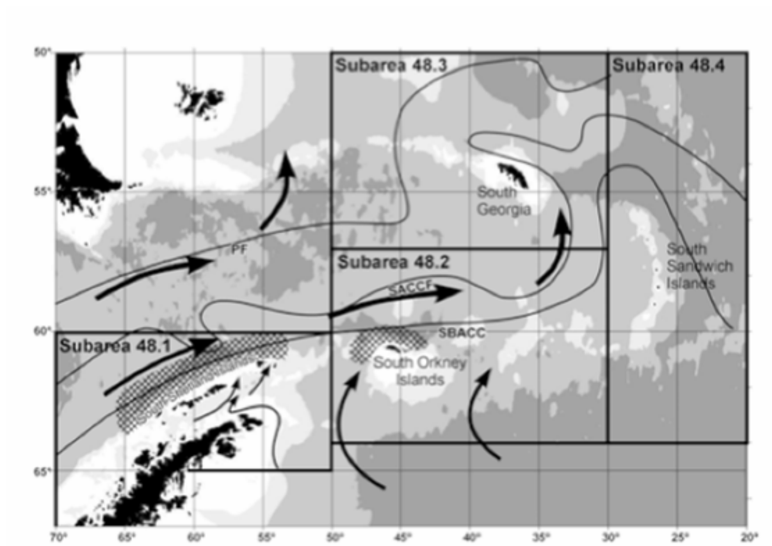


Figure 12: Krill spawning areas (cross-hatched), major currents and frontal zones in the southwest Atlantic sector of the Southern Ocean; PF – Polar Front, SACCF – Southern Antarctic Circumpolar Current Front, SBACC – southern boundary of the ACC (sources: Marr, 1962; Orsi et al., 1995; Hofmann et al., 1998). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

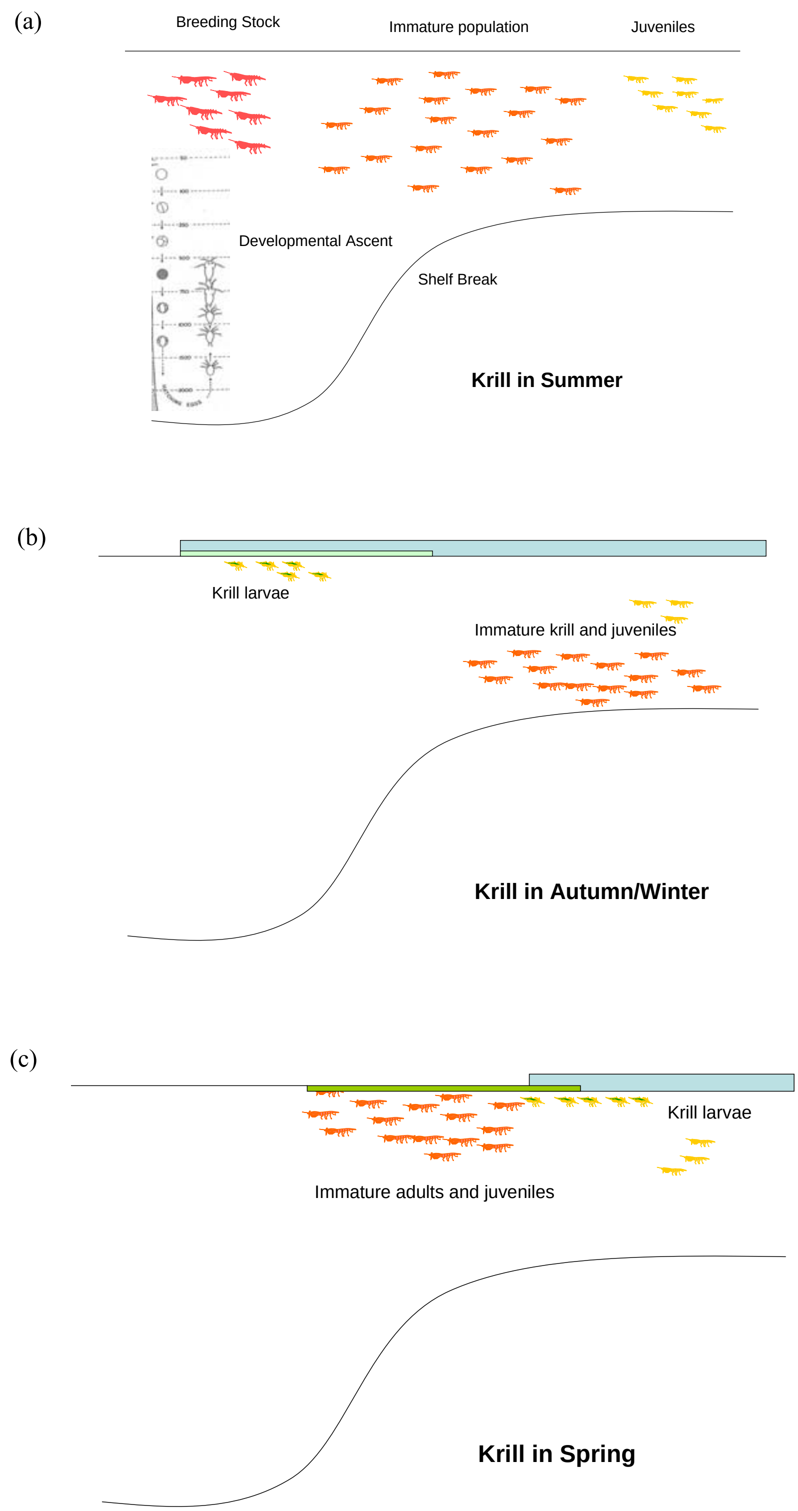


Figure 13: Conceptual model of krill population in summer and winter (modified from WG-EMM-04/50). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

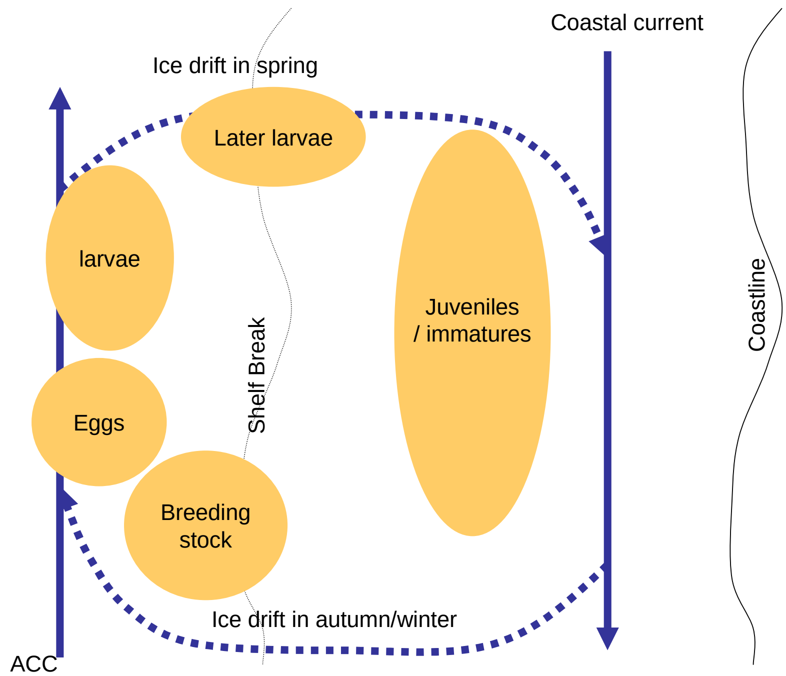


Figure 14: Conceptual model of krill in spring and plan view of ontogenetic migration pattern (modified from WG-EMM-04/50). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

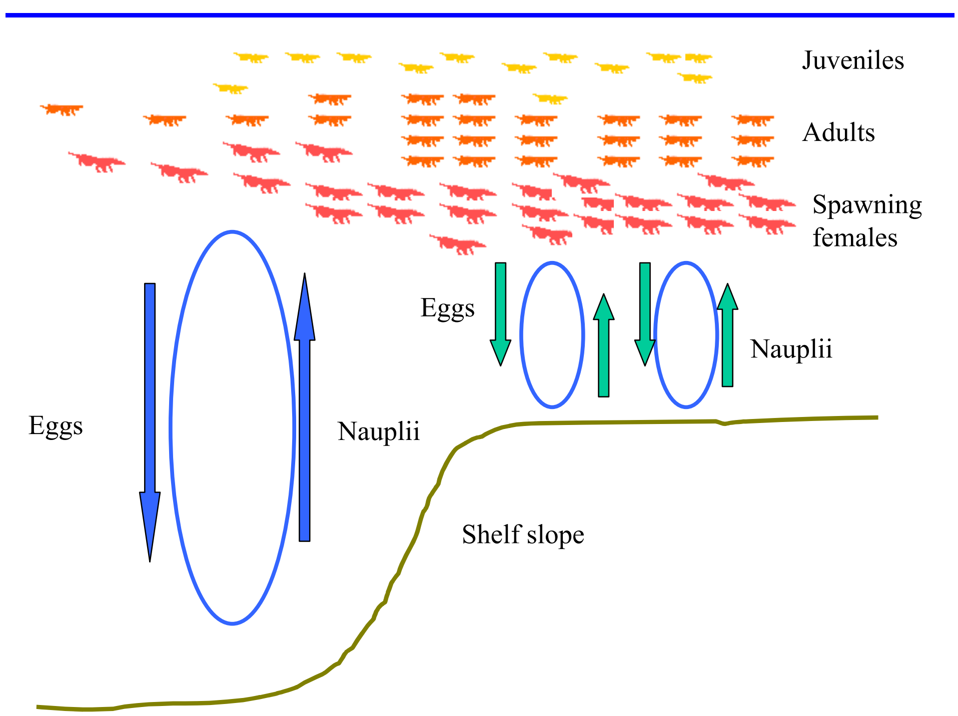
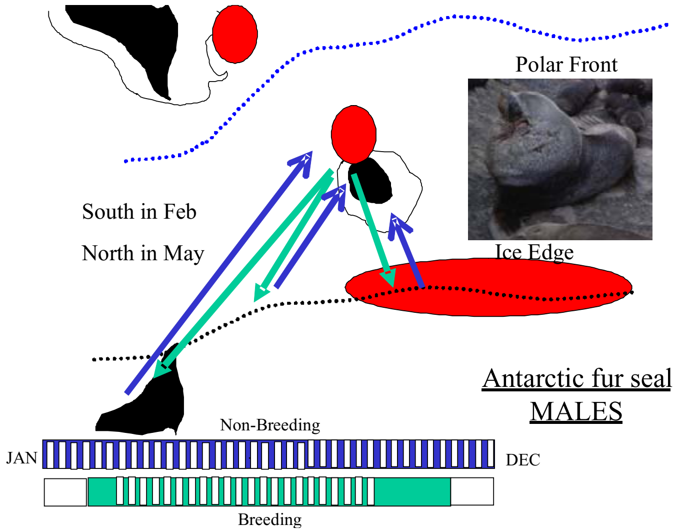


Figure 15: Alternative summer distribution of krill at South Orkney Islands. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.



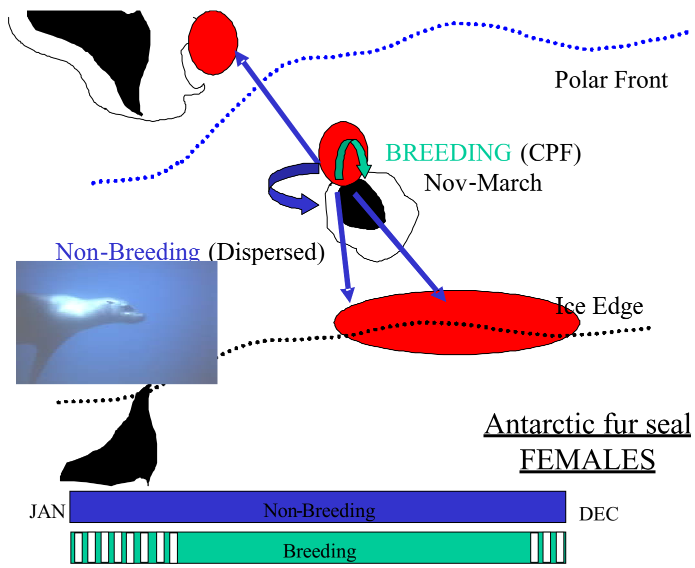


Figure 16: Conceptual model of the seasonal distribution of Antarctic fur seals associated with a sub-Antarctic island in Area 48. Top panel shows males. Bottom panel shows females. The lower bars in each panel indicate the time spent at sea by non-breeding and breeding individuals. For male seals there is a southward dispersal away from the breeding site in January with a northward return in early winter. Female seals that are central-place foragers during the breeding season disperse away from the island to other foraging areas (indicated by the filled ellipses) outside the breeding season. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

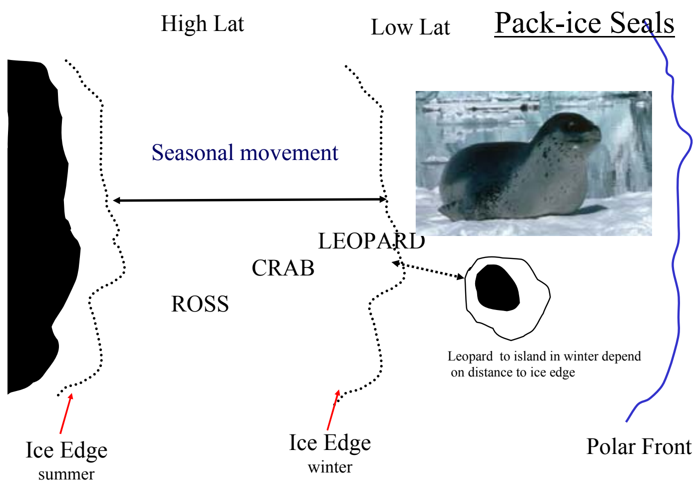


Figure 17: The spatial and temporal distribution of pack-ice seals that follow the seasonal advance and retreat of the pack-ice and the extent of the dispersal of leopard seals to sub-Antarctic islands as a function of the proximity of the pack-ice edge. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

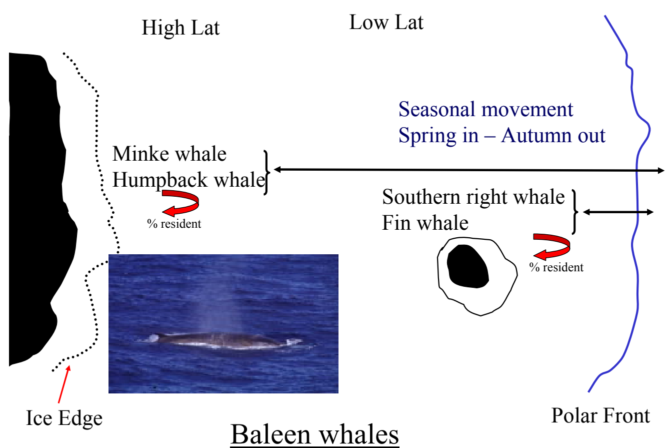


Figure 18: The spatial and temporal distribution of baleen whales separated into a high-latitude group comprising minke and humpback (possible also blue) and a lower latitude group, associated with the sub-Antarctic, comprising fin and southern right whale categories (possibly also sei). The straight arrows indicate the major migration directions, the looped arrows indicate a small proportion that stay over winter in the system. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

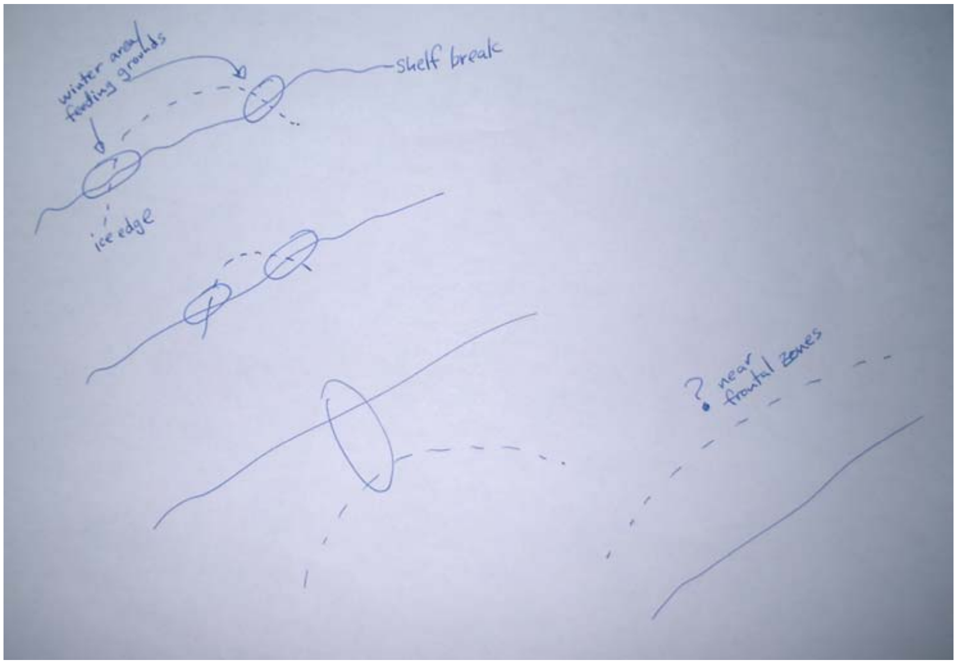


Figure 19: Graphical representation of Adélie penguin foraging locations relative to the ice-edge and shelf break. In the absence of ice, the penguins are expected to forage on the shelf break. Otherwise they would be expected to forage near the ice-edge. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

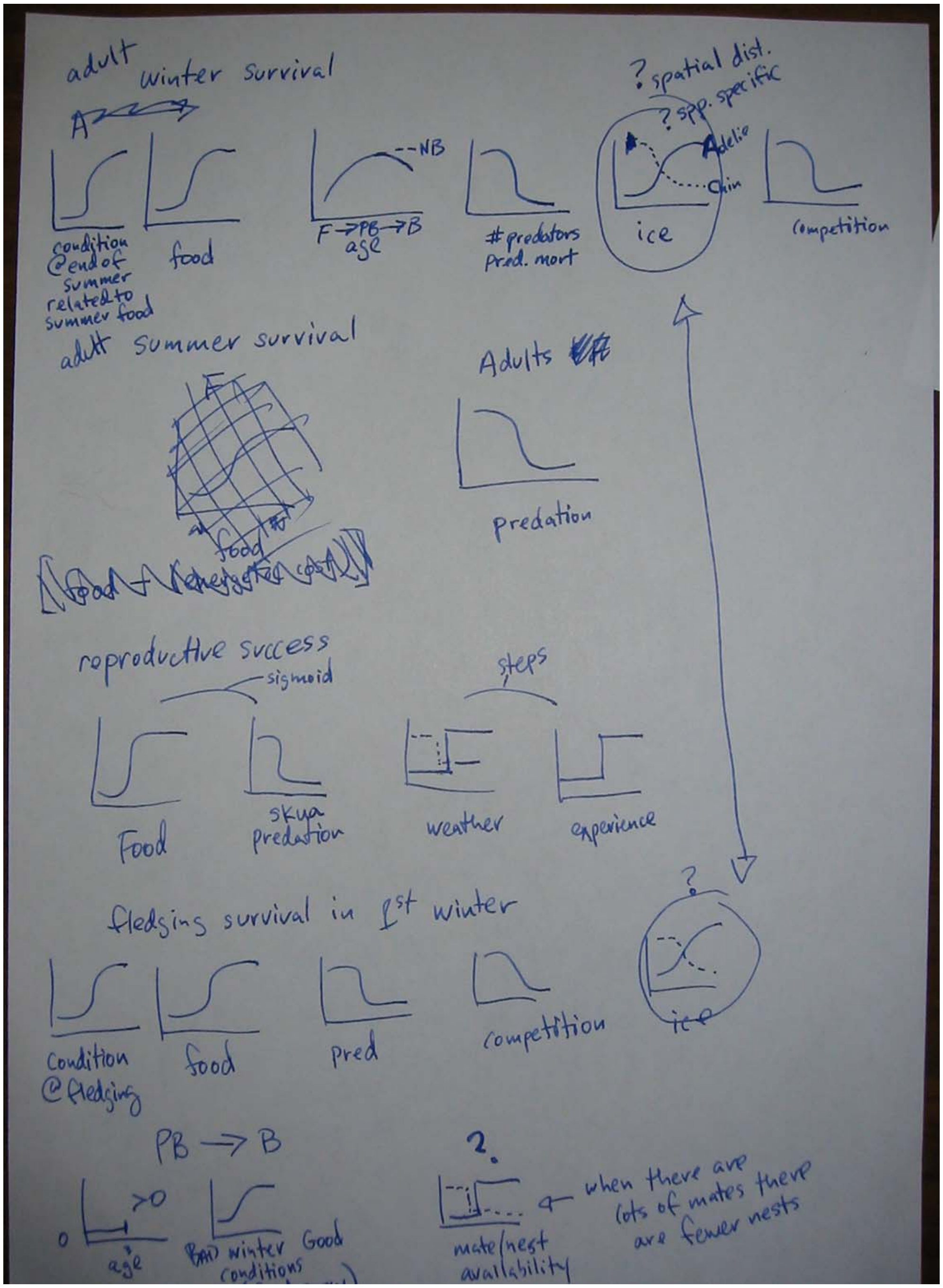


Figure 20: Graphical representations of the form of relationships affecting Adélie penguin demography. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

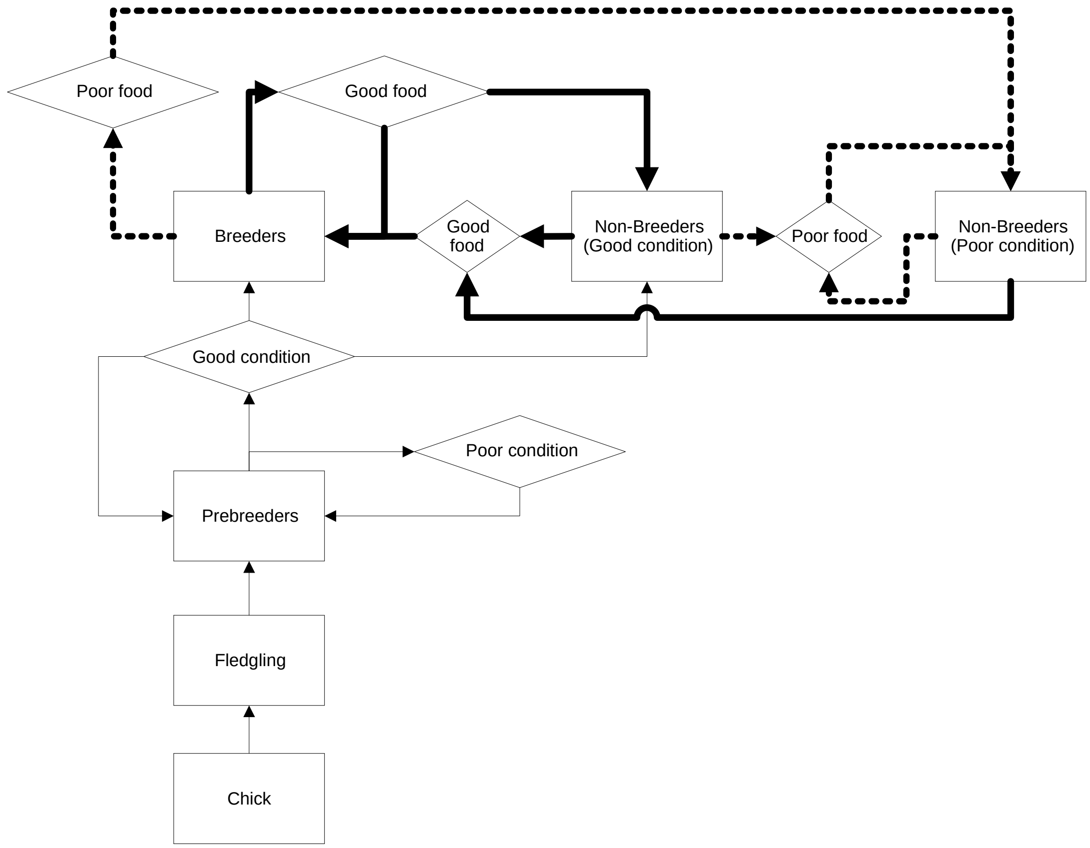


Figure 21: A generalised conceptual model of the transition between different phases in birds. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

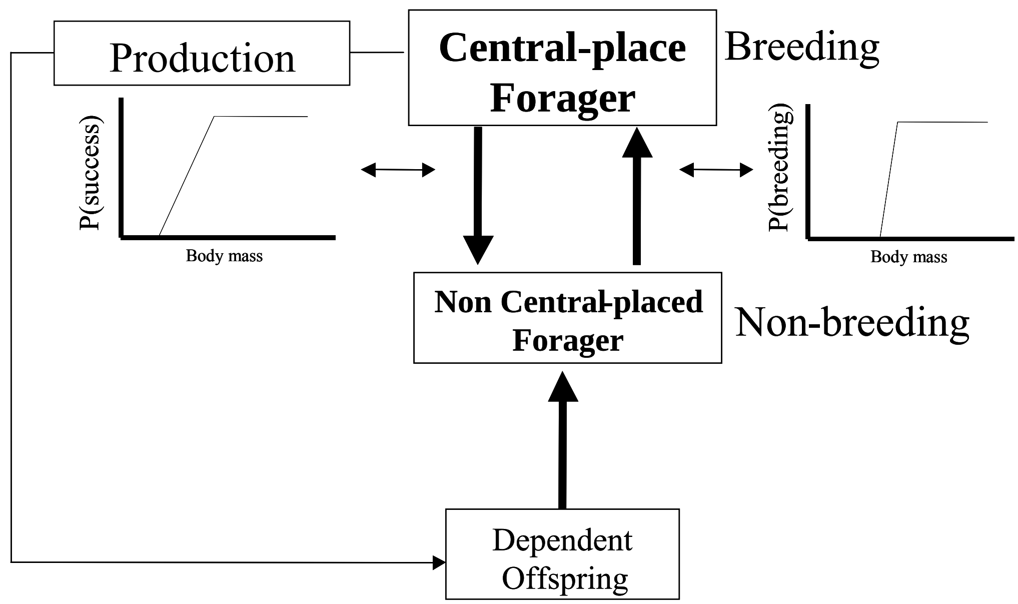


Figure 22: Diagram showing the three main elements of an investment breeder – dependent offspring, non-breeder (wide foraging distribution) and breeder (central-place forager). The transition from non-breeding to breeding depends on the non-breeder being a minimum age; thereafter its body condition will influence whether it can become a breeder, shown by the function of probability of breeding with body condition (substituted by body mass in this case) prior to the breeding season. Successful breeding will depend on the maintenance of body mass during the breeding season. The transition to having non-breeding foraging behaviours will occur at the time at which it no longer has dependent offspring, i.e. when the pup/chick dies or weans/fledges. This transition may be determined by a condition function in a similar way to that described above. Body condition will be affected by the costs of different activities, such that parental investment could be a substantial cost to a breeder (i.e. relative costs of activities comparing breeders to non-breeders might be in the order of 2:1, with dependent offspring not having any cost). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

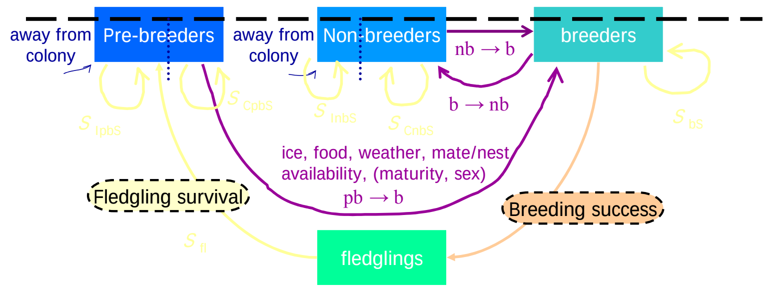


Figure 23: Demography of Adélie penguins at Béchervaise Island (WG-EMM-04/53). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

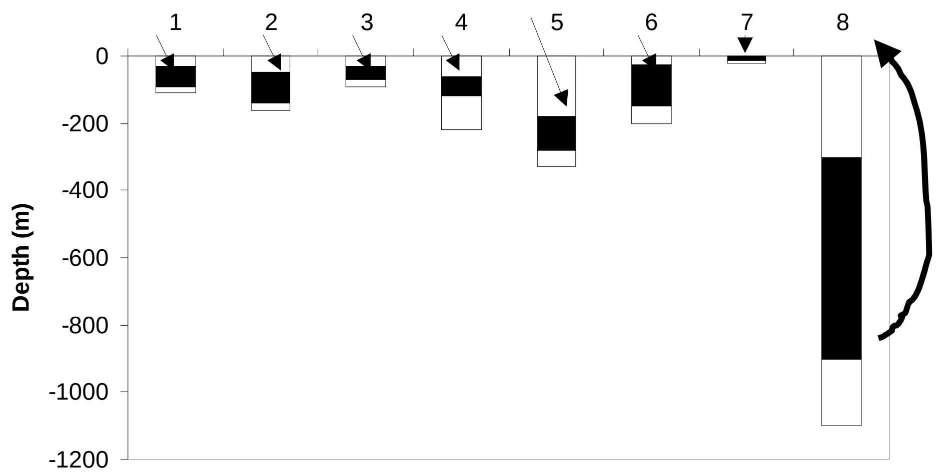


Figure 24: Generalised conceptual model of the vertical foraging distribution of air-breathing predators. The filled sections of the bars indicate the depth region of highest frequency, the upper and lower quartiles of the dive depths are indicated by the unfilled sections. The arrows on the figure indicate the direction of movement from the primary location in which the foragers spend the greater part of their time budget. The numbers refer to the taxonomic grouping:

1 – chinstrap, Adélie and macaroni penguins, 2 – gentoo penguins, 4 – Antarctic fur, leopard and crabeater seals, 5 – king and emperor penguins, 6 – Weddell seals, 7 – baleen whales, 8 – flying birds, 9 – southern elephant seals and odontocete whales.

Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

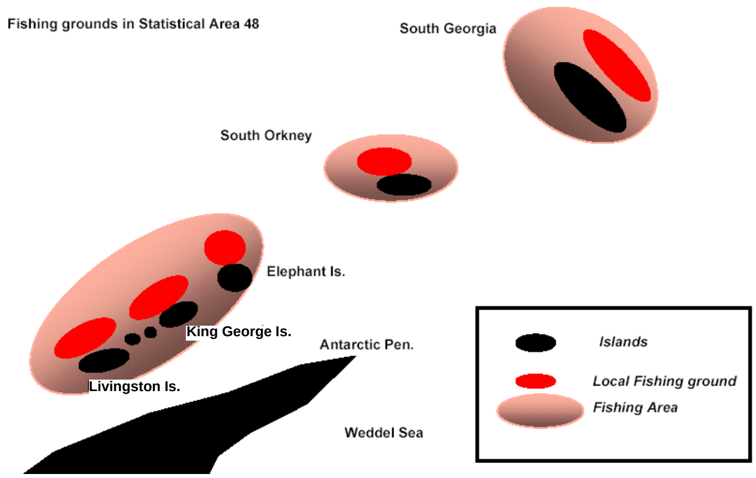


Figure 25: Conceptual illustration of krill fishing areas and grounds in Area 48 (WG-EMM-04/51). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

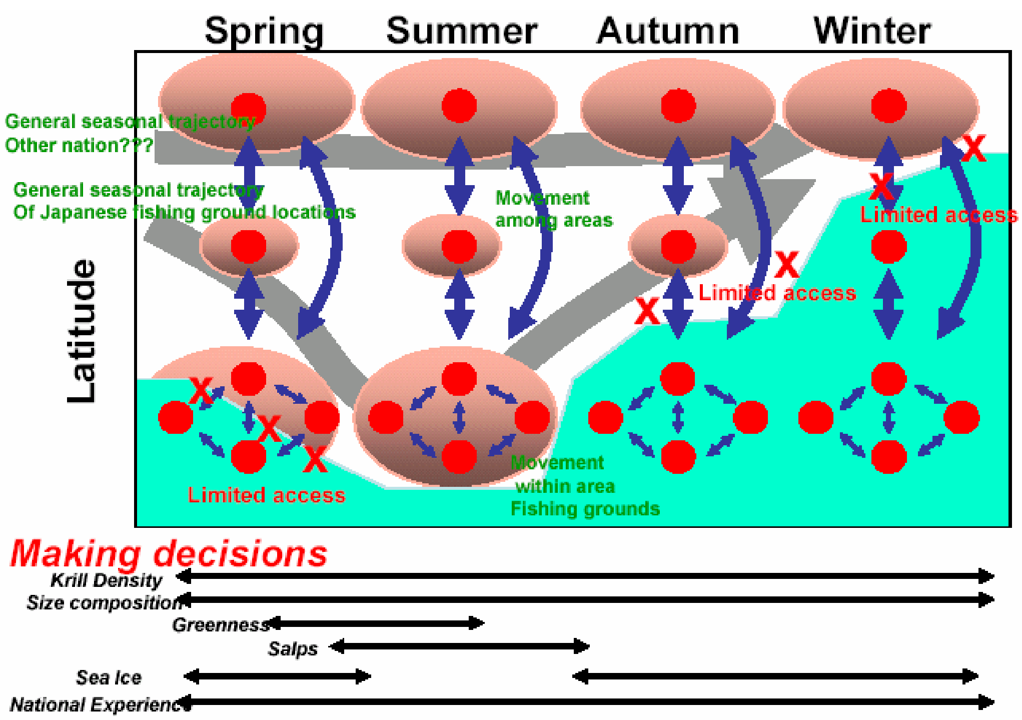


Figure 26: A conceptual illustration of the behaviour of the krill fishery through a season, and related major decision rules (WG-EMM-04/51). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

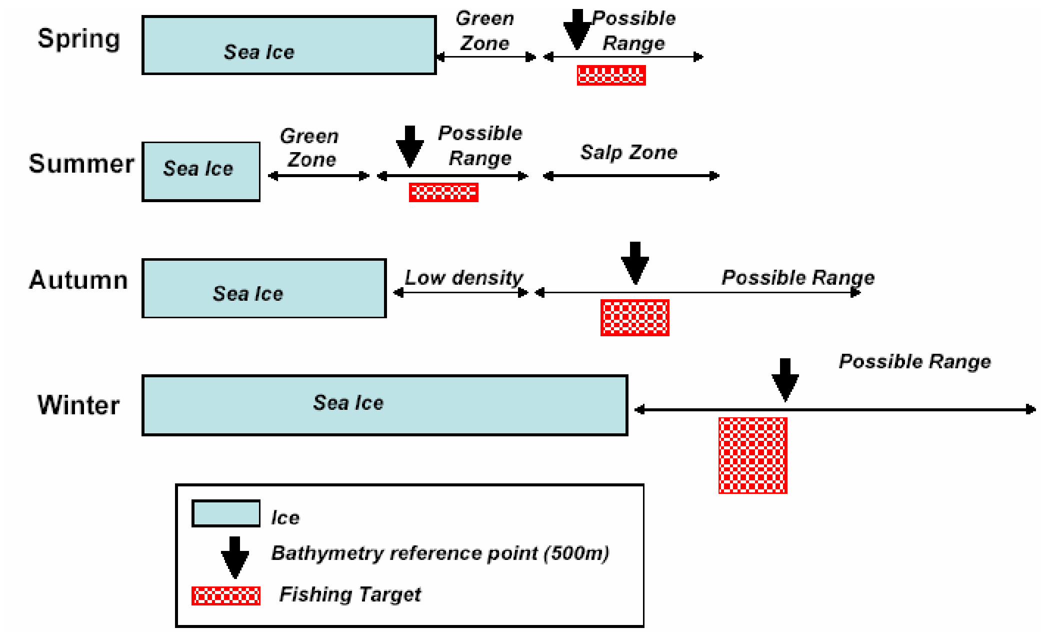


Figure 27: Krill fishing patterns characterised according to seasonal succession of physical and biological properties around the fishing grounds (generated according to information in WG-EMM-04/50). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

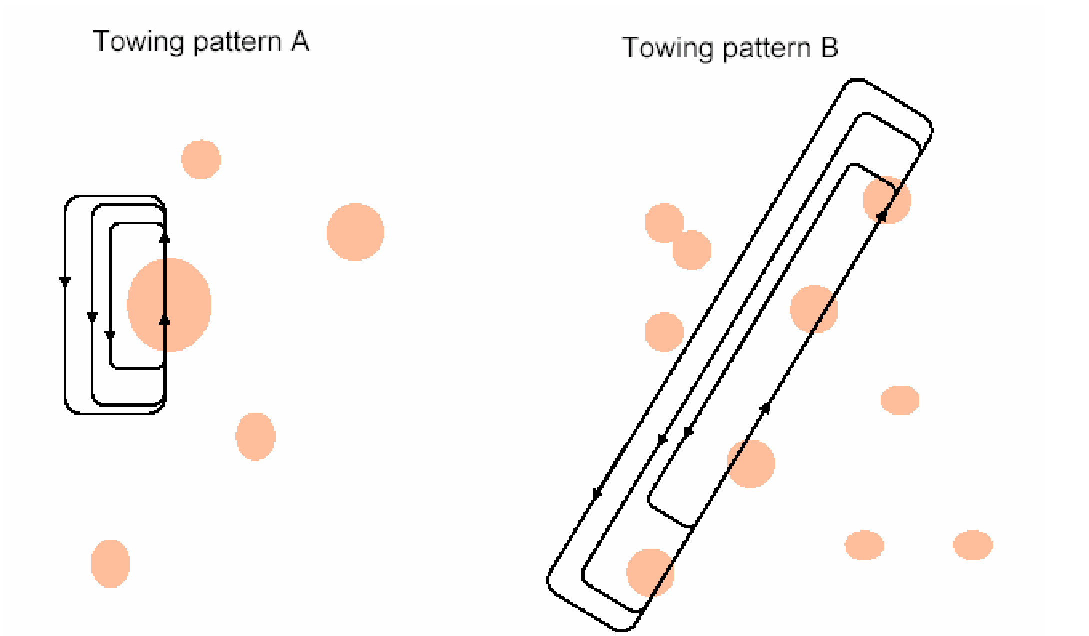


Figure 28: Different strategies of fishing operational pattern at same regional krill density but under different aggregation structure (generated according to information in WG-EMM-04/50). Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

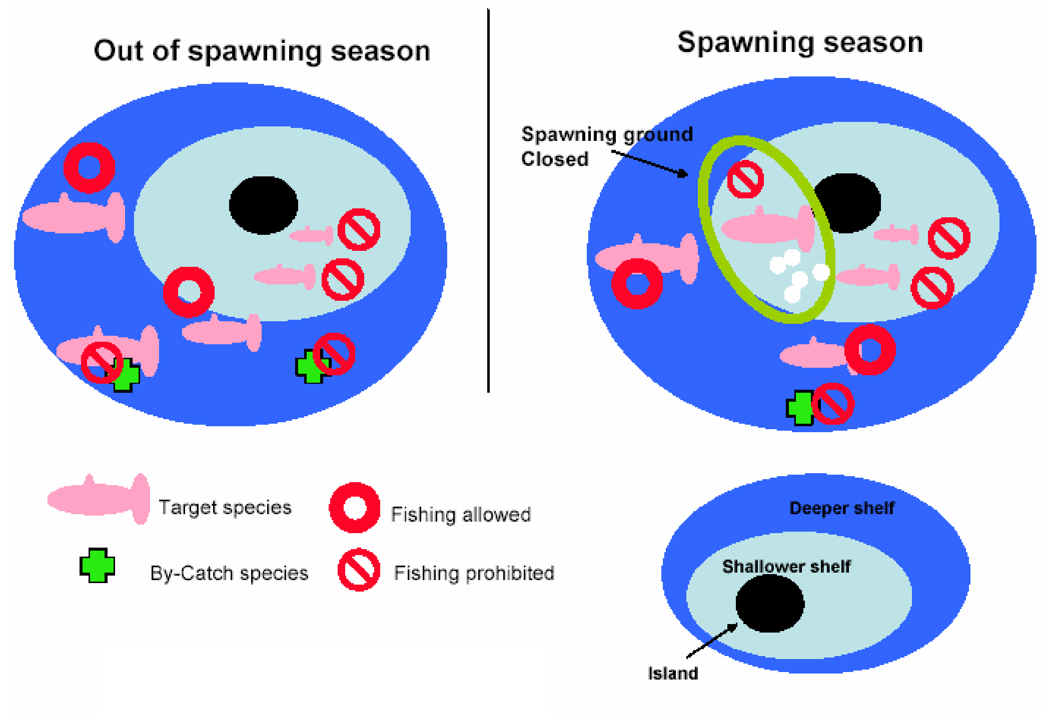


Figure 29: Conceptual illustration of an icefish fishing ground. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

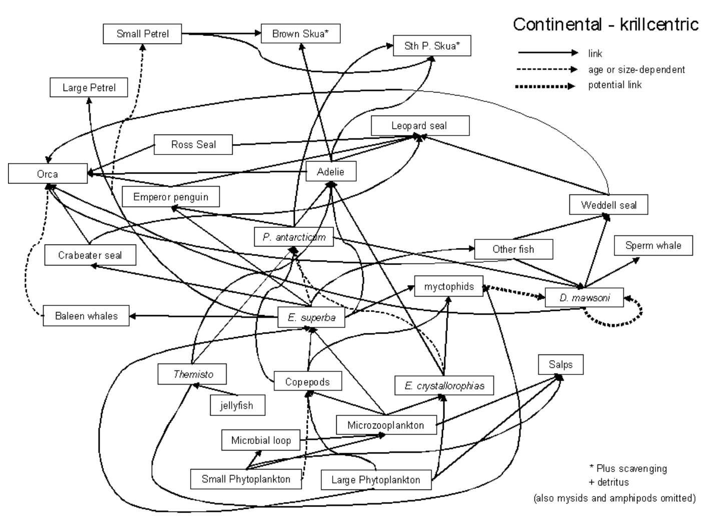


Figure 30: Schematic representation of the krill-centric food web around the Antarctic continent. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

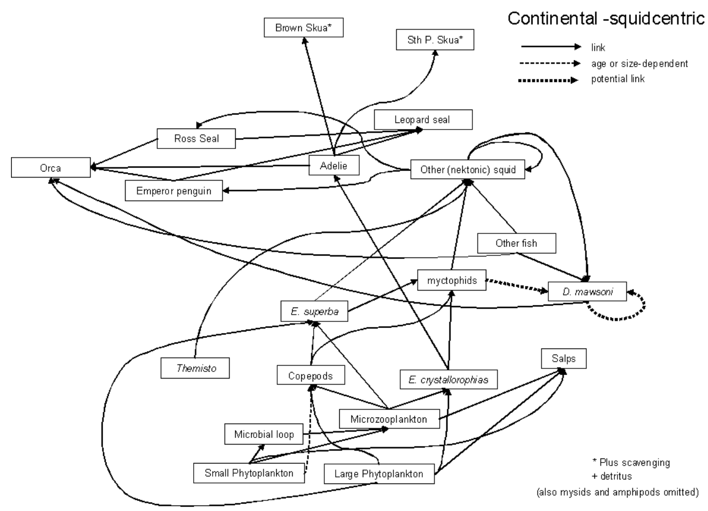


Figure 31: Schematic representation of the squid-centric food web around the Antarctic continent. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

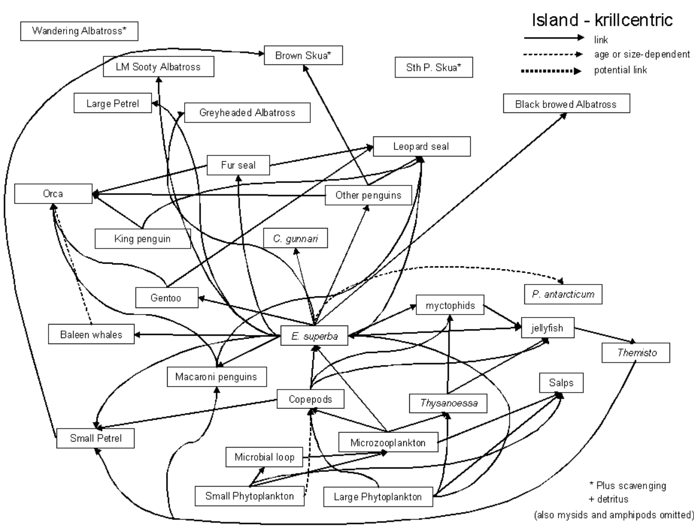


Figure 32: Schematic representation of the krill-centric food web around sub-Antarctic islands. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

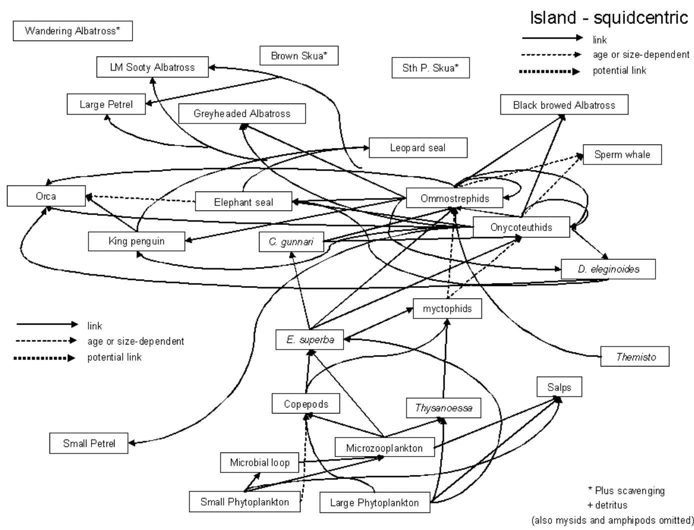


Figure 33: Schematic representation of the squid-centric food web around sub-Antarctic islands. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

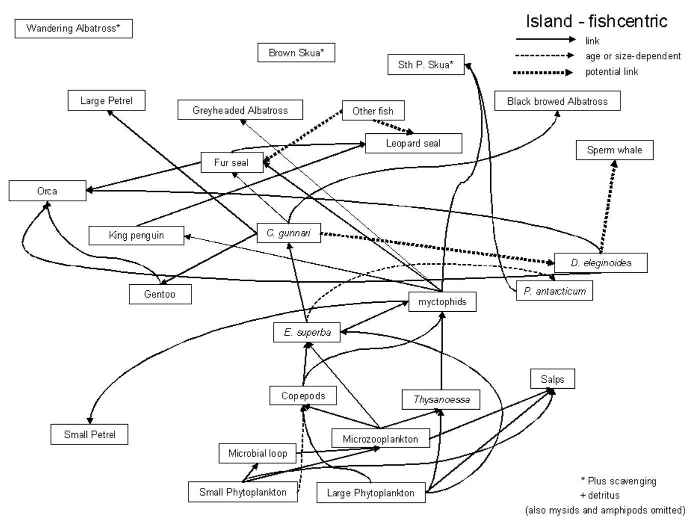


Figure 34: Schematic representation of the fish-centric food web around sub-Antarctic islands. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

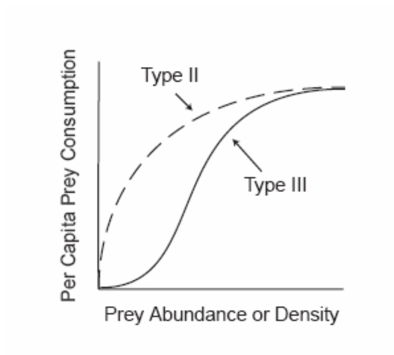


Figure 35: Functional responses that could be used to describe foraging by predators in Antarctic ecosystems. Not to be cited except for the purpose of CCAMLR: only the main features considered at the workshop are shown and, as such, this may be incomplete.

ATTACHMENT 1

AGENDA

Workshop on Plausible Ecosystem Models
for Testing Approaches to Krill Management
(Siena, Italy, 12 to 16 July 2004)

1. Opening of the workshop
   1.1 Purpose of the workshop
   1.2 Rapporteurs

2. Report from the Steering Committee on intersessional activities
   2.1 Invited experts
   2.2 Literature review of ecosystem models
   2.3 Catalogue of available software
   2.4 Existing data and estimates of parameters
   2.5 Aims and specifications for ecosystem modelling as it relates to the development of management procedures for krill

3. Desirable attributes of ecosystem models
   3.1 Attributes of models in the literature
   3.2 General attributes of models for evaluation of management procedures

4. Conceptual representation of key components
   4.1 General approach
      4.1.1 Biological scales
      4.1.2 Important attributes to consider
      4.1.3 Identifying needs for ‘field observations’
      4.1.4 Direct and indirect effects of fisheries
   4.2 Physical environment
   4.3 Primary production
   4.4 Pelagic herbivores and invertebrate carnivores
   4.5 Target species
   4.6 Mesopelagic species
   4.7 Central point foragers within the system
   4.8 Widely distributed and migratory species
   4.9 Fisheries

5. Plausible scenarios for Antarctic marine ecosystems

6. Model formulation and specification
   6.1 Modelling interactions between species
   6.2 Handling space
   6.3 Handling time
   6.4 Peripheral processes and boundary conditions

7. Future work
    7.1 Tools available
    7.2 Software development
    7.3 Software requirements
    7.4 Coordination

8. Report adoption

9. Close of workshop.

ATTACHMENT 2

LIST OF PARTICIPANTS

Workshop on Plausible Ecosystem Models
for Testing Approaches to Krill Management
(Siena, Italy, 12 to 16 July 2004)

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ANNEX 5

REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT
(Hobart, Australia, 11 to 22 October 2004)

CONTENTS

1 The tables and figures relating to Agenda Item 5 appear within the text of this section.

[2] These tables relate to Agenda Items 1–4 and 6–16.
[3] These figures relate to Agenda Items 1–4 and 6–16.

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 11 to 22 October 2004)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 11 to 22 October 2004. Participants were welcomed by the Convener, Dr S. Hanchet (New Zealand), and the Secretariat's Executive Secretary, Dr D. Miller.

1.2 Dr Hanchet advised the Working Group that Dr M. Belchier (UK) would not be attending this year's meeting due to the recent death of his father. The Working Group expressed its sincere condolences to Dr Belchier and his family.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The agenda of the meeting was discussed and adopted with the following changes:

- subitem 5.3 was renamed 'Assessment and management advice on other fisheries'
- 'Assessment of risk' was added under item 6
- 'Scientific observer duties' was also added under item 6.

2.2 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.

2.3 The report was prepared by the participants. Dr I. Everson (Consultant) assisted with the formatting and restructuring of the report.

Meeting documents

2.4 WG-FSA noted with pleasure that the majority of meeting documents had been submitted by the deadline (24 September 2004). Congratulations were extended to the Secretariat, and in particular Mrs R. Marazas (Website and Information Services Officer) for promptly placing available documents on the Working Group's webpage; approximately 85 documents were available on the website by the Monday following the deadline.

2.5 A number of documents had been submitted after the deadline due to extenuating and other circumstances. In addition, some documents had been revised and resubmitted after the deadline. WG-FSA considered these documents and agreed that all the late and revised documents would be accepted at this meeting. However, WG-FSA emphasised that this action should not be seen as setting a precedent. The Working Group agreed that the established practice of submitting documents well in advance of the meeting should be retained at future meetings.

2.6 WG-FSA reviewed the existing guideline for the submission of meeting documents. It was agreed that the submission of documents to future meetings shall be in accordance with the following rules:

(i) The deadline for the submission of documents is to be set at 0900 h (Hobart time) exactly two weeks prior to the commencement of the meeting (e.g. if WG-FSA-05 starts on 10 October 2005, then the deadline for the submission of documents will be 0900 h (Hobart time) on Monday, 26 September 2005).

(ii) With the exception of Secretariat papers dealing with data (see iii), the deadline will apply to all documents submitted to WG-FSA, including SC-CAMLR and CCAMLR working papers and background papers.

(iii) Secretariat papers dealing with data may be submitted between the deadline and 0900 h on the first day of the meeting.

(iv) Factual corrections to documents will be accepted at any time. However, if such corrections are made after the deadline, then the author(s) must clearly indicate the changes in the revised document(s). Documents with any other type of revision will be considered as new documents and these new documents will be subject to the deadline.

(v) Documents submitted after the deadline and before the start of the meeting may be accepted, subject to prior notification, at the discretion of the Conveners of WG-FSA and WG-IMAF and the Chair of the Scientific Committee.

Report restructure

2.7 Dr Hanchet recalled that in 2003 WG-FSA and the Scientific Committee identified the need to rewrite and restructure the WG-FSA report. The main aims of such a restructure were to provide advice to the Scientific Committee, which was brief, could be easily followed and was available to public scrutiny. Subsequent discussions between the Conveners of WG-FSA and WG-IMAF and the Chair of SC-CAMLR, as well as other WG-FSA members and the Secretariat, defined three phases of work:

- Phase 1 was to prepare a draft structure and format of the report in consultation with all parties involved.
- Phase 2 was to refine the structure of the report format and to develop draft ‘Fishery Reports’ for selected fisheries for presentation to the WG-FSA-SAM meeting in July 2004.
- Phase 3 was to refine these drafts and develop full ‘Fishery Reports’ for all the fisheries being reviewed and, where possible, assessed, and to develop a revised report structure in time for the WG-FSA meeting in October 2004.

Information on the restructure was distributed in SC CIRCS 04/11, 16, 18 and 21.

2.8 In considering the restructure process, several objectives were identified:

(i) to provide clearer documentation
(ii) to provide clearer management advice
(iii) to make the reviews and assessments more transparent
(iv) to make the report shorter.

2.9 Following further consultation, it was agreed to contract Dr Everson (former Convener of WG-FSA) to undertake a major part of the work identified in Phases 1–3. It was also agreed that Dr Everson should attend the meeting so as to assist with the preparation of the report under the new restructured format.

2.10 The main thrust of the restructure was to provide the main part of the WG-FSA report with a greater fishery-specific focus. Initially, this was achieved by a simple reorganisation of the existing information. This provided a clearer document which met the objectives of transparency and clearer documentation and management advice.

2.11 It was acknowledged that this approach would probably fail to meet objective (iv), which was to make the report shorter. An attempt to make the report shorter in the last two years, by inclusion of text in SC-CAMLR background documents, had received some negative feedback from some WG-FSA and Scientific Committee Members and the Secretariat. The main issues were concerned with poor documentation, loss of transparency, additional time for adoption, and additional Secretariat resources required for formatting and photocopying. It was agreed that the questions of report length, and the related issues of format, transparency, resources and translation be considered at this meeting of WG-FSA, and further discussed at SC-CAMLR-XXIII and CCAMLR-XXIII.

2.12 Dr Everson had presented draft plans at WG-FSA-SAM. He had revised these and introduced them at WG-FSA. The Working Group was pleased with the overall plans and, with some modifications, these were accepted for the current meetings.

REVIEW OF AVAILABLE INFORMATION

Data requirements specified in 2003

Development of the CCAMLR database

3.1 The Data Manager, Dr D. Ramm, provided an update on recent developments in managing CCAMLR's data (WG-FSA-04/5 Rev. 1). During the intersessional period, the Secretariat had revised a number of databases used in support of the work of WG-FSA. The revision addressed issues raised by WG-FSA (e.g. SC-CAMLR-XXII, Annex 5, paragraphs 5.108 and 5.123), and this included the simplification of operating procedures, improvements in the user-interface and further developments in data checking routines. Most of this work was undertaken in databases which:

- run the routine fishery-related queries used by WG-FSA
- generate the catch-weighted length frequencies
- extract the length densities used by CMIX.

3.2 Work in 2004 also included further validation of survey data, and improvements to CCAMLR's data form used for submitting data from bottom trawl surveys (form C4). The revised data form, in Microsoft Access format, allows users to either enter data manually using data entry panels, or download processed data to database tables in standard CCAMLR form. A copy of the data form was made available on WG-FSA-04's server.

3.3 In addition in 2003, WG-FSA-SFA discussed the archiving of acoustic data from finfish surveys (WG-FSA-03/14, paragraphs 8.1 to 8.6) and this matter was further discussed by the Scientific Committee (SC-CAMLR-XXII, paragraphs 12.8 to 12.11). The Scientific Committee recommended that the Secretariat liaise with WG-FSA-SFA and current acoustic equipment manufacturers and software developers for advice on data storage and collection, and then develop a draft plan for consideration by the 2004 meeting of WG-FSA-SAM.

3.4 The development of the CCAMLR acoustic database is progressing in two parts:

- the development of a structure for storing data from the CCAMLR-2000 Survey and other acoustic-type data from krill surveys;
- the development of a complementary structure which would meet the acoustic requirements of WG-FSA-SFA.

3.5 While these developments are complementary and may overlap to some extent, the requirements for archiving the CCAMLR-2000 Survey data are well described (SC-CAMLR-XIX, Annex 4, Appendix G, paragraphs 6.1 to 6.4) and this work is nearing completion (WG-EMM-04/18). However, the needs of WG-FSA-SFA are yet to be specified and consultation with the conveners of WG-FSA-SFA during 2004 indicated that the matter of a CCAMLR database for archiving acoustic data from finfish surveys remains in the early stage of conception.

Data processing

3.6 The Working Group noted that all of the fishery and observer data collected so far in the 2003/04 season had been submitted by the time of the meeting. These data included:

- catch and effort reports from 10 fisheries;
- 84 fine-scale catch and effort datasets (typically one dataset per month per vessel);
- logbooks and reports from scientific observers deployed on longliners (44 cruises), finfish trawlers (11 cruises) and a krill trawler (1 cruise), including two outstanding reports received during the meeting.

3.7 All of these data had been received and processed by Mrs L. Millar (Data Administration Officer) and Mr E. Appleyard (Scientific Observer Data Analyst) in time for the meeting. Preliminary validation of these data had also been undertaken, and routine analyses were reported in WG-FSA-04/5 Rev. 1, 04/6 Rev. 1, 04/7 Rev. 1 and 04/8 Rev. 1. The Working Group thanked Mrs Millar and Mr Appleyard for their dedicated efforts in preparing the data for the meeting.

3.8 The Working Group noted that data from the 2003/04 season would be fully validated in 2005. It was also noted that a number of fishery datasets had been submitted after the deadlines agreed by the Commission (CCAMLR-XXIII/BG/8).

Fishery plans

3.9 In 2004, the Secretariat undertook a major reorganisation and reconstruction of the database which holds the time series of information used in the Fishery Plans (WG-FSA-SAM-04/4). This information includes:

- management measures and fishery requirements reported annually in the *Schedule of Conservation Measures in Force*;
- other management information reported in the reports of the Scientific Committee and Commission;
- operational and catch information derived from data submitted to CCAMLR.

3.10 In addition, the layout of the Fishery Plan was revised and information is now presented in three sections:

Section 1: Management measures and fishery requirements
Section 2: Operational aspect (i.e. 'what really happened')
Section 3: Catches derived from STATLANT data, fine-scale data and catch and effort reports.

3.11 WG-FSA endorsed the definition of 'fishery' and 'annual reporting interval' used in the Fishery Plans, whereby:

> A fishery is defined as a fishing operation which targets a discrete species (or species group) in a discrete statistical region (i.e. an area, subarea or division); several types of fishing gear may be used in a fishery, and a fishery may be closed for long-term periods.
>
> The annual reporting interval used in each Fishery Plan reflects the seasonal period defined by the Commission at the time when the relevant measures were in force. Thus the annual interval in each plan captures the requirements, operations and catches of the time and maintains the historic setting in which each fishery has been managed by CCAMLR. Since 2001 (Conservation Measure 32-01), all fisheries are managed by CCAMLR season (1 December to 30 November of the following year) and this corresponds to the reporting period now used in the *Statistical Bulletin*.

Fisheries information

Catch, effort, length and age data reported to CCAMLR

3.12 Ten fisheries were conducted under the conservation measures in force in 2003/04:

- fishery for *Champsocephalus gunnari* in Subarea 48.3
- fishery for *Champsocephalus gunnari* in Division 58.5.2
- fishery for *Dissostichus eleginoides* in Subarea 48.3
- exploratory fishery for *Dissostichus* spp. in Subarea 48.6
- fishery for *Dissostichus eleginoides* in Division 58.5.2
- exploratory fishery for *Dissostichus* spp. in Division 58.4.2
- exploratory fishery for *Dissostichus* spp. in Division 58.4.3b
- exploratory fishery for *Dissostichus* spp. in Subarea 88.1
- exploratory fishery for *Dissostichus* spp. in Subarea 88.2
- fishery for *Euphausia superba* in Area 48.

3.13 In addition, four other managed fisheries were conducted in the Convention Area in 2003/04:

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

3.14 Catches of target species by region and gear reported from fisheries conducted in the CCAMLR Convention Area in the 2003/04 fishing season are summarised in Table 3.1.

3.15 Catch, effort and length data were submitted for all fisheries managed under conservation measures. Data were also submitted from fisheries operating in EEZs, albeit not all in the standard CCAMLR format.

Estimates of catch and effort from IUU fishing

3.16 WG-FSA reviewed estimates of IUU catches in the Convention Area prepared by the Secretariat and based on information submitted by 1 October 2004 (SCIC-04/3). The deterministic method presently used by the Secretariat to estimate IUU fishing effort was the same method as used in previous years. This method used information on the number of vessels sighted/apprehended and reports of port inspections. Ancillary information on fishing trips and catch rates is derived from CCAMLR data on licensed vessels. The estimates of IUU catch in 2003/04 were then pro-rated to the end of the season (30 November 2004).

3.17 Following discussion, WG-FSA agreed that a pro-rated adjustment to the end of the season was inappropriate in subareas and divisions which are extensively covered by sea-ice in late winter/early spring (Divisions 58.4.2, 58.4.3a, 58.4.3b and 58.4.4 and Subarea 88.1). The estimate of IUU catches was revised accordingly (SCIC-04/3 Rev. 2) and is summarised in Table 3.2. The development of standard methods for estimating total removals of toothfish inside and outside the Convention Area including, where applicable, IUU catches, was further discussed under Item 8.

Catch and effort data for toothfish fisheries in waters adjacent to the Convention Area

3.18 Catches of *Dissostichus* spp. in CCAMLR waters which were reported to the Secretariat in STATLANT data and catch and effort reports, and catches outside the Convention Area reported in the CDS for the 2002/03 and 2003/04 seasons are summarised in Table 3.3.

3.19 WG-FSA noted that the catch of *Dissostichus* spp. outside the Convention Area in 2003/04 was taken mostly in Area 41 (6 342 tonnes) and Area 87 (3 701 tonnes). Overall, the CDS-reported catch from areas outside the Convention Area was markedly lower than that reported in previous years. A subgroup on IUU fishing was convened to examine, among other issues, the possible causes for the decline in CDS-reported catches on the high seas outside the Convention Area. The apparent decline in IUU catches in the Convention Area was also examined. The report of the subgroup is discussed under Item 8.

Scientific observer information

3.20 During the 2003/04 fishing season, the Scheme of International Scientific Observation provided observer coverage in all finfish fisheries in the Convention Area.

3.21 For the 2003/04 season, reports and data were submitted by international and national observers from a total of 44 cruises fishing for *Dissostichus* spp. in the Convention Area. Cruises were undertaken in Subareas 48.3 (16), 48.6 (1), 58.6 and 58.7 (2), 88.1 and 88.2 (22), and in Divisions 58.4.2 and 58.4.3b (1) and 58.5.2 (2). Observers were deployed by eight Members: Australia (1), Chile (7), Russia (5), South Africa (14), Spain (1), Ukraine (2), UK (12) and Uruguay (1).

3.22 Trawl cruises fishing for finfish in Subarea 48.3 (6) and in Division 58.5.2 (5) were observed by 11 scientific observers (6 international and 5 national) provided by: Australia (5), South Africa (2), Spain (1) and the UK (3). A single trawl cruise fishing for krill in Area 48 was observed by a single international observer designated by Ukraine.

Research information

Research surveys

Results

3.23 The USA conducted a multi-disciplinary research cruise in the Atlantic sector of the Southern Ocean during the 2004 austral winter as part of the International Collaborative Expedition to collect and study Fish Indigenous to Sub-Antarctic Habitats (ICEFISH) (WG-FSA-04/61). Sampling during the cruise included demersal finfish, benthic invertebrates and information on seafloor composition. Trawling was conducted in the CCAMLR Convention Area at Shag Rocks, South Georgia (Subarea 48.3), the South Sandwich Islands (Subarea 48.4) and Bouvetøya (Subarea 48.6) from 5 to 30 June 2004. A wide contrast in finfish and invertebrate species composition between island groups was observed with the greatest differences between the South Sandwich Islands and Bouvetøya, where the isolation of the latter island likely played a role in the different community structure. A substantially greater number of *Lepidonotothen squamifrons* and rattails (*Macrourus holotrachys*), which were sparse or absent on the shelf areas of South Georgia and the South Sandwich Islands, were observed around Bouvetøya.

3.24 Australia conducted a random stratified trawl survey (n = 145) in Division 58.5.2 in the vicinity of Heard Island (200–1 500 m) in May 2004, continuing the time series started in 1990. The 2004 survey included stations in all the shallow strata as well as in four deeper strata (1 000–1 500 m) (WG-FSA-04/76). The increase in total survey area, relative to the 2003 survey, was due to the increase in deeper strata surveyed in 2004. Preliminary assessments of toothfish and icefish using data from the survey are provided in WG-FSA-04/76 and 04/77 respectively.

3.25 The UK completed its ninth fish stock assessment survey in Subarea 48.3 during January and February 2004 (WG-FSA-04/85). A total of 65 demersal trawls were made on the survey and all were used for estimating fish biomass. In addition to the random stratified bottom trawl survey, the research was extended by a week to further investigate the use of acoustic methods for determining icefish biomass.

3.26 As part of the BioRoss research program (WG-FSA-04/60), a survey of the Ross Sea (Subarea 88.1) was conducted from the New Zealand research vessel *Tangaroa* in February March 2004. A total of 52 bottom trawls and five beam trawls were carried out in depths of 50 m to over 1 000 m along five transects in the western Ross Sea between Cape Adare and Cape Hallett (SSRU 881H) and on four seamounts around the Balleny Islands (SSRU 881E). Fifty-seven species of fish were identified from a total fish catch of 4 250 kg. The catch included 126.3 kg of *D. mawsoni* and 2.8 kg of *D. eleginoides*. Eight small (less than 2 kg) specimens of *D. mawsoni* were caught at 183–574 m depth at the Balleny Islands (WG-FSA-SAM-04/7). The survey also provided information on the main by-catch species for the exploratory longline fishery in Subarea 88.1. WG-FSA-SAM-04/7 presented trawl catch data by tow for *M. whitsoni* and *Bathyraja eatonii*. Over 1 000 kg of *M. whitsoni* was caught, with high catch rates in SSRU 881H (up to 10 000 kg km^{-2}).

3.27 Australia provided a simulation approach to the evaluation of recruitment surveys for toothfish for the Heard Island region (Division 58.5.2) (WG-FSA-04/74). Assessments of long-term sustainable yield for this region have been based on data obtained from annual random stratified trawl surveys (RSTS) and from targeted commercial fishing operations via an observer program. Evaluations of both the current RSTS design for Division 58.5.2 and some options for future modifications of the design were investigated using a simulation environment using the program Fish Heaven with data analysis carried out using 'S-plus'. Fish Heaven is a simulation program that uses a spatially explicit, age-structured fish population dynamics model. Recruitment, movement, mortality, growth and fishing (both commercial and research) were simulated for the toothfish for the Heard Island Plateau region. Censuses of fish stocks by age class were compared to population estimates based on simulated RSTS hauls. For a series of 10 years of survey, age-4 recruitment was estimated using 111 RSTS stations, assuming the age of every fish caught in the surveys is known without error and assuming knife-edge fishing selectivity at age 4, using either (i) the age-4-alone RSTS results or (ii) age-4–8 RSTS results using back-projections from each age to age 4 for each of six cohorts.

Future surveys

3.28 Scientific research surveys notified to the Secretariat are placed on the CCAMLR website, and the notifications for 2004/05 received by 24 September 2004 were listed in Table 4 of CCAMLR-XXIII/BG/8 and are given in Table 3.4.

3.29 One notification, submitted by New Zealand on 23 July 2004, was for a longline survey of *D. mawsoni* in Subarea 88.3 where the survey vessel would take no more than 100 tonnes of *D. mawsoni*. The survey vessel would take no more than 35 tonnes of all other species combined.

3.30 The notification by New Zealand falls under paragraph 3 of Conservation Measure 24-01. This requires a response from Members within two months of the circulation of the notification, if they wish to request a review by the Scientific Committee. The proposed research plan was circulated on 4 August 2004 (COMM CIRC 04/73). No comments or advice have been received in advance of the start of WG-FSA-04.

3.31 WG-FSA noted that Subarea 88.3 is currently closed to exploratory fishing based on the poor CPUE experienced during an exploratory fishery for toothfish by Chile in 1998. At that time it was recommended that any future consideration of opening Subarea 88.3 to exploratory fishing should be preceded by a research survey.

3.32 Some members of WG-FSA were concerned at the high maximum catch and suggested that in future it would be useful for survey designs submitted under Conservation Measure 24-01, paragraph 3, to be referred to WG-FSA for review prior to consideration by the Commission.

Combining acoustic and trawl survey data to estimate *C. gunnari* standing stock

3.33 Although no specific meeting had taken place, there was continued interest in developing methods to combine acoustics with trawl survey data to estimate the standing stock of icefish in line with recommendations in paragraph 3.41 of SC-CAMLR-XXII, Annex 5 and discussion at WG-FSA-SAM (WG-FSA-SAM-04/10).

3.34 No acoustic estimates of abundance were available for *C. gunnari* in Subarea 48.3 from the 2004 UK survey (WG-FSA-04/85). However, acoustic data had been collected during the bottom trawl survey and four additional days had been allocated to acoustic survey work in conjunction with pelagic trawling. This short acoustic survey showed that *C. gunnari* of all ages spend time in midwater and reinforced the belief that a bottom trawl survey significantly underestimates *C. gunnari* biomass (WG-FSA-SAM-04/20) corroborating the results of the Russian trawl acoustic survey in 2002 (WG-FSA-02/44, WG-FSA-SAM-04/10).

3.35 Problems with using the ‘dB difference method’ (Hewitt et al., 2002; Watkins and Brierley, 2003) to distinguish between *E. superba* and *C. gunnari* had been discussed at WG-FSA-SAM and had been described in WG-FSA-SAM-04/20. It was noted from this study that two targeted trawls on ‘krill-like’ marks ($\Delta SV_{120kHz-38kHz}$ filter 2 dB to12 dB) caught almost entirely *C. gunnari*.

3.36 The Working Group noted that a three-frequency 'dB difference' algorithm has been developed for krill identification (Hewitt et al., 2003; Azzali et al., 2000). The Working Group recommended that further analysis using available datasets from UK and Russian surveys be undertaken and the results reported to WG-FSA-SAM-05 or SG-ASAM-05.

3.37 The Working Group noted that the development of acoustic methods for species identification could be addressed in two ways:

- determination of multi-frequency algorithms for species discrimination
- techniques for validation of acoustic species identification by reference to species composition and size from trawl sampling.

3.38 It was noted that the UK is planning a combined acoustic and pelagic trawl survey of the commercial fishing grounds to the northwest of South Georgia for January 2005. It is hoped that this survey will provide new information on target discrimination, target strength and diurnal migration patterns of *C. gunnari*. Depending on the results from this proposed work in 2005, it may be possible to analyse acoustic data from the 2004 UK survey to produce abundance estimates for *C. gunnari*.

3.39 The Working Group noted that there is parallel work in progress on acoustic delineation of *C. gunnari* and *E. superba* being carried out by WG-EMM and supported the proposal by WG-EMM (Annex 4, paragraph 4.92) to establish a standing SG-ASAM to coordinate the work of WG-FSA and WG-EMM and review issues such as this which are common to both working groups.

Tagging studies

3.40 A number of papers reported ongoing tag–recapture experiments in the CCAMLR Convention Area. At South Georgia, 4 151 *D. eleginoides* have been tagged by the UK since 2000 with 195 recaptures (WG-FSA-04/82). At Heard and McDonald Islands 9 801 *D. eleginoides* have been tagged by Australia since 1998 with 1 934 recoveries, and at Macquarie Island 6 416 fish have been tagged since 1995 with 817 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.), with one fish caught in Subarea 88.2 after 18 years, about 1 300 n miles from its release location (WG-FSA-04/34). Further north in the Ross Sea, nearly 4 000 *D. mawsoni* and *D. eleginoides* have been tagged since 2000 with about 50 recaptures (WG-FSA-04/36).

3.41 The Working Group noted that the tagging results have provided an insight into the nature of toothfish movement in the CCAMLR Convention Area (WG-FSA-04/82), and have potential to be used as abundance estimates in some areas (WG-FSA-04/36, 04/75 and 04/82). The Working Group recalled its advice from last year, that it had some concerns over potential biases when using the approach to estimating absolute abundance and reiterated its advice that these be examined through simulation during the intersessional period (SC-CAMLR-XXII, Annex 5, Appendix D, paragraph 8).

3.42 Three papers were presented that developed methods for the estimation of abundance from tag–recapture data (WG-FSA-04/36, 04/75 and 04/82), ranging from Petersen estimates, exact time of release and recapture stock assessment model, and integrated stock assessment model methods. The Working Group recommended that further research be undertaken on the development of robust abundance estimators from tag–recapture data.

3.43 The Working Group noted that there are a number of assumptions that have to be met to achieve an unbiased estimate of abundance using tag–recapture experiments. It would be necessary to quantify initial release mortality, tag loss and tag detection rates, as these can lead to bias in the abundance estimate. There are also issues relating to mixing assumptions, emigration, and immigration. The Working Group recommended that these issues be investigated as tagging programs develop, and by further studies.

3.44 The Working Group discussed the possibility of an experiment to evaluate initial tag-related mortality using acoustic 'mortality' tags. Acoustic mortality tags are designed to detect local movement over a pre-determined time period using an array of deployed hydrophones. The Working Group recommended that a feasibility study, incorporating discussion of the practical application and methods of tag-mortality estimation from resulting data, be developed during the intersessional period.

3.45 The Working Group recommended that tagging of toothfish continue to be a requirement for all new and exploratory toothfish fisheries (Conservation Measure 41-01, Annex C), and encouraged its use in all fisheries where appropriate.

3.46 The Working Group noted that Conservation Measure 41-01/C requires Members to report all relevant tag data and any tag recaptures to the CCAMLR Data Manager within two months of the vessel departing these fisheries.

3.47 The Working Group then went on to discuss revisions to the protocol for tagging and data management. The Working Group agreed that:

(i) NIWA in New Zealand (on behalf of the New Zealand 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'. Further, the Working Group recommended that all participants in that fishery return their tag data directly to NIWA at the conclusion of each fishing trip;

(ii) MRAG in the UK offered to act as the repository for all tagging data from the Subarea 48.3 fishery. Further, the Working Group recommended that all participants in that fishery return their tag data directly to MRAG at the conclusion of each fishing trip;

(iii) AAD in Australia offered to act as the repository for all tagging data on the Kerguelen Plateau, including Division 58.5.2. Further, the Working Group recommended that all participants in that fishery return their tag data directly to AAD at the conclusion of each fishing trip;

(iv) The Working Group noted that there may be some conflict between Conservation Measure 41-01/C (requiring Members to report all relevant tag data and any tag recaptures to the CCAMLR Data Manager within two months of the vessel departing these fisheries), and paragraphs (i) to (iii) above;

(v) the Working Group noted that a range of different tags have been used by different nations and vessels within some areas, and recommended that the Commission develop a means for coordinating the issue of tags and recording of tags released. The preferred tagging type is a 'T' bar tag (various colours) manufactured by Hallprint Pty, South Australia. Further, that the Secretariat tagging database be updated to record:

(a) the tag types, colours, descriptions (including text), and numbers issued to each vessel for each season;

(b) the tag types, colours, descriptions (including text), and numbers issued to each vessel that were unused at the end of each season;

(c) the repositories and the Commission work to ensure that the tags used within each area by vessels are unique (i.e. the possibility of duplication in the tags issued is minimised);

(vi) during the intersessional period, the feasibility of using numeric validation schemes (e.g. check-digits) be investigated for use on tags;

(vii) during the intersessional period, the use of slings, holding tanks, or other devices for bringing or holding fish on board, be investigated as to their feasibility to ensure that tagged fish can be released in optimum condition. Where appropriate, the tagging guidelines should be amended accordingly at the next meeting of WG-FSA;

(viii) tagging procedures, including 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. Tagging should only be carried out by observers or experienced fishing industry technicians, who have received training in tagging according to the guidelines in the tagging protocol;

(ix) all fish should be double tagged (the Working Group noted that this would likely increase detection rates, be of low additional cost, and allow estimation of the tag loss rate);

(x) for all recaptured tagged fish (i.e. fish caught that have a previously inserted tag) that:

(a) it should not be re-released, even if it was at liberty for only a short period, except in circumstances where this is specifically prescribed within the experimental design of an individual tagging program;

(b) it should be biologically sampled (e.g. length, weight, sex, stage and a photograph of each fish), the otoliths recovered, and the resulting data (including otoliths) be returned as part of the submission of tag–recapture data;

(c) its physical recaptured tags be returned as part of the submission of tag–recapture data;

(xi) the feasibility of a reward system for tag recoveries be considered during the intersessional period;

(xii) the protocol in the *Scientific Observers Manual* be updated to reflect the recommendations of the Working Group. Revision of the protocol will be undertaken and circulated by email. The Working 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 2004/05 season. The protocol should be placed on the Secretariat website as soon as possible.

3.48 Observers would 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. Observers would also be responsible for returning the tags and for the extraction of otoliths from tagged fish. The Working Group noted that all otoliths should be stored in the dark, as some may have been marked with strontium chloride or tetracycline for age validation experiments (WG-FSA-03/80).

3.49 Results from the skate tagging program in Division 58.5.2 (WG-FSA-04/68) indicate that skates moved very little between release and recapture, even after extended periods at liberty. The distances travelled ranged between 0.2 to 7 n miles with periods at liberty ranging from 208 to 822 days. Growth rates estimated from recaptured skates were 20 mm per year in total length, 21 mm per year in disk width and 0.14 kg per year in weight. Recapture rates were 2.5% for *B. eatonii* and 0.8% for *B. murrayi* for skates tagged in the trawl fishery and 0.05% for skates tagged in the longline fishery. In Subarea 48.3 (South Georgia), 55 *Amblyraja georgiana*, ranging in size from 21 to 96 cm (TL), were tagged and released during the groundfish research trawl in 2004 (WG-FSA-04/85). The Working Group recalled that WG-FSA-02/42 indicated more substantial movement in Subarea 88.1, where one fish moved 59 km in 38 days and another 72 km. The smallest distance reported was 7 km.

3.50 The Working Group 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 (paragraph 6.69).

3.51 The Working Group was informed that a tag–recapture program on *D. eleginoides* is being carried out by the National Institute of Fisheries Research and Development (INIDEP, Argentina) from August 2004, within the EEZ of Argentina and in international waters outside the CCAMLR Convention Area. Approximately 500 fish have been tagged to date, and it is expected that about 5 000 fish will be tagged over three years. The objectives of the program are to investigate migration patterns and to provide information for assessment. More information on the program can be found at www.inidep.edu.ar.

Biological parameters

3.52 Six submitted papers provided new biological information of potential use in assessments.

3.53 WG-FSA-04/28 Rev. 1 reported differences in length–mass and other biological parameters for *D. mawsoni* caught north and south of 70°S in Subarea 88.1 based on data from the New Zealand longline vessel *San Aotea II* in the last four fishing seasons. In general, fish in the northern areas were larger, had higher gonadosomatic indices and had a lower condition factor than fish in the southern area. WG-FSA-04/28 Rev. 1 hypothesised that these differences may be due to spawning migration of *D. mawsoni* to the northern seamounts within Subarea 88.1.

3.54 Estimates of age and growth of *A. georgiana* in Subarea 88.1 based on interpretation of caudal thorns were presented in WG-FSA-04/29. Maximum age was estimated to be 14 years, and estimated age at maturity was 6–7 years for males and 8–11 years for females. Age estimates were very uncertain because reading precision was low and because thorn growth may cease in large individuals. The Working Group noted that the relative fast growth rates reported for *A. georgiana* contrasted with the much slower growth by tagged *B. eatonii* in Division 58.5.2 (WG-FSA-04/68).

3.55 WG-FSA-04/67 reported on a preliminary study to validate the annual deposition of growth rings in the otoliths of *D. eleginoides* from Division 58.5.2. As part of the tagging program, fish were injected with strontium chloride, which produces a mark on the otolith. Sixty-nine fish were recaptured after more than a year at liberty and the number of observed annuli, subsequent to the strontium mark, were consistent with the time at liberty. The Working Group agreed that this provided additional validation for toothfish ageing.

3.56 WG-FSA-04/86 used otoliths from pre-recruits and juveniles (trawl survey) and the longline fishery to age *D. eleginoides* from Subarea 48.3, and generated new von Bertalanffy growth parameters. The resulting growth curve had a lower L_∞ and higher k than the curve currently used in assessments. The lower L_∞ was probably the result of sampling fewer large fish. The Working Group agreed that the von Bertalanffy parameters may be appropriate to the growth of young fish and could therefore be used to estimate starting bounds for CMIX analyses, but are not appropriate for projections in the GYM.

3.57 In WG-FSA-04/70 age densities of *C. gunnari* estimated by CMIX were compared with direct ageing from otoliths. Discrepancies were found in the allocation to age classes. The Working Group agreed that there is a need to further investigate the parameters used in CMIX analyses of *C. gunnari* and emphasised the need to develop reliable direct ageing methods.

3.58 WG-FSA-04/10 provided a detailed review of icefish biology, including a review of growth parameters and reproductive parameters.

3.59 At WG-FSA-03 the Working Group asked WG-FSA-SAM to provide advice to the CCAMLR Otolith Network (CON) on what was required for future meetings (SC-CAMLR-XXII, Annex 5, paragraph 12.6). Following discussions at WG-FSA-SAM, the Working Group requested that, for toothfish, CON:

(i) provide all existing age–length data (from otoliths) obtained according to the agreed CON protocols for the active CCAMLR fisheries to the Secretariat;

(ii) if necessary, read additional otoliths from larger fish to provide a suitable sample size (5–10 otoliths per 10 mm length class) of these fish;

(iii) derive age–length keys for different fisheries (and years), including, where possible, estimation of ageing error;

(iv) provide an update on the status of validation of ageing;

(v) provide results of repeat ageing readings (within and between readers) to determine errors in ageing;

(vi) read otoliths from at least one of the trawl surveys in each area to allow the Working Group to develop an age–length key. (This key will be used to evaluate the number of otoliths necessary to carry out the modal decomposition currently being undertaken using CMIX.)

(vii) read otoliths from recaptured tagged fish as appropriate (paragraph 3.47).

3.60 The Working Group also requested that the Data Manager, in consultation with Members, develop further the CCAMLR age database to include the facility for multiple readings and readers, sampling designs (e.g. random or non-random), ring counts as well as ages, source of otoliths and other relevant information, and then to populate the database with the age–length and associated data provided by CON.

PREPARATION FOR ASSESSMENT AND ASSESSMENT TIMETABLE

Report of the Subgroup on Assessment Methods

4.1 The second meeting of WG-FSA-SAM was held at the University of Siena, Siena, Italy, from 5 to 9 July 2004. The Working Group thanked Prof. S. Focardi and his team and the subgroup coordinator, Dr A. Constable (Australia), for such a successful meeting. The meeting was convened by Dr Constable.

4.2 The Working Group noted that the extra day of the meeting and the participation by the Secretariat had greatly helped facilitate the meeting and the preparation of the report.

4.3 The Working Group noted the progress made by WG-FSA-SAM on reviewing methods to estimate recruitment of *D. eleginoides* as requested by the Scientific Committee (SC-CAMLR-XXII, paragraph 4.50; WG-FSA-04/4, paragraphs 2.1 to 2.9), and that submissions on revisions of the recruitment series in Subarea 48.3 have been received by WG-FSA for its meeting this year (WG-FSA-04/82, 04/92). It was noted that the discrepancies in the historical recruitment series for Subarea 48.3 identified at WG-FSA-03 had been identified and resolved. One of the issues now resolved was an unexplained scaling factor which appears to have inflated the density estimates in some of the hauls in some of the surveys used in the CMIX analysis conducted in 1999. It also appears that the 1999 CMIX analyses had used three strata rather than the six that are now used.

4.4 The Working Group also noted that the design of surveys might contribute to increased variation in the recruitment series. This is considered further in paragraph 12.9. The Working Group agreed that further simulation evaluation of survey designs will help identify what is required to robustly estimate the recruitment parameters from a time series of surveys. The Working Group encouraged WG-FSA-SAM to continue examining the issue of survey design.

4.5 The Working Group noted that no further work had been carried out on methods to standardise time series of CPUE (WG-FSA-04/4, paragraphs 2.10 to 2.12). Nevertheless, it noted that it is desirable to establish standard methods, as far as practicable, for use in analysing CPUE from all fisheries in CCAMLR.

4.6 The Working Group was encouraged by the progress made in developing assessments for exploratory fisheries (WG-FSA-04/4, paragraphs 2.13 to 2.20). It noted that an integrated software package, CASAL, provided by New Zealand, may be able to help establish assessments for *D. mawsoni* in Subarea 88.1 in the near future (see also paragraph 4.8).

4.7 The Working Group agreed that Members be requested to submit papers on a long-term management procedure for *C. gunnari* (WG-FSA-04/4, paragraphs 2.21 to 2.25).

4.8 The Working Group noted the substantial progress being made towards the inclusion of acoustic data in the assessments of abundance of *C. gunnari* in Subarea 48.3 (WG-FSA-04/4, paragraphs 2.10 to 2.12).

4.9 The Working Group noted the considerations by WG-FSA-SAM on:

(i) the evaluation of survey designs for *D. eleginoides* and *C. gunnari* (WG-FSA-04/4, paragraphs 3.1 to 3.5);

(ii) the estimation of IUU activities (WG-FSA-04/4, paragraphs 3.9 to 3.11);

(iii) alternative assessment methods for *Dissostichus* spp. including:

   (a) age-structured production models (ASPMs) (WG-FSA-04/4, paragraphs 3.13 to 3.21);

   (b) tagging (WG-FSA-04/4, paragraphs 3.22 to 3.24);

   (c) local depletion experiments (WG-FSA-04/4, paragraphs 3.25 to 3.32);

(iv) plausible operating models for *Dissostichus* spp., including:

   (a) spatial structure of populations (WG-FSA-04/4, paragraphs 3.35 to 3.42);

   (b) growth and mortality (WG-FSA-04/4, paragraph 3.43);

   (c) biomass, egg production and stock-recruitment relationships (WG-FSA-04/4, paragraphs 3.45 and 3.46);

   (d) catch equations and observation models (WG-FSA-04/4, paragraphs 3.47 to 3.50);

   (e) observation models and spatial and temporal distribution of fishing mortality (WG-FSA-04/4, paragraphs 3.51 and 3.52).

4.10 The Working Group noted the consideration by WG-FSA-SAM of the review of the GYM software (WG-FSA-04/4, paragraphs 4.1 to 4.11). Although the purpose of the review is not clearly defined, the Working Group agreed that the primary task, in terms of the software, would be in reference to its 'user-friendliness' and the degree to which users will be able to undertake the existing CCAMLR assessments using the GYM. This is further considered in paragraphs 13.9 to 13.11.

4.11 The Working Group noted that the term 'Generalised Yield Model' now had two meanings, the first of which is in reference to the assessment method for *D. eleginoides*, while the second is in reference to the software used to implement the assessment method. It was noted that the GYM is the current tool to implement the toothfish, icefish and krill assessments. As such, it would be preferable to refer to the assessment of *D. eleginoides* by some other term, such as 'recruitment-based long-term annual yield', which is used in the Standard Method Descriptions (SC-CAMLR-XXI/BG/28). This would mean that the term, GYM, refers to the implementation software for these assessments.

4.12 The Working Group noted the discussion by WG-FSA-SAM of other software, including:

- CMIX (WG-FSA-04/4, paragraphs 4.13 and 4.14)
- AD Model Builder (WG-FSA-04/4, paragraphs 4.15 and 4.19)
- Fish Heaven (WG-FSA-04/4, paragraphs 4.20 to 4.22)
- CASAL (WG-FSA-04/4, paragraphs 4.23 and 4.24).

4.13 The Working Group noted that it had tasked WG-FSA-SAM to develop an assessment timetable for the forthcoming meeting of the Working Group (SC-CAMLR-XXII, Annex 5, paragraph 9.24).

4.14 In this respect, the advice of WG-FSA-SAM on assessments in 2004 was:

(i) The technical and calculation difficulties have been overcome with the survey data of *D. eleginoides* in Subarea 48.3 and, as a result, the assessment of yield for Subarea 48.3 from last year can now be reworked as requested by the Scientific Committee last year (SC-CAMLR-XXII, paragraph 4.73). The subgroup also noted that all other assessments from last year can be undertaken, pending updated data, parameters or other information (WG-FSA-04/4, paragraph 5.2).

(ii) The subgroup had agreed that it is highly desirable for Members to circulate new or revised methods, parameters or other work well before the WG-FSA meeting in order for Members to prepare and review these submissions as much as possible prior to the Working Group meeting. Notwithstanding this, the subgroup agreed that the two-week deadline for submissions to the Working Group was still appropriate (WG-FSA-04/4, paragraph 5.3).

(iii) In reference to the request by WG-FSA for the subgroup to consider the assessment timetable for the coming meeting, the subgroup agreed that WG-FSA should be the body deciding on the assessment timetable and work plan at the Working Group meeting rather than the subgroup. As such, the subgroup agreed to recommend that the Working Group determine the assessment timetable and work plan on the first day of its meeting based on the submission of papers, including subgroup reports, and the agreement of the Working Group to proceed (WG-FSA-04/4, paragraph 5.4).

4.15 The Working Group noted the recommendations of WG-FSA-SAM for future work for developing assessment methods (WG-FSA-04/4, paragraphs 7.1 to 7.10), including:

(i) Recruitment of toothfish –

(a) investigate estimates of error (bias and precision) associated with each observation of each cohort when endeavouring to infer the effects of natural mortality on cohorts (WG-FSA-04/4, paragraph 2.8(iii)(a));

(b) investigate the potential for interannual variations in survey efficiency to influence observed densities of cohorts in each year (WG-FSA-04/4, paragraph 2.8(iii)(b));

(c) an analysis of optimal survey stratification/coverage should be undertaken at South Georgia;

(d) simulation evaluation of alternative survey designs;

(e) simulation analysis of alternative methods of estimating cohort strength, including those that attempt to take account of different catchabilities between surveys (CMIX, age–length key);

(f) development/description of plausible models for toothfish that can be used to develop operating models;

(g) growth of cohorts over time should be investigated, including reference to work on age-determination and the uncertainties in age readings (WG-FSA-04/4, paragraphs 3.6 to 3.8).

(ii) CPUE from toothfish fisheries –

(a) conduct additional research in order to develop a standardised approach to CPUE standardisation in toothfish assessments.

(iii) Assessments for exploratory fisheries –

(a) further develop an integrated stock modelling approach for the assessment of *D. mawsoni* using CASAL (WG-FSA-04/4, paragraph 2.16);

(b) simulation studies should be carried out to determine appropriate spatial and temporal scales for the effort manipulation approach (WG-FSA-04/4, paragraph 2.20);

(c) further simulation studies should be undertaken to determine how assessments for exploratory fisheries can best be used to meet the Commission objectives (WG-FSA-04/4, paragraph 2.20).

(iv) Estimating mortality and total removals of skates and rays –

   (a) development of methodologies using some form of controlled, sentinel fishing so that tag and recapture programs may be used to obtain data on rajids in longline fisheries (WG-FSA-04/4, paragraph 2.46).

(v) Parameter estimation –

   (a) undertake further work on length-at-age in toothfish (WG-FSA-04/4, paragraph 3.6);

   (b) advise CON on the need for age–length data (WG-FSA-04/4, paragraph 3.6);

   (c) develop the CCAMLR age database (WG-FSA-04/4, paragraph 3.7);

   (d) request submission of papers to WG-FSA-04 dealing with apparent inconsistencies between regions in growth and mortality parameters of toothfish and icefish (WG-FSA-04/4, paragraph 3.8).

(vi) Alternative assessment methods for *Dissostichus* spp. –

   (a) request submission of papers to WG-FSA on the following assessment issues:

      • estimation of the level of bias and precision in biomass estimates generated from ASPM, tagging and local depletion assessment methods (WG-FSA-04/4, paragraph 3.32);

      • investigation of the properties of the ASPM using an alternative likelihood function (WG-FSA-04/4, paragraph 3.21);

      • reanalysis of the level of IUU fishing for toothfish in Subarea 48.3 following observed decline in CPUE series between 1995 and 1996;

      • investigation of the spatial stratification of CPUE for toothfish in Subarea 48.3 and the potential for space–time interactions at smaller spatial scales;

      • investigate an appropriate measure of fishing effort to be used within standardised CPUE series for toothfish in Subarea 48.3;

      • comparison of alternative assessment methods for utilising toothfish tagging data within Subarea 48.3, including examination of the properties and assumptions of each method (WG-FSA-04/4, paragraph 3.23);

      • consideration of how to use point estimates of biomass derived from alternative methods to calculate estimates of yield (WG-FSA-04/4, paragraph 3.24);

(b) request the Secretariat to compile comments and reviews by WG-FSA of alternative assessment methods in the past, including ASPM, depletion experiments and mark–recapture analyses (WG-FSA-04/4, paragraph 3.15);

(c) the subgroup encouraged Members to further develop operating models for toothfish and their use in evaluation of assessment methods and management procedures and to submit papers elaborating on potential functional forms and/or components of plausible models to WG-FSA-04 and WG-FSA-SAM-05 (WG-FSA-04/4, paragraph 3.53);

(d) investigate the use of an integrated stock modelling approach to the assessment of toothfish using CASAL (WG-FSA-04/4, paragraph 4.23, noting paragraph 5.5(ii)).

(vii) Assessments of *C. gunnari* –

(a) encourage Members to submit papers on the development of long-term management procedures for consideration by WG-FSA at its next meeting (WG-FSA-04/4, paragraph 2.25);

(b) to use the results of acoustic data, the following areas need to be addressed (WG-FSA-04/4, paragraph 2.39(ii)):

- discrimination of *C. gunnari* from other acoustic scatterers;
- further improvements in target strength estimates for *C. gunnari*;
- age-specific patterns in daily vertical distribution of *C. gunnari*;

(c) experimental and simulation studies will be useful in determining the appropriate design of trawl and acoustic surveys, including the use of target trawls, for use in assessments of icefish biomass (WG-FSA-04/4, paragraph 3.2).

(viii) Software –

(a) request the Secretariat to obtain information on the procedures used by RFMOs for adopting assessment software;

(b) task the Convener of WG-FSA, the Coordinator of WG-FSA-SAM and the Data Manager to submit a paper to WG-FSA-04 that develops options on procedures to review and validate software used by CCAMLR;

(c) recompile the FORTRAN version of CMIX so that it may be run under Windows XP (WG-FSA-04/4, paragraph 4.13) and has the flexibility to increase the number of minimisation evaluations able to be performed and that the performance of the new version is validated against the old version;

(d) acquire a single-user licence for AD Model Builder (and add-ons) (WG-FSA-04/4, paragraph 4.19).

(ix) Other work –

(a) request that WG-EMM consider the issues associated with discriminating between *C. gunnari* and krill in acoustic surveys in Subarea 48.3 and whether the estimates of density and abundance of krill in this area may need to be revised (WG-FSA-04/4, paragraph 2.36);

(b) request that the Scientific Committee consider how papers from non-Members be received and utilised by its working groups (WG-FSA-04/4, paragraph 3.54).

4.16 The Working Group thanked WG-FSA-SAM for its report and noted the need to further consider the role of the subgroup into the future.

Status of assessment methods

4.17 The Working Group received a number of papers with elements contributing to assessment methods for this meeting.

4.18 WG-FSA-04/65 reported that a new version of the CMIX program had been compiled with the aim to enable it to run under the most recent version of the Microsoft Windows operating system. The paper outlined the results of comparisons in performance between the new and the old version. The recompiled version of CMIX produces very similar results as compared with the original version and the differences are unlikely to result in significant differences in the estimate of long-term yield of *D. eleginoides*.

4.19 The Working Group agreed that the new version of CMIX could be used for assessments in place of the older version.

4.20 WG-FSA-04/69 presented the application of the bootstrap method to estimate accuracy of mixture distribution parameters. The method allows estimating statistical characteristics of all the parameters in CMIX procedure as well as possible correlation between parameters and bias in estimates. The application of this method to data from the UK survey in 2002 shows that accuracy of mean component length is high (CV ~0.04), but total densities have CV ~0.3–0.5. CV of parameters of linear equations used to calculate the standard deviations of the mixture components is more than 1.0. The calculations show a high correlation between some parameters. Standard errors of densities exceed the values calculated by the original CCAMLR program.

4.21 WG-FSA-04/74 investigated the design of random stratified trawl surveys as a source of information for assessments of long-term sustainable yield using the GYM for *D. eleginoides* in Division 58.5.2. The simulation approach was utilised to investigate the influence of survey design on recruitment estimation of *D. eleginoides*. The implementation includes an operating model that describes population dynamic in time with a habitat model determining the distribution and assumed ontogenetic pattern of movement to deeper water with age. The observational model consisted of ‘research vessels’ and ‘commercial vessels’. The survey is simulated by ‘research vessels’ according to the specified survey design. The habitat model and observational models were implemented in Fish Heaven, a spatial simulation modelling package.

4.22 The simulations were aimed at evaluating the estimation of age-4 recruitment from direct survey estimates of ages 4 to 8 in consequent years. Optimum allocation of 111 trawl stations gave the average a percentage confidence interval of ±26.8%. Combining data from multiple surveys to estimate age-4 recruitment reduced the percentage confidence interval to ±14% and the option of sampling every second year gave a percentage confidence interval of ±19.8%.

4.23 The improved design of the trawl survey (WG-FSA-04/74) was used during the survey carried out in May 2004 in the Heard Island Plateau (Division 58.2.2). The estimates of age-4 recruitment were used to update recruitment series for a preliminary assessment of toothfish in this division (WG-FSA-04/76). The assessment was based on biological, fishery and simulation parameters identical to those used in the WG-FSA-03 GYM projection with updated catch history.

4.24 Preliminary assessment of *C. gunnari* in Division 58.5.2 based on the survey in the vicinity of Heard Island in May 2004 is presented in WG-FSA-04/77. The distribution of trawl stations between strata was changed according to the results of a review of historical survey data. The assessment was carried out using the method described by de la Mare et al. (1998) and using the GYM for short-term projection as had been done with the assessment of *C. gunnari* in Subarea 48.3.

4.25 WG-FSA-04/78 presented the preliminary assessment results of *C. gunnari* in Subarea 48.3. The assessment was based on the data from the UK trawl acoustic survey carried out in the South Georgia and Shag Rocks area in January–February 2004, but only bottom trawl survey data were used in calculations. The assessment used the standard methods based on bottom trawl survey data (de la Mare et al., 1998) and the GYM for short-term projection.

4.26 WG-FSA-04/91 presented information regarding the last modification of the GYM. This modification corrected a limitation in the use of cohorts more than one year younger than the recruitment age estimated from recruitment surveys. This limitation could result in an error in the alignment of the recruitment series with the fishing series. It was detected during the review of the methods for estimating the time series of recruitments of *D. eleginoides* for WG-FSA in 2004. The error does not affect the assessment in recent years and was corrected with a new version of the GYM now being available. The Working Group agreed that the new version should be used in assessment work this year.

4.27 WG-FSA-04/82 described the results of application of some methods to assess the state of the toothfish stocks in Subarea 48.3, among which three methods are fishery-dependent and one is fishery-independent:

(i) Traditional assessment based on the GYM application which utilised revised estimates of time series of recruitment and revised standardised CPUE series rapidly ran out of fish and resulted in 35 and 42% of the trials' estimates having a vulnerable biomass that is lower than the catch.

(ii) The ASPM model implemented the Brandão et al. (2003) in the AD Model Builder version that maximises a weighted combination of the CPUE trends and catch-length compositions failed to produce satisfactory fits with any weighted factor.

(iii) The tagging analysis based on Petersen estimates (Seber, 1985) gives the estimates of exploitable biomass for 2002, 2003 and 2004.

(iv) The local depletion method was not completed but the preliminary work is preserved, including the examination of the regression of initial CPUE on toothfish density.

4.28 The authors stated that the most consistent assessment appears to be that based on tagging data. The authors scaled the recruitment survey results keeping the CV for recruitment constant so that the median vulnerable biomass in the GYM projection corresponded with the mark–recapture estimates.

4.29 WG-FSA-04/92 investigated some inconsistencies in toothfish recruitment estimates identified at WG-FSA-03 and noted by the Scientific Committee to be considered in reviewing and evaluating the recruitment time series for *D. eleginoides* in Subarea 48.3. These inconsistencies include the problems of how to use the length-at-age information in CMIX analyses, which age groups should be included in the estimation of recruitment, and the influence of variations in catchability and elaboration of the set of decision rules to guide those attempting CMIX analyses. The investigation was carried out using a recompiled version of the CMIX program. The authors highlighted the sensitivity of the results to the length-at-age estimates used to guide the setting of parameters in CMIX. As such, they recommended that length-at-age be quickly resolved for *D. eleginoides* in Subarea 48.3. The investigation of the effects of excluding components and surveys on recruitment resulted in recommendations to exclude fish greater than 650–700 mm and include fish from 150 mm to that upper limit. On the basis of the work, six points were prepared as a checklist for proceeding in the process of estimating the time series of recruitments for toothfish.

New assessment methods

4.30 WG-FSA-04/25 presented two alternative toothfish CPUE analyses for Subarea 88.1 for the 1998 to 2003 seasons which update the preliminary analysis carried out in 2003. Estimates of relative year effect were obtained by GLM with fixed effect only and from a mixed-effect model following Candy (2003). Variables included in the analysis describe 35–46% of variation. Model diagnostics show a reasonable pattern in residuals, but the quantile-quantile plots indicate a deviation from the normal distribution. This suggests that extreme values of catch rate were not modelled well and there may be violations of model assumptions. The CPUE indices showed consistent trends in all models with a slight decline in 2001 and a large decline in 2004.

4.31 WG-FSA-04/36 described the conceptual approach to the new version of integrated assessment CASAL – C++ Algorithmic Stock Assessment Laboratory. It is a generalised stock assessment model, modelled either on age- or length-structured fishery population. Optionally, it also structured population by sex and maturity and takes into account growth. The data can be from different sources: fishery, survey or fishery biomass indices, survey proportion-at-age or proportion-at-size, mark–release observations. It generates either point estimates of the parameters (maximum posterior density or maximum likelihood) or can generate Bayesian posterior distribution using Monte Carlo Markov Chain methods. The projection stock status in the future can be based on deterministic or stochastic recruitment and can generate a number of yield measures commonly used in stock assessments. The CASAL model can be employed as an operating model simulator allowing investigation of model performance and assessing the impact of model misspecification. The model has been applied to the assessment of *D. mawsoni* in the Ross Sea. This is further discussed under Item 12.

4.32 WG-FSA-04/37 presented the further application of the ASPM which had been used to assess the state of the stock of *D. eleginoides* in the Prince Edward Islands vicinity in the last several years. This version of the model allows describing recruitment by the Beverton–Holt stock-recruitment relationship, with annual variations each treated as an estimable parameter and assumed to be lognormally distributed. The likelihood function used standardised CPUE time series and length frequencies of the catches with relative weights. The results obtained with updated data are very similar to the previous estimates and show high sensitivity to the weight multiplier used in the log likelihood objective function.

4.33 WG-FSA-04/75 presented the implementation of the exact time of release and recapture stock assessment models of Tuck et al. (in AD Model Builder) The previous version was applied to the stock of *D. eleginoides* at Macquarie Island. Recently Dr Tuck implemented the maximum likelihood estimation in AD Model Builder software. Now this software has been kindly made available to the Working Group by Dr Tuck. The paper contains descriptions of input and output files with the aim of facilitating usage of this software by members of WG-FSA-04.

Stock structure

4.34 Several papers investigated stock structure of species in different subareas. WG-FSA-04/21 contained the results of genetic structuring of the *D. eleginoides* population in the southwest Atlantic. Mitochondrial DNA data indicate a sharp genetic division between the Patagonian Shelf/North Scotia Ridge and Shag Rocks/South Georgia samples. The authors suggested that toothfish in the extreme west of Subarea 48.3 may not be from the same stock as those around Shag Rocks and South Georgia.

4.35 The same method as in the previous paper, mitochondrial DNA, and another one, introns, were used in WG-FSA-04/32 to determine genetic relationships among *D. mawsoni* from three CCAMLR areas – Subareas 48.1 and 88.1 and Division 58.4.2. It resulted in the recommendation that the Ross Sea *D. mawsoni* be treated as a separate stock unit.

4.36 Population structure of *C. gunnari* in the South Georgia area was investigated in WG-FSA-04/40. Analysis was based on the length and age structure of icefish and on the sample of morphometric measurements of 75 specimens with an average length of 22 to 23 cm, collected from different points of the area. The set of measurements includes 33 parameters. Each record in the sample refers to one of the three subdivisions: Shag Rocks and the western and eastern parts of South Georgia. There was also a sample of icefish otolith morphology data. The results obtained provide the basis to assume that the *C. gunnari* population in the South Georgia area is the major reproductive unit of the area while the shallow Shag Rocks area is a zone of life space extension or the feeding zone.

4.37 The Working Group agreed that *D. eleginoides* in Subarea 48.3 should be separated into three parts for the purposes of assessment and management. It recommended that the assessment only be applied to the area around Shag Rocks/South Georgia and that Maurice Ewing Bank to the north and the North Scotia Ridge in the west be considered as separate areas for which the Working Group does not have any information (Figure 5.5 in TOP 48.3 Fishery Report).

Assessment timetable

4.38 In order to help WG-FSA in its deliberations on the assessment timetable, Dr Constable provided an overview of the possible assessment work, the issues raised by WG-FSA-SAM and the Scientific Committee and the papers available to the meeting.

4.39 The following points were noted concerning the assessments this year:

(i) It was agreed that assessments would be undertaken according to the decision rules adopted by the Commission.

(ii) WG-FSA-SAM had been meeting intersessionally in order for it to review assessment methods prior to implementation by WG-FSA, thereby saving time at the Working Group meeting.

(iii) Evaluation of methods includes:

(a) the validation of the implementing software, scripts or worksheets
(b) examination of the methods to see that the assumptions are met
(c) simulation evaluation of the robustness of consequent advice with respect to CCAMLR objectives.

(iv) It was noted that the Working Group needs to consider what constitutes an adequate evaluation in order for the Working Group to use a method in its assessment work and in developing its advice to the Scientific Committee. This was referred to the general discussion in Item 12.

(v) This year, it was agreed to give attention to validating the implementation of methods submitted in papers to the Working Group as well as testing the assumptions of methods if possible. This would include sensitivity analyses.

4.40 This year, all the assessment work was undertaken with submitted preliminary assessments reviewed independently in consultation with the authors. The outcomes of the assessments were reported in the new Fishery Reports.

ASSESSMENTS AND MANAGEMENT ADVICE

New and exploratory fisheries

5.1 CCAMLR-XXIII/38 addressed the Commission's request that the Secretariat develop a procedure for forecasting closures in SSRUs (CCAMLR-XXII, paragraph 9.20). Key points of relevance to WG-FSA were summarised by Dr Ramm. WG-FSA noted that in 2003/04 the Secretariat had monitored 155 catch limits. A number of difficulties had been encountered while monitoring, and these had resulted in eight instances where catches exceeded their catch limits (over-runs). Factors which contributed to the over-runs included rapid changes in fishing pattern; the late submission of catch and effort reports; difficulties in forecasting closures in SSRUs, time lags and small catch limits, failure to monitor all by-catch species codes, and an unexpected communication problem between the Secretariat, a Member and its flagged vessels. As a result, the Secretariat had identified a number of changes which may improve the monitoring and management of CCAMLR fisheries.

5.2 The Working Group noted that the paper had implications for management which were not within the remit of Working Group. Those aspects of the paper however that would impact on the work of WG-FSA were discussed; particularly the issue of large numbers of vessels fishing in SSRUs which might impact on the ability of the Working Group to adequately interpret CPUE data and also affect the efficacy of the move-on rule to limit by-catch in the fishery.

5.3 The Working Group noted that there were alternative options for managing catch limits in SSRUs that could also be examined, such as:

- improving the forecasting methods for predicting closure
- multi-year catch limits
- open/closed SSRUs.

5.4 SC-CAMLR-XXIII/7 by the Delegation of Ukraine proposes amending a number of conservation measures that relate to exploratory *Dissostichus* spp. fisheries in Subarea 88.1 (Conservation Measure 41-09), Division 58.4.2 (Conservation Measure 41-05) and Division 58.4.1 (Conservation Measure 41-11).

5.5 SC-CAMLR-XXIII/7 stated that the proposed amendment to Conservation Measure 41-09 in Subarea 88.1 is based on the assumption that an error was made in the allocation of catch limits for *Dissostichus* spp. between SSRUs in Subarea 88.1 because 'the historical fishery data used were principally those for the year in which the fishery was conducted only by New Zealand which fished virtually throughout the whole of the Ross Sea because of the abnormally warm summer'.

5.6 The Working Group noted that this was incorrect, pointing out that the analysis to estimate fish density in each SSRU was based on the total catch of *Dissostichus* spp. divided by total effort by all vessels in each SSRU over the history of the fishery using a data extract made by the Secretariat during WG-FSA in 2003 (SC-CAMLR-XXII, paragraph 5.37). Thus, the allocation of catch limits already fulfils suggestion 3 of SC-CAMLR-XXIII/7, namely that one of the main criteria for allocating catch limits between SSRUs should be average CPUE from historical fishery data for all vessels.

5.7 The amendment to Conservation Measure 41-05 proposed in SC-CAMLR-XXIII/7 suggested:

(i) Australia provides a report on the implementation of paragraph 3 of Conservation Measure 41-05;

(ii) the deletion of paragraph 3 of Conservation Measure 41-05 based on the 'triviality of the argument for the protection of benthic communities' and 'taking into consideration the large numbers of vessels and uncertain ice conditions';

(iii) setting a catch limit for each SSRU in Division 58.4.2 of at least 500 tonnes of *Dissostichus* spp., i.e. no less than 2 500 tonnes for the whole division;

(iv) to allow only one vessel from each country to fish in the division during the forthcoming season;

(v) to allow each vessel to harvest no more than 200 tonnes of fish in each SSRU in Division 58.4.2.

5.8 The amendment to Conservation Measure 41-11 proposed in SC-CAMLR-XXIII/7 suggested:

(i) the deletion of paragraph 3 of Conservation Measure 41-11 based on the 'triviality of the argument for the protection of benthic communities' and 'taking into consideration the large numbers of vessels and uncertain ice conditions';

(ii) a catch limit of not more than 150 tonnes of *Dissostichus* spp. be set for each SSRU in Division 58.4.1, i.e. no less than 1 200 tonnes for the whole division;

(iii) to allow only one vessel from each country to fish in the division during the forthcoming season;

(iv) that each vessel be allowed to harvest no more than 70 tonnes of fish in each SSRU in Division 58.4.1.

5.9 Dr Constable noted that Australia had provided a report to WG-FSA this year on its fishing activities in Divisions 58.4.2 and 58.4.3b (WG-FSA-04/66). Additionally, research trawls in Division 58.4.2 by Australia had demonstrated that there were significant benthic communities present in waters shallower than 600 m which would be likely to be negatively impacted on by commercial fishing. In addition, recent video footage taken during a research cruise in Prydz Bay (Division 58.4.2) showed substantial abundance and diversity of benthic communities on the shelf areas.

5.10 For operational reasons related to ice conditions in high latitudes and in order to fulfil requirements in terms of research sets, it may be necessary to have the entire (10°) SSRU either open or closed rather than half the SSRU, consistent with the approach adopted for Division 58.4.1 at CCAMLR-XXII (Conservation Measure 41-11).

New and exploratory fisheries in 2003/04

5.11 Ten conservation measures relating to 12 exploratory fisheries were in force during the 2003/04 season, but fishing only occurred in respect of five measures and five fisheries. There was no reported fishing activity with respect to the following areas: Subarea 48.6 south of 60°S, Divisions 58.4.1 and 58.4.3a (Table 5.1).

5.12 Fishing occurred only with respect to the following fisheries: Subarea 48.6 north of 60°S (7 tonnes), Divisions 58.4.2 (20 tonnes), 58.4.3b (7 tonnes), Subareas 88.1 (2 166 tonnes) and 88.2 (375 tonnes) (Table 5.1). Fishery Reports have been prepared for Subareas 88.1 and 88.2 as these were the only two areas with significant levels of fishing activity.

Table 5.1: Summary table for exploratory fisheries in 2003/04.

Exploratory fisheries in Area 48 (Atlantic Ocean sector)

Subarea/Division	Member	Number of vessels		Reported catch (tonnes) of *Dissostichus* spp.
		Notified	Fishing	
48.6 north of 60°S	Argentina	2	0	
	Japan	1	1	
	Namibia*	6	0	
	New Zealand*	3	0	
	South Africa*	2	0	
	Spain	1	0	
Total	6	15	1	7
48.6 south of 60°S	Argentina	2	0	
	Namibia*	6	0	
	New Zealand*	3	0	
	South Africa*	2	0	
	Spain	1	0	
Total	5	14	0	0

* Withdrawn

Exploratory fisheries in Area 58 (Indian Ocean sector)

Subarea/Division	Member	Number of vessels		Reported catch (tonnes) of *Dissostichus* spp.
		Notified	Fishing	
58.4.1	Argentina	2	0	
	Australia	1	0	
	Namibia*	1	0	
	USA	2	0	
Total	4	6	0	0
58.4.2	Argentina	2	0	
	Australia	3	1	
	Namibia*	2	0	
	Russia	4	0	
	Ukraine	2	0	
	USA	2	0	
Total	6	15	1	20

(continued)

Table 5.1 (continued)

Subarea/Division	Member	Number of vessels		Reported catch (tonnes) of *Dissostichus* spp.
		Notified	Fishing	
58.4.3a	Argentina	2	0	
	Australia+	3	0	
	Namibia*	2	0	
	Russia	4	0	
	Ukraine	2	0	
	USA	2	0	
Total	6	15	0	0
58.4.3b	Argentina	2	0	
	Australia	3	1	
	Namibia*	2	0	
	Russia	4	0	
	Ukraine	2	0	
	USA	2	0	
Total	6	15	1	7

* Withdrawn + Trawl notification withdrawn

5.13 In most of the active exploratory fisheries, the fishing effort was low and the catches reported were relatively small. As has been the case for the last few years, the notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 41-09. A total of 2 166 tonnes of *Dissostichus* spp. was taken against a catch limit of 3 250 tonnes (paragraphs 5.50 to 5.53 and Table 5.2).

5.14 The total catch limit of 375 tonnes was taken solely by New Zealand in the exploratory *Dissostichus* spp. fishery in Subarea 88.2 (paragraph 5.56 and Table 5.3).

5.15 The exploratory fishery in Division 58.4.2 was undertaken by one Australian-flagged vessel which caught 20 tonnes of *Dissostichus* spp. against a catch limit of 500 tonnes. Fishing was carried out in SSRUs D and E (WG-FSA-04/66).

5.16 An exploratory fishery in Division 58.4.3b was undertaken for the first time by one Australian-flagged vessel which caught 7 tonnes of *Dissostichus* spp. against a catch limit of 300 tonnes (WG-FSA-04/66).

5.17 The exploratory fishery in Subarea 48.6 (north of 60°S) was undertaken by one Japanese-flagged vessel which caught 7 tonnes against a catch limit for *Dissostichus* spp. of 455 tonnes.

5.18 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. An extract of fine-scale data of vessels fishing in new and exploratory fisheries prepared by the Secretariat during the meeting was analysed by vessel and SSRU. The Working Group welcomed the results from some vessels which exceeded their required quota of research sets. However there were a number of instances (17%) where vessels failed to complete any research sets. There were also many cases where a vessel conducted some research sets but failed to complete the required quota (11%) even though more commercial sets were completed. Thus, in 28% of cases the required number of research sets were not completed as required under Conservation Measure 41-01. The Secretariat noted that it is unable to determine whether the above cases are because research sets were not done or because they were not submitted or specified correctly as research sets. The Working Group reiterated the necessity for submission of data under Conservation Measure 41-01 and urged Members to ensure that the required research sets are completed and data submitted to the Secretariat in a timely manner and accurate format.

5.19 An additional requirement specified in Conservation Measure 41-01 is that each longline vessel fishing in exploratory fisheries for *Dissostichus* spp. is required to tag and release *Dissostichus* spp. at the rate of one toothfish per tonne of green-weight catch throughout the season. Only six vessels out of 26 vessels fishing have reported tagging *Dissostichus* spp. in new and exploratory fisheries. The numbers of toothfish tagged by these six vessels were 4, 11, 9, 4, 49 and 216 respectively. There was not enough time available at the meeting to determine how these tag rates corresponded to the catch weight of *Dissostichus* spp. and whether they fulfilled the requirements of Conservation Measure 41-01. In addition, the Secretariat noted that there was reference to tagging in some observer reports from other vessels but that no tagging data was submitted. The Working Group noted its concern that the tagging requirements, as specified in Conservation Measure 41-01, were not being met by all vessels. It reiterated the importance for Members to conduct tagging and to submit data in accordance with Conservation Measure 41-01.

5.20 The Working Group noted that some sets or hauls reported as commercial data may meet the requirements of a research set/haul if they were separated by the required minimum distance, included the required number of hooks and satisfied the required soak time/effective fishing time. The Working Group suggested that the Secretariat could investigate methods for identifying sets that matched the criteria of the research plan under Conservation Measure 41-01 (e.g. 'Data Loser' (SC-CAMLR-XX, Annex 5, paragraph 4.31) although additional algorithms that incorporated soak time and number of hooks would need to be included). This data could then be used to investigate the spatial distribution of fishing effort/catch rates.

5.21 WG-FSA requested advice from the Scientific Committee regarding presentation of the data on research sets and tagging rates completed by Members as required under the Research and Data Collection Plan in Conservation Measure 41-01.

New and exploratory fisheries in 2004/05

5.22 A summary of new and exploratory fisheries notifications for 2004/05 is given in Table 1 of SC-CAMLR-XXIII/BG/3.

5.23 No notifications have been received from Members for exploratory fisheries in closed areas.

5.24 No notifications have been made for new fisheries.

5.25 Thirteen Members submitted a total of 26 notifications for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1, 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b.

Notification for exploratory bottom trawling in Subarea 48.3

5.26 There was one notification for an exploratory bottom trawl fishery for *C. gunnari* in Subarea 48.3. Although not strictly requiring notification under the exploratory fishery measure (Conservation Measure 21-02), WG-FSA welcomed the submission of this proposal for the group's consideration.

5.27 Concern about by-catch of fish species such as *Chaenocephalus aceratus*, *Pseudochaenichthys georgianus*, or *Gobionotothen gibberifrons*, had initially led to the prohibition on the use of bottom trawls in the directed fishery for *C. gunnari* in Subarea 48.3.

5.28 Dr D. Agnew (UK) explained that the motivation behind the proposal for an exploratory bottom trawl fishery in Subarea 48.3 (CCAMLR-XXIII/16) was to find a method of fishing, combining both bottom and midwater trawls that would reduce the impact of the icefish fishery on birds while minimising, as far as possible, impacts on benthos. The proposal formed part of industry initiatives to reduce bird by-catch, including trials of the various mitigation measures detailed in paragraphs 7.218 to 7.220. The icefish fishery in Division 58.5.2 successfully uses bottom trawls with low adverse impacts on benthos, other fish or birds, and the proposal intended to make use of the experience and gear technology currently being employed in that division in application to Subarea 48.3.

5.29 The exploratory fishery would undertake rigorous monitoring of benthic impacts and fish by-catch during bottom trawls and seabird interactions throughout. By-catch of fish would be counted against the catch limits in Conservation Measure 33-01. The proposal analysed the distribution of sensitive benthos (sponges and corals) encountered in the UK bottom trawl surveys, finding that they were most abundant in the east of the South Georgia shelf. The proposal defined an area for the bottom trawl fishery to avoid these concentrations, restricting it to the west and northwest of the shelf.

5.30 Some members felt that it would be very difficult to assign certain fishing areas to a commercial fishery in advance. Any commercial fishery is likely to move to areas where fish concentrations are being found irrespective if it is in the west or the east of the island. Dr Agnew confirmed that the vessel would not be permitted to fish with bottom trawls outside the defined area.

5.31 Some members were concerned that bottom trawling in this area would cause undue damage to by-catch species and benthic communities, at least locally, even if a light ground tackle is used. They advised against any bottom trawl fishery for icefish in Subarea 48.3. These members felt other mechanisms for reducing seabird mortality should be investigated, and that bottom trawling should not be resumed at the current state.

5.32 Dr C. Jones (USA) noted that in his opinion the maps of abundance and composition of benthic invertebrates from the ICEFISH 2004 cruise (WG-FSA-04/61) largely conflicted with the benthos impact maps set out in the UK notification. The ICEFISH cruise demonstrated sponge dominated communities on the northern and eastern shelf areas that were consistent with the results from the UK surveys. The ICEFISH cruise found also that the western part of the shelf in the proposed bottom trawling areas contained areas with high abundance of invertebrate communities that, although dominated by echinoderms, included abundant hexactinellids (glass sponges) and corals. In contrast, the UK fish surveys found sparse to absent 'key benthic species' in this area.

5.33 Dr Agnew commented that the differences between the benthos distribution data presented in CCAMLR-XXIII/16 and WG-FSA-04/61 were probably due to sampling method and survey design. The UK bottom trawl surveys covered a much wider area and undertook more hauls than the ICEFISH 2004 cruise (WG-FSA-04/61), but the latter used gear that fished closer to the seabed.

5.34 Given the fact that the design of the ground tackle and other parts of the front end of the net may have a significant effect on the ability of the net to catch benthos and non-target species, Dr K.-H. Kock (Germany) suggested that in undertaking such an assessment, the involvement of a gear technology specialist would be useful.

5.35 Another reason why some members were opposed to the resumption of bottom trawling in Subarea 48.3 was the potential for negative impacts on fish by-catch. A recently discovered nest-guarding parental care strategy used by *C. aceratus* is presented in WG-FSA-04/26. This species, as well as others that exhibit this strategy of parental care, would be seriously impacted by fishing techniques that damage the seabed, such as bottom trawling at the time *C. aceratus* and possibly other species guard their nests.

5.36 Dr Agnew pointed out that *C. aceratus* spawn in March–May at South Georgia (Kock, 1992) which is likely to be after the experimental bottom trawl fishery. By-catch limits are set for *C. aceratus* in Conservation Measure 33-01.

5.37 The Working Group recognised that in order to assess the likely impact of a future bottom trawl fishery on benthos, it would be necessary for the experimental fishery to obtain information on benthos over a significant part of the proposed area. It recalled the method for exploring the potential impacts of bottom trawling in new and exploratory fisheries undertaken in Division 58.4.2 (Conservation Measure 43-04). The Working Group considered that the rockhopper gear that would be used might not sample benthos efficiently. It recommended that the vessel should undertake experimental work by deploying a trawl that could fish closer to the bottom, such as a beam trawl, in order to better sample benthos. Such work should be sufficient to provide coverage of the area to determine how effectively the rockhopper gear retains by-catch of benthos as well as to indicate the relative abundance of benthos in the areas most likely to be fished into the future compared to other areas.

5.38 Some members recommended that an assessment of the potential for a bottom trawl fishery for icefish in Subarea 48.3 should be made following the conclusion of the experimental fishery. This assessment should consider the potential contribution of bottom trawling to minimising the by-catch of birds in the icefish fishery, as well as the impacts on benthos and mitigation of those impacts. The UK was requested to ensure that the data collected were sufficient to enable this analysis.

5.39 Other members felt that it would be unwise to embark on the reintroduction of any bottom trawling in Subarea 48.3.

Notifications for exploratory *Dissostichus* spp. fisheries

5.40 The numbers of vessels notified for exploratory fisheries for *Dissostichus* spp. in 2004/05 are shown, grouped by subarea or division, in Table 2 of SC-CAMLR-XXIII/BG/3.

All notifications were submitted by the deadline. As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions.

5.41 In 2003, the Commission introduced a cost recovery system in new and exploratory fisheries. It was agreed that a payment of A$8 000 should accompany each notification of a new and exploratory fishery (CCAMLR-XXII, paragraphs 3.16 to 3.23). This payment consists of a fee of A$3 000, representing the recovery of administrative costs, and a sum of A$5 000 to be refunded on commencement of fishing in accordance with the conservation measures in force.

5.42 There have been a very large number of notifications for fishing in Subareas 88.1 (10 notifications for up to 21 vessels), 88.2 (five notifications for up to 10 vessels) and Subareas 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3b (between 7 and 11 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.

5.43 The large number of notifications for exploratory fisheries, if translated into a large number of vessels fishing, may lead to issues with the standardisation of CPUE data for assessments (WG-FSA-04/25; Fishery Report for Subareas 88.1 and 88.2, paragraph 5.68) and may also reduce the effectiveness of the move-on rule for by-catch (paragraphs 6.72 and 6.73).

5.44 The Working Group noted that it is likely that there will be additional administrative problems in determining closure dates for fishing in SSRUs when many vessels are fishing simultaneously in a subarea or division (CCAMLR-XXIII/38).

5.45 WG-FSA-04/18 summarised a proposal by the Delegation of Japan to extend the fishing season for the exploratory fishery for *Dissostichus* spp. in Subarea 48.6 in the 2004/05 season. The fishing season is defined under Conservation Measure 41-04 (2003) as being 'from 1 March to 31 August'. The proposed extension would change this definition to 'from 1 December to 31 August'. This proposal is discussed under Item 7 where it was noted that it does not conflict with the IMAF assessment (paragraphs 7.193 to 7.196 and Table 7.16).

5.46 SC-CAMLR-XXIII/BG/19 proposed conducting an experimental set-up of combined bottom-vertical longlines for the exploratory fisheries for *D. mawsoni* in Subareas 88.1 and 88.2 in order to determine whether *D. mawsoni* occur in the meso- and bathypelagic areas. The Working Group encouraged work of this kind and noted that this experiment should be conducted within the guidelines of existing conservation measures and noted that there may be implications for IMAF depending on the sink rate of lines and whether hooks were set at the surface. In addition, the Working Group noted that if the objective is to estimate the depth range at which *Dissostichus* spp. may be caught, then a series of longlines could be set, each longline with hooks in a particular depth band. If each line has hooks at all depths then fish may follow the 'food trail' up the longline thus confounding results.

Progress towards assessments of new and exploratory fisheries

5.47 The Working Group was unable to develop management advice based on assessments of yield and is therefore unable to provide any new advice on catch limits for any of the exploratory fisheries.

5.48 Given the large number of notifications for the 2004/05 fishing year, the Working Group reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status for exploratory fisheries.

5.49 WG-FSA-04/36 and WG-FSA-SAM-04/8 detailed methods and approaches that might be used to monitor abundance and estimate precautionary yields. These issues, in relation to progress towards an assessment in Subarea 88.1 and future research requirements, are discussed in detail in the Fishery Report for Subareas 88.1 and 88.2, paragraphs 5.69 to 5.75.

Fishery Report: Exploratory fishery for *Dissostichus* spp. in Subareas 88.1 and 88.2

1. Details of the fishery

1.1 Reported catch

5.50 The number of vessels active in fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2 during the current year is shown in Tables 5.2 and 5.3 respectively.

Table 5.2: Number of vessels authorised in Conservation Measure 41-09, number of vessels that fished, and the catch of *Dissostichus* spp. in Subarea 88.1 in 2003/04 (source: catch and effort reports).

Member	Vessels authorised in CM 41-09	Number of vessels that fished	Reported catch (tonnes)		
			D. mawsoni	*D. eleginoides*	Total
Argentina	2	2	162	1	163
Japan	1	0	0	0	0
Korea, Rep. of	2	2	114	0	114
New Zealand	6	4	729	1	729
Norway	1	1	98	0	98
Russia	2	2	283	0	283
South Africa	2	1	110	0	110
Spain	2	1	114	0	114
Ukraine	3	3	153	9	162
UK	1	1	16	0	16
USA	2	2	185	1	187
Uruguay	2	2	190	0	191
Total	26	21	2154	12	2166

Table 5.3: Number of vessels authorised in Conservation Measure 41-10, number of vessels that fished, and the catch of *Dissostichus* spp. in Subarea 88.2 in 2003/04 (source: catch and effort reports).

Member	Vessels authorised in CM 41-10	Number of vessels that fished	Reported catch (tonnes)		
			D. mawsoni	*D. eleginoides*	Total
Argentina	2	0	0	0	0
Korea, Rep. of	2	0	0	0	0
New Zealand	6	3	374	<1	375
Norway	1	0	0	0	0
Russia	2	0	0	0	0
South Africa	2	0	0	0	0
Ukraine	3	0	0	0	0
Total	18	3	374	<1	375

5.51 The catch limit for Subarea 88.1 was 3 250 tonnes, and for Subarea 88.2 was 375 tonnes.

5.52 The fishery was active from 1 December 2003 to 31 August 2004 for Subarea 88.1, and 1 December 2003 to 6 March 2004 for Subarea 88.2.

5.53 The fishery saw a steady expansion of effort from 1997/98 to 2000/01, a slight drop in 2001/02, followed by an increase in 2002/03, and an almost three-fold increase in 2003/04. The catch of *D. mawsoni* has shown a steadier increasing trend over the same period, peaking at 2 166 tonnes in Subarea 88.1 and 374 tonnes in Subarea 88.2 for the 2003/04 season. There has been a general trend towards fishing deeper over the course of the exploratory fishery, though in 2003/04 fishing was slightly shallower than 2002/03 (WG-FSA-04/20).

5.54 Although the total catch was about 67% of the catch limit for Subarea 88.1, catch limits in SSRUs B, C, G and H (see Figure 5.2), were exceeded by 1.8, 2.2, 0.1 and 199 tonnes respectively. Heavy ice conditions restricted fishing south of 73°S. Consequently little catch was taken in SSRUs 881J–L. With the southern SSRUs closed from ice, the fishery was effectively closed from mid-March 2004 (WG-FSA-04/20).

5.55 It was noted that the catch limits were exceeded because of the rapid changes in fishing pattern, the late submission of catch and effort reports, difficulties in forecasting closures in SSRUs, time lags in reporting, small catch limits in some SSRUs, and communication problems between the Secretariat, some Members and vessels (CCAMLR-XXIII/38).

5.56 In Subarea 88.2, the catch limit of 375 tonnes was fully taken (375 tonnes), and the fishery was closed on 6 March 2004. Fishing was carried out in SSRUs 882A, B, E and G, although no catch was recorded in SSRU 882G. Most of the catch (362 tonnes) was taken in SSRU 882E.

5.57 The historical catches for Subareas 88.1 and 88.2 are given in Tables 5.4 and 5.5.

Table 5.4: Catch history for *Dissostichus* spp. in Subarea 88.1 (source: STATLANT data to 2002/03, and catch and effort data in 2003/04).

Fishing season	Reported catch (tonnes)	Estimated IUU catch (tonnes)	Total (tonnes)	Catch limit
1996/97	<1	0	<1	1980
1997/98	42	0	42	1510
1998/99	297	0	297	2281
1999/00	751	0	751	2090
2000/01	660	0	660	2064
2001/02	1325	92	1417	2508
2002/03	1831	0	1831	3760
2003/04	2166	240	2406	3250

Table 5.5: Catch history for *Dissostichus* spp. in Subarea 88.2 (source: STATLANT data to 2002/03, and catch and effort data in 2003/04).

Fishing season	Reported catch (tonnes)	Estimated IUU catch (tonnes)	Total (tonnes)	Catch limit
1996/97	0	0	0	1980
1997/98	0	0	0	63
1998/99	0	0	0	0
1999/00	0	0	0	250
2000/01	0	0	0	250
2001/02	41	0	41	250
2002/03	106	0	106	375
2003/04	374	0	374	375

1.2 IUU catch

5.58 The total estimated IUU catch in Subarea 88.1 was 240 tonnes in 2003/04. The only previously estimated IUU catch in Subarea 88.1 was 92 tonnes in 2001/02.

5.59 The Working Group noted that caution should be exercised in using the IUU data for Subarea 88.1. The estimates of IUU catch were based on an assumption that two IUU vessels fished for a period of 40 days each in Subarea 88.1, at a catch rate of 3 tonnes per day. The estimates were based on sightings of two unidentified vessels that occurred on one day only (9 February 2004). While the accuracy of the sightings is not in doubt, the Working Group noted that subsequent aerial surveillance of the Ross Sea by New Zealand did not detect any IUU vessel activity.

5.60 There was estimated to be no IUU catch in Subarea 88.2 in 2004, as was the case for previous years.

1.3 Size distribution of the catches

5.61 Mean length and age of *D. mawsoni* in the catch has increased over the course of the fishery, with most fish caught in 2003/04 between 100 and 170 cm TL (WG-FSA-04/84 Rev. 1 and 04/89).

5.62 Mean length and age of the *D. mawsoni* catch have generally increased in the past few years. Smaller fish tended to be caught closer to the shore, in the southern areas, with the larger fish caught on the northern offshore zone of the Ross Sea (WG-FSA-04/20, 04/25, 04/28 Rev. 1, 04/34, 04/84 Rev. 1 and 04/89).

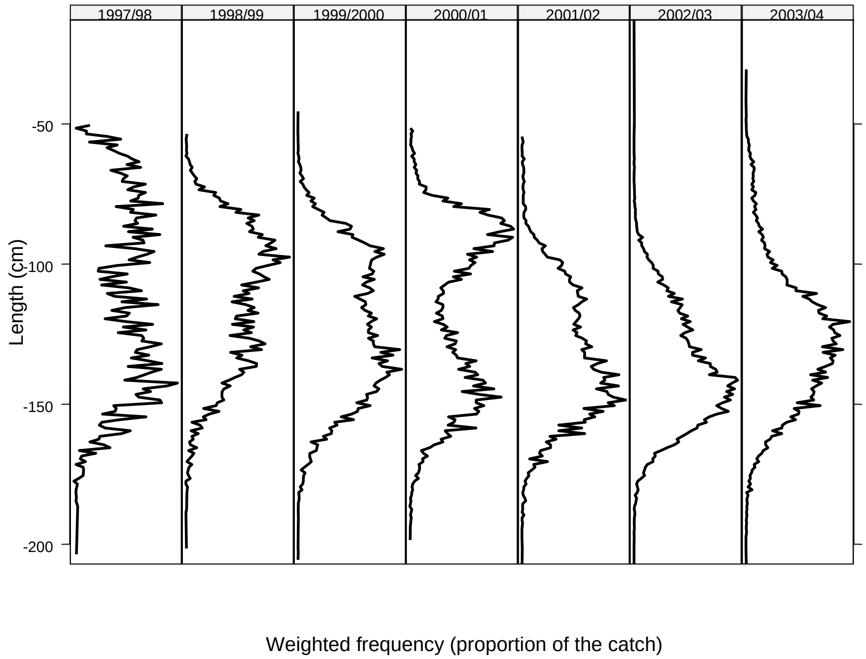


Figure 5.1: Catch-weighted length frequencies for *Dissostichus mawsoni* in Subarea 88.1 (source: observer, fine-scale and STATLANT data reported by 6 October 2004).

2. Stocks and areas

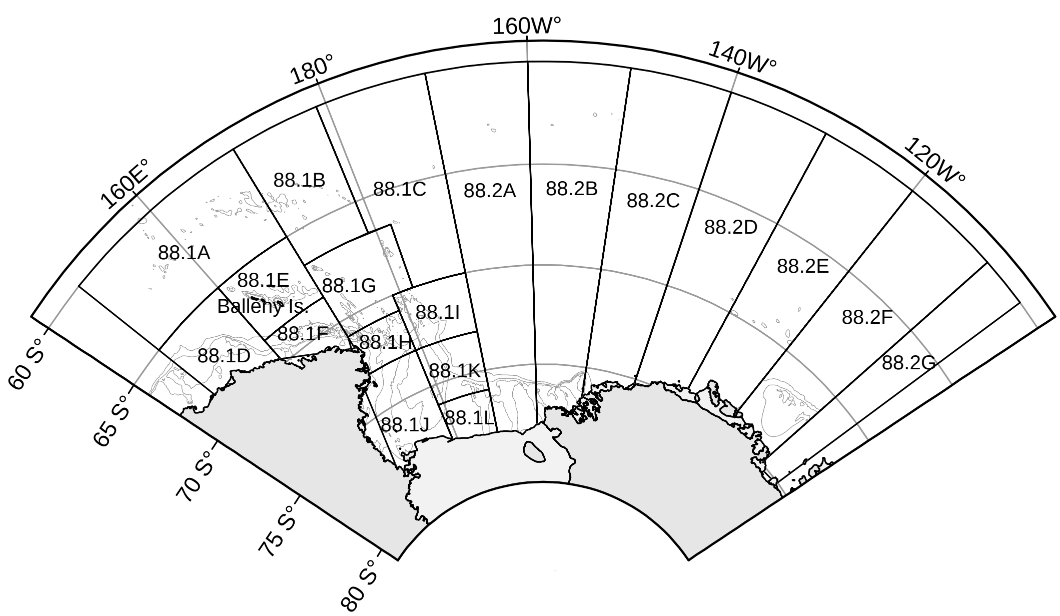


Figure 5.2: The Ross Sea, showing Subareas 88.1 and 88.2, and the subarea SSRUs (depth contours shown are at 500, 1 000 and 2 000 m).

5.63 Analysis of the genetic diversity for *D. mawsoni* from Subareas 48.1 and 88.1 and Division 58.4.2 found weak genetic variation between the three areas (WG-FSA-04/32). The weak genetic differentiation is supported by oceanic gyres, which may act as juvenile retention systems, and by limited movement of adult tagged fish.

5.64 Fully mature female fish were found in Subarea 88.1 in December (three months earlier than in the previous season) and in Subarea 88.2 for the first time. The onset of spawning may occur in December, continuing until at least June in both Subareas 88.1 and 88.2. Spawning is suspected to occur on isolated geographic features north of the main Antarctic shelf areas (WG-FSA-04/28 Rev. 1 and 04/35).

5.65 The Working Group recommended that Subareas 88.1 and 88.2 be treated as a single stock unit for assessment purposes, and that further research be undertaken on the stock structure of *D. mawsoni*.

3. Parameter estimation

3.1 Estimation methods

<u>Standing stock</u>

5.66 There are no estimates of the standing stock.

<u>Population structure</u>

5.67 The age composition of the commercial catch is given in WG-FSA-04/20. In the past three years, the catch composition has been dominated by fish aged 8 to 30 years (range 3 to 48 years).

<u>Standardised CPUE analysis</u>

5.68 A standardised CPUE analysis of the three main fishing grounds in Subarea 88.1 showed no significant trend from 1998/99 to 2002/03, but showed a large decline in 2003/04 (WG-FSA-04/25). The decline in 2003/04 was thought to be related to a combination of extreme ice conditions and effects from a large number of vessels operating in a confined area. The Working Group recommended that further intersessional work be undertaken to incorporate these effects within the CPUE standardisation. The CPUE indices are given in the Table 5.6.

Table 5.6: Standardised CPUE indices (catch/hook) for all vessels in Subarea 88.1 for 1998/99 to 2003/04.

Fishing season	Index	95% CI	CVs
1998/99	1.15	0.97–1.35	0.082
1999/00	1.10	0.99–1.23	0.053
2000/01	0.85	0.76–0.96	0.057
2001/02	1.20	1.08–1.32	0.052
2002/03	1.15	1.04–1.27	0.050
2003/04	0.67	0.61–0.74	0.050

3.2 Parameter values

Fixed parameters

Table 5.7: Parameter values for *Dissostichus mawsoni* in Subarea 88.1.

Component	Parameter	Value		Units
		Male	Female	
Natural mortality	M	0.15–0.2	0.15–0.2	y^{-1}
VBGF	K	0.102	0.095	y^{-1}
VBGF	t_0	0.31	0.50	y
VBGF	L_∞	170.3	184.5	cm
Length to mass	'a'	0.00000986	0.00000617	cm, kg
Length to mass	'b'	3.0335	3.1383	
Maturity	L_{m50}	100	100	cm
Range: 5 to 95% maturity		85–115	85–115	cm

4. Stock assessment

4.1 Calculation of existing catch limits

5.69 Previously, the Working Group 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 was based on analogy with *D. eleginoides* in Subarea 48.3, and was scaled by the estimates of mean recruitment in that population, and as such cannot be considered an independent assessment. The Working Group noted that this method was no longer considered appropriate for estimating yields for Subareas 88.1 or 88.2 (SC-CAMLR-XXII, paragraphs 4.186 and 4.189).

5.70 The Working Group recalled that catch limits should be applied separately for each SSRU and should reflect the fishable seabed area and fish density from that SSRU (SC-CAMLR-XXII, Annex 5, paragraph 5.36). The Working Group agreed that there was no new evidence presented to suggest that the SSRU catch limits should be revised.

5.71 There was no stock assessment available for the current year.

4.2 Progress towards assessment

5.72 The Working Group welcomed the development of an integrated assessment model using CASAL for Subarea 88.1 (WG-FSA-04/36). Catch, CPUE, proportions-at-age in the catch, and New Zealand vessels' tag–release and tag–recapture data from Subarea 88.1 were included with an illustrative model using the generalised stock modelling software CASAL.

4.3 Future research requirements

5.73 The Working Group recalled that WG-FSA-03 recommended the development of stand-alone methods to monitor abundance and estimate precautionary yields in Subarea 88.1. The Working Group also noted that WG-FSA-SAM-04 agreed that further development of an integrated stock-modelling approach to the assessment of *D. mawsoni* using CASAL would be desirable. WG-FSA-SAM-04 made the following recommendations:

(i) The model should be further developed, and should investigate methods for addressing problems with the existing fishing selectivity parameterisation.

(ii) Approaches to the validation of the software should be investigated (e.g. the simulation model used to evaluate the assessment of toothfish at Macquarie Island based on a mark–recapture model could be used).

(iii) Operating/simulation model approaches should be developed to investigate the following issues:

- evaluate selectivity versus availability issues;
- number of recaptures required for suitably precise estimates of biomass and yield;
- evaluate potential biases associated with closure of areas between years due to ice;
- tagging protocols (e.g. size, location and number of fish to tag);
- explore consequences of alternative model structural assumptions;
- use of research sets to provide contrast with commercial CPUE;
- alternative tagging estimators (e.g. Macquarie Island approach).

5.74 The Working Group noted that alternative methods of monitoring and assessing toothfish in new and exploratory fisheries were presented at WG-FSA-SAM-04 (WG-FSA-SAM-04/8). The papers recommended that tag–recapture experiments be used in conjunction with experimental manipulation of effort to monitor toothfish – and perhaps as importantly – the wider ecosystem effects of the toothfish fisheries. The papers further noted that simulation studies be carried out to determine the best way to use the effort manipulation.

5.75 The Working Group thanked New Zealand for the work that had gone into the development of an integrated modelling approach, and the examination of alternative approaches for monitoring abundance during the intersessional period.

5. By-catch of fish and invertebrates

5.1 By-catch removals

5.76 Appendix 3 of CCAMLR-XXIII/38 provided summaries of total removals of macrourids, rajids and other species by SSRU in Subarea 88.1. Data on by-catch in the exploratory fishery in Subareas 88.1 and 88.2 were described and analysed in WG-FSA-04/20. History of catch and limits are given for Subareas 88.1 and 88.2 in Tables 5.8 and 5.9 respectively.

Table 5.8: Reported by-catch landings for 1997/98 to 2003/04 in Subarea 88.1.

Fishing season	Macrourids		Rajids		Others	
	Catch	Limit	Catch	Limit	Catch	Limit
1997/98	9		5		1	
1998/99	22		39		5	50
1999/00	74		41		7	50
2000/01	62		9		14	50**
2001/02	154		25		10	50**
2002/03	67	140+#	11	50+	12	20+
2003/04	319	520†	23	163*	23	20

† or 16% of toothfish catch
* or 5% of toothfish catch
\# 50 for SSRU A
** for each SSRU

Table 5.9: Reported by-catch landings for 2000/01 to 2003/04 in Subarea 88.2.

Fishing season	Macrourids		Rajids		Others	
	Catch	Limit	Catch	Limit	Catch	Limit
2000/01	0		0		0	
2001/02	4		0		0	
2002/03	18	50†	0	60*	8	20+
2003/04	37	60†	0	50*	8	20

† or 16% of toothfish catch
* or 5% of toothfish catch
\+ by SSRU

5.77 The Working Group expressed concern that three by-catch limits were exceeded in Subarea 88.1 during the 2003/04 exploratory fishery:

(i) the limit of 124.2 tonnes for *Macrourus* spp. in SSRU 881I was exceeded by 141 tonnes (114%);

(ii) the limit of 20 tonnes for *Macrourus* spp. in SSRU 881E was exceeded by 12.2 tonnes (61%);

(iii) the limit of 20 tonnes for 'all other combined species' in SSRU 881I was exceeded by 1.8 tonnes (9%).

5.2 Assessments of impacts on affected populations

5.78 The estimate of γ for *M. whitsoni* in Subarea 88.1 in 2003 was 0.01439 (SC-CAMLR-XXII, paragraph 4.132). This indicates that *M. whitsoni* has relatively low productivity and thus may be vulnerable to overexploitation.

5.79 Mean standardised catch rates for *M. whitsoni* and *B. eatonii* were calculated from bottom trawls carried out during the BioRoss survey in February–March 2004 (paragraphs 6.7 to 6.15). However, trawl catch rates did not provide good estimates of standing stock for SSRU 881E and H because the small number of tows did not provide a representative sample of the overall area in the depth range 600 to 1 800 m in each SSRU (paragraphs 6.14 and 6.15).

5.80 In 2003, the Scientific Committee encouraged further work to examine more appropriate SSRU by-catch levels in Subarea 88.1 that are more in accordance with the by-catch distribution and abundance (SC-CAMLR-XXII, paragraph 4.199).

5.81 The Working Group explored three options for allocation of macrourid by-catch between SSRUs in Subarea 88.1 based on the current total catch limit of 520 tonnes (paragraphs 6.19 to 6.28):

1. Status quo
2. CPUE proportional limits
3. fixed SSRU limits.

5.82 The Working Group recommended that the Scientific Committee consider these alternative options for managing macrourid by-catch by SSRU in Subarea 88.1.

5.3 Mitigation measures

5.83 The Working Group compared by-catch rates of autoline and Spanish line vessels in Subarea 88.1 (paragraphs 6.60 to 6.64).

5.84 This analysis suggested that use of the Spanish longline system may reduce by-catch rates of macrourids. However, the Working Group noted that catch rates of macrourids were highly variable between SSRUs and a more complete analysis considering the spatial distribution of vessels with different gear types is required. The Working Group recommended that this work be conducted in the intersessional period.

5.85 The current by-catch limits and move-on rules are given in Conservation Measure 33-03.

5.86 The Working Group recommended that, where possible, all rajids should be cut from the line while still in the water, except on the request of the scientific observer (paragraph 6.75).

6. By-catch of birds and mammals

6.1 By-catch removals

5.87 Details of seabird by-catch are reported in paragraph 7.12 and Table 7.3, and summarised in Table 5.10.

Table 5.10: Seabird by-catch limit, reported seabird by-catch, by-catch rate and estimated by-catch for 1997/98 to 2003/04 in Subareas 88.1 and 88.2.

Fishing season	By-catch limit	By-catch rate (birds/thousand hooks)	Estimated by-catch
1997/98		0	0
1998/99		0	0
1999/00		0	0
2000/01		0	0
2001/02	3*	0	0
2002/03	3*	0	0
2003/04	3*	0.0001	1

* Per vessel during daytime setting.

5.88 Ad hoc WG-IMAF assessed the risk level of seabirds in this fishery in Subarea 88.1 as category 2 south of 65°S and category 3 north of 65°S (Table 7.16) and recommended:

- strict compliance with Conservation Measure 25-02 (but with the possibility of exemption to paragraph 4 to allow for daytime setting);
- south of 65°S, no need to restrict longline fishing season;
- north of 65°S restrict longline fishing to the period outside at-risk species' breeding season where known/relevant, unless line sink rate requirement is met at all times;
- daytime setting permitted subject to line sink rate requirements and seabird by-catch limits;
- no offal dumping.

5.89 Ad hoc WG-IMAF assessed the risk level of seabirds in this fishery in Subarea 88.2 as category 1 (Table 7.16) and recommended:

- strict compliance with Conservation Measure 25-02 (but with exemption to paragraph 4 to allow for daytime setting);
- no need to restrict longline fishing season;

- daytime setting permitted subject to line sink rate requirement;
- no offal dumping.

6.2 Mitigation measures

5.90 Conservation Measure 25-02 applies to these areas and in recent years has been linked to an exemption for night setting in Conservation Measure 24-02 and subject to a seabird by-catch limit. Offal and other discharges are regulated under annual conservation measures (e.g. Conservation Measures 41-09 and 41-10).

7. Ecosystem implications/effects

5.91 The Working Group noted that studies on the food-web interactions of macrourids would be useful in understanding the ecosystem effects of by-catch in this fishery.

8. Harvest controls for the 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.11: Summary provisions of Conservation Measure 41-09 for limits on the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 41-09	Advice for 2004/05	Paragraph reference
1. Access (gear)	Limited to vessels from Argentina, Japan, Republic of Korea, New Zealand, Norway, Russia, South Africa, Spain, Ukraine, UK, USA and Uruguay using longlines.	Review	
2. Catch limit	3 250 tonnes for Subarea 88.1 Individual SSRU limits (tonnes): A, D, F – 0 B – 80 C – 223 E – 57 G – 83 H – 786 I – 776 J – 316 K – 749 L – 180		
3. Season	1 December 2003 to 31 August 2004		
4. Fishing operations	In accordance with CM 41-01 (except paragraph 6).		
5. By-catch	Regulated in accordance with CM 33-03.	Review	5.81–5.82
6. Mitigation: seabirds	In accordance with CM 25-02 (except paragraph 4 night setting). CM 24-02 to apply.	Modify CM 24-02	7.111
7. Mitigation	Daylight setting allowed under CM 24-02.	Modify CM 24-02	7.111
8. Mitigation	No offal discharge.		
9. Observers	Each vessel to carry at least two scientific observers, one of whom shall be a CCAMLR observer.		
10. VMS	To be operational in accordance with CM 10-04.		
11. CDS	In accordance with CM 10-05.		
12. Research	Undertake research plan and tagging program as set out in CM 41-01, Annexes B and C.		
13. Data: catch and effort	(i) Five-day reporting system as in CM 23-01 (ii) Monthly fine-scale reporting system as in CM 23-04 on haul-by-haul basis.		
14. Target species	For the purposes of CMs 23-01 and 23-04, the target species is *Dissostichus* spp. and the by-catch is any species other than *Dissostichus* spp.		
15. Data: biological	Monthly fine-scale reporting system as in CM 23-05. Reported in accordance with the Scheme of International Scientific Observation.		
16. Discharge	Prohibition of discharge of: (i) oil (ii) garbage (iii) food waste >25 mm (iv) poultry or parts thereof (v) sewerage within 12 n miles of land.		

17. Additional elements	No live poultry or other living birds to be taken into Subarea 88.1, and any unconsumed dressed poultry is to be removed from Subarea 88.1.		
18. Additional element	Fishing within 10 n miles of Balleny Islands is prohibited.		

Table 5.12: Summary provisions of Conservation Measure 41-10 for limits on the exploratory fishery for *Dissostichus* spp. in Subarea 88.2 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 41-10	Advice for 2004/05	Paragraph reference
1. Access (gear)	Limited to vessels from Argentina, Republic of Korea, New Zealand, Norway, Russia, South Africa and Ukraine using longlines.	Review	
2. Catch limit	375 tonnes south of 60°S		
3. Season	1 December 2003 to 31 August 2004		
4. Fishing operations	In accordance with CM 41-01 (except paragraph 6).		
5. By-catch	Regulated in accordance with CM 33-03.		
6. Mitigation: seabirds	In accordance with CM 25-02 (except paragraph 4 night setting). CM 24-02 to apply.	Modify CM 24-02	7.111
7. Mitigation	Daylight setting allowed under CM 24-02.	Modify CM 24-02	7.111
8. Mitigation	No offal discharge.		
9. Observers	Each vessel to carry at least two scientific observers, one of whom shall be a CCAMLR observer.		
10. VMS	To be operational in accordance with CM 10-04.		
11. CDS	In accordance with CM 10-05.		
12. Research	Undertake research plan and tagging program as set out in CM 41-01, Annexes B and C.		
13. Data: catch and effort	(i) Five-day reporting system as in CM 23-01 (ii) Monthly fine-scale reporting system as in CM 23-04 on haul-by-haul basis.		
14. Target species	For the purposes of CMs 23-01 and 23-04, the target species is *Dissostichus* spp. and the by-catch is any species other than *Dissostichus* spp.		
15. Data: biological	Monthly fine-scale reporting system as in CM 23-05. Reported in accordance with the Scheme of International Scientific Observation.		
16. Discharge	Prohibition of discharge of: (i) oil (ii) garbage (iii) food waste >25 mm (iv) poultry or parts thereof (v) sewerage within 12 n miles of land.		
17. Additional elements	No live poultry or other living birds to be taken into Subarea 88.2, and any unconsumed dressed poultry is to be removed from Subarea 88.2.		

8.2 Management advice for new and exploratory fisheries

5.92 The Working Group reiterated the necessity for Members fishing in exploratory fisheries to ensure that the required research sets are completed (Conservation Measure 41-01) and submitted to the Secretariat in a timely manner and accurate format. In addition, *Dissostichus* spp. should be tagged and data submitted in accordance with Conservation Measure 41-01.

5.93 The Working Group recommended that tagging be continued as part of the Research and Data Collection Plan (Conservation Measure 41-01), and take account of the revision in the tagging protocol, especially the requirement that all tagged fish be double-tagged.

5.94 For high-latitude areas with narrow continental shelves the Working Group recommended that the existing depth limit should be retained in order to reduce the impact on benthic communities in shallower waters. It would also provide opportunities to better understand and assess the potential effects of fishing before it occurs throughout the area. In this respect the Working Group recommended the extension of the approach from Division 58.4.1 into Division 58.4.2.

5.95 In a similar way, the Working Group recommended that some SSRUs within exploratory fisheries in Divisions 58.4.1 and 58.4.2 and Subarea 88.1 retain zero catch limits, so that effects of fishing on *Dissostichus* spp. populations can be distinguished from environmental effects.

5.96 The Working Group noted a large number of notifications were received for exploratory fisheries in 2004/05 in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2 and 58.4.3b. Large numbers of vessels fishing in a particular SSRU may lead to difficulties with the standardisation of CPUE data for assessments (paragraph 5.68 and WG-FSA-04/25) and may also reduce the effectiveness of the move-on rule to limit by-catch in the fishery (paragraphs 6.72 and 6.73).

5.97 The Working Group noted the information presented in CCAMLR-XXIII/38 which indicated that there are additional administrative problems in determining closure dates for fishing in SSRUs when many vessels are fishing simultaneously in a subarea or division (paragraph 5.1).

5.98 The Working Group recalled that catch limits should be applied separately for each SSRU and should reflect the fishable seabed area and fish density from that SSRU (SC-CAMLR-XXII, Annex 5, paragraph 5.36). The Working Group noted that there was no new information on which to provide advice on SSRU catch limits for *Dissostichus* spp.

5.99 The Working Group noted that the number of vessels participating in the Subarea 88.1 toothfish fishery had increased substantially in the 2003/04 season, and had the largest number of vessels fishing in any of the CCAMLR statistical areas in this season. The number of vessels has had an impact on several aspects of the Working Group advice. The lack of important assessment information, such as standing stock and recruitment data, and the variable ice influence make this a difficult fishery for which to provide management advice. The Working Group reiterated the urgent need for data that will lead towards a formal assessment, and welcomed the progress with the tagging program and the development of an integrated stock-assessment model.

5.100 The Working Group was unable to provide any new advice on catch limits for *Dissostichus* spp. or any by-catch species in any of the exploratory fisheries.

5.101 The Working Group reiterated the urgent need to develop a means for estimating abundance and providing assessments of stock status for all exploratory fisheries.

5.102 The Working Group recommended that Subareas 88.1 and 88.2 be treated as a single stock unit for assessment purposes, and that further research be undertaken on the stock structure of *D. mawsoni*.

Fishery Report: *Dissostichus eleginoides* South Georgia (Subarea 48.3)

1. Details of the fishery

1.1 Reported catch (time series)

Table 5.13: Catch history for *Dissostichus eleginoides* in Subarea 48.3. Fishing seasons are given (i.e. 1988/89 is 1 December 1988 to 30 November 1989).

Fishing season	Catch limit	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	2500	1756	1775	3531
1991/92	3500	3809	3066	6875
1992/93	3350	3020	4019	7039
1993/94	1300	658	4780	5438
1994/95	2800	3371	1674	5045
1995/96	4000	3602	0	3602
1996/97	3540	3812	0	3812
1997/98	3330	3201	146	3347
1998/99	3500	3636	667	4303
1999/00	5310	4904	1015	5919
2000/01	4500	4047	196	4243
2001/02	5820	5744	3	5747
2002/03	7810	7534	0	7534
2003/04	4420	4482	0	4482

5.103 During the 2003/04 season the fishery was active from 1 May to 21 August 2004 (Table 5.13).

5.104 The Working Group agreed to define a new area within Subarea 48.3 relevant to the South Georgia and Shag Rocks stock (paragraph 5.107). The revised catches attributed to the South Georgia and Shag Rocks stock are given in Table 5.14.

Table 5.14: Catches from South Georgia and Shag Rocks in Subarea 48.3.

Fishing season	Official catch from Subarea 48.3	Corrected catch from South Georgia and Shag Rocks
1984/85	521	521
1985/86	733	733
1986/87	1954	1954
1987/88	876	876
1988/89	7204	7204
1989/90	7222	7222
1990/91	3531	3531
1991/92	6875	6871
1992/93	7039	7039
1993/94	5438	5438
1994/95	5045	4998
1995/96	3602	3542
1996/97	3812	3812
1997/98	3347	3347
1998/99	4303	4303
1999/00	5919	5911
2000/01	4243	4234
2001/02	5745	5722
2002/03	7528	7513
2003/04	4482	4447

Distribution of the fishery

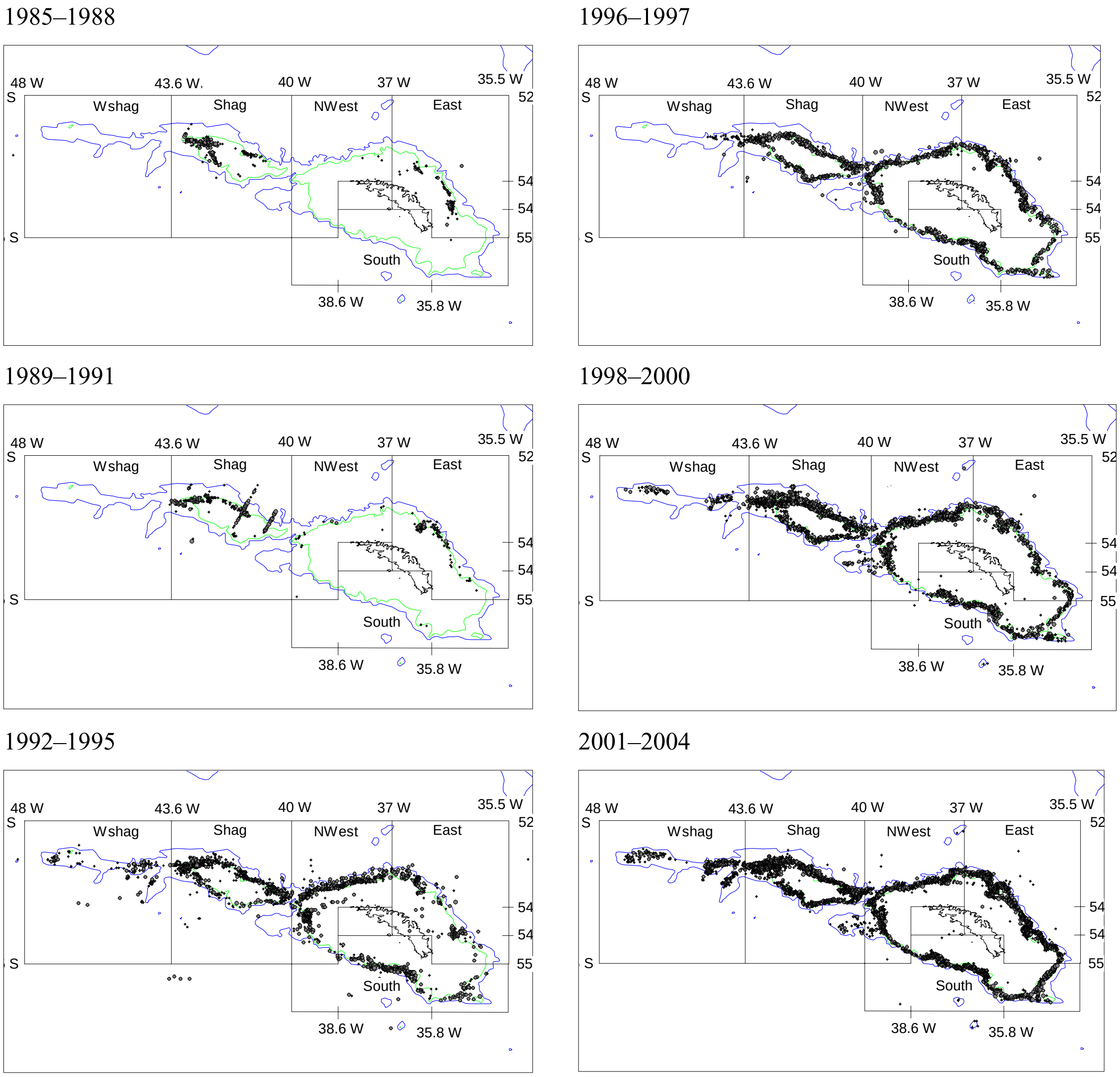


Figure 5.3: Distribution of catches in discrete time periods, graduated by the number of hooks set. Wshag – western Shag Rocks; Shag – Shag Rocks; NWest –northwest South Georgia; East – east South Georgia; South – south South Georgia.

1.2 IUU catch

5.105 The estimated IUU catch from Subarea 48.3 in the 2004 fishing season is zero. Dr Agnew informed the Working Group that the UK had continued to undertake patrols in the area, and apply the model estimating IUU catch described by Agnew and Kirkwood (2002).

1.3 Size distribution of catches (time series)

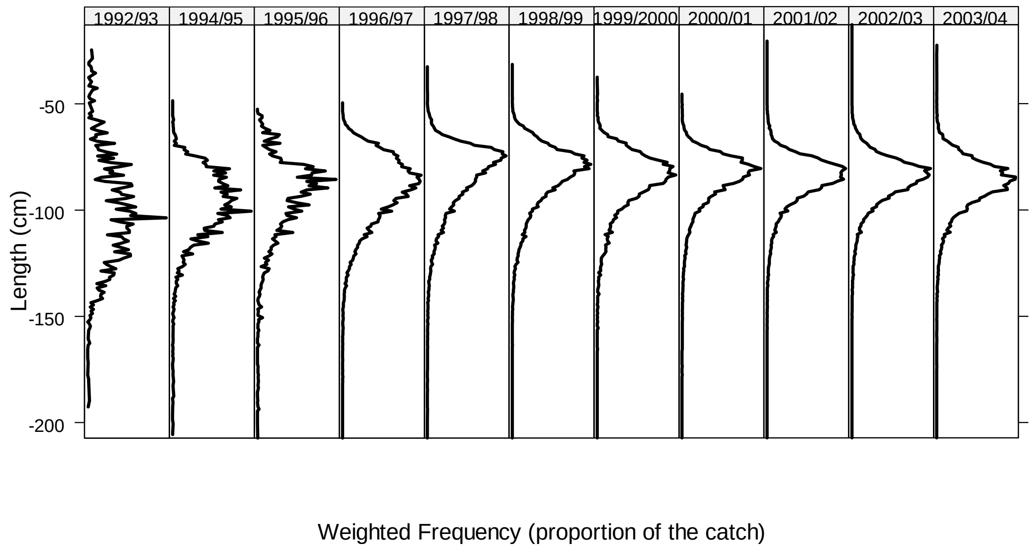


Figure 5.4: Catch-weighted length frequencies for *Dissostichus eleginoides* in Subarea 48.3 derived from observer, fine-scale and STATLANT data reported by 6 October 2004.

2. Stocks and areas

5.106 The fishery is largely restricted to waters adjacent to South Georgia and Shag Rocks in water down to 1 800 m depth. Much of Subarea 48.3 has a water depth in excess of 2 000 m and toothfish are known to occur there, albeit at low density. Toothfish are known to occur in adjacent areas. It has been demonstrated that there is genetic separation of those fish present in Subarea 48.3 from those found on the Patagonian Shelf (FAO Area 41).

5.107 The Working Group considered the information on stock structure provided by WG-FSA-04/21 that indicated that *D. eleginoides* occurring on Burdwood Bank and the North Scotia Ridge could be considered separate from the populations around Shag Rocks and South Georgia. The Working Group agreed to divide Subarea 48.3 into the area relevant to the South Georgia and Shag Rocks population, and other areas, according to Figure 5.5.

5.108 The Working Group agreed that its assessment would only apply to the Shag Rocks and South Georgia stock.

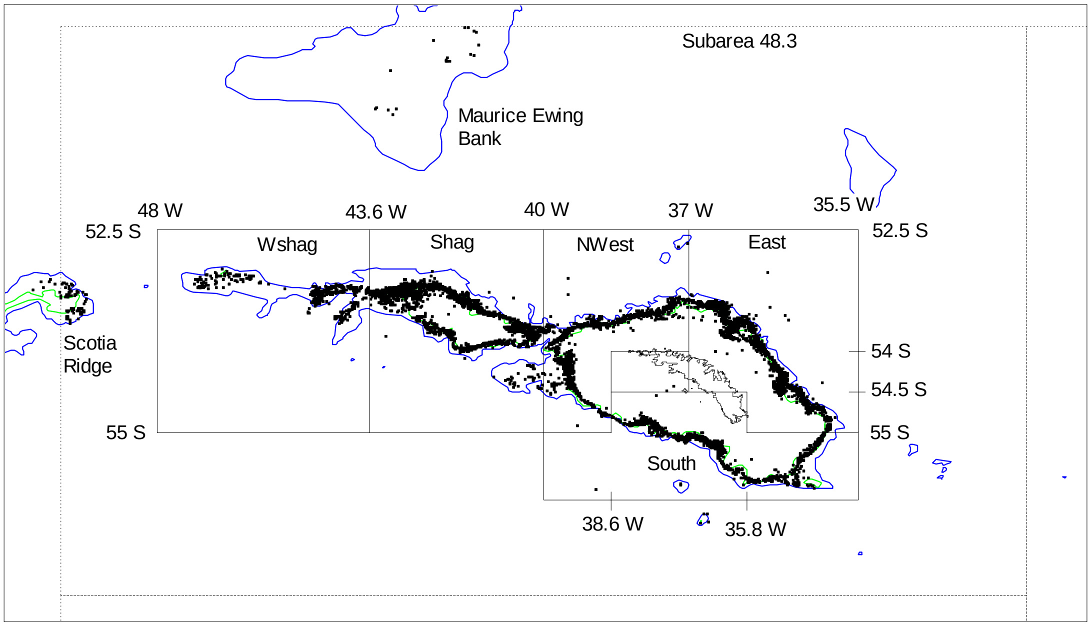


Figure 5.5: Definition of new areas in Subarea 48.3. The South Georgia and Shag Rocks stock is only present in areas Wshag, Shag, NWest, East and South (Table 5.14). See Figure 5.3 for area definitions.

3. Parameter estimation

3.1 Estimation methods

Trends in fishing vulnerability

5.109 The method (WG-FSA-02/64), used in 2002 and 2003, takes specific account of the tendency for the size of fish taken in the longline fishery to be positively correlated with depth fished, and 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.

5.110 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 the observer data. These are then converted to vulnerabilities-at-age using the growth curve estimated for Subarea 48.3. The analyses this year incorporated all available data for 2004 and indicated that the 'deep' vulnerability curve was most appropriate for the 2004 season (Figure 5.6). The age-specific vulnerabilities were updated for 2004 and projection years in the GYM.

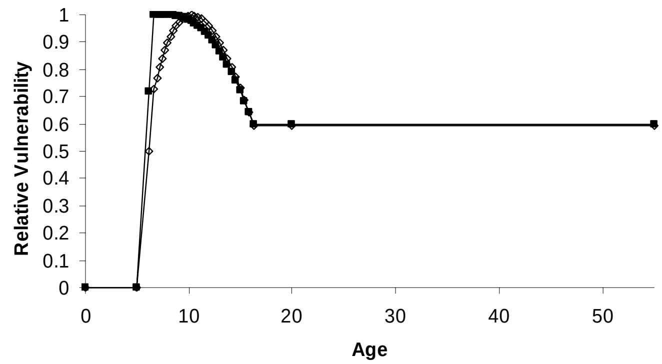


Figure 5.6: Vulnerability functions for Subarea 48.3: 'Deep' pattern (open squares) and 'Shallow' pattern (closed squares).

CPUE standardisation

5.111 WG-FSA agreed that the method used to standardise the CPUE series would be reviewed. Two methods are currently available to the Working Group – the previously used GLM and the GLMM approach described by Candy (2004). Drs Agnew and S. Candy (Australia) reviewed the characteristics of the fits using both methods and, in particular examined the area-by-year interaction. The QQ diagnostic plots for the GLMM model indicated that the random effects assumptions of the GLMM model (Candy, 2004) were reasonable (Figure 5.7). Examination of the area–season random effects indicated that there was not a significant trend in CPUE for the majority areas, although there was a suggestion of a trend for the Shag Rocks areas in the latter part of the series (Figure 5.8). Area interactions with the other main effects were also considered, but none were found to be significant.

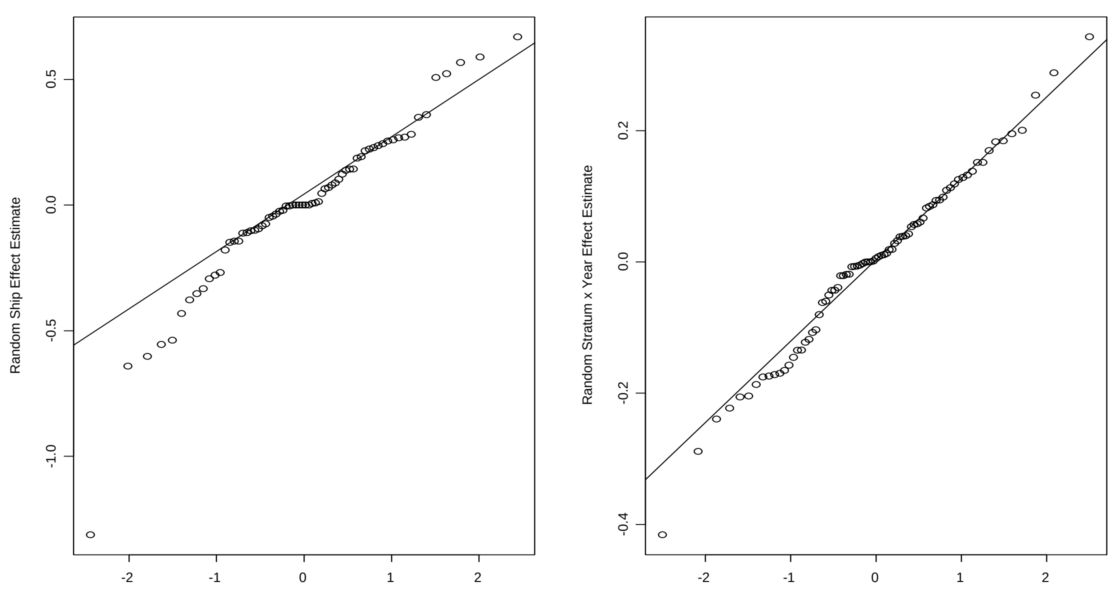


Figure 5.7: QQ diagnostic plots for the random vessel and area-by-season effects for the GLMM for Subarea 48.3.

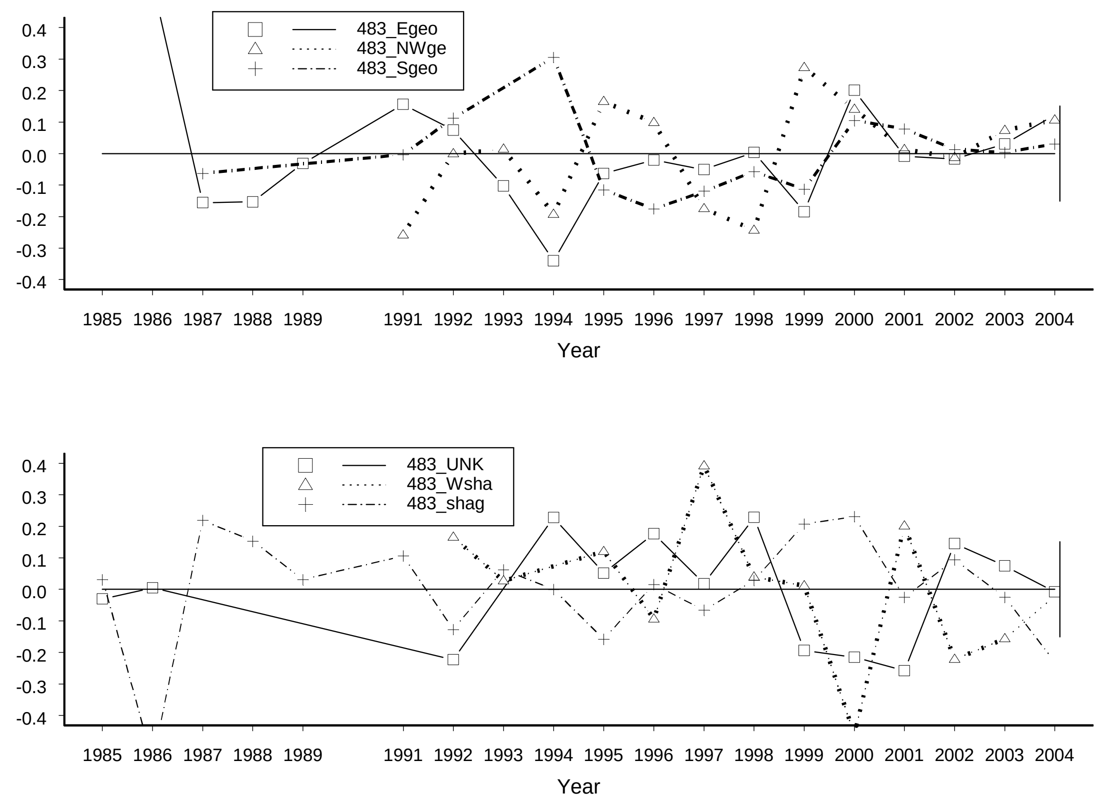


Figure 5.8: Deviation from the standardised CPUE trend by area for Subarea 48.3. Egeo – east South Georgia, NWge – northwest South Georgia, Sgeo – south South Georgia, UNK – unknown location, Wshag – west Shag Rocks, Shag – Shag Rocks.

5.112 On the basis of the outcomes of these analyses, the Working Group agreed that the random-effects GLMM should be used as the method for standardisation of CPUE series for use in GYM assessments for this year and for further development of the ASPM method. The revised series was calculated using the GLMM with area–season as a random effect and area as a fixed effect, with CPUE scaled to the south South Georgia area. The revised series is given in Figure 5.9 along with the equivalent standardisation using the standard GLM used in previous years.

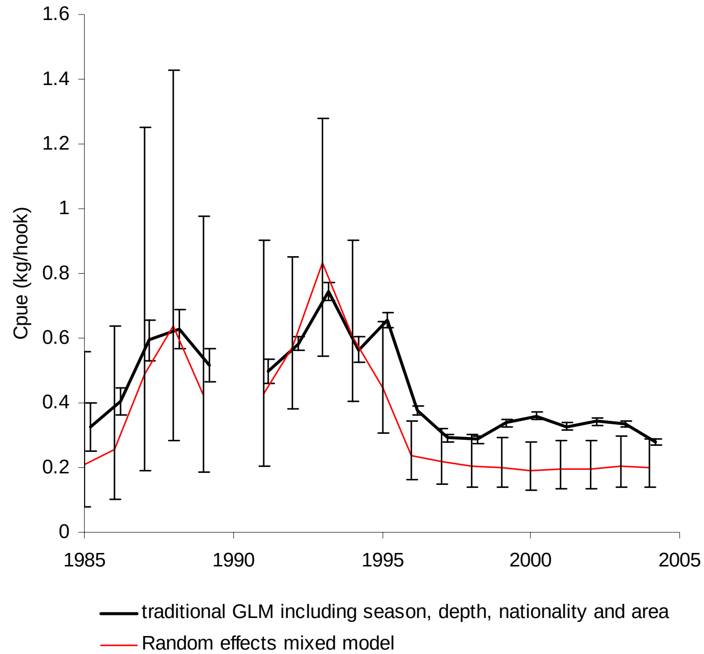


Figure 5.9: Standardised longline CPUE by fishing season for Subarea 48.3 using the GLMM method with a random-effects model (thin line) and the standard GLM method (thick line) previously used by the Working Group. Both series have been standardised for Chilean vessels fishing between depths of 1 000 and 1 500 m in the southern sector of South Georgia.

5.113 In addition, the Working Group examined the spatial variation in catch and effort around South Georgia and Shag Rocks over the period from 1986 to 2004 (Figure 5.3).

Mean size in commercial catch

5.114 Fisheries data (reports of weight and number of fish caught) were analysed in a standard GLM (Figure 5.10). Mean weight declined from 1992 to 1998, increasing gradually thereafter.

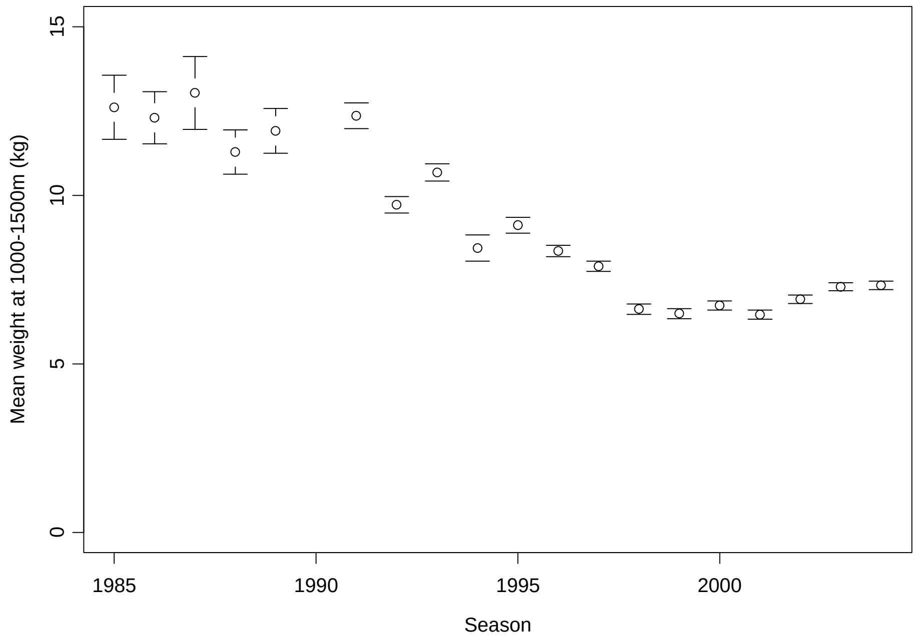


Figure 5.10: Mean weight of toothfish in the catch calculated using a GLM of similar form to that for the standard GLM (paragraphs 5.111 to 5.113), standardised to Chilean vessels fishing between depths of 1 000 and 1 500 m, in the southern sector of South Georgia.

Recruitment

5.115 Estimates of numbers of recruits at age 4 are calculated by applying the CMIX program to length-density data (numbers/km^2 for each length class) from each survey haul, weighted by the proportion of the stratum area in the overall survey and the inverse proportion of the number of survey hauls in the stratum. The data extractions for the 2004 survey were done using six strata: three depth strata (50–150, 150–250 and 250–500 m) each for South Georgia and Shag Rocks (see SC-CAMLR-XXI, Annex 5, paragraph 5.60).

5.116 The Working Group considered the review of approaches to estimating recruitment presented in WG-FSA-04/92 which suggested that a number of issues be considered in the process of estimating and revising the time series of recruitments for toothfish:

(i) Establish what would be a reasonable length for a fish at age 0 (time zero in the year).

(ii) Establish the birthday of the fish in the year (time 0). If this needs to be varied in some years, then the period in the year that would accommodate time 0 will need to be considered.

(iii) Estimate (establish) the lengths-at-age (e.g. from growth parameters) and their variances to be used for validating the observed distributions in the mixture analyses.

(iv) Adjust the t_0 of the growth parameters so that the length-at-age of 0.0 is appropriate and then estimate lengths-at-age for the given survey time (adding a proportion of the year from the birthday to the survey).

(v) Choose the bounds around the estimated mean length-at-age to accommodate a plausible birthday, plausible interannual variation in growth and consistency with other surveys.

(vi) Choose appropriate ranges of the standard deviations of length-at-age to ensure that cohort growth (across all lengths of the cohort) are plausible.

5.117 The Working Group agreed to review the CMIX analyses presented in order to arrive at a revised series of recruitments for Subarea 48.3 based on the recruitment series calculated using the current Subarea 48.3 and Belchier et al. (2004) (in WG-FSA-SAM-04/16) growth parameters presented in WG-FSA-04/92.

5.118 A number of issues associated with the estimation of mean recruitment and the recruitment series for Subarea 48.3 were identified by the Working Group for review during the meeting. These included:

(i) the length range used in the CMIX analyses that are sampled consistently by the surveys;

(ii) individual components that may need to be excluded due to poor fits of the CMIX analyses;

(iii) individual surveys that may need to be excluded due to particularities of the survey resulting in poor coverage of the cohorts of interest.

5.119 In light of the above, Drs C. Davies (Australia) and G. Kirkwood (UK) reviewed the CMIX analyses presented in WG-FSA-04/92 and, on the basis of their review, recommended the following with respect to the estimation of revised recruitment series for Subarea 48.3:

(i) the size range for components to be included in the estimation should be 200–600 mm;

(ii) the 2000 Russian survey should be excluded on the basis of very low densities and less than adequate coverage;

(iii) the CMIX analysis for the 1988 UK survey presented in WG-FSA-04/92 for the Subarea 48.3 growth parameters should be revised to obtain a better fit.

5.120 The recruitment series, mean recruitment and its CV were re-estimated in the GYM (version 5.0.1e, GYUI 5.0.1e build 92) following these revisions. The Working Group agreed that the series generated using the Subarea 48.3 growth parameters would be used as a base-case for this year's assessment and the series estimated using the Belchier et al. (2004) parameters would be used in sensitivity analyses.

Effects of stratification on CMIX estimates of abundance

5.121 Usually, CMIX is used to process trawl survey data by pooling data across strata using a transformation of individual hauls within a stratum in order to have a single pooled dataset, weighted by the area of the stratum and the proportion of hauls within a stratum. Following consideration of the survey design and the distribution of length classes between strata, some checks were undertaken of the total abundances of fish being estimated from the pooled data compared to summing the estimates for individual strata. These were also compared to outcomes from using all the data without assigning them to strata or transforming them in any way.

5.122 The differences in outcomes are illustrated in Tables 5.15 to 5.17.

5.123 These differences might be a function of the transformation to pool the data and the manner in which the proportion of non-zeros in each stratum affect the Aitcheson delta estimator. They might also arise from the non-linear function in the density calculation. It was also noted that a difficulty with using the data without strata is that it assumes the sampling density for a stratum is the same across all strata. If the sampling density is not the same across strata then biases might arise. The Working Group had insufficient time to explore these issues further and recommended that WG-FSA-SAM review this at its next meeting.

Table 5.15: CMIX results from UK surveys in 2002 and 2004 in Subarea 48.3 where data are pooled across strata using the formula to weight individual hauls by the proportion of the total area in the stratum and the inverse proportion of all hauls in that stratum. This analysis was on the basis of six strata.

Index	Age 3	Age 4	Age 5	Age 6	Age 7	Total
2002 Survey:						
Means of mixture components		327.139	444.872	515.692	581.92	
Standard deviations of mixture components		29.3328	24.5213	6.08945	50	
Total density of each mixture component		46.4708	22.2315	4.43781	12.4313	
SD of each mixture component density		8.43531	13.2061	2.79363	2.5423	
Abundance		1904991	911343	181920	509600	3 507 854
2004 Survey:						
Means of mixture components	216.474	334.442	470.818	487.879	650.355	
Standard deviations of mixture components	16.9256	25.6042	35.6371	36.8922	48.8452	
Total density of each mixture component	58.8412	32.8541	6.18E-02	10.7741	4.11461	
SD of each mixture component density	356.29	7.48437	0.396087	1.95942	1.79337	
Abundance	2412095	1346798	2534	441666		4 203 093

Table 5.16: CMIX results from UK surveys in 2002 and 2004 in Subarea 48.3 for each stratum. Strata for which CMIX did not successfully resolve fits are shown.

Survey, Stratum	Index	Age 3	Age 4	Age 5	Age 6	Age 7	Total
2002							
1	Means of mixture components	252.9	333.1	470.9	516.5	629.7	
	Standard deviations of mixture components	8.7	8.7	8.8	8.8	8.8	
	Total density of each mixture component	51.5	403.0	55.6	99.9	33.0	
	SD of each mixture component density	26164.3	912989.0	28281.9	50783.8	16803.7	
	Abundance	75820	593778	81956	147163	48694	947 411
2	Not resolved						
3	Not resolved						
4	Not resolved						
5	Not resolved						
6	Means of mixture components	227.9	334.5	467.5	477.3	645.8	
	Standard deviations of mixture components	20.2	28.4	38.8	39.5	52.6	
	Total density of each mixture component	5.3	2.3	54.3	4.4	3.0	
	SD of each mixture component density	1960.7	903.9	16903.4	1045.3	1295.9	
	Abundance	41995	18508	433125	34728	24010	552 366
	Sum of abundance from 2002 strata 1 and 6	117815	612286	515081	181891	72704	1 499 777
2004							
	Means of mixture components	321.3	436.2	559.8			
1	Standard deviations of mixture components	25.6	25.6	25.6			
	Total density of each mixture component	181.7	37.8	21.3			
	SD of each mixture component density	28.3	17.7	24.9			
	Abundance	267686	55652	31401			354 740
2	Means of mixture components	332	439	521	590	668	
	Standard deviations of mixture components	20	21	21	22	22	
	Total density of each mixture component	198	43	11	9	16	
	SD of each mixture component density	105	12	5	4	22	
	Abundance	369716	79506	20801	15998	30578	516 599
3	Means of mixture components	332.4	438.2	512.0	582.2	709.9	
	Standard deviations of mixture components	21.9	21.9	21.9	21.9	21.9	
	Total density of each mixture component	86.9	142.2	96.2	43.9	2.2	
	SD of each mixture component density	27.8	46.6	32.2	14.3	38.8	
	Abundance	139846	229019	154811	70704	3472	597 852
4	Not resolved						
5	Not resolved						
6	Not resolved						
	Sum of abundance from 2004 strata 1–3	777247	364178	207013	86702	34050	1 469 190

Table 5.17: CMIX results from UK surveys in 2002 and 2004 in Subarea 48.3 assuming no strata.

Index	Age 3	Age 4	Age 5	Age 6	Age 7	Total
2002 Survey:						
Means of mixture components	324.4	440.4	525.7	592.1	675.4	
Standard deviations of mixture components	25.8	25.8	25.8	25.8	25.8	
Total density of each mixture component	124.0	39.4	13.6	10.8	3.6	
SD of each mixture component density	25.3	7.7	4.4	3.3	3.1	
Abundance	5082103	1614505	556603	441895	149572	7 844 678
2004 Survey:						
Means of mixture components	339.4	482.2	565.9	662.5		
Standard deviations of mixture components	23.3	28.6	31.8	35.4		
Total density of each mixture component	69.6	25.9	6.8	6.6		
SD of each mixture component density	152.8	69.1	56.1	40.0		
Abundance	2853310	1061931	279416	269448		4 464 106

Mark–recapture estimates of vulnerable biomass

5.124 WG-FSA-04/82 presented a refinement of a Petersen mark–recapture estimator of toothfish vulnerable biomass in Subarea 48.3 initially considered at WG-FSA-SAM-04 (WG-FSA-SAM-04/17). As requested by the subgroup, the authors revised the estimator and the data inputs to take account of:

- selectivity in the fishery (e.g. Tuck et al. (2003) selectivities were calculated according to Kirkwood (2002) using a deep selectivity pattern for 2002 and 2004 and a shallow pattern for 2003);
- initial tag mortality (assumed to be 10%);
- tag loss rate (calculated from double tag returns to be 6% per year);

and had provided estimates of confidence intervals. WG-FSA-04/82 also investigated the sensitivity of the results to different levels of tag loss rate, natural mortality and initial tag mortality.

5.125 The tagging program in the commercial fishery in Subarea 48.3 was initiated in 2000, hence some tagged fish have now been four years at liberty. Data on distance moved by individual recaptures presented in WG-FSA-04/82 suggested that although most toothfish move less than 50 km at least in the short term, significant numbers were moving several hundred km over several years at South Georgia. WG-FSA-04/82 ignored tags recovered in the same year in which they were released. Since fishing takes place in mid-winter, this equates to a minimum time at liberty of approximately 180 days to allow sufficient time for mixing. All tag return rates reported below utilise this day-at-liberty definition. The paper also reported the results of the Jolly–Seber estimator, but considered that there were not enough time periods of future sampling for it yet to provide a robust estimator of population size.

5.126 In the implementation of the analysis presented in WG-FSA-04/82 tagged fish were treated differently depending on whether they were ever recovered or not. The tagged population at the time of sampling was calculated from two populations of tagged fish:

- the population that was tagged but has never been recaptured. For these a probability of recapture was calculated taking into account natural mortality, tag mortality and tag loss rate;

- the population that was tagged and was later recaptured (i.e. their presence in the tagged population is known at the time of sampling). These were given a probability of recapture of 1.

5.127 The Working Group investigated the effect of treating all tagged fish equally to the various mortality estimates. This reduced the estimates of the tagged population at the time of sampling, and consequently the estimates of vulnerable biomass (from 52 400, 53 800 and 61 800 tonnes to 44 600, 50 800 and 60 300 tonnes for 2002, 2003 and 2004 respectively).

5.128 The overall recovery rate of tags (recovery of tags that were tagged in a previous season expressed as a percentage of the tagged population) was 12, 15 and 7% in 2002, 2003 and 2004 representing 30, 82 and 48 tag recoveries respectively. There was not sufficient time at the meeting to examine the potential source of this variability in recapture rate among years further. However, on the basis of distribution of effort and tag recaptures presented in Figure 5.11 it does not seem to be a result of changes in the distribution of fishing effort.

5.129 The spatial analysis presented in Figure 5.11 indicates that tags were recovered from a much more restricted area in 2002 than in subsequent years and that a large proportion of the returned tags recaptured in 2002 were from a restricted area at Shag Rocks. Following this analysis, the Working Group agreed that it would be important to further investigate the relationship between the distribution of effort and recaptures at a finer spatial scale intersessionally.

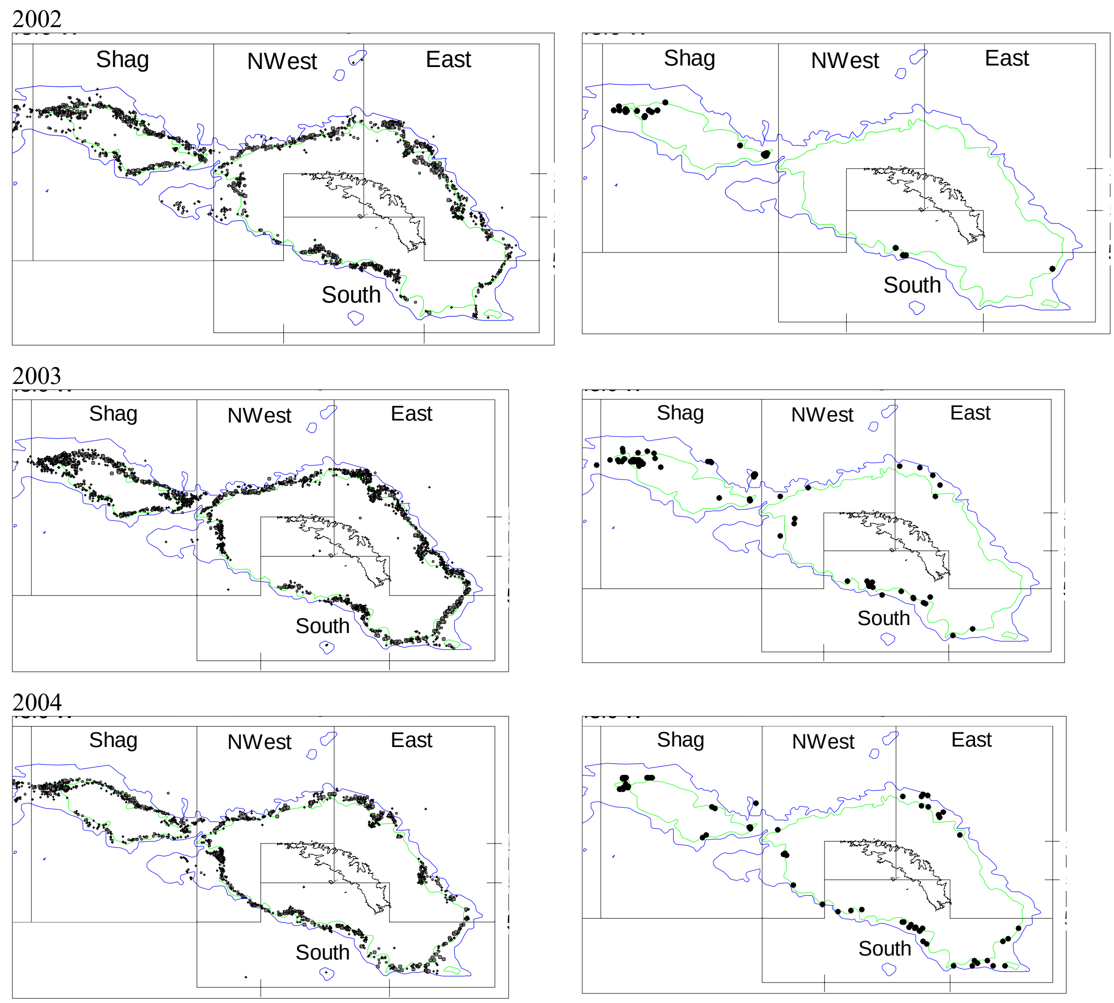


Figure 5.11: Distribution of (a) fishing effort and (b) recaptured tags by year since the commencement of the tagging program in Subarea 48.3. See Figure 5.3 for area definitions.

5.130 Issues of mixing were investigated by calculating Petersen estimates for three separate areas, Shag Rocks (including west Shag Rocks), northwest and east South Georgia and south South Georgia (see Figure 5.3 for area definitions). The distribution of releases by area and year are given in Table 5.18. The distribution of returns indicated movement between each of these three areas (Table 5.19). However, there was a larger proportion of returns within Shag Rocks and south South Georgia than in the northwest and east South Georgia area (Table 5.19). Fish were recorded to move between northwest and east South Georgia and both other areas.

Table 5.18: Distribution of releases of *Dissostichus eleginoides* among areas within Subarea 48.3 (not including 2004).

South Georgia	Number of fish tagged and released				
	2000	2001	2002	2003	Total
Shag Rocks	91	324	186	129	730
Northwest and east	44	7	99	92	242
South		16	116	134	266
Total	135	347	401	355	1238

Table 5.19: Distribution of recaptures of *Dissostichus eleginoides* among areas within Subarea 48.3. Data are pooled over the 2001/02 and 2003/04 fishing seasons.

Tagged at South Georgia	Recovered at South Georgia			Total
	Shag Rocks	Northwest and east	South	
Shag Rocks	112	5	0	117
Northwest and east	2	7	1	10
South	0	2	31	33
Total	114	14	32	160

Table 5.20: Results of Petersen estimates of vulnerable biomass in Subarea 48.3. Estimates were made for three separate areas (rows 1–3) and the whole area combined. The standard error is Bailey's binomial variance calculated according to Seber (1985, p. 61).

South Georgia	No. tags recovered			Exploitable biomass (tonnes)			se		
	2002	2003	2004	2002	2003	2004	2002	2003	2004
Shag Rocks	29	59	26	17 197	17 354	20 599	6 054	4 355	7 630
South	1	15	16	6 146	8 708	10 219	6 955	4 139	4 721
Northwest and east	0	8	6		36 152	38 419		22 407	26 623
Total	30	82	48						

5.131 Estimates of vulnerable biomass for each area and associated standard errors are given in Table 5.20. The level of movement between northwest and east South-Georgia and the other areas, and the relatively low number of tags recovered in this area, created larger variances around the Petersen estimates for northwest and east South-Georgia than for the other areas.

5.132 The results of Petersen estimates considering South Georgia and Shag Rocks as a whole are also presented in Table 5.21. The variance estimate was derived using Bailey's binomial variance (Seber, 1985, p. 61). Confidence intervals were also independently estimated by bootstrapping daily commercial catch and tag recovery data. The bootstrap Petersen estimates were slightly skewed (Table 5.21).

Table 5.21: (a) Petersen estimates and Bailey's binomial variance estimated upper and lower confidence intervals; and (b) bootstrap Petersen estimates of vulnerable biomass.

Fishing season	(a) Analytical estimate			(b) Bootstrap estimate			
	Estimate	Lower 95%	Upper 95%	Mean	Median	Lower 95%	Upper 95%
2001/02	44 615	29 157	60 073	46 890	45 861	33 331	66 801
2002/03	50 777	39 918	61 635	51 328	50 916	41 896	63 556
2003/04	60 270	43 565	76 975	61 573	60 521	47 228	82 023

5.133 Several of the analyses described above highlight sensitivities of estimates of biomass to the number and distribution of recaptures during the early period of a tagging program. For example, in the case of the 2002 estimate most recaptured fish (97%) had only been at liberty for one year. By contrast, 50% of fish recaptured in both 2003 and 2004 had been at liberty for two or more years. Figure 5.11 shows that recaptures were initially concentrated in the Shag Rocks area and have become progressively more widely distributed over 2003 and 2004.

5.134 The Working Group considered the results of the sensitivity analyses and identified a number of issues that would need to be considered in using the estimates of vulnerable biomass in assessments of long-term yield:

(i) the point estimate of vulnerable biomass and the variance measure to be used in projections;

(ii) the extent to which the closed population and mixing assumptions of the Petersen estimator is violated;

(iii) the differences between the estimates obtained using Petersen and Jolly–Seber estimators, and which may be more robust and precautionary.

5.135 Some of these issues were addressed to a degree in the time available during the meeting. The Working Group agreed that future work should focus on further examination of the Petersen, Jolly–Seber and alternative mark–recapture estimators to better understand the properties of the estimators for estimating vulnerable biomass of *D. eleginoides*. The Working Group suggested that a broader review of alternative estimators in use elsewhere, and evaluation of alternative estimators using simulated data to explore the sensitivity of the methods to known violations of the underlying assumptions would be useful.

5.136 In light of the work completed during the meeting, some members thought it appropriate to use the Petersen mark–recapture estimate of vulnerable biomass to guide the GYM projections. Dr P. Gasyukov (Russia) considered that the Working Group had not had sufficient opportunity to review and validate the methods and that it may be premature to use this method, particularly given the relatively early stage of the tagging program. Drs Kirkwood and Agnew pointed out, however, that an assessment using mark–recapture data had been presented at WG-FSA-SAM-04, that they had subsequently implemented the modifications requested by the subgroup, and that the data and spreadsheet implementing the model had been made available to the Working Group at the meeting.

5.137 The Working Group agreed to use the 2003 and 2004 bootstrap estimates of vulnerable biomass to adjust two GYM runs as part of the sensitivity analysis for this year's assessment of long-term yield. This adjustment was to scale the survey recruitment data in order that the median vulnerable biomass in 2004 from tagging corresponded to the estimated biomass from the GYM projections.

ASPM estimate of biomass

5.138 The ASPM, implemented in AD Model Builder initially by Brandão and Butterworth (WG-FSA-03/97) and modified by Agnew and Kirkwood (WG-FSA-04/82), was reviewed by the Working Group and revised to include the point estimates of exploitable biomass from tagging data as a third data source to be used in the fitting procedure (the other two sources being the annual catch–length frequencies and the standardised CPUEs). Each of these observations is compared with model predictions and a joint likelihood is calculated as the weighted sum of the individual likelihoods. This approach allows different weightings to be given to each of the three sets of observations in the fitting procedure.

5.139 Several different combinations of input data and weightings of data series were investigated. Although in the original formulation by Brandão and Butterworth the model is free to estimate fishing selectivity, selectivity was fixed in these runs to the selectivities estimated by the method of Kirkwood (2002). Following the analysis presented in WG-FSA-04/82, deep selectivity was assigned to years 1989–1997 and 2001–2004, and shallow selectivity to 1985–1988 and 1998–2000. The results are shown in Table 5.22 and examples of fits to the different data input series are given in Figure 5.12.

Table 5.22: Results of sensitivity tests of the current ASPM formulation in AD Model Builder. B_0 is the estimated unexploited vulnerable biomass and B_{exp} is the estimated current (2004) vulnerable biomass in thousands of tonnes.

Run number	Sensitivity test	CPUE	Steepness	Length weighting	Tag weighting	B_0 (1985)	B_{exp} (2004)
1	Different weightings on standardised CPUE	Standard GLM	0.6	1	0	114	79
2			0.6	0.1	0	73	36
3			0.6	1	1	91	56
4	Different weightings on standardised CPUE	Random effects GLMM	0.6	1	0	118	84
5			0.6	0.1	0	65	28
6			0.6	10	0	132	98
7	Steepness	Random effects GLMM	0.8	1	0	120	87
8	Tag weighting	Random effects GLMM	0.6	1	1	92	57
9			0.6	0.1	1	88	53
10			0.6	1	0.1	114	80
11	GLM from 1997only	Standard GLM ≥1997	0.6	10	0	135	101
12			0.6	0.1	0	186	152
13	GLMM from 1997 only	GLMM ≥1997	0.6	10	0	137	103
14			0.6	0.1	0	299	266

Figure 5.12(a)

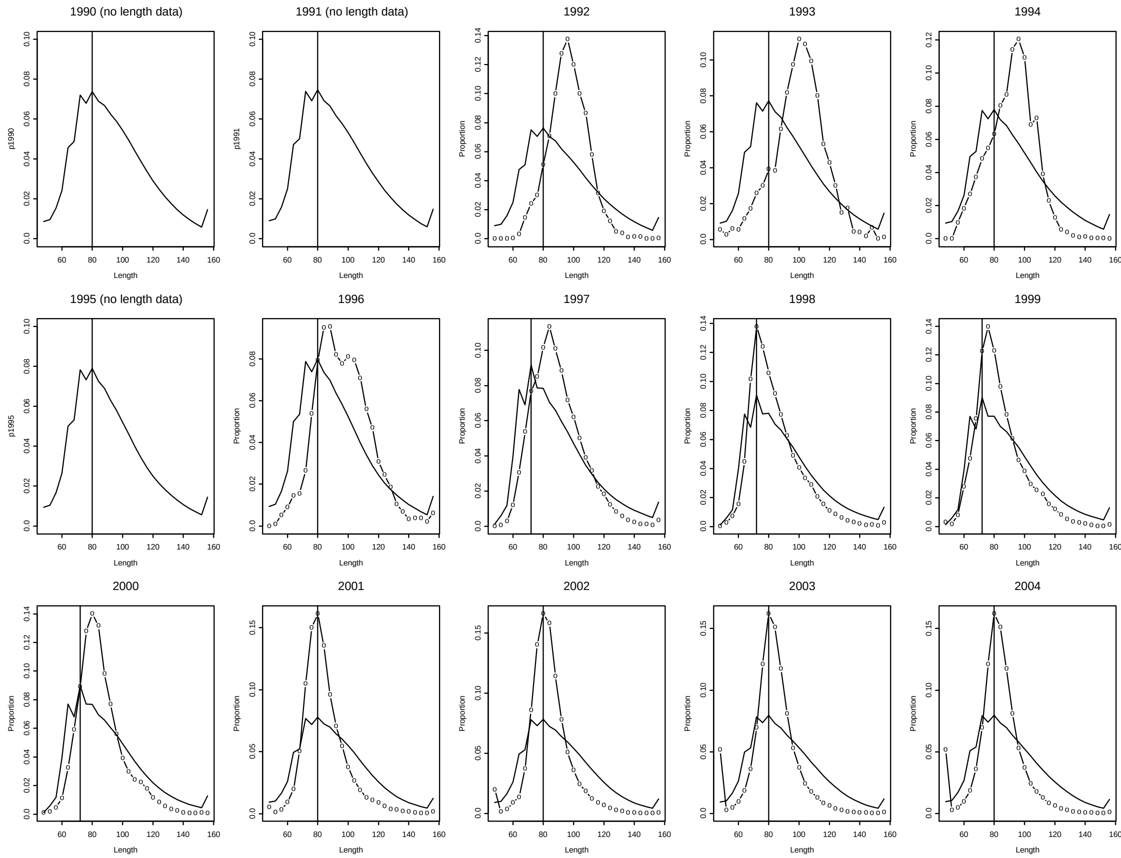


Figure 5.12(b)

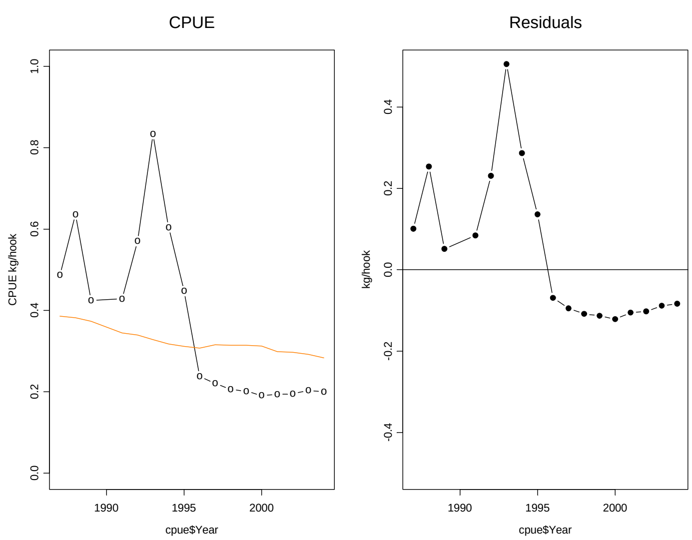


Figure 5.12(c)

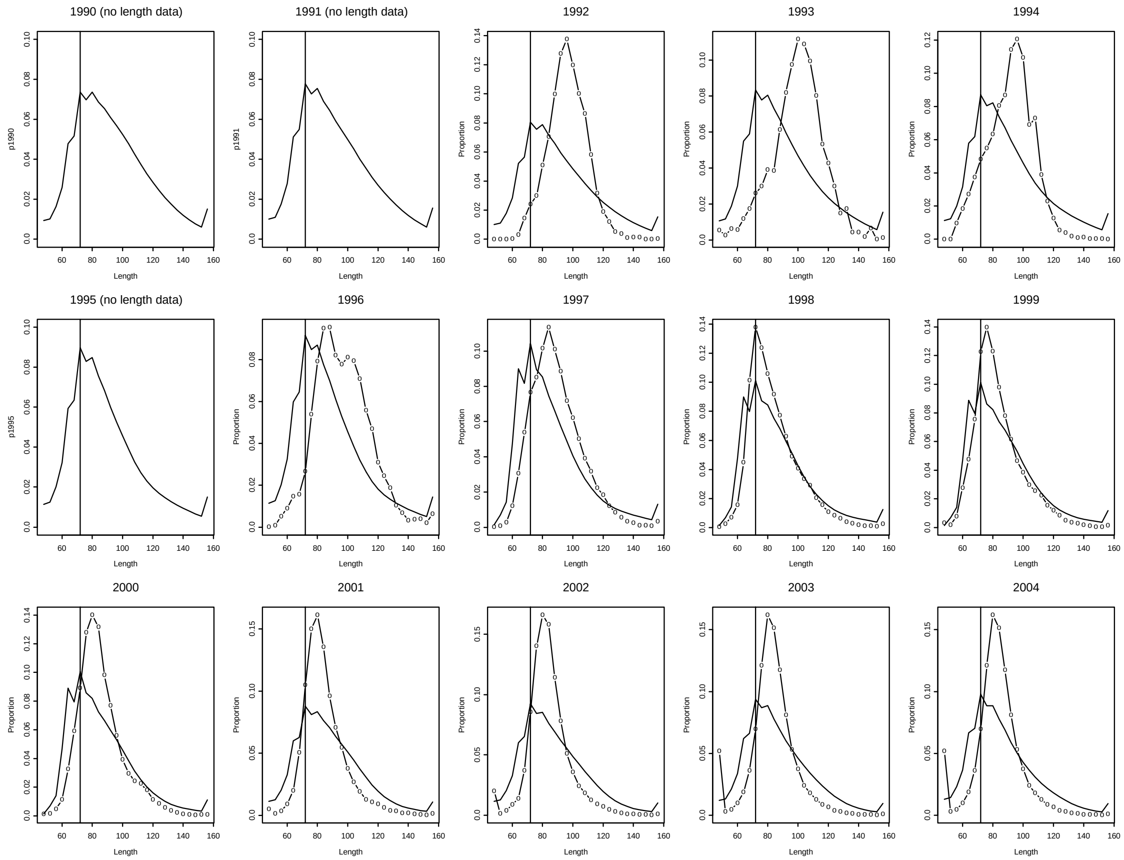


Figure 5.12(d)

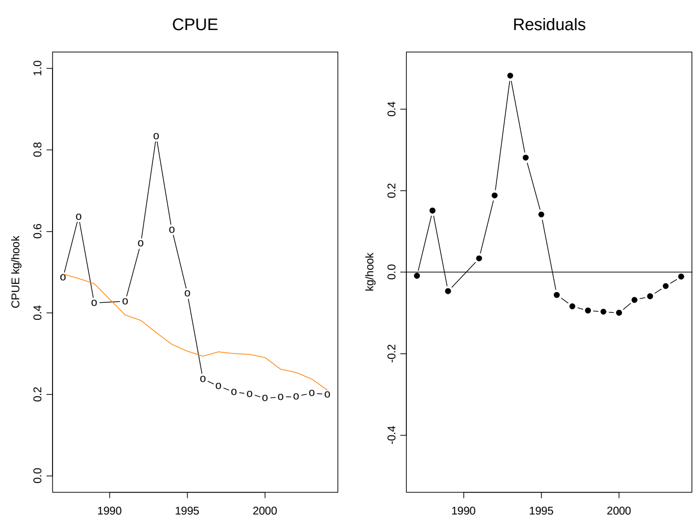


Figure 5.12(e)

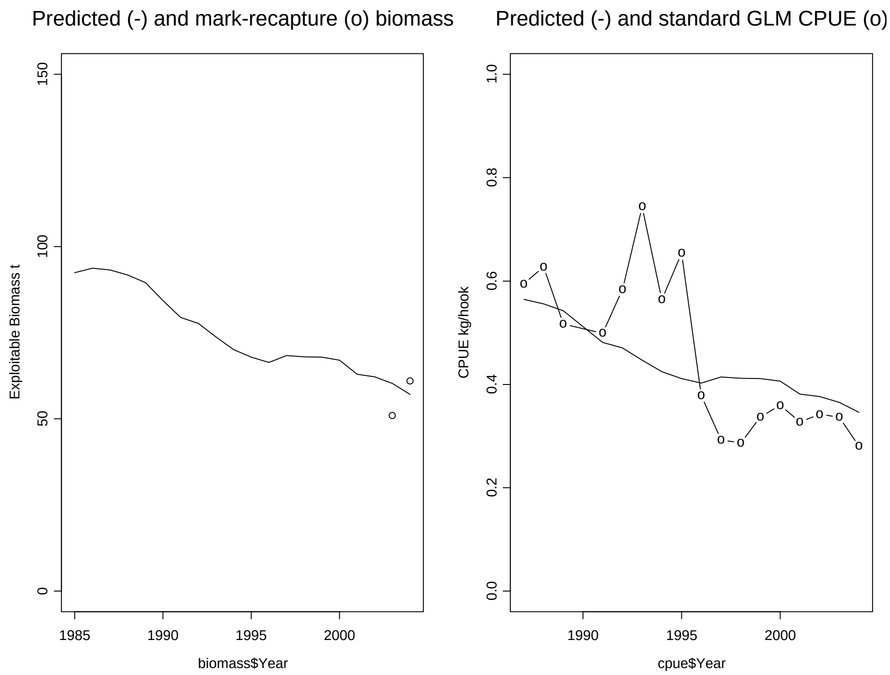


Figure 5.12: Two runs of the AD Model Builder ASPM implementation using the GLMM CPUE series. (a) length composition (-o- = observed, ___ = predicted, with the mode of the predicted identified by a vertical bar) with length composition weighting = 10; (b) CPUE fit (-o- = observed, ___ = predicted) and residuals with length composition weighting = 10; (c) and (d), the same with length composition weighting = 0.1. (run numbers 5 and 6 in Table 5.22), (e) ASPM fit to the standard GLM and tagging data with an equal weighting (1). Exploitable biomass and tag-estimated exploitable biomass (o) is shown (run number 3 in Table 5.22). Note that for the years 1990, 1991 and 1995 there was no observed length-frequency data.

5.140 Reviewing these sensitivity trials, the Working Group noted that the results of the ASPM were highly dependent on the weighting factors used, and the values specified for fixed parameters. None of the fits to the full CPUE series were satisfactory, there being large trends in the residuals. The most significant residual discrepancies are the inability of the model to predict the rapid decline in CPUE over the period from 1995 to 1996, or the relatively constant CPUE since 1997. Although the runs with high weighting on the length composition data were able to predict reasonably accurately the catch composition from about 1997 onwards, the fits to data from the early 1990s were poor. Adjusting the weighting factors to produce a better fit to either the length or CPUE dataset results in a much poorer fit to the other dataset, and no weighting factor produced a satisfactory fit to both length and CPUE data. Inclusion of the tagging estimates of biomass in 2003 and 2004 assisted the model, but did not improve the fit to the CPUE data.

5.141 The Working Group therefore agreed that the ASPM cannot be used at this meeting to provide reliable estimates of stock abundance. However, the revisions to the model and detailed review of the sensitivity trials provided several promising lines of further research, and it is recommended that these be pursued in the intersessional period for review by WG-FSA-SAM.

3.2 Parameter values

Biological parameters

Table 5.23: Parameter values for *Dissostichus eleginoides* in Subarea 48.3.

Component	Parameter	Value	Units
Natural mortality	M	0.132–0.2	y^{-1}
VBGF	K	0.066	y^{-1}
VBGF	t_0	–0.21	y
VBGF	L_∞	1946	mm
Length to mass	‘a’	2.5E-09	mm, kg
Length to mass	‘b’	2.8	
Maturity	L_{m50}	930	mm
Range: 0 to full maturity		780–1080	mm

Time series

Total removals

5.142 Estimated total removals are set out in Table 5.14.

Selectivity-at-age

Table 5.24: 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, 2004, future projections
0	0.00	0
4.9	0.00	0
6.17	0.72	0.5
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

Standardised CPUE

5.143 The standardised CPUE series for the 2004 season was estimated using the GLMM method proposed by Candy (2004). The revised CPUE series is presented in Table 5.25. This revised series was used as the base-case series for the GYM assessment.

Table 5.25: Standardised series of CPUEs in kg/hook for *Dissostichus eleginoides* in Subarea 48.3, from the random effects GLMM standardised for Chilean vessels fishing between depths of 1 000 and 1 500 m in the southern sector of South Georgia used in the GYM assessments for 2004. The years prior to 1989 were not used in the GYM assessments.

Fishing season	CPUE estimate	Upper 95% CI	Lower 95% CI
1984/85	0.2106	0.5576	0.0795
1985/86	0.2564	0.6393	0.1028
1986/87	0.4866	1.2494	0.1895
1987/88	0.6358	1.4297	0.2827
1988/89	0.4249	0.9748	0.1852
1989/90	-	-	-
1990/91	0.4284	0.9035	0.2032
1991/92	0.5701	0.8509	0.3820
1992/93	0.8338	1.2807	0.5428
1993/94	0.6042	0.9002	0.4055
1994/95	0.4478	0.6504	0.3083
1995/96	0.2381	0.3462	0.1637
1996/97	0.2205	0.3229	0.1506
1997/98	0.2059	0.3028	0.1400
1998/99	0.2014	0.2935	0.1381
1999/00	0.1909	0.2782	0.1310
2000/01	0.1934	0.2815	0.1328
2001/02	0.1947	0.2832	0.1338
2002/03	0.2035	0.2981	0.1390
2003/04	0.1997	0.2905	0.1373

Recruitment

5.144 The recruitment series for Subarea 48.3 was revised based on the results of the CMIX analyses completed using the Subarea 48.3 growth parameters (WG-FSA-04/92). The series was also estimated using the growth parameters provided by Belchier et al. (2004) (WG-FSA-04/92).

5.145 Both of the revised series result in substantially lower estimates of mean recruitment and, in the case of the Belchier et al. (2004) series, a higher CV than those used in the 2002 assessment or the revised estimate used in the 2003 assessment (Table 5.26). The Working Group noted that this reduction in mean recruitment was largely due to the identification of the errors in previous analyses (SC-CAMLR-XXII, Annex 5, paragraphs 5.104 to 5.115), the sources of which had subsequently been rectified (WG-FSA-SAM-04/16).

Table 5.26: Revised recruitment series for Subarea 48.3 based on review of data extractions and CMIX analysis presented in WG-FSA-SAM-04/16 and WG-FSA-04/92, and revisions to CMIX analysis for the 1998 UK survey completed during the meeting. Both series exclude the Russian 2000 survey. The FSA-04 48.3 vB series was used as the base-case for the 2004 long-term yield assessment. The FSA-04 48.3 Belchier et al. (2004) vB series was used in sensitivity analyses. See paragraphs 5.144 and 5.145 for details of revised series.

Split-year	FSA-02	FSA-03 new 02	FSA-04 48.3 vB	FSA-04 Belchier et al. (2004) vB
1986				0.120
1987	1.349	1.349	0.846	0.834
1988	0.845	0.845	0.568	0.558
1989	4.214	4.244	0.017	0.195
1990	9.374	9.374	1.954	1.096
1991	6.7	6.700	1.227	0.005
1992			0.260	2.018
1993	11.799	11.799	5.312	4.633
1994	2.13	2.225	1.259	0.561
1995	1.003	0.984	1.252	0.004
1996	0.691	0.690	1.118	0.258
1997	2.947	2.947	1.794	1.549
1998	1.14	1.140	0.659	0.659
1999			0.124	0.038
2000			0.139	0.148
2001	2.504	1.067	0.664	0.155
2002	4.207	1.066	0.992	0.677
2003	10.694	2.015	1.814	0.074
2004			-	0.840
2005			1.379	0.756
2006			2.47	0.649
Mean	4.257	3.318	1.255	0.754
CV	0.90	1.06	0.949	1.369

4. Stock assessment

4.1 Model structure and assumptions

5.146 The GYM, using input data from Section 3 of this Fishery Report, was used to estimate the constant catch that would satisfy the CCAMLR decision rules. These are:

1. Depletion rule: Determine the catch that results in a probability of the spawning stock biomass falling below 20% of its estimated pre-exploitation level of not more than 10% over the 35-year projection period.

2. Escapement rule: Calculate the catch that results in a median escapement of 50% of the spawning stock biomass in the final year of the 35-year projection;

3. Choose the lower of the two estimates of long-term yield.

Model configuration

5.147 The GYM was run (Table 5.27) according to the configuration detailed in Table 5.42.

Table 5.27: GYM configuration for the assessment of *Dissostichus eleginoides* in Subarea 48.3.

Age structure	Recruitment age	4 years
	Plus class accumulation	35 years
	Oldest age in initial structure	55 years
Simulation specification	Number of runs	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	1001
	Year prior to projection	1983
	Reference start date	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

5.148 In the Subarea 48.3 recruitment series (Table 5.26) the likelihood method was used to weight each trial projection based using the standardised CPUE series in Table 5.25.

4.2 Model estimates

5.149 In preparation for the assessment, the Working Group considered the preliminary assessment using the GYM provided in WG-FSA-04/82. In particular, it noted that in the initial assessment presented, a large proportion (~40%) of trials did not realise the known catches in the latter part of the known series (WG-FSA-04/82, Figure 6).

5.150 The Working Group considered a range of factors that may contribute to the known catch series not being realised, these included:

(i) the revised estimates of absolute recruitment being biased;

(ii) the nature of the real time series of recruitments immediately prior to the known series;

(iii) the upper end of the range of natural mortality (M) currently used in the assessment being too high; and/or

(iv) the current growth parameters being biased.

5.151 The Working Group noted that the unrealised catches could result from any one or a combination of the above.

4.3 Sensitivity analyses

5.152 The Working Group conducted an initial series of sensitivity analyses using the GYM to explore the potential source of the unresolved catches in the current assessment. The analyses included examining the effect of :

(i) a the range of M used (0.13–0.2 and 0.13–0.165)
(ii) the uses of point estimates of M (0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.20)
(iii) assuming different values to scale the estimates of recruitment over the known period (1987–2004) of the fishery (1, 2 and 3).

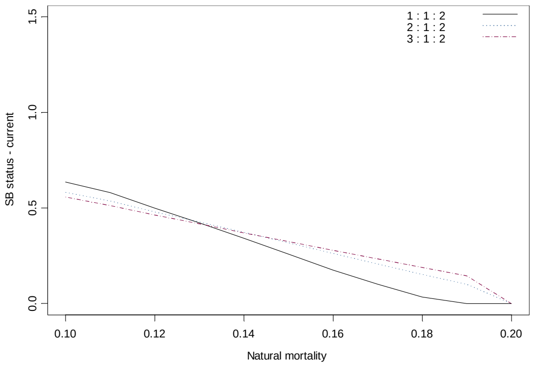
5.153 The base-case for these analyses was: M = 0.13–0.20, and recruitment scaler = 1. The revised Subarea 48.3 recruitment series (Table 5.26), GLMM CPUE series (Table 5.25) and likelihood weighting of trials (Kirkwood and Constable, 2001) were consistently used for all diagnostic analyses.

5.154 The results of the diagnostic analyses are presented in Figure 5.13. The Working Group noted that the estimate of M had a significant effect on the proportion of trials with unresolved catches, and in particular that for values of M less than 0.15 the known catch history was resolved in all trials, whereas the proportion of trials for which the catches were not resolved increased rapidly for values of M greater than 0.16. The Working Group also noted that scaling the estimated recruitment series resulted in 100% of trials resolving the catch series, up to values of M of approximately 0.18 or higher. Above values of 0.18 for M, the proportion of trials with unresolved catches increased markedly and the results for other variables examined were also unrealistic.

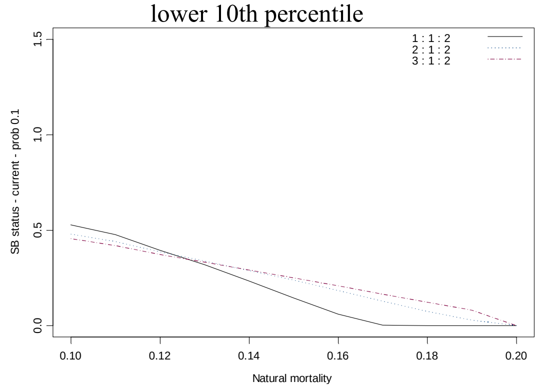
Figure 5.13(a)

Current spawning stock status

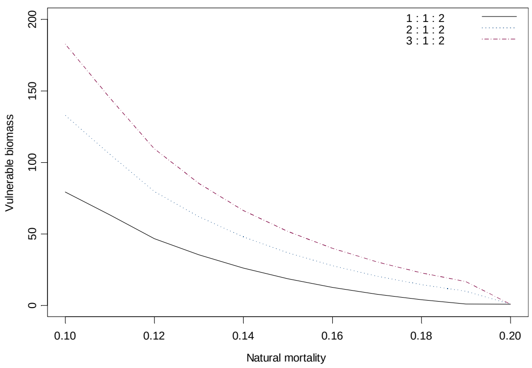
median



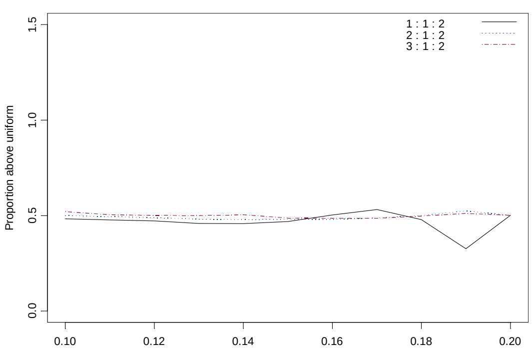
lower 10th percentile



Vulnerable biomass (thousand tonnes)



Proportion of trials
with statistical weight above uniform weight



not resolving known catch series

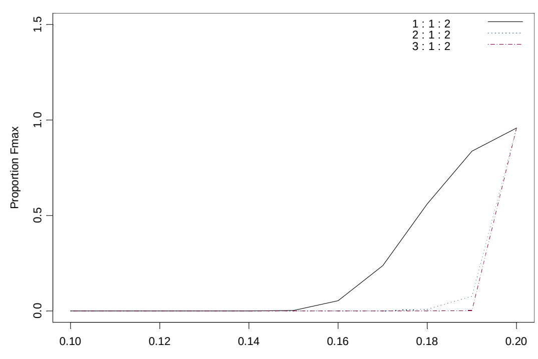
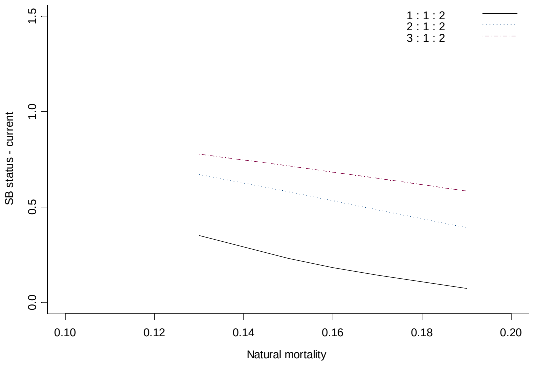


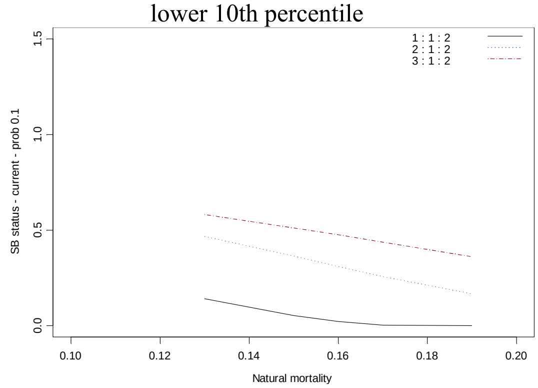
Figure 5.13(b)

Current spawning stock status

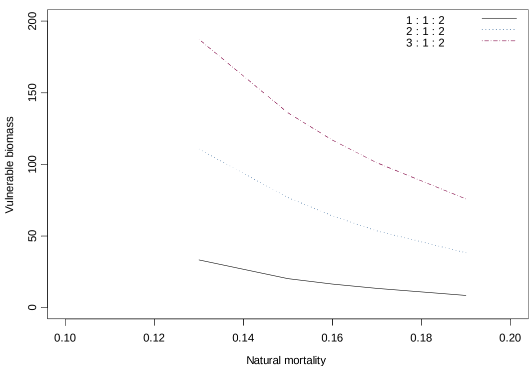
median



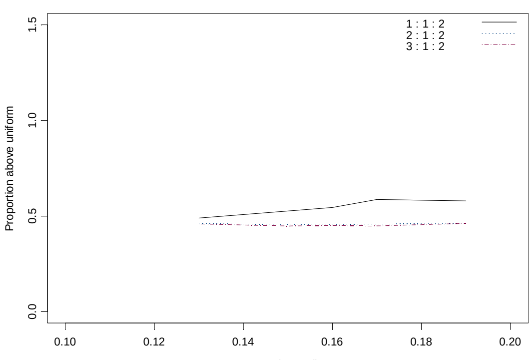
lower 10th percentile



Vulnerable biomass (thousand tonnes)



Proportion of trials
with statistical weight above uniform weight



not resolving known catch series

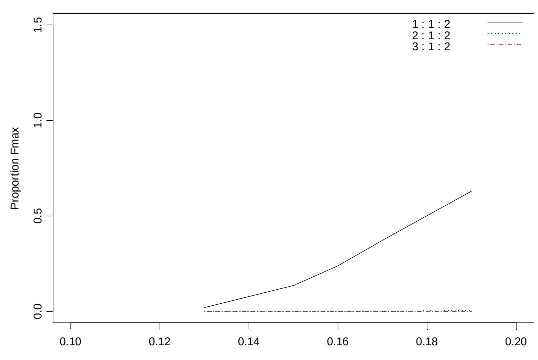


Figure 5.13: Results of initial sensitivity trials using the GYM examining the possible attributes of the stock of *Dissostichus eleginoides* in Subarea 48.3 with different scenarios for recruitment and natural mortality. Values of spawning stock status and vulnerable biomass shown here are the median values for each year. Trials were weighted by the goodness of fit to the standardised CPUE series before the medians were determined.

(a) Recruitment is modelled as a lognormal function with recruitments in 1984–2005 estimated from the surveys. Mean recruitment in years for which no observations were made is modelled as the estimate from the surveys (solid line), 2x the estimate (dotted line) and 3x the estimate (dashed line).

(b) Recruitment is modelled as a lognormal function in all years of the trials. Mean recruitment is modelled as the estimate from the surveys (solid line), 2x the estimate (dotted line) and 3x the estimate (dashed line).

4.4 Discussion of model results

Alternative scenarios for the 2004 assessment

5.155 On the basis of the results of the sensitivity analyses and the considerable uncertainty in the current status of the stock in Subarea 48.3, the Working Group agreed that a range of scenarios should be run for the 2004 assessment for consideration in providing advice for 2004. The factors to be included in the scenarios are given in Table 5.28. The results are presented in Tables 5.29 and 5.30 and Figure 5.14.

Table 5.28: Summary of alternative scenarios examined for *Dissostichus eleginoides* in Subarea 48.3 for the 2004 assessment. The base-case assessment was: M = 0.13–0.20, recruitment scaler = 1 and test values of 500 and 1 500 tonnes.

Factor	Levels	Values
Range of natural mortality	2	(0.13–0.20); (0.155–0.175)
Scaling of recruitment series	4–5	0.5, 1, 1.5, 1.78, 2
Constant catch level*	3–4	500–4 780 tonnes

* The test values for catch level varied among scenarios, including a catch value that resulted in an estimate of vulnerable biomass that approximated the estimate of vulnerable biomass from the Petersen mark–recapture estimate (Table 5.21).

Table 5.29: Results of the alternative scenarios examined for the 2004 assessment of *Dissostichus eleginoides* in Subarea 48.3. M range = range of natural mortality; Rec. = scaler used to multiply estimated densities of recruits (ages 2–4); Year: 1984 = year prior to known series; 2004 = end of 2004/05 season; SB.stat50 = median spawning biomass over the projection period; SB.stat10 = lower 10th percentile of spawning biomass; TB.50 = median total biomass prior to known catch series; VB50 = medium vulnerable biomass at start of know catch series; P.depl. = probability of the spawning stock biomass being below 0.2 of unfished biomass over the projection period; P.Fmax = proportion of trials for which the known catch series was not resolved; P. > wt = proportion of trials with a greater than uniform weight (for CPUE adjustment). All scenarios were run using the revised Subarea 48.3 recruitment series given in Table 5.26 with 2 001 trials per scenario. The base-case (see paragraph 5.153) is shown in bold.

M range	Rec.	Test catch (tonnes)	Year	SB.stat50	SB.stat10	TB.50	VB50	P.depl.	P.Fmax	P. > wt
0.13–	0.5R								0.991	0.395
0.20			1984	1.000	0.791	36.657	0.000			
			2004	0.000	0.000	2.344	0.423			
		1000	2005	0.000	0.000	2.233	0.511			
		1000	2039	0.520	0.211	22.827	16.566	0.991		
		3000	2005	0.000	0.000	2.233	0.480			
		3000	2039	0.000	0.000	2.118	0.413	1.000		
0.13–	**1R**								**0.311**	**0.586**
0.20			**1984**	**1.023**	**0.810**	**87.155**	**0.000**			
			2004	**0.217**	**0.001**	**25.116**	**15.231**			
		500	**2005**	**0.186**	**0.000**	**23.517**	**14.289**			
		500	**2039**	**0.895**	**0.685**	**77.265**	**53.904**	**0.526**		
		1500	**2005**	**0.182**	**0.000**	**23.517**	**14.247**			
		1500	**2039**	**0.697**	**0.466**	**63.827**	**45.408**	**0.548**		
0.13–	1.5R								0.000	0.463
0.20			1984	1.017	0.806	119.595	0.000			
			2004	0.454	0.260	57.019	36.755			
		500	2005	0.418	0.226	55.457	35.096			
		500	2039	0.931	0.719	109.187	76.459	0.057		
		1500	2005	0.414	0.222	55.457	35.050			
		1500	2039	0.793	0.572	96.849	68.561	0.079		
0.13–	1.78R								0.000	0.459
0.20			1984	1.017	0.806	141.960	0.000			
			2004	0.552	0.385	78.050	50.994			
		3000	2005	0.506	0.338	76.157	48.763	0.020		
		3000	2039	0.655	0.413	99.194	71.261			
		3500	2005	0.504	0.336	76.157	48.740	0.053		
		3500	2039	0.598	0.339	92.895	66.710			
0.13–	2R								0.000	0.456
0.20			1984	1.017	0.806	159.543	0.000			
			2004	0.611	0.457	94.376	61.993			
		1000	2005	0.568	0.416	92.401	59.436	0.000		
		1000	2039	0.901	0.685	141.987	99.583			
		3000	2005	0.562	0.409	92.401	59.345	0.005		
		3000	2039	0.694	0.460	116.580	83.369			
		3500	2005	0.560	0.407	92.401	59.320	0.020		
		3500	2039	0.644	0.400	110.009	79.082			

Table 5.29 (continued)

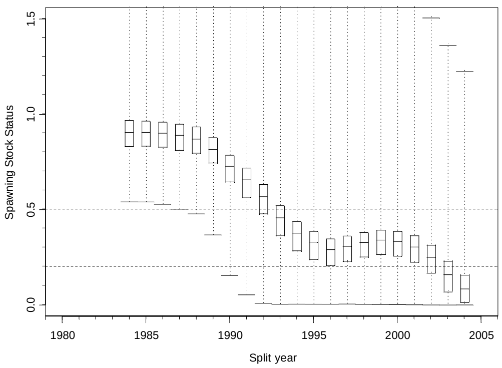
M range	Rec.	Test catch (tonnes)	Year	SB.stat50	SB.stat10	TB.50	VB50	P.depl.	P.Fmax	P. > wt
0.155–0.175	0.5R								1.000	0.542
			1984	0.985	0.773	34.843	0.000			
			2004	0.000	0.000	2.246	0.422			
		1000	2005	0.000	0.000	2.116	0.479	1.000		
		1000	2039	0.495	0.220	21.619	15.732			
		3000	2005	0.000	0.000	2.116	0.454	1.000		
		3000	2039	0.000	0.000	1.978	0.386			
0.155–0.175	1R								0.139	0.544
			1984	1.026	0.813	79.414	0.000			
			2004	0.149	0.027	18.701	10.635			
		500	2005	0.121	0.013	17.069	9.982	0.785		
		500	2039	0.893	0.677	70.402	49.318			
		1500	2005	0.117	0.012	17.069	9.936	0.814		
		1500	2039	0.683	0.449	57.236	40.910			
0.155–0.175	1.5R								0.000	0.458
			1984	1.018	0.805	115.949	0.000			
			2004	0.454	0.352	55.676	36.072			
		500	2005	0.419	0.323	54.026	34.712	0.001		
		500	2039	0.931	0.715	107.001	74.957			
		1500	2005	0.415	0.319	54.026	34.666	0.001		
		1500	2039	0.797	0.575	94.696	67.024			
		3590	2005	0.406	0.311	54.026	34.567	0.134		
		3590	2039	0.487	0.233	66.434	47.725			
0.155–0.175	2R								0.000	0.452
			1984	1.019	0.805	154.879	0.000			
			2004	0.613	0.505	92.762	61.171			
		500	2005	0.573	0.473	90.955	58.835	0.000		
		500	2039	0.950	0.734	145.004	101.459			
		1500	2005	0.570	0.470	90.955	58.790	0.000		
		1500	2039	0.851	0.633	133.134	93.801			
		4780	2005	0.560	0.461	90.955	58.638	0.109		
		4780	2039	0.496	0.248	89.925	64.338			

Table 5.30: Estimates of constant catch that will satisfy the decision rules for each alternative scenario for the 2004 assessment of *Dissostichus eleginoides* in Subarea 48.3. The third part of the decision rule states that the lower of the two catch levels is selected as the estimate of long-term yield. All scenarios were run using the revised Subarea 48.3 recruitment series given in Table 5.26 with 2 001 trials per scenario. See Table 5.29 for description of column heading. The base-case (see paragraph 5.153) is shown in bold.

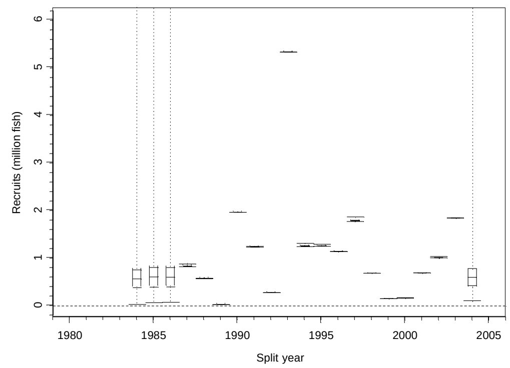
M range	Rec.	SB.stat50	P.depl.	P.Fmax	P. > wt	Escapement rule catch	Depletion rule catch
0.13–0.20	0.5R	0.000	1.000	0.991	0.395	1075.6	0
0.13–0.20	**1R**	**0.697**	**0.548**	**0.311**	**0.586**	**2499**	**0**
0.13–0.20	1.5R	0.793	0.079	0.000	0.463	3626.4	2454.55
0.13–0.20	1.78R	0.598	0.053	0.000	0.459	4347.1	4216
0.13–0.20	2R	0.644	0.020	0.000	0.456	4918.4	6166.67
0.155–0.175	0.5R	0.000	1.000	1.000	0.542	977.79	0
0.155–0.175	1R	0.683	0.814	0.139	0.544	2373	0
0.155–0.175	1.5R	0.487	0.134	0.000	0.458	3503.7	3055.71
0.155–0.175	2R	0.496	0.109	0.000	0.452	4739.1	4509.17

Figure 5.14(a)

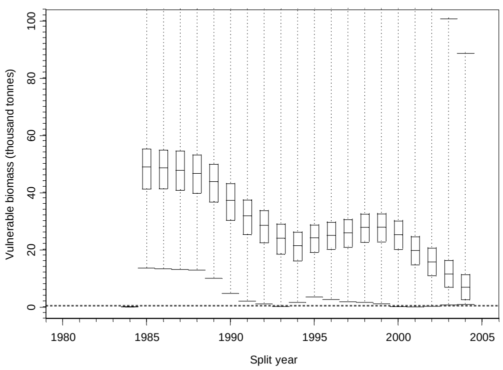
Spawning stock status



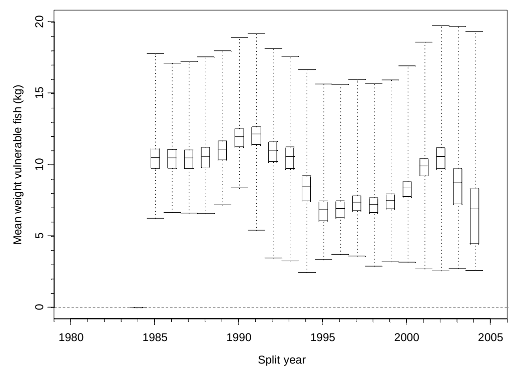
Recruitment



Vulnerable biomass



Mean weight of vulnerable fish



Fishing mortality

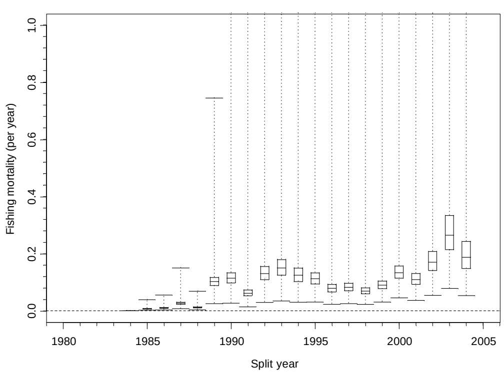
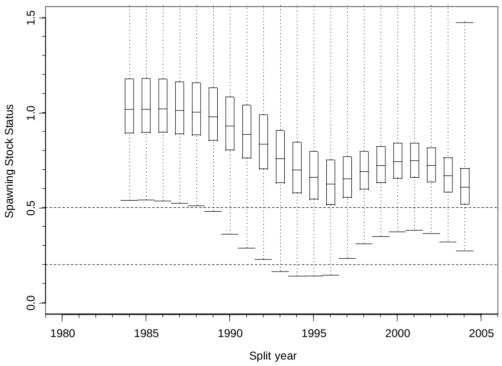
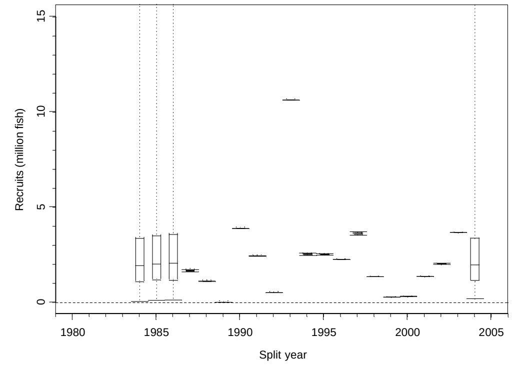


Figure 5.14(b)

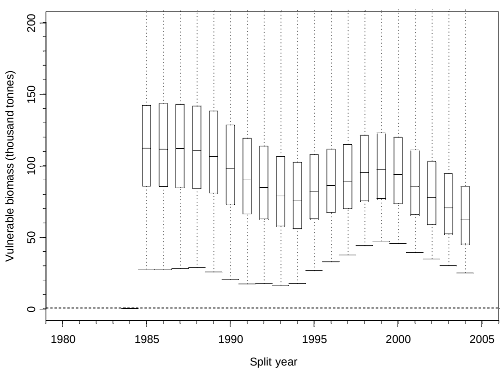
Spawning Stock Status



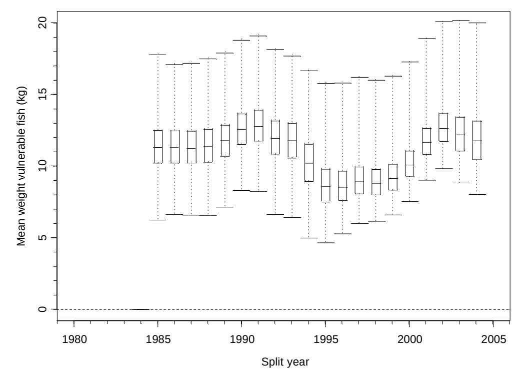
Recruitment



Vulnerable biomass



Mean weight of vulnerable fish



Fishing mortality

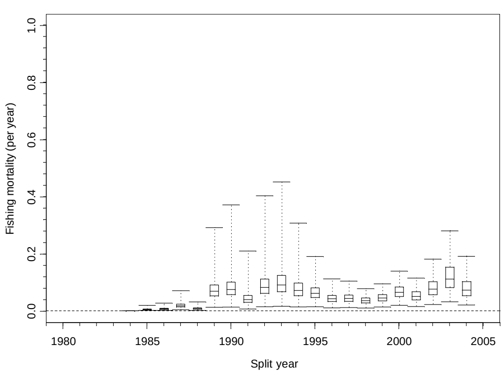


Figure 5.14: Box plots showing the results of trials using the GYM examining the possible attributes of the stock of *Dissostichus eleginoides* in Subarea 48.3 with different scenarios for recruitment for the range of natural mortality between 0.13 and 0.2. The known catch series is taken between 1984 and 2004. Trials were weighted by the goodness of fit to the standardised CPUE series before estimating the values of the box plots. The mid-line in each box is the median. The upper and lower limits to the box are the lower (0.25) and upper (0.75) quartiles. The ends of the whiskers show the minimum and maximum values observed in the trials.

(a) Base case: recruitment is modelled as a lognormal function with recruitments in 1984–2005 estimated from the surveys. Mean recruitment in years for which no observations were made is modelled as the estimate from the surveys.

(b) Recruitment is modelled as a lognormal function with recruitments in 1984–2005 estimated from the surveys. Survey data were scaled by 2x in these projections. Mean recruitment in years for which no observations were made is modelled as the estimate from the surveys.

5. By-catch of fish and invertebrates

5.1 Estimation of by-catch removals

5.156 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).

Table 5.31: By-catch (tonnes) reported from longline fisheries in Subarea 48.3. GRV – *Macrourus* spp., SRX – rajids.

Fishing season	GRV		SRX		Others	
	Removals	Limit	Removals	Limit	Removals	Limit
1988/89	2		22		0	*
1989/90	0		0		0	*
1990/91	9		26		0	*
1991/92	1		2		0	*
1992/93	2		0		0	*
1993/94	0		12		0	*
1994/95	13		98		11	*
1995/96	40		58		0	*
1996/97	34		44		4	*
1997/98	24		15		2	*
1998/99	21		19		1	*
1999/00	18		12		5	*
2000/01	22		28		3	*
2001/02	53	291	26	291	13	
2002/03	75	390	38	390	19	
2003/04	30	221	6	221	4	

* None specified

Estimated cut-off catch

5.157 Estimates of total mortality for fish cut from longlines in Subarea 48.3 were made in 2003. Sufficient data to repeat these calculations was not available at the 2004 WG-FSA meeting.

5.2 Assessments of impact on affected populations

5.158 No assessments for rajids or macrourids in Subarea 48.3 have yet been undertaken.

5.3 Mitigation measures

5.159 By-catch limits and move-on rules are included in the annual conservation measure established for this fishery (Conservation Measure 41-02). In addition, mitigation measures for rajids consist of cutting rajids off lines at the water surface.

6. By-catch of birds and mammals

5.160 Details of seabird by-catch (taken from Table 7.3) are summarised in Table 5.32. Estimated potential seabird removals in the IUU fishery are summarised in SC-CAMLR-XXIII/BG/23 and Table 7.15.

Table 5.32: Estimated by-catch of seabirds in Subarea 48.3.

Fishing season	By-catch rate (birds/thousand hooks)	Estimated by-catch
1996/97	0.23	5 755
1997/98	0.032	640
1998/99	0.013*	210*
1999/00	0.002	21
2000/01	0.002	30
2001/02	0.0015	27
2002/03	0.0003	8
2003/04	0.001	18

* Excluding *Argos Helena* line-weighting experiment cruise

5.161 Ad hoc WG-IMAF has assessed the level of risk of incidental mortality of seabirds in Subarea 48.3 as category 5 (SC-CAMLR-XXIII/BG/21).

6.1 Mitigation measures

5.162 Conservation Measure 25-02 applies to this subarea.

6.2 Interactions involving marine mammals with longline fishing operations

5.163 No interactions were reported in the 2004 fishing season.

7. Ecosystem effects

5.164 The Working Group did not examine the ecosystem effects of the longline fishery for toothfish in Subarea 48.3.

8. Harvest controls for the 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.33: Summary of provisions of Conservation Measure 41-02 for *Dissostichus eleginoides* in Subarea 48.3 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 41-02	Advice for 2004/05	Paragraph reference
1. Access (gear)	Longlines and pots only		
2. Catch limit	4 420 tonnes	Review	
3. Season: longline	1 May to 31 August 2004 Extension possible to 14 September 2004 for vessel complying fully with CM 25-02 in 2002/03.		
3. Season: pots	1 December 2003 to 30 November 2004		
3. By-catch: seabirds	During extension period (1–14 September 2004) any vessel catching three (3) seabirds to cease fishing.		
4. By-catch: crabs	By-catch of crabs to be counted against crab catch limit.		
5. By-catch: finfish	Total combined catch of skates and rays ≤221 tonnes Total catch of *Macrourus* spp. ≤221 tonnes		
6. By-catch: any species	Move-on rule		
7. Mitigation	In accordance with CM 25-02.		
8. Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer.		
9. Data: catch and effort	(i) Five-day reporting system as in CM 23-01 (ii) Monthly fine-scale reporting system as in CM 23-04 on haul-by-haul basis.		
10. Target species	For the purposes of CMs 23-01 and 23-04, *Dissostichus eleginoides* is the target species and the by-catch is any species other than *D. eleginoides.*		
11. Jellymeat	Number and weight of fish discarded, including those with jellymeat condition, to be reported. These catches count towards the catch limit.		
12. Data: biological	Monthly fine-scale reporting system as in CM 23-05. Reported in accordance with the Scheme of International Scientific Observation.		

8.2 Management advice

5.165 In summary the Working Group noted the following points arising from the various analyses undertaken during the meeting:

(i) Size distribution of the catch: in the early 1990s the catch was characterised by a range of fish sizes (approximately 60–145 cm) with a mode just greater than 100 cm. In the late 1990s, the size of fish ranged from 60 to 120 cm with a mode between 70 and 80 cm. In recent years, the mode has increased slightly.

(ii) Distribution of fishing effort: the fishery and assessment relate to the fishing areas around South Georgia/Shag Rocks, not to Maurice Ewing Bank or North Scotia Ridge (Figure 5.5). Fishing has occurred throughout the area, although the pattern has changed over the development of the fishery. During the early period (1989–1996), the fishery expanded across the area from an initial concentration of effort around Shag Rocks. Since 1996 the fishery has extended over the entire area (Figure 5.3).

(iii) Trends in standardised CPUE by area: the main fishing areas have different trends in CPUE. The main trends evident in the data are for Shag Rocks and the southern South Georgia area. At Shag Rocks, the CPUE has been variable over the early period (up to 1995) and then increased through to 1999, after which time it has declined. In the southern South Georgia area, the CPUE declined between 1994 and 1996 and has been increasing more recently.

(iv) Trends in standardised CPUE overall: the CPUE time series is characterised by an early period (1987–1994), a period of rapid decline (1995–1996) and a later period of relatively constant CPUE since 1996. The later period in the GLMM is approximately 35% of the level in the early period. The later period in the GLM is approximately 50% of the level in the early period.

(v) Trends in standardised mean weight of fish in the commercial catch: this time series is similar to the expectation derived from the size distribution of the catch with the mean weight declining from approximately 12 kg in the early period to 6–7 kg in the later period.

(vi) Recruitment: the time series of recruitments estimated from surveys shows the trends in recruitment in the region. The number of survey hauls and their distribution could be improved to increase precision of the estimates for each year. Interannual variation in the performance of the surveys is likely to be a random factor. Such variation will influence the magnitude of the coefficient of variation of the estimated mean recruitment. Improvements in survey design will most likely reduce the CV but may not alter the mean. The estimate of mean recruitment may be influenced (biased) by other factors but there is no direct information at present to estimate bias, if it exists.

(vii) Biomass estimates from mark–recapture data: these estimates are based on 160 recaptures, with variable representation between areas. The most coverage was for Shag Rocks. The tagging program at South Georgia has been expanded in 2004 but the releases are much less than for other areas in the Convention Area. The Working Group explored some of the underlying assumptions of the Petersen method, such as that the tagged population is well mixed with the untagged population and there is a constant recapture rate (tags recaptured / tags in the population) over time, although there may not be a sufficiently long time series to determine if the assumptions are met at this stage. With respect to mixing, a large proportion of the tagged fish have been recaptured less than 20 km from their location of release. The annual recapture rate has been 12% in 2002, 12% in 2003 and 7% in 2004. If the fish are not well mixed and the distribution of release and recapture effort were to vary among years, then estimates of abundance from the tagging experiment could be biased.

(viii) Results of the ASPM: the ability for the ASPM to fit to the data is dependent on a number of assumptions and parameter inputs, including recruitment, growth and mortality rates. It could also be influenced by the selectivity/vulnerability function and the accuracy of the estimates of vulnerability at age/length.

(ix) Sensitivity tests on estimates of current status of the population using the GYM: the problem of realising the known catch series in the GYM projections using the parameters applied in the assessment by WG-FSA last year could be resolved by lowering the range of natural mortality, increasing the starting biomass while retaining the estimated recruitment series, or by increasing the magnitude of recruitment during the known catch series. These trials showed that estimates of vulnerable biomass, along with the known catch series, could be realised by different combinations of these parameters. The respective combinations will influence the status of the stock when the trajectory is passed through a specific vulnerable biomass.

(x) Estimated catch from a recruitment-based long-term annual yield assessment: following the revision of the recruitment series and the application of this in the usual assessment of the past, the resulting long-term annual yield would be zero. If the assessment is undertaken using the lognormal parameters derived from the time series of recruitments but without applying the known catch and recruitment series, then the long-term annual yield would be estimated to be approximately 1 900 tonnes.

5.166 Dr Constable noted that there were a number of issues that remain to be resolved in the assessment for *D. eleginoides* in Subarea 48.3 and that it would be useful to undertake an evaluation of the robustness of the different approaches considered at this meeting to achieving the objectives of the Commission. Dr Constable summarised a number of points for the Working Group to consider in reconciling some of the different outcomes from the work at this meeting. On the basis of those points, Dr Constable also suggested advice on the status of the stock and potential yield in the coming season. The points included:

(i) The early and later periods of the standardised CPUE series provide a strong signal of the abundance of the vulnerable biomass. The standardisation process has aimed to remove variation in CPUE that might arise from different vessels (nationality), depths and seasons. Consequently, the series provides an estimation of the relative trends in abundance of the vulnerable biomass. The series is then used to weight the outcomes of the GYM projections so that those consistent with the CPUE series are given greater weight. The series can be divided into two main periods – an early, high period and a later, lower period. These two periods involve different fishing fleets operating in the area.

(a) If the early phase of each period was the time when the respective fleets were learning about the area, then the values of CPUE from these parts would be expected to represent the general catch density of the area. The ratio of the standardised CPUE at these times would therefore reflect the relative change in abundance of the vulnerable biomass.

(b) After the learning period, the fleets would be expected to focus on areas of greatest catch density. There is potential for the CPUE to become stable if the areas being fished are areas of aggregations of toothfish, even though the overall biomass might be declining. It is not known if this is or is not the case in Subarea 48.3.

(ii) In view of the results of the GYM projections from 1984 to 2004 based on the survey estimates of recruitment (unscaled recruitment series) and those projection results based on a scaling of the recruitment series by a factor of 2:

(a) the relative differences in the standardised CPUE and in the standardised mean weight of fish between the period of the late 1980s compared to the period in the late 1990s are most closely reflected in the relative differences in the respective median values of vulnerable biomass and mean weight of fish in the GYM projections using the unscaled recruitment series;

(b) if the median vulnerable biomass from these GYM projections are examined in the early 1990s and the early 2000s, the GYM projections decline compared to the CPUE series remaining constant in those periods. In this respect, the Working Group would need to undertake a finer-resolution analysis of the fishing effort to determine if hyper-stability in the CPUE series could have arisen;

(c) an alternative interpretation is that the relative difference between the median vulnerable biomass in 1989 compared to 2004 in the 2x scaled recruitment projections is in agreement with the relative differences between those years in the CPUE series. In this case, the decline in mean weight of vulnerable fish in the projections is not matched by the standardised series.

(iii) With respect to the tagging experiment, there has been insufficient time to explore fully whether the assumptions of mixing, and the degree to which the recapture rate is relatively constant, are met. Biases in the estimation of biomass may arise due to the high rate of recaptures less than 20 km from release, the low number of tags in the water and the potential for relative concentrations of fishing effort to have shifted from one year to another during the tagging experiment. A longer time series and a greater number of tags will help identify whether the mixing assumptions and, consequently, constant recapture rates can be satisfied.

(iv) The sensitivity trials of the GYM projections indicate that a combination of parameters other than mean recruitment could improve the fits of the model to the known catch series as well as estimates of the vulnerable biomass, such as those arising from the tagging experiment.

(v) The manner in which advice can be given needs to be based on the precautionary approach and the potential consequences of being incorrect in the interpretation of the data.

(vi) If the unscaled recruitment series is correct, then the sustainable long-term annual yield of a pristine stock might be around 1 900 tonnes. The results of the projections in this case imply that the spawning stock is likely to be nearing depletion. It is not known at what level a reduction in recruitment might arise but the critical level has widely been regarded as 20% of the pre-exploitation median spawning biomass, as reflected in the CCAMLR decision rules.

(vii) If the scaled recruitment series to give the estimate of vulnerable biomass estimated from the tagging experiment is correct, then the fishery might be able to be maintained at the current level.

(viii) The consequences of applying the CCAMLR decision rules and accepting one case when the other is correct are respectively:

(a) unscaled recruitments – the estimate of yield would be zero for the coming year. Once the methods have been resolved and a robust estimate of yield from a new method is obtained then the fishery would be reopened;

(b) scaled recruitment – the fishery would continue with unknown consequences for recruitment and stock recovery and a greater potential for long-term depletion.

(ix) A difficulty with this assessment is the degree to which parameters other than scaling the recruitments could influence the process and result in a different outcome for spawning stock status, such as estimates of growth rate, selectivity and natural mortality.

(x) Given the extent to which the tagging program has increased and the work on evaluating management procedures is under way, it is conceivable that progress could be made in the coming year to resolve some of the issues and use new data from the tagging program to help address the assumptions and to better estimate the magnitude of the vulnerable population.

(xi) On that basis and considering precaution, it would seem prudent to at least ensure the catch would not lead to the probability of depletion increasing by more than a small amount over the next year while the issues are examined in more detail over the coming year. This would protect future options for the fishery and help ensure that the stock status is not appreciably altered in the short term. This method would require estimates of the probability of depletion with no catch in the future. There was insufficient time to undertake that work. The following steps could be followed to help determine whether a nominal catch might lead to an increased probability of depletion:

(a) Table 5.29 presents the status of the spawning stock under alternative scenarios for recruitment, natural mortality and future catch rates. The lower 10th percentile of spawning stock status in specific years shows the spawning stock status for which there is a 10% chance it will be less than or equal to that value in that year. This corresponds to the part of the decision rule that relates to depletion in that a catch is chosen with a 10% chance of depletion below 20% of the median pre-exploitation biomass.

(b) The aim would be for that 10th percentile to not be appreciably reduced over one year. In this respect, the change in value of the lower 10th percentile of spawning stock status between 2004 and 2005 is a guide to the consequence of the nominated catch levels in the scenarios. A large reduction in the 10th percentile would indicate that a catch at that level would be unlikely to retain the status quo.

5.167 Drs Kirkwood and Agnew noted the following points for discussion and suggested possible advice:

(i) Results of a GYM run with 2 000 trials using the standard set of input parameters, the revised standardised CPUE series and the revised recruitment series are shown in Figure 5.14. Examining these results, the following features are apparent:

(a) Diagnostic statistics collected during this run indicate that in over 31% of the trials, the population abundance from 1984 to 2004 was insufficiently large to allow all the known catches to be taken.

(b) Despite the fact that the CPUE likelihood weighting of trials had been applied, the time series of predicted median vulnerable biomass indicate trends that are incompatible with those in the standardised CPUE series:

- There is a severe decline of about 80% in predicted vulnerable biomass from 1999 to 2004. This is a period during which the standardised GLMM CPUE was almost completely flat, and even the standard GLM only shows a 15% decline.

- The relative declines from 1985 to 2004 are also much greater than in the standardised CPUE; 90% in the GYM in Figure 5.14(a) versus 50–60% in the GLM/GLMM.

- By contrast, declines in the scaled runs are much closer to the GLM and GLMM runs (Figure 5.14(b); 50% decline compared to 50–60% decline in GLM/GLMM).

(c) There is no evidence from the plots of fishing distribution for the severe contractions of fishing area that would be expected if hyper-stability was the explanation for these discrepancies.

(d) It was inconceivable, if current vulnerable biomass is only 2 to 3 times higher than the catch level, that major signals would not be seen in the CPUE series.

(e) The estimated vulnerable biomass in 2004 (around 15 000 tonnes) is considerably less than half the lower 95% confidence limit of the mark–recapture abundance estimates for 2003 and 2004.

(f) If the analysis by Dr Gasyukov was correct (paragraph 5.169), the level of recruitment estimated by the survey would be even lower. This would mean that more than 50% of GYM trials, and up to 99% (Table 5.29, 0.5R) would not realise the catch. This is clearly implausible, and serves to emphasise the severe uncertainty surrounding the survey estimates of recruitment and the CMIX procedure.

(g) If there is the possibility that the GYM can be reconciled with current recruitment simply by adjusting natural mortality, growth etc., then confidence in GYM runs must surely be undermined. Following points made by Dr Gasyukov, Drs Agnew and Kirkwood saw no justification for changing these fundamental parameters, and are therefore driven to the conclusion that the explanation for the fact that the unscaled recruitment GYM fails to match other analyses (CPUE, tagging and ASPM) is because surveys are not providing an accurate estimate of recruitment.

(ii) In the view of Drs Agnew and Kirkwood, the most likely reason for these incompatibilities is that the calculated recruitment estimates are downwardly biased estimates of the true absolute recruitment. These incompatibilities also rule out direct use of these GYM results to calculate long-term yields according to the usual CCAMLR decision rules.

(iii) One way of resolving these problems is to treat the calculated recruitment series as providing a relative, rather than absolute, index of actual recruitment. As described in WG-FSA-04/82, this can be done by determining a raising factor for the recruitment series that results in a GYM prediction of current median vulnerable biomass equal to an estimate of current biomass obtained using a different estimation method. As discussed at WG-FSA-SAM-04, this approach would also accommodate use of the CCAMLR decision rules used for setting long-term catch limits.

(iv) In WG-FSA-04/82, three different estimators of current biomass were discussed: mark–recapture, ASPM and a depletion estimator. During this meeting, the mark–recapture and the ASPM estimators were further considered and modified:

(a) The range of estimates of current biomass calculated using the ASPM ranged from 28 000 to 266 000 tonnes, but in all cases the fits to the input data were sufficiently poor that the Working Group agreed that none of the ASPM estimates calculated at this meeting could be considered reliable.

(b) Bootstrapped median estimates of vulnerable biomass using the mark–recapture data for 2003 and 2004 were respectively 51 000 and 60 500 tonnes, with 95% confidence intervals 42 000–63 500 and 47 000–82 000 tonnes.

(v) Sensitivity trials run during the meeting included use of raising factors for the recruitment series used in the GYM of 1.5, 1.78 and 2.0. These produced median vulnerable biomasses in 2004 of 37 000 tonnes, 51 000 tonnes and 62 000 tonnes, corresponding respectively to a biomass lower than the lower confidence limit of the lowest mark–recapture estimate (42 000 tonnes), and approximately the median mark–recapture estimates for 2003 and 2004.

(vi) Application of the CCAMLR decision rules to these three sets of GYM calculations would result in long-term yields of 2 450, 4 200 and 4 900 tonnes. Accordingly, it is believed that an appropriate long-term yield calculated according to the CCAMLR decision rules would be 4 200 tonnes, corresponding to the lower of the two median mark–recapture estimates. Should a greater degree of precaution be desired for the forthcoming year, then a lower catch limit in the range 2 450–4 200 tonnes would be appropriate.

5.168 Dr Gasyukov reminded the Working Group that it has agreed rules of procedure for conducting assessments. These included standard methods and software for assessments, for example, the CMIX program and Excel add-in. In this context he was concerned that a range of methods had been introduced for the assessment of *D. eleginoides* in Subarea 48.3 (tagging estimates of abundance, ASPM estimate of abundance) in response to the outcomes of the review of the recruitment series and initial assessment of the implications. He noted that the current assessment method had been used by the Working Group for 10 years and that it was necessary to more thoroughly investigate and understand the reasons for the observed results before considering alternative methods. He considered it important that the Working Group acknowledge the errors that have affected previous assessments, that these errors had resulted in the catch limit being set at nearly 8 000 tonnes and that in this context it was not a surprise that the stock may be very depleted.

5.169 Dr Gasyukov noted that very few Members had the opportunity, in terms of time and documentation, to appropriately review or verify the application of the alternative methods to the assessment and, therefore, were not in a position to provide advice on their robustness for use in the assessment of *D. eleginoides*. He emphasised that he did not want to discourage the exploration, development and adoption of alternative methods, such as the ASPM and mark–recapture methods, only that the Working Group be afforded appropriate opportunity to review and understand methods before their application to assessments, including the provision of appropriate specifications and documentation for their use. In light of this, he expressed great concern over the use of the mark–recapture estimates of abundance to scale the revised recruitment series so that the median vulnerable biomass from the GYM projections corresponded to the estimates of biomass from the mark–recapture method. He noted that the assessment using the current assessment method and the revised recruitment series indicated a long-term yield in the order of 1 900 tonnes, that the stock may be very depleted and that there was no scientific basis to disregard the current assessment. In addition, he noted that the preliminary examinations of the effect of stratification on the estimates of recruitment from CMIX indicate that the revised series of recruitments may not be correct and that this required urgent investigation.

5.170 Given these issues, Dr Gasyukov urged the Working Group to be precautionary in its advice, and not modify the current assessment approach until there had been the opportunity to better understand the issues that had not been resolved at this meeting, and that resolving these issues should be the priority for the next meeting of WG-FSA-SAM.

5.171 Drs Kock and O. Wöhler (Argentina) indicated that they shared a number of the concerns expressed by Dr Gasyukov with respect to changing the current assessment methods and the use of the mark–recapture estimates of biomass, particularly given the potential for the stock to be depleted. They also considered that the views expressed by Dr Constable were a balanced assessment of the information available to the Working Group.

5.172 Dr R. O'Driscoll (New Zealand) noted that much of the information used for assessments, including CPUE and tagging estimates, are fishery-dependent and would not be available if the fishery is closed.

8.3 Comments from general discussion on assessment of *D. eleginoides* in Subarea 48.3

5.173 The Working Group noted that Shag Rocks and west Shag Rocks are primary recruitment areas and that the CPUE has been declining since 1999 at Shag Rocks. An additional measure might be to establish local-area limits in the defined areas to protect parts of the stock. The Working Group agreed that it might be useful to consider a much lower catch in the area of Shag Rocks and west Shag Rocks to protect recruits but not so low that the tagging experiment could not continue.

5.174 The Working Group considered that more detailed analysis of the spatial pattern of the fishery should be a high priority to investigate the potential for hyper-stability in the standardised CPUE series raised by Dr Constable.

5.175 The Working Group was unable to provide further advice on assessments this year.

Fishery Report: *Dissostichus eleginoides* Kerguelen Islands inside French EEZ (Division 58.5.1)

5.176 Insufficient information was available at the meeting to complete a Fishery Report for this fishery. The Working Group recommended that French scientists be requested to provide the information required during the coming intersessional period.

Standardisation of CPUE

5.177 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 1998/99 to 2003/04 fishing seasons were examined. These data had been kindly provided by Prof. G. Duhamel (France). GLMMs and LMMs as described in Candy (2004) and WG-FSA-03/34 were used to investigate trends in CPUE (kg/hook) and average weight of caught fish (kg) respectively.

5.178 Figure 5.15 shows the standardised CPUE series for 1998/99 to 2003/04, along with estimated total removals for the period 1995/96 to 2003/04. There is a general decreasing trend in the standardised CPUE.

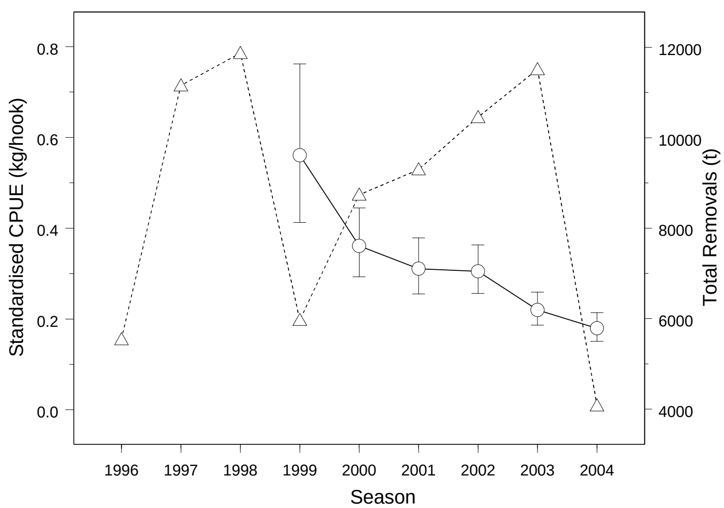


Figure 5.15: Time series of both total removals (dashed line) and standardised CPUE (solid line) obtained from the fitted GLMM. Error bars represent approximate 95% confidence bounds on the estimates.

5.179 With regard to total removals, the Working Group had noted last year that there had been a dramatic increase in total removals since 1998/99. The estimated total removals for 2003/04 are substantially lower than those in 2002/03 (from 11 511 to 4 079 tonnes). Most of this reduction resulted from a lowering of estimated IUU catch from 7 825 tonnes in 2002/03 to 643 tonnes in 2003/04.

5.180 Figure 5.16 shows the corresponding series of standardised average weights in the catch. The decrease in the standardised average weight probably indicates that the older age classes are becoming less numerous in the exploited stock.

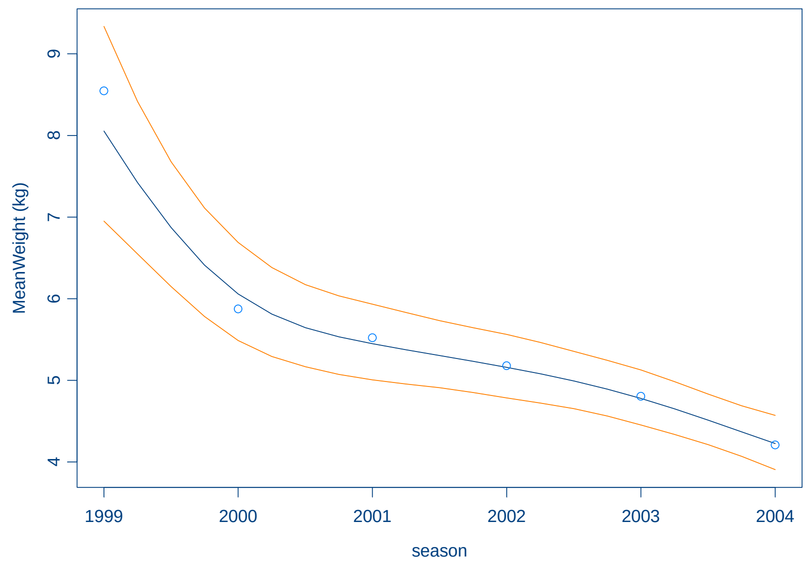


Figure 5.16: Time series of standardised average weight (kg) obtained from the LMM fitted to log(average weight) using a cubic smoothing spline. Error bounds represent approximate 95% confidence bounds on the estimates.

Management advice

5.181 Last year, the Working Group had agreed that it is imperative that steps be taken to substantially reduce total removals from 2002/03 levels. The Working Group welcomed the substantial reduction that had been achieved in 2003/04, but noted that in the absence of a stock assessment it is not possible to determine whether this reduction in catches, if sustained, would allow the declining trends in standardised CPUE or mean lengths to be halted or reversed.

5.182 As for other toothfish fisheries in the CCAMLR Convention Area, the Working Group recommended that tag–recapture experiments be conducted. It also noted that the carrying out of a recruitment survey in the Kerguelen area would be very beneficial for a fuller assessment of toothfish stocks on the Kerguelen Plateau.

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

Fishery Report: *Dissostichus eleginoides* Heard Island (Division 58.5.2)

1. Details of the fishery

1.1 Reported catch

5.184 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2003/04 season was 2 873 tonnes (Conservation Measure 41-08) for the period from 1 December 2003 to 30 November 2004. The catch reported for this division as of 1 October 2004 was 2 269 tonnes. Reported catches along with the respective catch limits and number of vessels active in the fishery are shown in Table 5.34. In Division 58.5.2, the fishery was a trawl fishery from the 1996/97 to the 2001/02 season. For the last two seasons the fishery has been prosecuted by both trawlers and longliners. The longline fishery was active from 1 May to 14 September 2004 and the trawl fishery was active from 1 December 2003 to 30 November 2004.

Table 5.34: Catch series of *Dissostichus eleginoides* in Division 58.5.2 from 1989/90 to 2003/04. T – Trawler; LL – longliner; *season will finish on 30 November 2004.

Fishing season	Number vessels	Catch limit (tonnes)	Reported catch (tonnes)			IUU estimate (tonnes)	Total removals (tonnes)
			Total	Trawl	Longline		
1989/90			1	1	0	0	1
1990/91			0	0	0	0	0
1991/92			0	0	0	0	0
1992/93			0	0	0	0	0
1993/94			0	0	0	0	0
1994/95		297	0	0	0	0	0
1995/96		297	0	0	0	3000	3000
1996/97	2	3800	1927	1927	0	7117	9044
1997/98	3	3700	3765	3765	0	4150	7915
1998/99	2	3690	3547	3547	0	427	3974
1999/00	2	3585	3566	3566	0	1154	4720
2000/01	2	2995	2980	2980	0	2004	4984
2001/02	2	2815	2756	2756	0	3489	6245
2002/03	2T + 1LL	2879	2844	2574	270	1512	4356
2003/04	2T + 1LL	2873	2269*	1717*	552	637	2906*

1.2 IUU catch

5.185 Details of the IUU catches attributed to Division 58.5.2 are given in Table 3.3 and questions of the attribution of IUU catches reported in Areas 47 and 51 are considered in paragraphs 8.12 and 8.13.

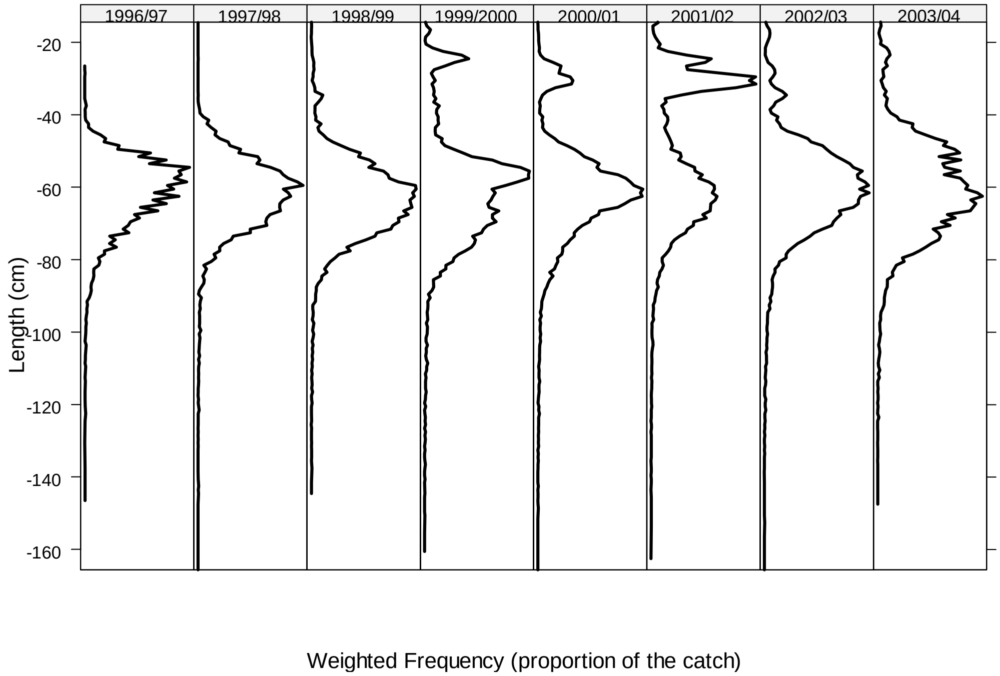


Figure 5.17: Catch-weighted length frequencies for *Dissostichus eleginoides* in Division 58.5.2 derived from observer, fine-scale and STATLANT data from the trawl fishery reported by 6 October 2004.

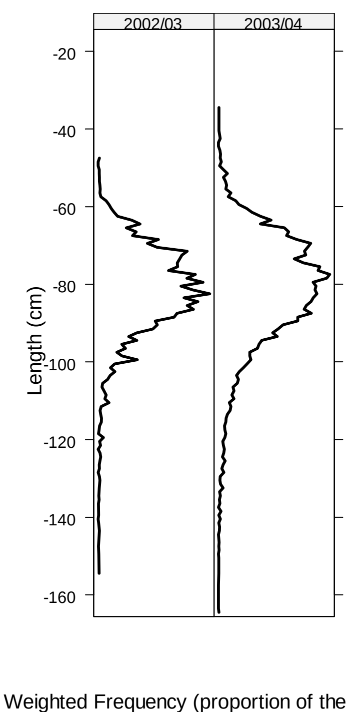


Figure 5.18: Catch-weighted length frequencies for *Dissostichus eleginoides* in Division 58.5.2 derived from observer, fine-scale and STATLANT data from the longline fishery reported by 6 October 2004.

1.3 Size and distribution of catches

5.186 Catch-weighted length frequencies are illustrated in Figures 5.17 (trawl fishery) and 5.18 (longline fishery). The Working Group noted that the modal size of fish caught in the longline fishery was greater than that in the trawl fishery.

2. Stocks and areas

5.187 *D. eleginoides* occurs throughout the Heard Island and the McDonald Islands Plateau, from shallow depths near Heard Island to at least 1 800 m depth around the periphery of the plateau. Annual random stratified trawl surveys conducted since 1997 have shown that younger fish (less than about 600 mm TL) predominate on the plateau in depths less than 500 m, but no areas of local abundance have been discovered. As fish grow, they move to deeper waters, and are recruited to the trawl fishery on the plateau slopes in depths of 450 to 800 m. Here there are several areas of local abundance that constitute the main trawling grounds where the majority of fish caught are between 500 and 750 mm TL (Figure 5.17). Older fish are seldom caught in the trawl fishery, and it is assumed that they move into deeper water (>1 000 m depth) where they are caught by the longline fishery. This fishery mostly operates between 1 000 and 1 200 m depth and catches larger fish than in the trawl fishery (Figure 5.17), but few fish >1 000 mm TL. It is assumed that the largest fish are at depths greater than 1 200 m.

5.188 Genetic studies have demonstrated that the *D. eleginoides* population at Heard Island and McDonald Islands is distinct from those at distant locations such as South Georgia and Macquarie Island (Appleyard et al., 2002), but that within the Indian Ocean sector there appears to be no distinction between fish at Heard, Kerguelen, Crozet or Marion/Prince Edward Islands based on genetic studies (WG-FSA-03/66). This, combined with results from tagging data which show movement of some fish from Heard Island to Kerguelen and Crozet Islands (Williams et al., 2002) suggests that a metapopulation of *D. eleginoides* may exist in the Indian Ocean sector (WG-FSA-03/72).

3. Parameter estimation

3.1 Parameter values

Fixed parameters

5.189 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 5.35.

Table 5.35: Input parameters for the assessment of *Dissostichus eleginoides* in Division 58.5.2.

Component	Parameter	Value	Units
Natural mortality	*M*	0.13–0.2	y^{-1}
VBGF	*K*	0.29	y^{-1}
VBGF	t_0	–2.46*	y
VBGF	L_∞	2465	mm
Length to mass	‘*a*’	2.59E-09	mm, kg
Length to mass	‘*b*’	3.2064	
Maturity	L_{m50}	930	mm
Range: 0 to full maturity		780–1 080	mm

* Adjusted from estimated parameter of t_0 = –2.56 years to start of fishing season on 1 December.

Recruitment survey

5.190 No report of the Australian research survey was tabled at the meeting, but brief details were available in WG-FSA-04/76. Full details of the survey are desirable for future assessments. Australia undertook a trawl survey of Division 58.5.2 in May 2004 to estimate density of juvenile toothfish (WG-FSA-04/76). The survey used the same strata as used in the 2000–2002 surveys, with all strata being sampled in the 2004 survey. The number of randomly located trawl stations per strata was based on a review of the survey design for estimating abundance of juvenile *D. eleginoides* presented to the 2004 meetings of WG-FSA-SAM (WG-FSA-SAM-04/19) and WG-FSA (WG-FSA-04/76) (Table 5.36). The increase in the total area of the survey between 2003 and 2004 reflects the fact that the 2003 survey did not include the three northern strata (WG-FSA-03/33). The five stations from the Shell Bank strata in the 2004 survey were excluded from the inputs to assessment as operational constraints prevented the random stations from being completed and the resulting stations were not well distributed across the stratum.

Table 5.36: Details of the 2004 Heard Island survey for *Dissostichus eleginoides*.

Name of area	Mean survey date (DOY)	Area (km^2)	Hauls allocated	Hauls completed	Valid hauls
Ground B	137.4	480.8	25	25	25
Gunnari Ridge	143.6	520.7	18	18	13
Plateau deep east	147.5	13 120	30	30	30
Plateau deep northeast	124.4	15 090	7	7	7
Plateau deep southeast	138.4	5 340	5	5	5
Plateau deep west	125.4	13 370	5	5	5
Plateau north	123.8	15 170	10	10	10
Plateau southeast	146.4	10 620	30	30	30
Plateau west	126.6	10 440	10	10	10
Shell Bank	155.8	1 758	5	5	5
All strata		**85 909**	**145**	**145**	**140**

Recruitment estimates

5.191 Survey data was not available from the CCAMLR Secretariat, as it had been submitted in fine-scale format, rather than research-survey format. The data was available directly from the Australian representatives. Length densities were estimated from the Heard Island survey in May 2004 using the CMIX program, with both mean length (estimated from von Bertalanffy growth parameters) and standard deviation of length fixed (Table 5.37). The standard deviations are calculated using a coefficient of variation of length-at-age of 0.12, which is estimated during the fitting of the growth curve to size-at-age. There are no clear modes present in the length-density data and the fitting relies entirely on the growth curve parameters, which are based on size-at-age data. The Working Group noted that, given the lack of defined modes in the length-density data, it would be useful to evaluate the relative benefits of age–length keys as an alternative method for estimating densities of cohorts and that this would best be done using simulated data.

Table 5.37: Input parameters for CMIX analysis of survey data to estimate length densities of *Dissostichus eleginoides* in Division 58.5.2 in May 2004.

Age class	Mean size (mm fixed)	SD (fixed)
2	326	39
3	387	46
4	447	53
5	504	60
6	560	67
7	615	74
8	668	80
9	719	86

Parameter	Value
Minimisation	Yes
Maximum number of function calls	10 000
Minimum reporting frequency	100
Stopping criteria	1.0E-10
Frequency for convergence testing	5
Fit quadratic surface	No
Simplex expansion coefficient	1

5.192 The CMIX analysis indicates that four main age classes were present in the sampled population (ages 4, 5, 6 and 9; Figure 5.19). The 9-year-old cohort was not used to estimate the recruitment series as it was considered not fully sampled by the survey.

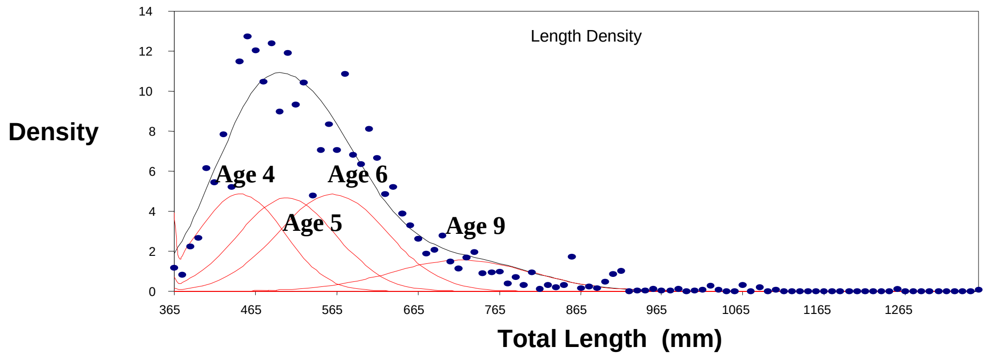


Figure 5.19: Results of CMIX analysis of survey data to estimate length densities of *Dissostichus eleginoides* in Division 58.5.2 in May 2004.

Biomass check

5.193 The estimated length densities from the CMIX program were converted to a biomass estimate using the length–weight relationship, the seafloor area and the mean size at age. This biomass was checked against the Trawl CI estimate from the survey (Table 5.38), and produced a similar estimate of biomass.

Table 5.38: Biomass check for the estimated densities generated by CMIX.

Age	4	5	6	9	
Density (numbers km^{-2})	64.62	70.2726	81.61	33.44	*a* = 2.59E-09
Area (km^2)	85 909	85 909	85 909	85 909	*b* = 3.20640
Numbers	5 551 440	6 037 049	7 011 033	2 872 797	
Mean size (mm)	447	504	560	719	
Mean weight (kg)	0.815	1.198	1.679	3.742	
Biomass (tonnes)	4 525.342	7 230.989	11 772.59	10 750.29	34 279.21
Trawl CI					34 733

CPUE series

5.194 The CPUE series was not updated at the 2004 meeting. The series was updated in 2003 (Candy, 2003). The CPUE series is not used in the assessment procedure as the trawl fishery is confined to a relatively small proportion of the area occupied by the stock, and therefore trends in commercial CPUE are not expected to reflect trends in stock status.

Tagging studies

5.195 A tagging study was undertaken at Heard Island from 1998 to 2001 (Williams et al., 2002). There was no time to consider this study in relation to the assessment at the meeting.

Table 5.39: Estimated cohort strengths of *Dissostichus eleginoides* from surveys undertaken in Division 58.5.2 since 1990. Only values in boxes were included in the 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. Zero density values for age-3 and age-7 fish from the 2004 survey are included in the table and the assessment as 0.001, with standard error (SE) of 0.001.

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*		
2004	0.43	85 909	242.8	246.0	*Mean*	0.001	64.620	70.727	81.601	0.001	
					SE	*0.001*	*38.548*	*67.242*	*40.211*	*0.001*	

Recruitment series

5.196 The recruitment series was updated with the recruitment estimates from the 2004 survey (Table 5.39). At WG-FSA-03 it was agreed that recruitment data from two trawl surveys (1992 and 2000 in Table 5.39) 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 used from other surveys (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 greater densities. Thus, it is likely this survey underestimated the density of some cohorts. 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. The Working Group agreed that the 2003 survey did not adequately sample age-7 fish, and so these were not included in the series. 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 5.40.

Table 5.40: Updated recruitment series used in the assessment of *Dissostichus eleginoides* in Division 58.5.2. Based on a natural mortality of 0.165 yr^{-1}.

Year at age 4 birthday	WG-FSA-04
1986	4.3273
1987	0.1207
1988	2.4920
1989	3.7900
1990	1.1200
1991	0.6690
1992	2.7427
1993	0.8248
1994	7.2051
1995	9.2260
1996	7.2946
1997	14.171
1998	6.5321
1999	2.3324
2000	4.5859
2001	3.2006
2002	1.9120
2003	3.0936
Mean	4.2022
CV	0.8464

Fishing vulnerabilities (FV)

5.197 In Division 58.5.2, the fishery was a trawl fishery for the period 1996/97 until the 2001/02 season. For the last two seasons both trawlers and longliners have prosecuted the fishery. Age-based fishing vulnerabilities have been applied since 1996/97 (Table 5.41). Note the same trawl-based vulnerabilities are applied to both the trawl and longline fisheries. This will result in a more conservative estimate of yield than applying longline vulnerabilities.

5.198 In the 1995/96 season a length-based vulnerability function was applied, with vulnerability starting at 550 mm TL, 50% vulnerability at 670 mm TL and full vulnerability at 790 mm TL.

Table 5.41: Fishing vulnerabilities for *Dissostichus eleginoides* in the trawl and longline fishery in Division 58.5.2.

Fishing season	Ages over which FV = 0	Ages over which FV = 1	Ages over which FV = 0
1995/96	Length based (see text)		
1996/97	0–6.9	7–7.9	8–max
1997/98	0–6.0	6.1–10.0	12–max
1998/99	0–5.5	6.0–13.0	15–max
1999/00	0–4.0	4.0–14.0	15–max
2000/01	0–7.9	8.0–14.0	15–max
2001/02	0–7.9	8.0–14.0	15–max
2002/03	0–7.9	8.0–14.0	15–max
2003/04	0–7.9	8.0–14.0	15–max

4. Stock assessment

4.1 Model structure and assumptions

5.199 The GYM, using input data from paragraphs 5.189 to 5.198, was used to estimate the constant catch that would satisfy the CCAMLR decision rules. These are:

1. Depletion rule: Determine the catch that results in a probability of the spawning stock biomass falling below 20% of its estimated pre-exploitation level of not more than 10% over the 35-year projection period.

2. Escapement rule: Calculate the catch that results in a median escapement of 50% of the spawning stock biomass in the final year of the 35-year projection.

3. Choose the lower of the two estimates of long-term yield.

Model configuration

5.200 The GYM was run according to the configuration detailed in Table 5.42.

Table 5.42: GYM model configuration for the assessment of *Dissostichus eleginoides* in Division 58.5.2.

Category	Parameter	Value
Recruitment age	Start	4 years
	Fully selected	8 years
Plus class accumulation		35 years
Oldest age in initial structure		55 years
Simulation specification	Number of runs	10 001
	Depletion level	0.2
	Seed for random number generator	–24 189
Individual trial specification	Years to remove initial age structure	1
	Observations to use in median SB_0	1 001
	Year prior to projection	1985
	Reference start date	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

4.2 Model estimates

5.201 The constant catch for which there was median escapement of 50% of the median pre-exploitation spawning biomass level at the end of the 35-year projection period was 2 787 tonnes. The yield at which there is a less than 10% chance of spawning biomass dropping to less than 20% of the initial biomass was 3 091 tonnes. Following the third part of the CCAMLR rule, the lower yield of 2 787 tonnes is recommended.

4.3 Sensitivity analyses

5.202 Three sensitivity trials were run at WG-FSA-03 to investigate the effects of the alternative vulnerabilities, and of excluding older age classes from the estimation of the recruitment series (SC-CAMLR-XXII, Annex 5, paragraphs 5.138 to 5.140). In a preliminary assessment, contained in WG-FSA-04/76, the assessment was run with the updated recruitment series and with just ages 3–7 (i.e. excluding the 8 year olds in the 1999 survey) and with the catch series used prior to the 2003 meeting (WG-FSA-03/33). The alternative scenarios produced minor differences in the projected catch.

5. By-catch

5.1 By-catch removals

5.203 By-catch removals for the toothfish fisheries (longline and trawl) are detailed in Table 5.43. By-catch will also arise from the directed fishery for *C. gunnari* in the same division. In trawls targeting *D. eleginoides*, 25 by-catch species were recorded, with the target species comprising of 98.6% of the total catch by weight, followed by *B. eatonii* (0.3%) and *C. gunnari* (0.3%).

Table 5.43: By-catch limits and associated removals (in tonnes) from the toothfish fisheries in Division 58.5.2. OT – otter trawl, LLS – set longlines, LIC – *Channichthys rhinoceratus*, NOS – *Lepidonotothen squamifrons*, GRV – *Macrourus* spp., SRX – rajids.

Fishing season	LIC – OT	LLS	Limit	NOS – OT	LLS	Limit	GRV – OT	LLS	Limit	SRX – OT	LLS	Limit	Other – OT	LLS	Limit
1995/96	0	0		0	0		0	0		0	0		0	0	5%*
1996/97	0	0		0	0		0	0		2	0		5	0	50**
1997/98	0	0	80	0	0	325	0	0		4	0	120	36	0	50
1998/99	0	0	150	8	0	80	1	0		2	0		3	0	50
1999/00	0	0	150	0	0	80	4	0		7	0		4	0	50
2000/01	0	0	150	5	0	80	1	0	50	5	0	50	7	0	50
2001/02	1	0	150	1	0	80	4	0	50	4	0	50	54	0	50
2002/03	0	0	150	0	0	80	1	3	465	8	5	120	5	0	50
2003/04	0	0	150	2	0	80	2	42	360	5	62	120	6	3	50

* 5% move-on rule if individual haul exceeds 5%, limit not specified.
** Move-on rule if catch of any by-catch species exceeds 5% of target species.

5.2 Assessments of impact on affected populations

5.204 No stock assessments of individual by-catch species were undertaken in 2004. By-catch limits of *C. rhinoceratus* and *L. squamifrons* are based on assessments carried out in 1998 (SC-CAMLR-XVII, Annex 5, paragraphs 4.204 to 4.206) and by-catch limits of the grenadier *Macrourus carinatus* are based on assessments carried out in 2002 and 2003 (SC-CAMLR-XXII, Annex 5, paragraphs 5.245 to 5.249).

5.3 Mitigation measures

5.205 The fishery operates under Conservation Measure 33-02.

5.206 The Working Group recommended that, where possible, all rajids should be cut from the line while still in the water, except on the request of the scientific observer (paragraph 6.75).

6. By-catch of birds and mammals

5.207 No seabird mortality has been reported in the two years to date of longline fishing in Division 58.5.2 (paragraph 7.13). In the trawl fishery in this area, six seabirds were killed in 2003. Seabirds were released alive in 2002 (1), 2003 (11) and 2004 (7) (Table 7.18).

5.208 In 2003/04 three fur seals were killed when the *Austral Leader* (trawl fishery) was targeting toothfish.

6.1 Mitigation measures

5.209 Longline fishing is conducted in accordance with Conservation Measures 24-02 and 25-02; trawl fishing in accordance with Conservation Measure 25-03.

5.210 During 2003/04 the longline fishery was restricted to the winter months with day setting of lines prohibited. As part of an adaptive approach to management, and in view of the absence of any seabird by-catch in the 2003/04 fishery, a proposal has been submitted to modify Conservation Measure 25-02 to allow setting by autoline vessels at any time in the day/night cycle (paragraphs 7.84 to 7.86). Ad hoc WG-IMAF has assessed the risk level of seabirds in this fishery in Division 58.5.2 as category 4 (SC-CAMLR-XXIII/BG/21) and supported the proposed recommendations (paragraph 7.86) with respect to autoline vessels in Division 58.5.2:

(i) restrict fishing to the period from 1 May to 14 September;

(ii) use paired streamer lines during all sets of longlines;

(iii) retain on board fish offal and discards;

(iv) be permitted to set longlines at any time in the day/night cycle;

(v) comply with the provisions of Conservation Measure 24-02 or use longlines containing 50 g lead/m integrated weight such that lines sink to 10 m depth at no less than 0.2 m/s, with a preferred average rate of no less than 0.24 m/s;

(vi) abide by all other seabird conservation provisions in Conservation Measure 25-02;

(vii) in the event that three seabirds are caught during daylight setting of lines, vessels must revert to night setting of longlines (as currently applies under Conservation Measure 24-02).

7. Ecosystem implications/effects

5.211 Fishing gear deployed on the seabed can have negative effects on sensitive benthic communities. The potential impacts of fishing gear on the benthic communities in Division 58.5.2 are limited by the small size and number of commercial trawl grounds and the protection of large representative areas of sensitive benthic habitats from direct effects of fishing in an IUCN category Ia marine reserve (SC-CAMLR-XXI/BG/18). The Marine Reserve and associated conservation zone comprises around 17% of the area of the Australian EEZ around Heard Island and McDonald Islands and falls entirely within CCAMLR Division 58.5.2.

5.212 Dr Davies indicated that by-catch of benthos was monitored by observers in the early stages of the development of the fishery and that by-catch of benthos was much lower in areas that have subsequently become the main fishing grounds.

8. Harvest controls for the 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.44: Summary of provisions of Conservation Measure 41-08 for *Dissostichus eleginoides* in Division 58.5.2 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 41-08	Advice for 2004/05	Paragraph reference
1. Access (gear)	Trawls or longlines		
2. Catch limit	2 873 tonnes west of 79°20'E (see CM 32-14)	Revise catch to 2 787 tonnes	5.201
3. Season: trawl	1 December 2003 to 30 November 2004		
3. Season: longline	1 May to 31 August 2004, with possible extension to 14 September for any vessel that has demonstrated full compliance with CM 25-02 in the 2002/03 season.		
4. By-catch	Fishing shall cease if the by-catch limit of any species, as set out in CM 33-02, is reached.		
5. Mitigation	In accordance with CMs 24-02, 25-02 and 25-03.	Exemption from paragraph 4 of CM 25-02 and modification of CM 24-02	7.86
6. Observers	Each vessel to carry at least one scientific observer and may include one additional CCAMLR scientific observer.		
7. Data: catch and effort	(i) Ten-day reporting system as in Annex 41-08/A (ii) Monthly fine-scale reporting system as in Annex 41-08/A on haul-by-haul basis.		
8. Target species	For the purpose of Annex 41-08/A, the target species is *Dissostichus eleginoides* and the by-catch is any species other than *D. eleginoides*.		
9. Jellymeat	Number and weight of fish discarded, including those with jellymeat condition, to be reported. These catches count towards the catch limit.		
10. Data: biological	Fine-scale reporting system as in Annex 42-02/B. Reported in accordance with the Scheme of International Scientific Observation.		

Fishery Report: *Champsocephalus gunnari* South Georgia (Subarea 48.3)

1. Details of the fishery

1.1 Reported catch

5.213 In Subarea 48.3, a pelagic or semi-pelagic trawl fishery targets *C. gunnari* (Table 5.45). During the 2003/04 season the fishery caught 2 686 tonnes between 9 December 2003 and 25 April 2004. The catch limit for the 2003/04 season was 2 887 tonnes (Conservation Measure 42-01).

Table 5.45: Catch history for *Champsocephalus gunnari* in Subarea 48.3 (source: STATLANT data available from 1977 to 2003; 2004 from catch and effort reports).

Fishing season	Catch (tonnes)	Catch limit (tonnes)	Vessels
1976/77	93 595		-
1977/78	7 472		
1978/79	809		
1979/80	8 795		
1980/81	27 903		
1981/82	54 040		
1982/83	178 824		
1983/84	35 743		
1984/85	628		
1985/86	21 008		
1986/87	80 586		
1987/88	36 054	35 000	
1988/89	3*	0	
1989/90	8 135	8 000	
1990/91	44*	26 000	
1991/92	5*	0	
1992/93	0	9 200	
1993/94	13*	9 200	
1994/95	10*	0	
1995/96	0	1 000	
1996/97	0	1 300	
1997/98	6*	4 520	
1998/99	265	4 840	1
1999/00	4 114	4 036	2
2000/01	960	6 760	6
2001/02	2 667	5 557	7
2002/03	1 986	2 181	5
2003/04	2 686	2 887	6

* Fishery closed, catch information from surveys.

1.2 IUU catch

5.214 There was no evidence of IUU activity in this fishery.

1.3 Size distribution of the catches

5.215 Catch-weighted length frequencies from observer, fine-scale and STATLANT data are presented in Figure 5.20 for 1986 to 2004. These plots include data from both the commercial fishery and research trawl surveys.

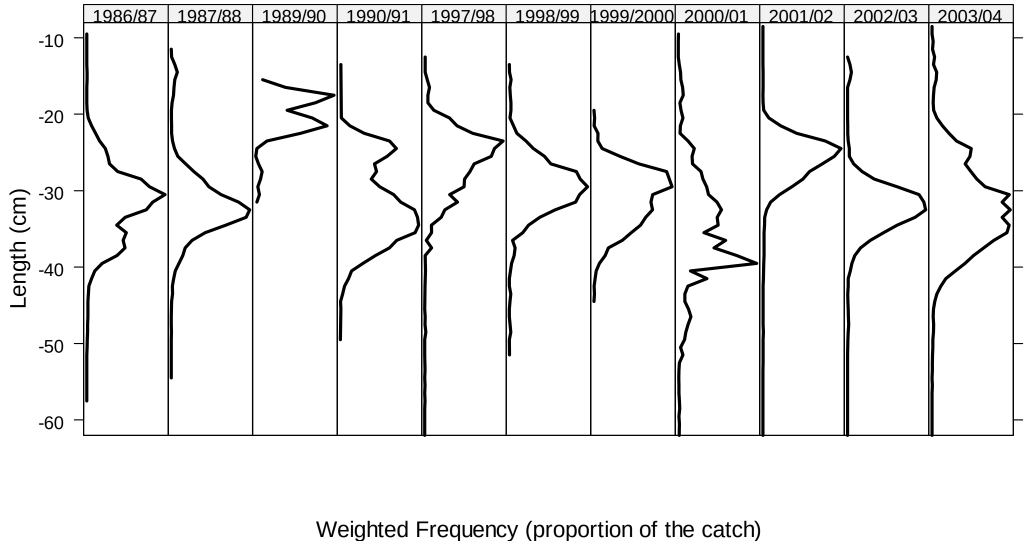


Figure 5.20: Catch-weighted length frequencies for *Champsocephalus gunnari* in Subarea 48.3 derived from observer, fine-scale and STATLANT data reported by 6 October 2004.

2. Stocks and areas

5.216 Within Subarea 48.3 *C. gunnari* is restricted to the shelf area generally shallower than 500 m deep. Differences in length distribution have been noted between Shag Rocks and South Georgia (WG-EMM-03/7, WG-FSA-04/40 and 04/85). These differences are not thought to represent separate stocks. So for purposes of stock assessment it is assumed that there is a single stock present. *C. gunnari* is considered a semi-pelagic species, young (0+ and 1+) fish are found in the pelagic zone, but with increased age (size) fish become more demersal in habit (WG-FSA-02/7).

3. Parameter estimation

3.1 Estimation methods

Standing stock

5.217 During WG-FSA-03, the Working Group agreed to use a combination of bottom trawl and acoustic surveys to estimate the standing stock of *C. gunnari* in Subarea 48.3. The Working Group also agreed that the UK standing stock estimate should be raised by a factor of 1.241 to account for differences in catchability (related to trawl headline height) of the UK and Russian surveys (SC-CAMLR-XXI, Annex 5, paragraphs 5.103 and 5.104).

Acoustic surveys

5.218 No new estimates of standing stock were available from acoustic surveys. The Working Group continues to investigate methods to combine acoustics with trawl survey data to estimate the standing stock of icefish in line with recommendations in WG-FSA-03 (SC-CAMLR-XXII, Annex 5, paragraph 3.41) and discussions at WG-FSA-SAM (WG-FSA-SAM-04/10) (paragraphs 3.33 to 3.39). During the UK survey in Subarea 48.3, four additional days were allocated to acoustic survey work in conjunction with pelagic trawling. This work showed that *C. gunnari* of all ages spend time in midwater and reinforced the belief that a bottom trawl survey significantly underestimates *C. gunnari* biomass (WG-FSA-SAM-04/20), corroborating the results of the Russian trawl-acoustic survey in 2002 (WG-FSA-02/44, WG-FSA-SAM-04/10).

Trawl surveys

5.219 In January 2004 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-04/85). The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

5.220 Following the procedure agreed at WG-FSA-03, estimates of standing stock were obtained using the bootstrap procedure, with the UK survey estimates (within 12 strata; Table 5.46) adjusted by a correction factor of 1.241, applied prior to the bootstrap procedure. An estimate of the lower one-sided 95% CI of biomass was calculated for the assessment and tabled below.

Table 5.46: Seabed areas of survey strata used to estimate biomass within the bootstrap procedure.

Component	Description	Value
Nominal date of survey	Mid-point	23 Jan 2004
Survey timing (days since start of year)		15
Seabed area of survey strata		km^2
1. Shag Rocks	1. 50–150 m	1 473.5
	2. 150–250 m	1 870.5
	3. 250–500 m	1 610
2. Northwest South Georgia	4. 50–150 m	1 816
	5. 150–250 m	2 189
	6. 250–500 m	2 068
3. Northeast South Georgia	7. 50–150 m	1 037
	8. 150–250 m	4 113
	9. 250–500 m	994
4. South South Georgia	10. 50–150 m	6 008
	11. 150–250 m	12 902
	12. 250–500 m	5 141
Bottom trawl survey	Bottom to 6 m	tonnes
Biomass estimates from bootstrap procedure	Mean	139 010
	SE	67 759
	Lower CI	26 165
	Upper CI	287 917
	One-sided lower 95% interval	44 369

Population structure

5.221 The distribution of densities-at-age was derived using the CMIX program, with bounds for means estimated from von Bertalanffy growth parameters (Table 5.47) and the standard deviations linearly related to the means. Initial CMIX runs did not converge using data from the entire length-density distribution, so the CMIX analysis was re-run excluding fish greater than 400 mm from the analysis (age 6+ and over) and using the input parameters detailed in Table 5.47. The results (Table 5.48 and Figure 5.21) indicate a high density of 1+ fish. The Working Group noted that previous surveys had rarely caught 1+ fish, and the bottom trawl survey is considered to underestimate the 1+ age class. As a result, fish from the trawl survey did not provide a reliable estimate of biomass.

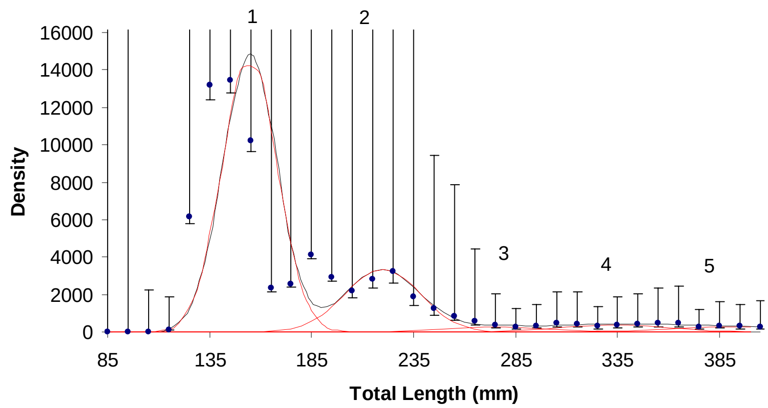


Figure 5.21: CMIX analysis of truncated length-density distribution from the 2004 bottom trawl survey in Subarea 48.3.

Table 5.47: Input parameters for the CMIX analysis of *Champsocephalus gunnari* length density in Subarea 48.3.

Parameter	Value
Size range included	80–410 mm
Survey date	15
Birthday	245
t_0	–0.58
k	0.17
L_∞	557 mm
Proportion between cohorts	0.5
Number of cohorts	5
Bounds on intercept (start, step)	1, 50 (15, 1.0)
Bounds on slope (start, step)	0.0, 0.4 (0.07, 0.01)
No. function calls	1 000
Reporting frequency	100
Stopping criteria	1E-6
Freq. for convergence testing	5
Simplex expansion coefficient	1

Table 5.48: Results generated from CMIX for the truncated length-density distribution.

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5
Mean length (mm)	154.7	219.7	275.0	332.0	392.4
Standard deviations (mm)	12.9	18.0	22.3	26.7	31.4
Total density	49 476	15 284	1 618	2 458	2 236
SD of component density	64 027	10 851	1 238	1 785	1 170
Sum of observed densities = 72 891.8					
Sum of expected densities = 70 424.9					

5.222 The Working Group raised two points of concern over the results of the current mixture analysis. First, the magnitude of the mean length densities of the age 1+ cohort was considerably higher than that observed in the total length-density distribution. This was caused by the relatively poor sampling of the age 1+ cohort in the trawl survey. The large number of hauls with zero catch, a low number of samples, and the presence of high densities within few hauls led to higher mean length densities and very high standard errors.

5.223 Second, the fit to the age 1+ cohort was poor and had a very large standard deviation associated with it (cf. Figure 5.21). High values of length densities within individual length classes from a few hauls in the survey were thought to contribute to this issue. The patchy sampling of the 1+ (and to a lesser extent 2+) fish may be due to several factors, including variable gear selectivity and horizontal and vertical patchiness of fish distribution. These concerns warrant further intersessional investigation of the sensitivity of the recommended yield to the attribution of biomass to the age 1+ cohort.

5.224 The Working Group agreed that age 1+ fish should be excluded from the biomass estimate in the 2004/05 yield calculation. However, since age 1+ could be available to the fishery in the second year of the projection (as age 3+ fish), it was agreed to produce two estimates of yield in 2005/06 to either include or exclude these fish.

5.225 The 1+ fish were subtracted from the standing stock estimate by multiplying the biomass estimate by the proportion (by mass) of 1+ fish calculated in the CMIX output (Table 5.49). Due to the poor fit of the mixture analysis, the allocated biomass for age 1+ fish is believed to be an overestimate. The proportion of age 1+ fish removed from the total biomass can therefore be considered precautionary. The one-sided lower 95% CI of biomass of fish aged between 2+ and 5+, estimated from the 2004 UK bottom trawl survey, was 34 841 tonnes. The initial age structure was also revised to exclude age 1+ fish.

Table 5.49: Calculation of the proportion of biomass-at-age derived for the truncated length-density distribution.

Age	Density %	Mean length (mm)*	Mean weight (kg)	Density (numbers/km^2)	Prop. biomass
1	69.6	131	0.009	48 857	0.215
2	21.5	198	0.039	15 404	0.276
3	2.2	254	0.092	1 769	0.074
4	3.5	301	0.165	2 552	0.193
5	3.2	341	0.252	2 101	0.243

* Derived from VBGF

3.2 Parameter values

Fixed parameters

5.226 As in previous years, the Working Group noted several discrepancies between the length-frequency distributions of *C. gunnari* sampled at Shag Rocks and South Georgia (WG-FSA-04/85). Recent studies have analysed length-frequency data for each area (WG-EMM-03/7). The results indicate that *C. gunnari* at Shag Rocks have a similar growth rate to fish at South Georgia, but are approximately five months older. The Working Group agreed that this information could be helpful in resolving the length-frequency distribution and should be investigated within the intersessional period.

5.227 The fixed parameters remain unchanged from 2003 and are presented in Table 5.50.

Table 5.50: Fixed parameters used in the 2004 assessment of *Champsocephalus gunnari* in Subarea 48.3.

Component	Parameter	Value	Units
Natural mortality	M	0.71	y^{-1}
VBGF	K	0.17	y^{-1}
VBGF	t_0	–0.58	y
VBGF	L_∞	557	mm
	Date ‘0’	245	d
Length to mass	‘*a*’	5.47E-10	kg, mm
Length to mass	‘*b*’	3.42	

Removals

Fishing mortality (catches since survey)

5.228 Catches taken after the assessment of biomass from the bottom trawl survey (i.e. 23 January 2004) must be included within the assessment. These are detailed below.

Season	Catch (tonnes)
2003/04	1 114

Initial age structure

Total density of each mixture component

5.229 The proportion of density-at-age was derived from the CMIX program for ages 1+ to 5+. VBGF parameters were selected to calculate mean length at age (Table 5.50).

Selectivity

5.230 A linear selectivity vector was used for *C. gunnari*, starting at 2.5 years and fully selected at age 3. In 2003, the assessment used a linear selectivity vector starting at 2.0 years.

This value had been used because no age 1+ fish had been caught in the previous bottom trawl survey. Sensitivity analysis was used to explore the effect of changing the starting value in the current assessment (paragraph 5.233).

4. Stock assessment

4.1 Model structure and assumptions

5.231 The GYM was used to perform the short-term projection of the *C. gunnari* biomass. Estimates of yield were derived by determining the maximum catch level (fishing mortality) that had a less than 5% chance of reducing the spawning stock biomass to below 75% of the level that would occur in the absence of fishing in the two years following a survey biomass estimate.

Model configuration

Table 5.51: GYM model configuration for the assessment of *Champsocephalus gunnari* in Subarea 48.3.

Category	Parameter	Value
Recruitment age	Start	2.5 years
	Fully selected	3 years
Plus class accumulation		10 years
Oldest age in initial structure		10 years
Maturity	L_{m50}	0 mm***
	Range: 0 to full maturity	0 mm
Spawning season	Set so that the status of the stock is determined at the start of each year.	30 Nov–30 Nov
Simulation specification	Number of runs	1
Individual trial specifications		
	Years to remove initial age structure*	0
	Year prior to projection**	2003
	Reference start date	01/12
	Years to project stock in simulation	2
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001

* Set to 0 since catches were made after the survey, else set to 1.
** GYM requires first year of 2003/04 split-year.
*** Maturity is not used in the short-term projection. It is set to 0 to allow the GYM to monitor the whole population.

4.2 Model results

5.232 A single short-term projection of yield in 2004/05 (Year 1) and 2005/06 (Year 2), excluding age 1+ fish in the initial biomass, was computed. A short-term projection of yield was also derived for 2005/06 (Year 2) using 1+ fish:

	Year 1 (2004/05) (tonnes)	Year 2 (2005/06) (tonnes)
Yield age 2+ fish only	3 574	2 262
Yield including age 1+ fish		5 935

4.3 Sensitivity analyses

5.233 The appearance of age 1+ fish in the trawl survey prompted a review of the selectivity vector employed within the GYM. The effect of changing the starting age of the linear selectivity vector from 2.0 to 2.5 and 2.95 (knife-edge) was examined where all age 1+ fish were included in the assessment. The Working Group agreed to run the assessment using a starting age of 2.5, similar to that used for Division 58.5.2. Further investigation of the properties of the selectivity vector was recommended during the intersessional period.

4.4 Discussion of model results

5.234 The projection of age 2+ fish from 2003/04 gives a projected yield of 3 574 tonnes in the 2004/05 season. This value is considered to be very precautionary since the assessment does not take into account the pelagic component of the population. The Working Group agreed to recommend this catch limit.

4.5 Future research requirements

5.235 The Working Group identified a number of future research requirements for the intersessional period:

(i) The acoustic protocol for assessing *C. gunnari* in Subarea 48.3, including:

  (a) discrimination of *C. gunnari* from other acoustic scatterers
  (b) further improvements in target strength estimates for *C. gunnari*
  (c) age-specific patterns in daily vertical distribution of *C. gunnari*
  (d) combination of trawl and acoustic indices for stock assessment.

(ii) Explore the effect of using alternative growth parameters for Shag Rocks and South Georgia in the assessment.

(iii) Examine in more detail why the mixture analysis had a poor fit to age 1+ fish.

(iv) The proposed age determination workshop for *C. gunnari* in 2005 is expected to benefit the assessment in Subarea 48.3 (paragraphs 9.8 to 9.12).

5. By-catch of fish and invertebrates

5.1 By-catch removals

5.236 The total reported by-catch of fish taken in recent years is indicated in Table 5.52.

Table 5.52: Total reported by-catch (tonnes) for five species between 1998/99 and 2003/04. NOG – *Gobionotothen gibberifrons*, SSI – *Chaenocephalus aceratus*, SGI – *Pseudochaenichthys georgianus*, NOR – *Notothenia rossii*, NOS – *Lepidonotothen squamifrons.*

Fishing season	NOG	Limit	SSI	Limit	SGI	Limit	NOR	Limit	NOS	Limit
1998/99	0	1470	0	2200	0	300	0	300	0	300
1999/00	0	1470	0	2200	0	300	0	300	0	300
2000/01	0	1470	0	2200	4	300	0	300	0	300
2001/02	0	1470	5	2200	5	300	0	300	0	300
2002/03	0	1470	1	2200	5	300	0	300	0	300
2003/04	0	1470	0	2200	2	300	0	300	0	300

5.2 Mitigation measures

5.237 The by-catch limits are set out in Conservation Measure 33-01. Move-on rules are included in the annual conservation measure set for this fishery, e.g. Conservation Measure 42-01.

6. By-catch of birds and mammals

5.238 Details of seabird by-catches this year are reported in paragraphs 7.205 to 7.212.

5.239 Seabird mortality in this trawl fishery is summarised in Table 5.53 (taken from Table 7.18).

Table 5.53: Number of seabirds killed in the trawl fishery in Subarea 48.3. DIC – *Diomedea chrysostoma*, DIM – *Thalassarche melanophrys*, PRO – *Procellaria aequinoctialis,* PWD – *Pachyptila desolata*, MAI – *Macronectes giganteus*.

Fishing season	Trawls observed	DIC	DIM	PRO	PWD	MAI
2000/01	315	5	46	41		
2001/02	431		18	49	1	
2002/03	182	1	7	28		
2003/04	221	1	26	59		1

5.240 The species concerned are all listed as globally threatened; given the increased level and rate of seabird by-catch in 2003/04, consideration of a reduction in by-catch limits at both the vessel level and for the whole icefish trawl fishery in Subarea 48.3 was recommended (paragraphs 7.213 to 7.217).

6.1 Mitigation measures

5.241 Conservation Measure 25-03 applies to this fishery. For discussion of the problems of avoidance of seabird by-catch see SC-CAMLR-XXII, Annex 5, paragraphs 6.237 to 6.240. Further discussion of this year's approaches to mitigation in this fishery are provided in paragraphs 7.218 and 7.219. A proposal for further experiments, requiring relaxation of the current vessel seabird by-catch limit, was supported (paragraph 7.220).

7. Ecosystem implications/effects

5.242 The current pelagic trawl fishery for *C. gunnari* in Subarea 48.3 has minimal impact on the benthic ecosystem. There is a small by-catch of other icefish species, but this is typically much smaller than the catch limits for these species. *C. gunnari* play an important role in the ecosystem of the South Georgia shelf as predators of krill, *Themisto* and other euphausiids, and as prey of fur seals and gentoo penguins (see Everson et al., 1999). Icefish may also be consumed by juvenile toothfish in years of high icefish abundance at Shag Rocks. Estimates of icefish standing stock have been shown to vary with variability in krill abundance at South Georgia, and in years of poor krill availability icefish condition is poorer and larger quantities are likely to be consumed by both fur seals and gentoo penguins, which are normally krill dependent.

8. Harvest controls for the 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.54: Summary of provisions of Conservation Measure 42-01 for *Champsocephalus gunnari* in Subarea 48.3 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 42-01	Advice for 2004/05	Paragraph reference
1. Access (gear)	Trawling only Bottom trawl prohibited	Review	5.26–5.39
2. Access (area)	Fishing prohibited within 12 n miles of South Georgia from 1 March to 31 May.		
3. Catch limit	2 887 tonnes 722 tonnes between 1 March and 31 May	Revise to 3 574 tonnes	5.232
4. Move-on rule	Move on if >100 kg caught of which >10% by number are <240 mm TL.		
5. Season	1 December 2003 to 30 November 2004		
6. By-catch	By-catch rates as in CM 33-01 to apply, plus move-on rule.		
7. Mitigation	In accordance with CM 25-03.		
8. Seabirds	Any vessel catching 20 seabirds to cease fishing.	Review	7.214–7.217
9. Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer.		
10. Data: catch and effort	(i) Five-day reporting system as in CM 23-01 (ii) Monthly fine-scale reporting system as in CM 23-04 on haul-by-haul basis.		
11. Target species	*Champsocephalus gunnari* By-catch is any species other than *C. gunnari.*		
12. Data: biological	Monthly fine-scale reporting system as in CM 23-05. Reported in accordance with the Scheme of International Scientific Observation.		
13. Research	20 research trawls to be conducted as described in Annex 42-01/A between 1 March and 31 May.		

Fishery Report: *Champsocephalus gunnari* Heard Island (Division 58.5.2)

1. Details of the fishery

1.1 Reported catch

5.243 The trawl fishery for *C. gunnari* in Division 58.5.2 has caught 51 tonnes from a catch limit of 292 tonnes in the 2003/04 fishing season (Conservation Measure 42-02). Historical reported catches along with the respective catch limits and number of vessels active in the fishery are shown in Table 5.55.

Table 5.55: Catch history for *Champsocephalus gunnari* in Division 58.5.2 (source: STATLANT data available from 1972 to 2003; 2004 from catch and effort reports).

Fishing season	Reported catch (tonnes)	Catch limit (tonnes)	Number vessels
1971/72	5 860		*
1973/74	7 525		*
1974/75	9 710		*
1976/77	15 201		*
1977/78	5 166		*
1989/90	2		*
1991/92	5		*
1992/93	3		*
1993/94	0		*
1994/95	0	311	*
1995/96	0	311	*
1996/97	227	311	1
1997/98	115	900	3
1998/99	2	1 160	1
1999/00	137	916	2
2000/01	1 136	1 150	2
2001/02	865	885	2
2002/03	2 345	2 980	2
2003/04	51	292	2

* No information

1.2 IUU catch

5.244 There was no evidence of IUU activity in this fishery.

1.3 Size distribution of the catches

5.245 Catch-weighted length frequencies from observer, fine-scale and STATLANT data are presented in Figure 5.22 for 1996/97 to 2003/04. These plots include data from both the commercial fishery and research trawl surveys.

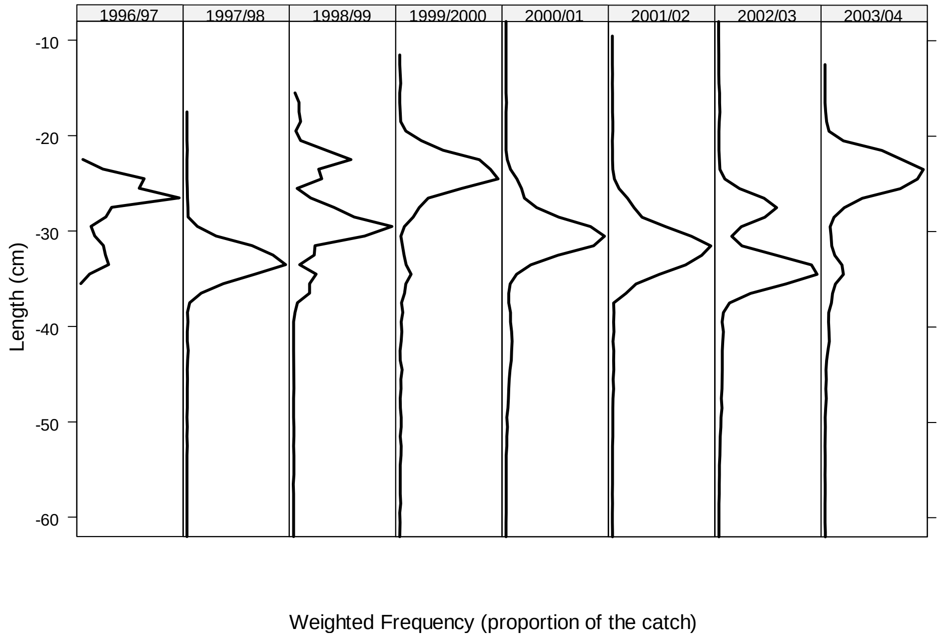


Figure 5.22: Catch-weighted length frequencies for *Champsocephalus gunnari* in Division 58.5.2 derived from observer, fine-scale and STATLANT data reported by 6 October 2004.

2. Stocks and areas

5.246 Within Division 58.5.2 this species is restricted to the shelf area in the vicinity of Heard Island in water generally shallower than 500 m. Previous analyses indicate that stocks on the Heard Plateau and Shell Bank have different size structure and recruitment patterns. The Working Group agreed that in light of this the two areas should be treated as separate stocks for assessment purposes (WG-FSA-97). *C. gunnari* have been absent or present in very low abundances on Shell Bank over recent years. Due to their low abundance observed in the current year, no assessment has been conducted for the Shell Bank stock for the 2004/05 season.

3. Parameter estimation

3.1 Estimation methods

Standing stock

5.247 The results of a bottom trawl survey were briefly summarised in WG-FSA-04/77. This had been undertaken according to the same design as in previous surveys for this region. Estimates of standing stock biomass were made using the bootstrap procedure.

Population structure

5.248 The distribution of densities at age was derived using the CMIX program and fixing the mean length for ages 4 and 5 (Table 5.56). The Working Group noted that the 2004 Australian bottom trawl survey had sampled a large cohort corresponding to age 2+ fish. It is evident that the very strong year class present in the 2003 survey as 1+ fish and in the 2002 juvenile *C. gunnari* survey, has now entered the fishery and dominates the population structure in 2004 (Figure 5.23). This is consistent with the prediction from the 2003 assessment. Details of the fit are presented in Table 5.57.

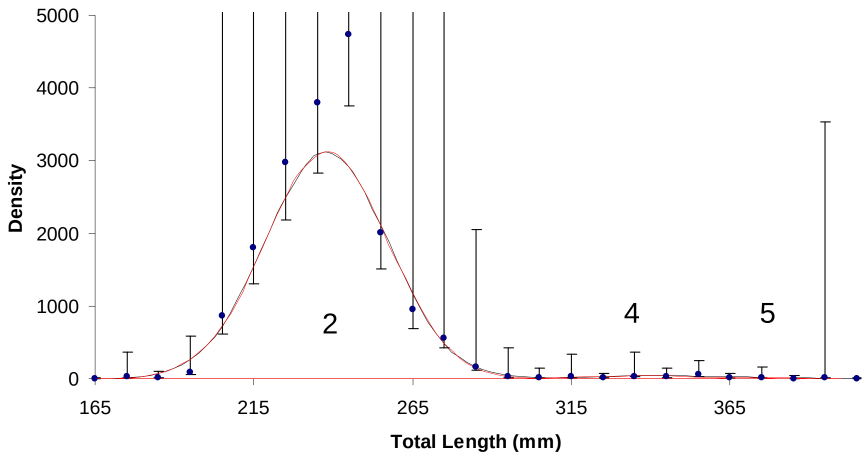


Figure 5.23: Size distribution of *Champsocephalus gunnari* from the 2004 bottom trawl survey in Division 58.5.2 with 95% confidence interval.

Table 5.56: Input parameters for the CMIX analysis of *Champsocephalus gunnari* length density in Division 58.5.2.

Parameter	Value
Size range included	160–410 mm
Means (no VBGF)	Age 2: (214–251 mm)
	Age 4: 339 mm (fixed)
	Age 5: 372 mm (fixed)
Standard deviations related linearly to the mean	Yes
Bounds on intercept (start, step)	1, 50 (15, 1.0)
Bounds on slope (start, step)	0.0, 0.4 (0.07, 0.01)
No. function calls	1 000
Reporting frequency	100
Stopping criteria	1E-6
Freq. for convergence testing	5
Simplex expansion coefficient	1

Table 5.57: Results generated from CMIX analyses for *Champsocephalus gunnari* in Division 58.5.2.

	Comp. 1	Comp. 2	Comp. 3
Mean length (mm)	238	339	372
Standard deviations (mm)	19.0	19.0	19.0
Total density (numbers km^{-2})	15 072	185	42
SD of component density	6 027	87	42
Sum of observed densities = 18 242.7			
Sum of expected densities = 15 298.1			
Intercept = 18.99			
Slope = 0.0			

5.249 The Working Group raised a point of concern over the large size distribution of age 2+ fish (200–280 mm), and the complete lack of age 3+ fish within the population. The observed distribution was consistent with previous analyses of cohort structure that indicated few age 2+ in the population during 2003 (WG-FSA-03/32).

Other parameters

5.250 There were no changes to other parameter values.

3.2 Parameter values

Fixed parameters

5.251 The fixed parameters remain unchanged from previous assessments (Table 5.58).

Table 5.58: Fixed parameters used in the 2004 assessment of *Champsocephalus gunnari* in Division 58.5.2.

Component	Parameter	Value	Units
Natural mortality	M	0.4	y^{-1}
VBGF	K	0.323	y^{-1}
VBGF	t_0	0.275	y
VBGF	L_∞	457	mm
Length to mass	‘a’	2.629E-10	kg/mm
Length to mass	‘b’	3.515	

Standing stock

5.252 Similar to last year, an estimate of standing stock biomass was calculated using the bootstrap procedure. The area of seabed sampled, and an estimate of the one-sided lower 95% CI of biomass was calculated (Table 5.59).

Table 5.59: Seabed areas within three geographic strata used to bootstrap estimates of biomass.

Nominal date of survey – 12 May 2004				
Survey strata	Locality and depth range	Seabed area (km^2)	Biomass (tonnes)	One-sided lower 95% CI (tonnes)
1	Gunnari Ridge	520.7	17 270	5 956
2	Plateau southeast	10 620	6 327	331
3	Plateau west	10 440	250	108
Totals	Plateau and Gunnari Ridge	21 581	23 847	**8 982***

* This value is not the sum of the strata values but is a separate stratified estimate of the total biomass and was used in the assessment.

Removals

5.253 No *C. gunnari* were caught following the survey (5 to 25 May 2004).

Initial age structure

5.254 The proportion of density-at-age was derived from the CMIX program for ages 2+ to 5+. VBGF parameters were selected to calculate mean length-at-age (Table 5.60).

Selectivity

5.255 A linear selectivity vector was used for *C. gunnari*, starting at 2.5 years and fully selected at age 3.

Recruitment

5.256 The short-term projection of *C. gunnari* does not include recruitment data.

Proportion of biomass-at-age

5.257 An estimate of the proportion of biomass-at-age was calculated and presented in Table 5.60. This demonstrates that the age 2+ cohort contributes to both the highest number and biomass of animals within the population.

Table 5.60: Calculation of the proportion of biomass-at-age derived for the truncated length-density distribution.

Age	Density %	Mean length (mm)*	Mean weight (kg)	Density (number/km^2)	Prop. biomass
2	98.5	195	0.029	15 072	0.91
3	0.0	268	0.090	0	0.00
4	1.2	320	0.168	185	0.06
5	0.3	358	0.249	42	0.02

* Obtained from VBGF

4. Stock assessment

4.1 Model structure and assumptions

5.258 The GYM, used routinely for the assessment of long-term yield of other species in the CCAMLR Convention Area, configured to perform the short-term projection, was used.

Model configuration

Table 5.61: GYM model configuration for the assessment of *Champsocephalus gunnari* in Division 58.5.2.

Category	Parameter	Value
Recruitment age	Start	2.5 years
	Fully selected	3 years
Plus class accumulation		10 years
Oldest age in initial structure		10 years
Maturity	L_{m50}	0 mm***
	Range: 0 to full maturity	0 mm
Spawning season	Set so that the status of the stock is determined at the start of each year.	30 Nov–30 Nov
Simulation specification	Number of runs	1
Individual trial specifications		
	Years to remove initial age structure*	1
	Year prior to projection**	2003
	Reference start date	01/12
	Years to project stock in simulation	2
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001

* Set to 1 since no catches were made after the survey, else set to 0.
** GYM requires first year of 2003/04 split-year.
*** Maturity is not used in the short-term projection. It is set to 0 to allow the GYM to monitor the whole population.

Decision rules

5.259 To assess a catch level such that fishing should not, without any substantial risk, specified in this instance as 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.

5.260 To achieve this, the one-sided lower 95% confidence bound of the biomass estimate is used as the starting point for the projection.

4.2 Model results

5.261 A single deterministic short-term projection of yield in 2004/05 (Year 1) was calculated for the Heard Plateau and Gunnari Ridge. Yield estimates derived from the short-term projections of 2+ fish for the 2004/05 season are:

	2+ fish
Actual yield in Year 1 (2004/05)	1 864 tonnes
Estimated yield in Year 2 (2005/06)	1 766 tonnes

4.3 Sensitivity analyses

5.262 No specific sensitivity analyses were undertaken at the meeting.

4.4 Discussion of model results

5.263 The projection of age 2+ fish from 2003/04 gives a projected yield of 1 864 tonnes in the 2004/05 season. The Working Group agreed to recommend this catch limit.

4.5 Future research requirements

5.264 The Working Group recommended that outputs from the age determination workshop for *C. gunnari* in 2005 may benefit future assessments in Division 58.5.2 (paragraphs 9.8 to 9.12).

5. By-catch of fish and invertebrates

5.1 By-catch removals

5.265 The total reported by-catch (tonnes) of fish taken in recent years is indicated in Table 5.62.

Table 5.62: Total reported by-catch (tonnes) for four species between 1995/96 and 2003/04. LIC – *Channichthys rhinoceratus*, NOS – *Lepidonotothen squamifrons*, GRV – *Macrourus* spp., SRX – rajids.

Fishing season	LIC	Limit	NOS	Limit	GRV	Limit	SRX	Limit	Other	Limit
1995/96	0		0		0		0		0	5%*
1996/97	2		0		0		1		2	50**
1997/98	5	80	4	325	0		0	120	2	50
1998/99	4	150	0	80	0		0		0	50
1999/00	4	150	0	80	0		0		1	50
2000/01	1	150	0	80	0	50	0	50	0	50
2001/02	3	150	0	80	0	50	1	50	0	50
2002/03	22	150	0	80	0	465	20	120	1	50
2003/04	6	150	0	80	1	360	3	120	1	50

* 5% move-on rule if individual haul exceeds 5%, limit not specified.
** Move-on rule if catch of any by-catch species exceeds 5% of target species.

5.2 Mitigation measures

5.266 Conservation Measure 33-02 currently applies to this fishery. Move-on rules are included in the annual conservation measure established for this fishery (e.g. Conservation Measure 42-02).

6. By-catch of birds and mammals

5.267 In the trawl fishery in Division 58.5.2 six seabirds were killed in 2003. Seabirds were released alive in 2002 (1), 2003 (11) and 2004 (7) (Table 7.18). The provisions of Conservation Measure 25-03 apply to this fishery.

7. Ecosystem implications/effects

5.268 Bottom trawl gear is used to target both *C. gunnari* and *D. eleginoides* in Division 58.5.2. The potential impacts of fishing gear on benthic communities are limited by the small size and number of commercial trawl grounds, a strategy of fishing trawling gear lightly or just off the bottom, and the protection of large areas sensitive to the effects of bottom trawling (see also paragraph 5.211).

8. Harvest controls for the 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.63: Summary of provisions of Conservation Measure 42-02 for *Champsocephalus gunnari* in Division 58.5.2 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 42-02	Advice for 2004/05	Paragraph reference
1. Access (gear)	Trawling only		
2. Access (area)	Definition of area open for fishing		
3.	Chart illustrating area open (Annex 42-02/A)		
4. Catch limit	292 tonnes	Revise to 1 864 tonnes	5.262
5. Move-on rule	Move on if >100 kg caught of which >10% by number are less than minimum size (1 Dec–30 April = 24 cm, 1 May–30 Nov = 29 cm).		
6. Season	1 December 2003 to 30 November 2004		
7. By-catch	By-catch rates as in CM 33-02 to apply.		
8. Mitigation	In accordance with CM 25-03.		
9. Observers	Each vessel to carry at least one scientific observer and may include one additional CCAMLR scientific observer.		
10. Data: catch and effort	(i) Ten-day reporting system as in Annex 42-02/B (ii) Monthly fine-scale reporting system as in Annex 42-02/B on haul-by-haul basis.		
11. Target species	*Champsocephalus gunnari* By-catch is any species other than *C. gunnari*.		
12. Data: biological	Fine-scale reporting system as in Annex 42-02/B. Reported in accordance with the Scheme of International Scientific Observation.		

Fishery Report: *Dissostichus eleginoides* Prince Edward Islands EEZ (Subareas 58.6 and 58.7)

1. Details of the fishery

5.269 A licensed fishery within the South African EEZ at the Prince Edward Islands started in October 1996. Part of the South African EEZ is outside the CCAMLR Convention Area (Area 51) and part falls within Subareas 58.6 and 58.7 and Division 58.4.4 (Figure 5.24).

5.270 Although the fishery began in 1996, intelligence reports indicated that IUU vessels were operating in the area in 1995 and possibly 1994. Since the start of the licensed fishery, the estimated IUU catch has exceeded the reported catch for most years (Table 5.64). Since the start of the fishery a maximum of five operators have been licensed by South Africa to fish in any one year. During the 2002/03 and 2003/04 fishing seasons, two licensed vessels were active in the fishery.

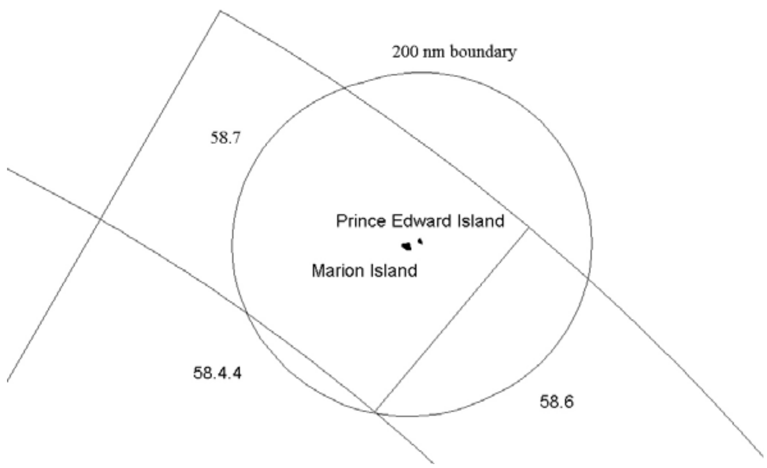


Figure 5.24: Map showing the position of the South African EEZ at the Prince Edward Islands and the boundaries of the relevant CCAMLR areas.

1.1 Reported catch (time series)

5.271 The total annual catches taken in Subarea 58.7 as reported to CCAMLR are presented in Table 5.64.

Table 5.64: Catch history for *Dissostichus eleginoides* in Subarea 58.7 (source: WG-FSA-04/5 Rev. 1 and SCIC-04/3 Rev. 2). Fishing season is from 1 December to 30 November.

Fishing season	Total reported catch (tonnes)	IUU catch (tonnes)	Total removals (tonnes)
1995/96	869	4958	5827
1996/97	1193	7327	8520
1997/98	637	598	1235
1998/99	301	173	474
1999/00	1015	191	1206
2000/01	235	120	355
2001/02	98	78	176
2002/03	219	138	357
2003/04	50	58	108

5.272 The status of the resource within the South African EEZ was assessed in WG-FSA-04/37. For that assessment, the removals from the South African EEZ were estimated (Table 5.65). The reported catch column includes catches taken in the South African EEZ within Subareas 58.7 and 58.6 as well as catches from Area 51 outside the CCAMLR region. In WG-FSA-04/37 the authors noted that the reported catches underestimate total mortality as losses through depredation by cetaceans are not included.

Table 5.65: Catch history for *Dissostichus eleginoides* in the South African EEZ as used in the assessment (source: WG-FSA-SAM-04/12 and WG-FSA-04/37). The limited data for 1996 have been pooled with the 1997/98 season.

Fishing season	Vessels (non-IUU)	Catch limit (tonnes)	Reported landed catch (tonnes)	IUU catch (tonnes)	Total extractions (tonnes)
1996/97	7	2 500	2 921	21 350	24 271
1997/98	4	3 000	1 011	1 808	2 819
1998/99	4	2 750	956	1 014	1 970
1999/00	3	2 250	1 562	1 210	2 772
2000/01	5	2 250	352	352	704
2001/02	2	600	200	306	506
2002/03	2	500	313	256	569
2003/04	2	500	97	156	253

1.2 IUU catch

5.273 The estimated IUU catch in Subarea 58.7 is presented in Table 5.64, whereas the estimated IUU catch from the South African EEZ (as used in the assessment in WG-FSA-04/37) is presented in Table 5.65.

5.274 IUU fishing has occurred since at least 1995 (and possibly 1994), and in most years the estimated IUU catch within the South African EEZ has exceeded the reported catch Table 5.65). The IUU catch in the South African EEZ prior to 2003 (Table 5.65) was estimated as the sum of the IUU catch estimated for Subarea 58.7 and 50% of that estimated for Subarea 58.6 (Brandão et al., 2002). For 2003 and 2004 the IUU catch estimates are based on the number and duration of fishing activities of illegal vessels known or believed to have operated in the South African EEZ and on the average green weight tonnages of vessels operating legally in that area in the corresponding years (WG-FSA-04/37). Note that CCAMLR records indicated only one reported IUU vessel in this area during 2004, whereas other intelligence reports indicated that at least three IUU vessels were seen within the South African EEZ (WG-FSA-04/37).

1.3 Size distribution of catches (time series)

5.275 Annual estimated catch length frequencies are presented in Figure 5.25.

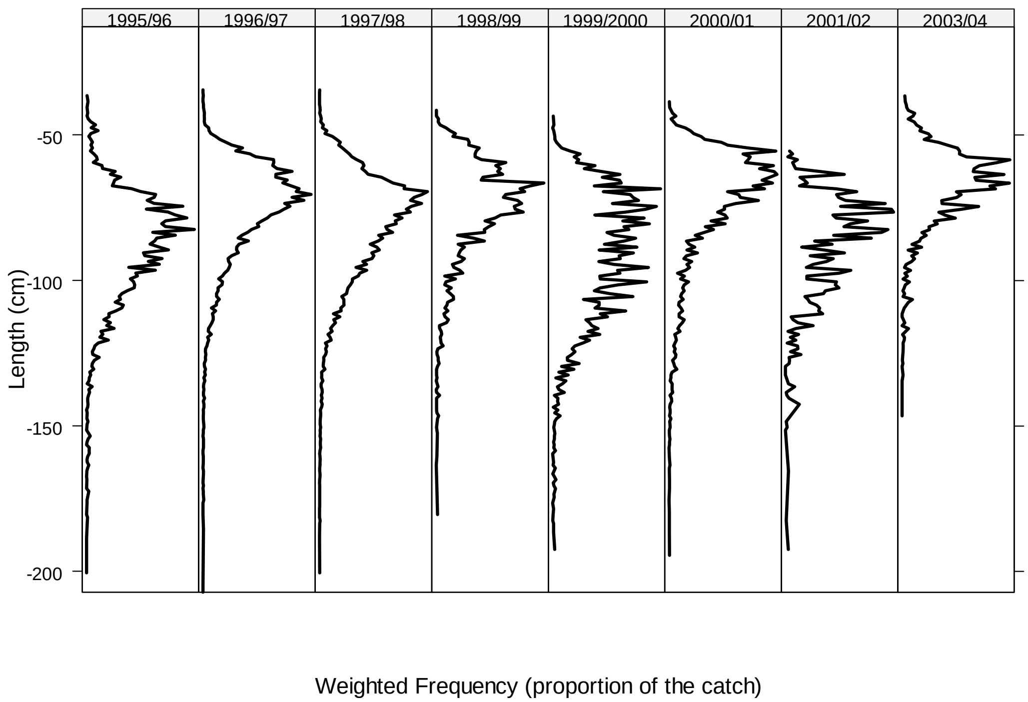


Figure 5.25: Catch-weighted length frequencies for *Dissostichus eleginoides* in Subarea 58.7 derived from observer, fine-scale and STATLANT data reported by 6 October 2004.

2. Stocks and areas

5.276 The South African EEZ around the Prince Edward Islands is mainly in Subarea 58.7 but extends east into Subarea 58.6, south into Division 58.4.4, and north of the Convention Area in to Area 51 (Figure 5.24), however there are currently no fishing grounds in the south of the South African EEZ. The majority of the fishery occurs down to about 1 500 m, but fishing depths in excess of 2 000 m have been recorded.

3. Parameter estimation

3.1 Biological parameters

5.277 None of the parameters used in the assessment were derived specifically from this fishery, rather they have been assumed from work on toothfish in other areas within the CCAMLR Convention Area.

Table 5.66: Parameter values used in the assessment of the toothfish stock in the South African EEZ at the Prince Edward Islands (source: WG-FSA-04/37).

Component	Parameter	Value	Units
Natural mortality	M	0.2	y^{-1}
VBGF	K	0.066	y^{-1}
VBGF	t_0	–0.21	y
VBGF	L_∞	194.6	cm
Length to mass	‘a’	2.5E-05	cm, kg
Length to mass	‘b’	2.8	
Age at maturity	t_m	10	y

Standardised CPUE

5.278 CPUE was standardised by applying the GLM approach described in Appendix 1 of WG-FSA-04/37.

Table 5.67: Standardised longline CPUE by season for *Dissostichus eleginoides* in the South African EEZ at the Prince Edward Islands (source: WG-FSA-04/37).

Fishing season	Standardised CPUE
1996/97	3.628
1997/98	0.976
1998/99	0.851
1999/00	0.505
2000/01	0.306
2001/02	0.325
2002/03	0.409
2003/04	0.263

4. Stock assessment

4.1 Model structure and assumptions

5.279 An ASPM was used to assess the status of the *D. eleginoides* resource in the South African EEZ at the Prince Edward Islands (WG-FSA-04/37). The methodology is thoroughly presented in Appendix 1 of that paper. The Working Group noted that several refinements had been added since WG-FSA-SAM-04/12 was presented at WG-FSA-SAM-04.

4.2 Model estimates

5.280 Estimated exploited biomass and projections under three levels of future catches for the base-case ASPM model from WG-FSA-04/37 are presented in Figure 5.26. Further model estimates are available in WG-FSA-04/37.

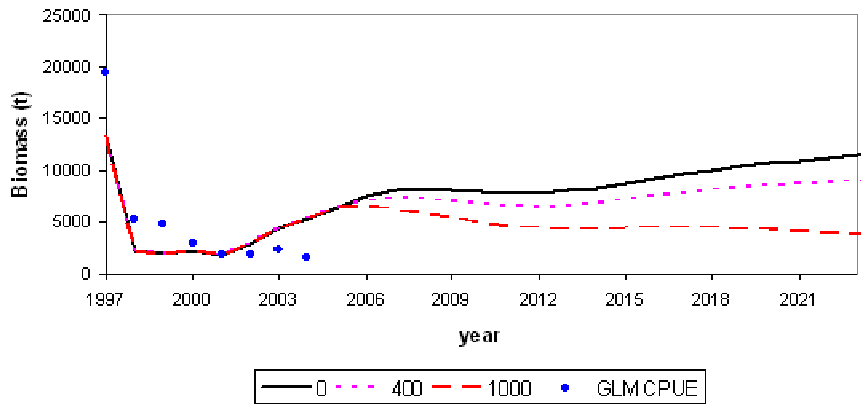


Figure 5.26: GLM-standardised CPUE indices to which the ASPM was fitted (divided by the estimated catchability *q* to express them in biomass units) and estimated exploitable biomass, together with projections under future annual catches of 0, 400 and 1 000 tonnes. Source: WG-FSA-04/37.

4.3 Sensitivity analyses

5.281 Several sensitivity analyses were explored in WG-FSA-04/37 by applying different weightings to the catch-at-length and CPUE data.

4.4 Discussion of model results

5.282 The Working Group considered that the results of the ASPM model were unstable and were very sensitive to the weightings used for the assessment, which were entirely arbitrary. The Working Group also noted that the estimates of yield provided in the paper were not based on the CCAMLR decision rules.

4.5 Future research requirements

5.283 The Working Group encouraged further development of this work. In particular they noted the importance of a full evaluation of the ASPM modelling approach (paragraph 4.15), and requested that the code for the model presented in WG-FSA-04/37 be lodged with the CCAMLR Secretariat.

5.284 The Working Group also noted the development of tagging studies in many other toothfish fisheries in the Convention Area and encouraged South Africa to consider implementing tagging in their EEZ.

5. By-catch of fish and invertebrates

5.1 Estimation of by-catch removals

5.285 Estimated annual by-catch removals for the South African EEZ in Subareas 58.6 and 58.7, but excluding Area 51, are reported in Table 5.68. The Working Group noted that the voluntary submission of fine-scale data was poor for some years and encouraged South Africa to submit more fine-scale data in future.

Table 5.68: Reported by-catch landings from toothfish directed longline fishing by South African vessels fishing in Subareas 58.6 and 58.7. Source: fine-scale and STATLANT data.

Fishing season	*Macrourus* spp.	Rajids	Other species
1995/96	0	0	0
1996/97	0	0	0
1997/98	0	1	1
1998/99	0	0	0
1999/00	203	18	54
2000/01	72	2	7
2001/02	8	0	0
2002/03	no fine-scale data submitted		
2003/04	1	0	0

5.2 Assessments of impact on affected populations

5.286 It was not possible to assess the impacts on affected populations.

5.3 Mitigation measures

5.287 There are no mitigation measures in force.

6. By-catch of birds and mammals

6.1 Estimation of by-catch removals

5.288 Details of seabird by-catch (taken from Table 7.3) are summarised in Table 5.69. Estimated potential seabird removals in the IUU fishery are summarised in SC-CAMLR-XXIII/BG/23 and Table 7.15.

Table 5.69: Estimated by-catch of seabirds in the South African EEZ in Subareas 58.6 and 58.7.

Fishing season	By-catch rate (birds/thousand hooks)	Estimated by-catch
1996/97	0.52	834
1997/98	0.194	528
1998/99	0.034	156
1999/00	0.046	516
2000/01	0.018	199
2001/02	0	0
2002/03	0.003	7
2003/04	0.025	39

5.289 Ad hoc WG-IMAF has assessed the level of risk of incidental mortality of seabirds in the fishery in the South African EEZ at the Prince Edward Islands (in both Subareas 58.6 and 58.7) as category 5 (SC-CAMLR-XXIII/BG/21 and Table 7.17). For new and exploratory fisheries in areas of this risk level category the WG-IMAF recommendations are set out in Table 7.17.

6.2 Mitigation measures

5.290 South Africa has consistently required the application in this area of the mitigation measures recommended by CCAMLR with the exception of a closed season.

6.3 Interactions involving marine mammals with longline fishing operations

5.291 Anecdotal reports indicate that catch losses caused by toothed cetaceans taking fish from lines as they are hauled are substantial.

5.292 WG-FSA-04/8 Rev. 1 reported one seal entangled, but not killed, during the 2003/04 season.

7. Management advice

5.293 The Working Group considered that the results of the ASPM model were unstable and were very sensitive to the weightings used for the assessment, which were entirely arbitrary. The Working Group also noted that the estimates of yield provided in the paper were not based on the CCAMLR decision rules. Therefore the Working Group was unable to provide management advice for the fishery in the South African EEZ at the Prince Edward Islands.

5.294 The Scientific Committee should note the recommendations by ad hoc WG-IMAF with respect to mitigation of seabird mortalities (paragraphs 5.289 and 5.290).

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

Fishery Report: *Dissostichus eleginoides* Crozet Island inside French EEZ (Subarea 58.6)

5.296 Insufficient information was available at the meeting to complete a Fishery Report for this fishery. The Working Group recommended that French scientists be requested to provide the information required during the coming intersessional period.

Standardisation of CPUE

5.297 Haul-by-haul catch and effort data (fine-scale data) for the French longline fishery inside the French EEZ around Crozet Island in Subarea 58.6 for the 1998/99 to 2003/04 fishing seasons were examined. These data were kindly provided by Prof. Duhamel. GLMMs described by Candy (2004) and WG-FSA-03/34 were used to investigate trends in CPUE (kg/hook).

5.298 Figure 5.27 shows the standardised CPUE time series from 1998/99 and 2003/04 along with the total removals time series from 1995/96 to 2003/04. The standardised CPUE rose between 1998/99 and 1999/2000 but then fell steadily. Estimated total removals were very high in 1995/96 and especially 1996/97, but fell to around 3 000 tonnes in 1997/98 and have declined slowly since then to under 1 000 tonnes.

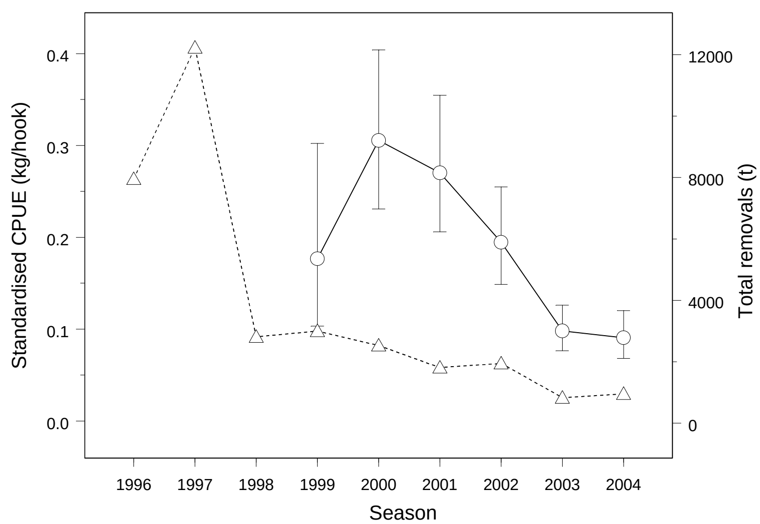


Figure 5.27: Time series of total removals (dashed line) and standardised CPUE (kg/hook) (solid line) obtained from the fitted GLMM. Error bars represent approximate 95% confidence bounds on the estimates.

Management advice

5.299 Estimated total removals have declined steadily over the last seven seasons and are at substantially lower levels than those taken before then. Nevertheless, standardised CPUE has fallen substantially since 1999/2000. In the absence of a stock assessment, the Working Group agreed that it was unable to recommend appropriate levels of catch for this fishery.

5.300 As for other toothfish fisheries in the CCAMLR Convention Area, the Working Group recommended that tag–recapture experiments be conducted. It also noted that conducting a recruitment survey would greatly assist in carrying out a stock assessment.

5.301 No new information was available on the state of fish stocks in Subarea 58.6 outside areas of national jurisdiction. The Working Group therefore recommended that the prohibition of directed fishing for *D. eleginoides*, described in Conservation Measure 32-11, remains in force.

Assessment and management advice for other areas and species in the Atlantic Ocean

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

5.302 CCAMLR closed commercial finfishing in the Antarctic Peninsula (Subarea 48.1) and the South Orkney Islands (Subarea 48.2) after the 1989/90 season. Both subareas should only be reopened to commercial fishing if scientific surveys had demonstrated that the condition of fish stocks had improved to the extent which would allow commercial harvesting.

5.303 The last surveys of the two areas occurred in 2003 (Subarea 48.1) and 1999 (Subarea 48.2). They showed no improvement in the condition of stocks which would give rise to considerations of reopening the two areas for commercial finfishing. No new information has become available since then as no surveys were conducted in the 2003/04 season.

Management advice

5.304 The Working Group recommended that the existing Conservation Measures 32-02 and 32-04 on the prohibition of finfishing in Subareas 48.1 and 48.2 remain in force.

South Sandwich Islands (Subarea 48.4) and Bouvet Island (Subarea 48.6)

5.305 Both subareas exhibit rather limited shelf areas 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 has set a catch limit of 28 tonnes of *Dissostichus* spp. for this subarea (Conservation Measure 41-03).

5.306 New information has been provided on fish stocks in both subareas from the US ICEFISH cruise in June–July 2004 (WG-FSA-04/61). A total of 18 stations with 36 gear deployments were conducted in the South Sandwich Islands, while 14 stations including 47 gear deployments were performed around Bouvet Island. The mouth opening of the various trawls used, however, was too small to provide quantitative estimates for larger fish species caught, such as many nototheniids and channichthyids. Fourteen and 11 species of finfish were caught in the South Sandwich Islands and around Bouvet Island respectively. The two most abundant species in the catches were the small-sized *L. larseni* and *L. nudifrons* in the South Sandwich Islands and *L. larseni* and *L. squamifrons* around Bouvet Island.

Management advice

5.307 No commercial fishing has ever occurred in the two subareas except longlining for *D. eleginoides* in 1994 which led to a catch limit of 28 tonnes. The Working Group recommended that the existing Conservation Measure 41-03 for *D. eleginoides* in Subarea 48.4 remains in force. Trawling, except for scientific purposes, should be prohibited in both subareas.

Electrona carlsbergi (Subarea 48.3)

5.308 The state of the stock was last assessed in 1994. A precautionary catch limit has initially 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, data reporting and research (Conservation Measure 43-01). Since the average life span of this species is about five years, the 1994 assessment is no longer applicable. CCAMLR decided to close the fishery on this species in 2003.

Management advice

5.309 Due to the lack of new information on the current status of the stock, the Working Group recommended that the fishery remain closed. It should only be reopened after a new survey on this species is conducted and results have been evaluated by CCAMLR.

Stone crabs (*Paralomis* spp.) (Subarea 48.3)

5.310 Stone crabs were not exploited in the 2002/03 and 2003/04 seasons. No proposal for the harvest of crabs has been received by CCAMLR for the 2004/05 season.

Management advice

5.311 Stone crabs are subject to Conservation Measures 52-01 and 52-02 regulating the fishery and experimental harvest of crabs. The Working Group recommended that these conservation measures should remain in force.

Martialia hyadesi (Subarea 48.3)

5.312 The exploratory fishery on *M. hyadesi* was subject to Conservation Measure 61-01. No new information on the species became available. No new request has been submitted to CCAMLR to continue exploratory fishing on this species in 2004/05.

Management advice

5.313 The Working Group recommended that the existing Conservation Measure 61-01 should remain in force.

FISH AND INVERTEBRATE BY-CATCH

6.1 The long-term status of by-catch taxa has been identified as an issue for urgent attention by the Scientific Committee (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.153). The key issues that need to be addressed are:

- 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.

6.2 Issues of potential mutual interest and importance to WG-FSA and ad hoc WG-IMAF identified by the Working Group in 2003 (SC-CAMLR-XXII, Annex 5, paragraph 5.231) included:

(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.

A work plan was agreed which addressed these issues as described below.

Assessment of the status of by-catch species or groups

6.3 The priority by-catch taxa for which assessments of status are required are macrourids and rajids (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.154).

Rajidae

6.4 No assessments were undertaken for rajids because there was insufficient biological information available.

6.5 Estimates of age and growth of *A. georgiana* in Subarea 88.1 based on interpretation of caudal thorns were presented in WG-FSA-04/29 (paragraph 3.54). Due to the uncertain and unvalidated age estimates, the Working Group decided that there was insufficient information on which to base an estimate of γ for *A. georgiana*.

Macrourus spp.

6.6 No new estimates of fishing selectivity or other biological parameters were available to update the estimates of γ for macrourids presented in SC-CAMLR-XXII, paragraph 4.132.

M. whitsoni in Subarea 88.1

6.7 The BioRoss research survey provided information on the main by-catch species for the exploratory longline fishery in Subarea 88.1 (paragraph 3.26). WG-FSA-SAM-04/7 presented bottom trawl catch data by tow for *M. whitsoni* and *B. eatonii*. The trawl was a rough-bottom orange roughy otter trawl with 28 m mouth opening, 5 m headline height, and 40 mm codend full inside mesh measurement. Total catches of *M. whitsoni* and *B. eatonii* were 1 075 and 157 kg respectively.

6.8 Mean standardised catch rates for *M. whitsoni* and *B. eatonii* were calculated for SSRUs 881H and E in two depth ranges (50–600 m and greater than 600 m) and are presented in Table 6.1.

6.9 The Working Group noted that the mean catch rate of *M. whitsoni* from depths greater than 600 m in SSRU 881H was an order of magnitude greater than the estimate of the mean density of *Macrourus* spp. from a research trawl survey of BANZARE Bank (Division 58.4.3a) (176 kg/km^2) (van Wijk et al., 2000), which is currently used to estimate B_0 for *M. carinatus* in Division 58.5.2 and *Macrourus* spp. in Division 58.4.3 (SC-CAMLR-XXII, Annex 5, paragraphs 5.249 and 5.252). However, the Working Group pointed out that the sample sizes in Subarea 88.1 were small and that there was considerable variation in catch rates between tows.

6.10 Estimates of B_0 for *M. whitsoni* in SSRUs 881H and E were derived using the mean density estimates from the trawl survey scaled up to the area of seabed in the depth range fished by the exploratory longline fishery (600–1 800 m) in that SSRU presented in WG-FSA-04/20.

6.11 The mean catch rate of *M. whitsoni* from depths greater than 600 m in SSRU 881H was 4 235 kg/km^2 (n = 6, 95% confidence interval 273–8 197 kg/km^2). The area of seabed in SSRU 881H from 600–1 800 m is 19 245 km^2, resulting in a mean biomass estimate of 81 500 tonnes (95% confidence interval 5 250–157 750 tonnes). The mean catch rate of *M. whitsoni* from depths greater than 600 m in SSRU 881E was 103 kg/km^2 (n = 4, 95% confidence interval 3.5–202 kg/km^2). The area of seabed in SSRU 881E from 600–1 800 m is 14 797 km^2, resulting in a mean biomass estimate of 1 520 tonnes (95% confidence interval 50–2 995 tonnes).

6.12 Long-term precautionary yields for *M. whitsoni* in SSRUs 881H and E were estimated using the following equation:

$$\text{Yield} = \gamma B_0.$$

6.13 The estimate of γ from the base-case assessment of *M. whitsoni* in Subarea 88.1 in 2003 was 0.01439 (SC-CAMLR-XXII, paragraph 4.132). Applying γ = 0.01439 gives a mean estimate of yield for *M. whitsoni* in SSRU 881H of 1 170 tonnes (95% confidence intervals 75–2 270 tonnes) and a mean estimate of yield for *M. whitsoni* in SSRU 881E of 22 tonnes (95% confidence intervals 1–43 tonnes).

6.14 The Working Group decided that these estimates of yield for *M. whitsoni* in Subarea 88.1 should not be used for management advice. Trawl catch rates did not provide good estimates of B_0 for SSRUs 881H and E because the small number of tows did not provide a representative sample of the overall area in the depth range 600–1 800 m in each SSRU.

6.15 The Working Group also noted that the relative difference in trawl catch rates between SSRUs 881H and E (much higher catch rates in 881H) were in contrast to the relative catch rates observed in the exploratory longline fishery (higher in 881E) (Table 6.2).

M. carinatus in Division 58.5.2

6.16 There was no new information to update the estimate of precautionary yield for *M. carinatus* of 360 tonnes in Division 58.5.2 (SC-CAMLR-XXII, Annex 5, paragraph 5.258).

Macrourus spp. in Division 58.4.3

6.17 There was no new information to update the estimates of precautionary yield for *Macrourus* spp. of 26 tonnes in Division 58.4.3a and 159 tonnes in Division 58.4.3b (SC-CAMLR-XXII, Annex 5, paragraph 5.259).

M. holotrachys in Subarea 48.3

6.18 There are currently no estimates of B_0 for *Macrourus* spp. in Subarea 48.3 or adjacent areas. Therefore the Working Group was not in a position to estimate a precautionary yield.

Management of by-catch limits by SSRU in Subarea 88.1

6.19 The Working Group considered management of by-catch limits for macrourids and rajids by SSRU in Subarea 88.1.

6.20 In the 2003/04 fishing season the by-catch allocation by SSRU was based on the following rule from Conservation Measure 33-03:

- rajids 5% of the catch limit of *Dissostichus* spp. or 50 tonnes whichever is greater
- *Macrourus* spp. 16% of the catch limit of *Dissostichus* spp. or 20 tonnes whichever is greater.

6.21 The Scientific Committee encouraged further work to examine more appropriate SSRU by-catch levels that are more in accordance with the by-catch distribution and abundance (SC-CAMLR-XXII, paragraph 4.199).

6.22 By-catch limits for macrourids were exceeded in SSRUs 881E and I in the 2003/04 fishery, even though total macrourid by-catch was only 69% of the limit (paragraph 5.77).

6.23 WG-FSA-04/20 examined mean rattail CPUE by area in Subarea 88.1 and found considerable variation between SSRUs. Rattail CPUE in SSRUs 881E, G, H, I and K was relatively high (0.018–0.050 kg/hook), whilst mean CPUE in the northern (SSRUs 881A–C) and southern (SSRUs 881J and L) areas was low (less than 0.006 kg/hook). An analogous CPUE analysis was not carried out for rajids in Subarea 88.1 because of uncertainties associated with the reporting of skates which were cut off lines and released (paragraph 6.86).

6.24 WG-FSA-04/20 proposed allocating catch limits as the product of the proportional CPUE and the proportional seabed area in SSRUs which are open for fishing. However, the authors concluded that it is not clear that this approach provides better catch limits than using the existing rule.

6.25 The following sections explore three options for allocation of macrourid by-catch between SSRUs in Subarea 88.1. Indicative catch limits under all three options (Table 6.2) were based on the 2004 total catch limit of 520 tonnes. The Working Group emphasised that it had no additional information to revise scientific advice on the overall catch limit, which is currently set at 16% of the *Dissostichus* spp. catch limit. This was derived from the by-catch limit for *Macrourus* spp. in Division 58.5.2 which was 16% of the catch limit for *Dissostichus* spp. in 2002/03 (CCAMLR-XXI, paragraph 11.53).

6.26 The Working Group recommended that the move-on rule requiring vessels to move to another location at least 5 n miles distant if the by-catch of any one species is equal to or greater than 1 tonne (Conservation Measure 33-03) should be retained for all of the proposed options.

Option 1 – Status quo

16% of the catch limit of *Dissostichus* spp. or 20 tonnes whichever is greater.

Advantages

- Simple – based on the same rule used to estimate overall catch limit.
- Encourages vessels to avoid areas with higher proportions of macrourid by-catch.

Disadvantages

- Not related to by-catch distribution or abundance (although limits are related to seabed area because toothfish limits are partially proportional to seabed area).

Option 2 – CPUE proportional limits

Catch limits as the product of the proportional CPUE and the proportional seabed area in SSRUs which are open for fishing (WG-FSA-04/20).

Advantages

- Is indicative of by-catch distribution (although this is limited by fishing effort) and abundance (if this is appropriately indexed by CPUE).

- Related to seabed area.

Disadvantages

- Estimates of longline CPUE may not be reliable measures of macrourid abundance.

- Proportional catch limits would vary between years as CPUE changes with the addition of new data.

- Differences in CPUE between SSRUs 881E and H were not consistent with differences in trawl catch rates in the BioRoss trawl survey (Table 6.1).

- Very low catch limits in some SSRUs would be difficult to monitor (CCAMLR-XXIII/38).

Option 3 – Fixed SSRU limits

Low catch limits (e.g. 20 tonnes) in northern and southern SSRUs where few rattails occur. Higher catch limits (e.g. 150 tonnes) in the other SSRUs.

Advantages

- Better reflects underlying rattail distribution (assuming fishery CPUE is an appropriate index of distribution) whilst not being overly restrictive on the fishery.

- Is more consistent with the approach used for rajids where the sum of the individual SSRU catch limits (50 tonnes in each SSRU) is higher than the overall catch limit (163 tonnes).

Disadvantages

- Not related to SSRU seabed area.
- Could lead to rattail catch limits which are higher than toothfish limits.
- Less incentive for by-catch mitigation if catch limits are less restrictive.
- Limits are arbitrary.

6.27 The Working Group discussed these three options. There was general support for moving towards catch limits that were more in accordance with rattail distribution, but the Working Group noted there was still considerable uncertainty about rattail abundance and distribution, population structure of *M. whitsoni* within Subarea 88.1, the role of macrourids in the ecosystem, and the impact of by-catch limits on fishing behaviour.

6.28 The Working Group further noted that fixed catch limits in Option 3 were arbitrary and that, while this type of option may have merit in the future, further information is required to determine appropriate levels for the fixed limits that would be flexible for the fishery while still being suitably precautionary.

Management advice

6.29 There were no new assessments of by-catch species in 2004.

6.30 Estimates of γ calculated for *Macrourus* spp. (SC-CAMLR-XXII, paragraph 4.132) indicated that they have relatively low productivity and thus may be vulnerable to overexploitation.

6.31 There was no new information to update the estimate of the precautionary by-catch limit of 360 tonnes for *M. carinatus* in Division 58.5.2 (SC-CAMLR-XXII, paragraph 4.134).

6.32 There was no new information to update the estimates of precautionary yield for *Macrourus* spp. of 26 tonnes in Division 58.4.3a and 159 tonnes in Division 58.4.3b (SC-CAMLR-XXII, Annex 5, paragraph 5.259).

6.33 Trawl survey estimates of *M. whitsoni* in Subarea 88.1 did not provide reliable estimates of standing stock because of the small number of tows, which did not provide a representative sample of the overall area.

6.34 In the absence of assessments for by-catch species, the Working Group recommended that precautionary measures, which place upper limits on by-catch and reduce the potential for localised depletion, be adopted.

6.35 The Working Group recommended that future work include research towards generating population parameters and estimates of standing stock for macrourids and rajids.

6.36 The Working Group suggested that the development of avoidance and mitigation measures for by-catch species be given high priority.

6.37 The Working Group recommended that the Scientific Committee consider alternative options for managing macrourid by-catch by SSRU in Subarea 88.1 (paragraph 6.26).

6.38 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) assessment of the status of by-catch species and groups;

(ii) estimation of by-catch levels and rates;

(iii) assessment of risk, both in terms of geographical areas and population demography;

(iv) mitigation measures;

(v) by-catch reporting.

Estimation of by-catch levels and rates

6.39 In 2003, WG-FSA compared by-catch information from STATLANT data (reported by Flag State at the end of the season), fine-scale data (haul-by-haul), and catch and effort data (reported by vessel in 5-day, 10-day or monthly periods) and concluded that fine-scale data is the most comprehensive of the three datasets for estimating levels of total removals of by-catch (SC-CAMLR-XXII, Annex 5, paragraph 5.283).

6.40 Estimates of total removals derived from fine-scale reports of by-catch by area for the 2003/04 fishing season are presented for longline fisheries in Table 6.3 and trawl fisheries in Table 6.4. Information contained in these tables was based on 5 501 individual haul-by-haul records.

6.41 Present and historical information about levels of by-catch from fine-scale data is also presented by managed fishery in individual Fishery Reports.

6.42 Information on levels of by-catch is also available from observer data and this is discussed in paragraphs 6.81 to 6.90.

6.43 In general, rajid (skate and ray) by-catch during 2003/04 was considerably lower than macrourid by-catch in all areas, with the exception of Division 58.5.2. However it is important to note that the estimates for rajids are conservative and do not include those cut or lost from longlines. By-catch of rajids as a percentage of target catch varied from <1 to 11% across all areas. Macrourid by-catch ranged from <1 to 14.6%, with the highest reported by-catch in Subareas 88.1 and 88.2.

6.44 The Working Group noted that no by-catch was reported from the midwater trawl fishery for *C. gunnari* in Subarea 48.3 in 2003/04.

6.45 Appendix 3 of CCAMLR-XXIII/38 provided summaries of total removals of macrourids, rajids and other species by SSRU in Subarea 88.1.

6.46 Data on by-catch in the exploratory fishery in Subareas 88.1 and 88.2 were described and analysed in WG-FSA-04/20. Catch and effort since 1997/98 were summarised using the new SSRU boundaries. The main by-catch species is *M. whitsoni*, which comprised 4–16% (mean 9%) of the annual catch. By-catch of *M. whitsoni* varies considerably between SSRUs, with relatively low by-catch in the northern (SSRUs 881A–C) and southern (SSRUs 881J and L) areas. There was also wide variation in by-catch percentage between vessels. Length frequencies for *M. whitsoni* were similar in the last three seasons, with most fish between 13 and 30 cm snout–vent length. The next most important by-catch group is skates (mainly *A. georgiana*), which made up 1–9% of the annual catch. The lower recorded by-catch percentage of skates in recent years is due to the release of skates at the surface, which were not included in estimates of total removals.

6.47 WG-FSA-04/66 and 04/68 presented by-catch information from the Australian fisheries in Division 58.5.2, and from exploratory fisheries in Divisions 58.4.2 and 58.4.3b, with estimates of total removals by fishing ground for the 2002/03 and 2003/04 seasons. By-catch in the trawl fisheries in Division 58.5.2 was only 1–2% of the total catch. By-catch percentages in the longline fisheries in Divisions 58.5.2, 58.4.2 and 58.4.3b were higher, ranging from 4–15% of the total catch. The main by-catch species were skates and macrourids in the *D. eleginoides* fishery and skates and *Channichthys rhinoceratus* in the *C. gunnari* fishery. The total landed skate catch in Division 58.5.2 was 34 tonnes in 2002/03 and 26 tonnes in 2003/04. Including skates cut from longlines revised these estimates to 43 tonnes in 2002/03 and 55 tonnes in 2003/04. Data on the by-catch of sleeper sharks (*Somniosus antarcticus*) and porbeagle sharks (*Lamna nasus*) in Division 58.5.2 were included in WG-FSA-04/68.

6.48 The Working Group noted discrepancies between estimates of total removals based on fine-scale data extracted during WG-FSA and those presented in CCAMLR-XXIII/38, WG-FSA-04/20 and 04/68. The discrepancies in Division 58.5.2 were due to the inclusion of the most recent data in the WG-FSA extraction which was not available when WG-FSA-04/68 was prepared. The Working Group recommended that work be carried out during the intersessional period to determine the reason for the other discrepancies.

6.49 The Working Group urged the Secretariat to develop standard methods to summarise by-catch removals by area and species prior to WG-FSA. It also recommended that the by-catch subgroup liaise intersessionally with the Secretariat to try and improve the reporting, transferral and extraction of by-catch data.

Management advice

6.50 The Working Group strongly reiterated the need for accurate reporting of by-catch in all data formats.

6.51 The Working Group recommended that estimates of total removals by area be summarised by the Secretariat for all by-catch species prior to WG-FSA.

6.52 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.

Assessment of risk, both in terms of geographical areas and population demography

Identification of levels of risk

6.53 The Working Group considered the possibility of producing risk assessments for fish and invertebrate by-catch species in a similar way to the assessment of seabirds.

6.54 The Working Group noted that defining risk was problematic. In particular it was felt that the level of knowledge about marine species in nearly all cases was too low in order to make informed statements about risk to by-catch populations. For example, population status and robustness of populations and sub-populations to human impacts are not generally known.

6.55 The Working Group considered it possible to categorise risk for marine species. Qualitative information on species of interest could be collated that could help categorise the risk for that species. This 'risk categorisation' might include (but not be restricted to):

- consideration of life-history characteristics which would make a species vulnerable to fishing activities. For example, growth rates, age at maturity, habitat range, spawning behaviour, diet, trawl or longline catchability, co-occurrence with exploited species;

- consideration of the overlap between the distribution of the species and fishing or other human activities. The overlap could be considered on a proportional basis if the distribution is known. When the distribution is not known, then it would be noted where overlap exists;

- consideration of any assessments or other information about population status;

- consideration of conservation measures in place to avoid and mitigate by-catch.

6.56 WG-FSA-03/69 presented a risk assessment for the sleeper shark (*S. antarcticus*) in Division 58.5.2. The Working Group prepared a summary table based on this paper as an example of the type of information that might be included in a risk categorisation for other by-catch species (Table 6.5).

6.57 The Working Group encouraged Members to collate information during the intersessional period to allow risk categorisation for other major by-catch species in the CCAMLR Convention Area. It also recommended that alternatives to, and refinements of, this categorisation be considered during the intersessional period.

6.58 The Working Group noted that tables of the type shown in Table 6.5 provided indicators of potential risk, not real and proven risk. The Working Group further noted that the comprehensiveness of the information provided would not equate with the level of risk, pointing out lack of information does not mean lack of risk.

Management advice

6.59 The Working Group encouraged Members to collate information to allow risk characterisation for major by-catch species in the CCAMLR Convention Area.

Consideration of mitigation measures

Estimates of by-catch by vessel

6.60 The Working Group analysed by-catch by vessel in 2003/04 from fine-scale data in an effort to relate by-catch to fishing method. 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.

6.61 Individual vessel by-catch information was extracted from fine scale (haul-by-haul) data. Because trawl gear configuration was relatively consistent across all vessels, only by-catch from longline vessels was considered.

6.62 A comparison of longline vessels from all areas revealed a contrasting gear configuration in Subarea 88.1, where 11 vessels used an autoline configuration and 10 vessels used the Spanish-system configuration.

6.63 There was little difference in mean relative by-catch of skates and rays between autoline and Spanish-system gear configuration in Subarea 88.1 (Figure 6.1a). However, mean relative level of *Macrourus* spp. by-catch appeared to be substantially higher for autoline longline systems (Figure 6.1b).

6.64 This analysis suggested that use of the Spanish longline system may reduce by-catch rates of *Macrourus* spp. However, before this conclusion could be reached, the Working Group felt it was important to examine the spatial vessel/gear-type patterns and by-catch rates in greater detail, as catch rates of *Macrourus* spp. were highly variable between SSRUs (see Table 6.2). The Working Group recommended that this work be conducted in the intersessional period.

Release of rajids

6.65 At WG-FSA-03, the Working Group recommended that, wherever possible, vessels 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 (SC-CAMLR-XXII, Annex 5, paragraph 5.297).

6.66 WG-FSA-SAM noted that there may be some degree of conflict between the above advice and the need for accurate estimates of recaptures of marked animals in areas where tag and recapture programs are being developed as progress towards rajid assessments (WG-FSA-04/4, paragraph 2.45). The Working Group recognised that it might be difficult to detect tagged rays if they are cut off at the sea surface rather than being brought on board.

6.67 The Working Group suggested that in some fisheries, and in some sea states, it might be possible to identify tags reliably when rays break the surface. Tagged animals could then be retained and untagged fish released. However, the Working Group noted that the detection probability was still likely to be lower than 100%, and it would be important to undertake some experiments to determine detection probability.

6.68 If the detection probability of tagged rajids at the sea surface is low, the Working Group suggested that it may be necessary for a relaxation of the requirement to cut all rajids from the line on specified vessels and/or for specified time periods.

6.69 At WG-FSA-02, 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.

6.70 No new information on the survivorship or vulnerability of rajids was available at WG-FSA-04. The Working Group noted that survivorship of skates and rays cut off longlines is still very uncertain and encouraged Members to undertake further survivorship experiments in the future.

6.71 Dr Agnew informed the Working Group that the UK was continuing with its program of research on rajids at South Georgia. This program includes assessment of discard survivorship, species distribution, abundance, growth and maturity. These studies are on-going, and a report to WG-FSA-05 is likely.

Impact of vessel competition on move-on rule

6.72 Conservation Measure 33-03, paragraph 4 ('move-on rule'), requires fishing vessels in new and exploratory fisheries to move to another location at least 5 n miles distant if the by-catch of any one species is equal to or greater than 1 tonne. The fishing vessel shall not return to any point within 5 n miles of the location where the by-catch exceeded 1 tonne for a period of at least five days.

6.73 The Working Group noted that, where there are a large number of vessels operating within a new and exploratory fishery, another vessel might immediately move into the area vacated by a vessel forced to shift location because of by-catch. This behaviour might reduce the effectiveness of the 'move-on rule' to mitigate by-catch. This issue should be drawn to the attention of the Scientific Committee and Commission.

Management advice

6.74 The Working Group recommended that further work should be carried out in the intersessional period to compare by-catch levels arising from different gear configurations and to determine whether this information could be used to develop mitigation and avoidance measures for by-catch.

6.75 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.

6.76 The Working Group noted that a relaxation of the above requirement to cut all rajids from lines whilst still in the water may be necessary so that tag and recapture programs could be conducted in longline fisheries if the detection probability of tagged rajids at the sea surface is low.

6.77 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.

6.78 The Working Group recommended that the Scientific Committee note the potential impact of competition between vessels in new and exploratory fisheries on by-catch mitigation (paragraph 6.73).

By-catch reporting

6.79 In order to adequately assess by-catch levels and rates, it is necessary to have accurate reporting of information on the total removals of by-catch taxa at a fishery level.

Information from scientific observers

6.80 Observer by-catch data was extracted by the Secretariat by fishery for the 2003/04 fishing season. While progress had been made since this dataset was examined last year, the quality of observer data for by-catch remained highly variable and significant problems still remain.

6.81 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 2003/04 season showed that the use of updated forms by observers has increased.

6.82 However, difficulties remain with the reporting, extraction and analysis of observer data which made the calculation of total removals at a fishery level not possible in some cases. The most common recurring problem was incomplete fields, particularly those that are necessary for estimates of total removals. For example, the field specifying whether a haul was observed as 'Y' or 'N' was left blank in a large number of instances. Similarly, the percentage of hauls/sets observed for landed by-catch and for the by-catch cut or lost from longlines was often not recorded. Thus estimates of total removals could not be routinely scaled up to fishery level. Further, some observers are scaling the catch to 100% before entering the data and then leaving the percentage observed unchanged, leading to over-inflated estimates. For the most part however, estimates of by-catch from observer data are underestimates. As observer data is the most detailed dataset available and the only dataset where information on cut-off by-catch can be obtained, the Working Group emphasised the need for accurate and consistent reporting.

6.83 Incomplete recording may be due to uncertainty by observers about by-catch data recording protocols. The Working Group recommended that observers be thoroughly briefed by technical coordinators, and guidelines for recording by-catch data be followed as closely as possible. In addition, the Working Group reiterated the importance of using the most up-to-date forms.

Reporting of cut-offs of rajids

6.84 The revised observers' logbooks and forms distributed by the Secretariat to technical coordinators in February 2003 included fields that specify discard methods (landed then discarded, retained, cut off, shaken off or gaffed, lost at surface or dropped off), and a field which indicates release condition as assessed by the observer (alive and likely to survive, injured and unlikely to survive, dead).

6.85 Information about rajids cut or lost from longlines was extracted from observer data for the 2003/04 fishing season (Table 6.6). There were only 149 records from longline fisheries on the CCAMLR observer database. The Working Group noted with concern that this represented a very limited number of observations, given the estimate of rajid by-catch within the Convention Area was almost 100 tonnes (Table 6.3).

6.86 The Working Group further noted that some Members have collected data on rajid cut-offs using their own national databases. For example, WG-FSA-04/68 presented estimates of cut-off skates and rays for the longline fisheries in Division 58.5.2 and for the exploratory longline fishery in Division 58.4.3b. The Working Group welcomed this information, and encouraged other Members to submit any available information on by-catch cut-offs from other fisheries to WG-FSA.

6.87 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.

Management advice

6.88 The Working Group noted that information on cut-offs is still not uniformly and accurately recorded and therefore it is still not possible to calculate estimates of cut-offs for all fisheries.

6.89 The Working Group reiterated the importance of collecting observer information on by-catch and requested that observers pay particular attention to:

(i) recording the percentage of a haul/set observed for landed/discarded by-catch
(ii) recording the percentage of a haul/set observed for cut-offs
(iii) recording the numbers of fish that are observed to be cut or lost from longlines.

INCIDENTAL MORTALITY OF MAMMALS AND SEABIRDS ARISING FROM FISHING

Intersessional work of ad hoc WG-IMAF

7.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMAF according to the agreed plan of intersessional activities for 2003/04 (SC-CAMLR-XXII, Annex 5, Appendix E). The report contained records of all activities planned and results of their completion and is available on the IMAF page of the CCAMLR website.

7.2 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 2003/04 fishing season.

7.3 The Working Group concluded that most tasks planned for 2003/04 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 2004/05, compiled by the Convener and Science Officer, be appended to its report (Appendix D).

7.4 The Working Group especially welcomed to the meeting Mrs T. Neves (Brazil) and Ms P. Toschik (USA) who were attending 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, including in relation to trawl fisheries. 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

7.5 Data were available from all 44 longline cruises conducted within the Convention Area during the 2003/04 season (details in WG-FSA-04/6 Rev. 1).

7.6 The Working Group noted that the proportion of hooks observed was similar to, or higher than, last year for Subareas 48.3 (28% (range 18–50) compared with 25% (range 17–63)) and 88.1 and 88.2 (61% (range 30–99) compared with 52% (range 35–62)), and with generally greater consistency across vessels. Only for one cruise (*Koryo Maru No. 11* (18%)) was the proportion of hooks observed lower than 20%; this compares with four such cruises last year.

7.7 As usual, the total observed seabird catch rate was calculated using the total number of hooks observed and the total seabird mortality observed (Table 7.1). 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

7.8 The total estimated seabird mortality was 18 birds (Tables 7.1 and 7.2) compared with 8, 27 and 30 birds in the last three years (Table 7.3). The overall catch rate was 0.001 birds/thousand hooks compared to 0.0003 and 0.0015 in the previous two years (Table 7.3). The five birds observed killed (all at night) comprised one grey-headed albatross, one black-browed albatross and three southern giant petrels (Table 7.4).

7.9 This represents a slight increase in by-catch total and rate compared with last year but values are still the second lowest yet recorded for this area.

South African EEZ in Subareas 58.6 and 58.7

7.10 The total estimated seabird mortality was 39 birds (Tables 7.2 and 7.3) compared with seven, zero and 199 bird mortalities in the last three years (Table 7.3). The overall catch rate was 0.025 birds/thousand hooks compared to 0.003, zero and 0.018 in the previous three years (Table 7.3). Of the 11 birds observed killed, 10 (all at night) were giant petrels and one (in daytime) was a white-chinned petrel (Table 7.4).

7.11 Values this year represent increases over the previous two years and although the total estimated seabird by-catch level is only 20% of that in 2001, the by-catch rate is very similar to that year.

Subareas 88.1 and 88.2

7.12 After seven successive years of zero seabird by-catch in the fishery in Subarea 88.1, a single southern giant petrel was observed killed this year. For the third successive year there was no incidental mortality of seabirds in Subarea 88.2.

Subarea 48.6 and Divisions 58.4.2, 58.4.3b and 58.5.2

7.13 This was the first year that longline fishing had been conducted in Subarea 48.6 and Divisions 58.4.2 and 58.4.3b, and the second such year for Division 58.5.2. No incidental mortalities of seabirds were observed in fishing operations.

7.14 Dr Constable suggested that it would be very useful to estimate the mean level of seabird by-catch for vessels fully compliant with mitigation measures in each part of the Convention Area. This would provide an appropriate basis for identifying vessels which report values significantly different from these levels. This should assist identifying the reasons or circumstances involved.

French EEZs in Subarea 58.6 and Division 58.5.1

7.15 The Working Group welcomed the participation of Dr T. Micol as a French representative to ad hoc WG-IMAF for a second year, allowing presentation and discussion of the French fishery results.

2001/02 and 2002/03 fishing seasons

7.16 The requested French data for 2001/02 and 2002/03 had been submitted to the Secretariat in tabulated form analogous to the summaries prepared by the Secretariat for the rest of the Convention Area (WG-FSA-04/6 Rev. 1). These tables are appended as Tables 7.5 to 7.8.

7.17 The total reported seabird mortality in 2001/02 for Subarea 58.6 and Division 58.5.1 was 1 243 and 10 814 birds respectively (Tables 7.5 and 7.6). The corresponding catch rates (reported birds/total hooks set) were 0.167 birds and 0.936 birds/thousand hooks.

7.18 The total reported seabird mortality in 2002/03 for Subarea 58.6 and Division 58.5.1 was 720 and 13 926 birds respectively (Tables 7.7 and 7.8). The corresponding catch rates (reported birds/total hooks set) were 0.109 and 0.518 birds/thousand hooks.

7.19 For Subarea 58.6, the annual by-catch rates decreased from 0.167 in 2001/02 to 0.109 in 2002/03, a decrease of 53%. For Division 58.5.1, the annual by-catch rates decreased from 0.936 in 2001/02 to 0.518 in 2002/03, a decrease of 45%.

7.20 In respect of incidental mortality of seabirds, it was emphasised that the totals of 12 057 birds killed in 2001/02 (1 243 birds in Subarea 58.6 and 10 814 in Division 58.5.1) and 14 646 birds killed in 2002/03 (720 in Subarea 58.6 and 13 926 in Division 58.5.1) represent the numbers of birds reported killed.

7.21 The reported totals of birds killed in these two years are based on retention of all birds brought on board each vessel, rather than on subsampling by observing seabird by-catch on a proportion of the hooks set and extrapolating to derive the total estimated seabird mortality. However, Dr Micol indicated that observers were used to make checks, which confirmed that virtually all birds brought on board were retained.

7.22 Intersessionally, France commissioned an analysis of the 2001/02 and 2002/03 data from the French research group led by Dr H. Weimerskirch, which is reported in WG-FSA-04/11. Findings show that the mortality was mainly of white-chinned petrels (93%), followed by grey petrels (5%), the former mainly caught in October and between January and April, the latter mainly between April and November. Fishing effort varied by area, as did catch rates of seabirds, with higher catch rates around Kerguelen (Division 58.5.1) than in the Crozet area (Subarea 58.6), with fishers setting more hooks in the Kerguelen area. Autoline vessels caught many times more birds than vessels using the Spanish system. The multivariate analysis showed that not one single factor was responsible for the by-catch mortality of seabirds. However, a significant part of the mortality of white-chinned and grey petrels is explained by season, area and method of fishing. Recommendations were made to allow continued reduction of seabird mortality. These were chiefly for fishing closures in the highest-risk periods for seabirds (February–March and October–November), using night setting, improved line weighting, using only white lines and redistributing fishing effort between the Crozet (lower risk) and Kerguelen (higher risk) areas.

2003/04 fishing season

7.23 In the first part of the 2003/04 season (until the end of February) the recording and reporting of by-catch was done in the same way as in previous years (paragraph 7.7). On cruises from March onwards, however, observers recorded by-catch on a proportion of the hooks set. These two datasets are shown separately in Table 7.9.

7.24 The total reported seabird mortality for Subarea 58.6 and Division 58.5.1 was 242 and 2 069 birds respectively (Table 7.9). The corresponding by-catch mortality rates were 0.080 and 0.127 birds/thousand hooks.

7.25 The Working Group noted that there was considerable variation between vessels in the levels of reported seabird by-catch. Thus in Subarea 58.6, 157 birds (65% of the total) were reported from cruise 2 of ship 5. In Division 58.5.1, 1 615 birds (78% of the total) were taken on one cruise each by ship 1 (700 birds), ship 2 (109 birds), ship 4 (144 birds), ship 5 (164 birds), ship 6 (349 birds) and ship 7 (149 birds). The Working Group requested analysis of the 2003/04 by-catch data to try to identify the factors responsible for the poor performance of these vessels, particularly in relation to interactions between timing and area of fishing and the nature of mitigation in use. It requested France to report the results of this analysis to the next meeting of the Working Group.

7.26 The reported seabird by-catch in Subarea 58.6 comprised 96% white-chinned petrels and 4% grey petrels; in Division 58.5.1 it comprised 94% white-chinned petrels and 5% grey petrels (Table 7.10).

7.27 For 3 of 18 cruises in Subarea 58.6 and 11 of 25 cruises in Division 58.5.1, the data on birds observed killed can be converted to estimates of total seabird by-catch mortality using reported data on the proportion of hooks observed. The mean proportions of hooks observed in Subarea 58.6 and Division 58.5.1 were 23.0% (n = 9; range 5.8–34.9%) and 24.7% (n = 11; range 6.0–33.4%). For the three cruises in Subarea 58.6, the observed by-catch of eight birds converts to an estimate of 100 birds killed (0.026 birds/thousand hooks). For the 11 cruises in Division 58.5.1, the observed by-catch of 334 birds converts to an estimate of 1 597 birds killed (0.125 birds/thousand hooks).

7.28 For the 2003/04 fishing season, therefore, probably the most accurate representation of seabird by-catch is given by combining the number of birds reported killed during the first half of the fishing season with the number of birds estimated killed in the second half of the season. On this basis, the totals for Subarea 58.6 and Division 58.5.1 would be 342 and 3 666 birds killed respectively, totalling 4 008 birds overall (Table 7.11).

7.29 Compared to last year, this represents reductions in seabirds killed of 42.5% (66.4% if reported data only are used) in Subarea 58.6, 73.7% (85.1% if reported data only are used) for Division 58.5.1 and 72.6% overall (84.2% if reported data only are used).

7.30 Similar comparison of by-catch rates indicated reductions of 26.6% for Subarea 58.6 (76.1% if estimated data only are used), 75.5% for Division 58.5.1 (75.9% if estimated data only are used) and 73.0% overall (85.7% if estimated data only are used).

7.31 All data available to the Working Group for seabird by-catch in the French EEZs in Subarea 58.6 and Division 58.5.1 are summarised in Table 7.11. The only statistics that can be compared directly across all years are the number of birds reported killed and the by-catch rates calculated on this basis. It was noted, however, that this would somewhat underestimate by-catch levels and rates for 2003/04 compared to other years.

7.32 Dr Micol indicated that for the 2004/05 fishing season data on seabird by-catch would be collected by observers on the basis of observing a proportion of the hooks set.

7.33 The Working Group agreed that this would be preferable and encouraged France to ensure that:

(i) this was done on every vessel
(ii) an appropriate proportion (not less than 25%) of hooks were observed on every vessel.

7.34 The Working Group noted that no data for 2000/01 appear to have been tabled at, or reported to, CCAMLR. It requested that France supply these data so that a comprehensive conspectus of the seabird by-catch history in this fishery is possible.

Mitigation measures

7.35 Last year, the Working Group emphasised the potential benefits of a testing program to evaluate the efficacy of existing and potential mitigation measures used in the French EEZs (SC-CAMLR-XXII, Annex 5, paragraph 6.25). Dr Micol summarised various efforts, including some collaborative projects and ad hoc experiments on the efficacy of different mitigation technologies (WG-FSA-04/87 and 04/88).

(i) Line weighting – collaboration was conducted between France and Australia (Dr G. Robertson) on the sink rate of integrated weighted lines (IWLs) and externally weighted lines in the French fishery. Dr Robertson indicated that insufficient reliable data were collected to perform a statistical analysis, but higher sink rates observed than those expected could be linked to the direction of propeller rotation. It was recommended that more trials should be conducted.

(ii) An exchange of personnel between New Zealand and France was initiated. Mr McNeill, member of the Working Group and New Zealand fishing industry representative, visited fishing companies and French administration at La Réunion Island (WG-FSA-04/52). He reported that there was discussion of mitigation strategies with French fishers, mainly in relation to IWLs. Many mitigation options were being used, including the use of several streamer lines (up to nine). Large-scale deployment of IWLs had yet to be adopted, although some French fishers had already undertaken preliminary trials. Issues that French fishing companies needed to assess before adopting IWLs voluntarily included: ease of usage, gear loss potential, higher relative cost of the lines, fitting through existing gear set-ups. Strengthening of magazine supports in some vessels would be necessary to handle the heavier lines. However, France is encouraging fishers to adopt IWLs.

(iii) Streamer lines – fishers used streamer lines in various numbers and configurations and these were found to be very useful in reducing seabird mortality. Significant reductions in seabird by-catch were achieved in the 2003/04 year compared with previous years. In part, increasing fishers' awareness of the issue and possible solutions played a role in achieving reductions in seabird mortality.

(iv) Colour of hookline – in 2002/03, vessels were equipped with either white or black hooklines. Those using white lines experienced significantly lower rates of seabird by-catch (WG-FSA-04/11).

(v) A former IUU vessel was converted into a patrol ship by France and a new system of satellite monitoring of vessels was established. This new system, linked to French navy vessels patrolling the zone, contributed to the deterrence of IUU vessels, with only one detected and arrested during the last year (to June 2004). Dr Micol noted that IUU fishing is presumably the most important mortality factor affecting seabirds and that combating IUU fishing is concomitantly saving birds.

(vi) France and French fishing companies were funding a study on population status of white-chinned and grey petrels on Kerguelen and Crozet, starting in November 2004.

7.36 The Working Group commended these initiatives, which it noted had already resulted in substantial reductions in by-catch rates and estimated total numbers of birds killed. Nevertheless these rates and totals still remained at levels which are a cause of serious concern and threat to the populations involved.

7.37 Mr McNeill commended the high level of feedback from the administration to vessel captains, companies and observers, particularly the monthly reporting of all birds killed for the zone and for the particular vessel, in order to encourage vessels to reduce their seabird by-catch.

7.38 Last year, Dr Micol provided a summary of the mitigation methods and measures used to reduce seabird by-catch on the vessels operating in the French EEZs (SC-CAMLR-XXII, Annex 5, paragraph 6.20(i–viii)). Based on an analysis of historical fishery and by-catch data, technical recommendations were made for changes to fishing practices.

7.39 In 2004, revisions to appropriate measures were made by the French authorities, reflecting recommendations from the analytical study and mitigation research. Thus, in addition to the existing requirements on offal discharge, night-setting, line weighting and streamer lines, the following revisions were enacted:

(i) at least two streamer lines, adhering to the provisions of Conservation Measure 25-02, must be used;

(ii) fishery closure during February (part of chick-rearing period of white-chinned petrels);

(iii) use of white-coloured hooklines.

7.40 Dr Micol also reported that the line-weighting regime was revised to require 8 kg/120 m on autoliners.

7.41 A variety of sanction measures, related to the daily reporting of seabird by-catch by individual vessels during fishing, was established. Vessels exceeding area-specific and time-bound seabird by-catch limits were sent a warning message in the first instance, and if seabird by-catch continued, vessels were required to move to a new subarea and to recommence fishing over 100 n miles from their current fishing location. Finally, subareas where upper limits for seabird by-catch had been reached would be closed to further fishing.

Recommendations to reduce seabird by-catch

7.42 The Working Group recognised the importance of the major reduction in seabird by-catch since the last fishing season. Given the annual review of seabird avoidance regulations by French authorities, the associated changes to improve the effectiveness of these requirements, and the apparent commitment to a mitigation research program, the Working Group expected that the necessary continued improvements are possible.

7.43 The Working Group discussed the need to provide incentives to fishers to further improve performance. Once fishers had adopted effective mitigation strategies, the Working Group suggested consideration could be given to reopening areas or seasons that have been restricted, particularly those in which fish catches are high and most profitable. This could even include daytime setting in appropriate cases, through a controlled experimental approach. This could have the advantage of a net decrease in fishing effort, with commensurably reduced risk to seabirds, where mitigation was fully effective. It was also recognised that closing the fishery in Division 58.5.1 between September and April, as in Subarea 48.3, would potentially greatly increase by-catch mortality of grey petrels, a globally threatened species.

7.44 Reduced seabird by-catch will be achieved through a suite of measures which have essentially constituted best practice in the Convention Area. This best practice includes: line weighting, night setting, use of streamer lines of a prescribed standard and performance, prohibition of offal discharge during the set, and fishery closures during times of high risk to breeding seabirds.

7.45 The Working Group recommended the following:

(i) Continue to undertake research programs and appropriate experiments to implement measures to further reduce seabird mortality to achieve levels and rates similar to those reported for other parts of the Convention Area.

(ii) Line weighting: use of IWL and weighting regimes that will ensure that longlines sink at >0.25 m/s. This sink rate can be achieved by compliance with the line sink rate requirements of Conservation Measure 25-02 (attachment to longlines of 5 kg weights at 50–60 m intervals) for autoliners.

(iii) Comply with the standards for streamer lines in Conservation Measure 25-02. However, paired streamer lines should be mandatory given the relatively high levels of seabird mortality that persist in the French EEZs. Where more than two sets of streamer lines are to be used, appropriate experiments should be conducted to demonstrate the utility of the additional streamer lines.

(iv) Maintain strict prohibitions on the discharge of offal at the set.

(v) Observer coverage and duties should be sufficient to ensure that at least 25% of hooks are observed on every vessel.

(vi) Maintain fishery closures in high-risk periods during seabird breeding seasons.

Implementation of Conservation Measures 25-02 and 25-03

7.46 Data from observer reports relating to compliance with these conservation measures in 2003/04 were provided in WG-FSA-04/6 Rev. 1 and 04/8 Rev. 1 and are summarised in Tables 7.1 and 7.12. Comparison with similar data from previous years is provided in Table 7.13. Observers did not provide all the required data on streamer line design for six cruises, so full assessments were not possible in these cases.

Streamer lines

7.47 Several specifications in Conservation Measure 25-02 had changed from the previous season, notably attachment height, line spacing and branched streamer length. Overall compliance with streamer line design has declined from 92% (34 of 37 cruises) last year to 64% (28 of 44 cruises) this year. The cruises where streamer lines did not comply failed on attachment height (7 cruises), total length (4 cruises) and branched streamer lengths (12 cruises) (Table 7.12). Although all vessels complied with the branched streamer spacing (a maximum of 5 m), one vessel only used two branched streamers. The conservation measure requires vessels to attach branched streamers along the whole aerial extent of the streamer line.

7.48 Two vessels failed on three different streamer line specifications (*Volna* and *Viking Bay*). Three other vessels failed on two specifications (*Mellas, Simeiz* and *Sonrisa*).

7.49 Vessels fishing in Subareas 48.6, 58.6, 58.7 and Divisions 58.5.2, 58.4.2 and 58.4.3b, used streamer lines on all sets. In Subarea 48.3, seven vessels undertook sets without using a streamer line. Of these, one vessel (*Isla Camila*) undertook more than 20 sets without a streamer line and the remaining vessels (*Polarpesca I, Tierra del Fuego, Ibsa Quinto, Jacqueline, Isla Alegranza* and *Argos Georgia*) less than five sets. In Subareas 88.1 and 88.2, six vessels (*Antarctic III, Arnela, No. 707 Bonanza, Punta Ballena, America I* and *South Princess*) undertook some sets (five or less) without using a streamer line.

Offal discharge

7.50 In Subarea 88.1, one vessel, the *Arnela*, was observed discharging offal during 4% of sets. Additionally, the *Arnela* logbook indicated offal was discharged during 24% of its hauls while fishing in Subareas 88.1 and 88.2. Offal discharge is prohibited in these subareas. This is the first year offal discharge has been reported in these subareas, other than one incident in 2002/03, and is particularly concerning because this could result in local seabirds learning to follow vessels.

7.51 With two exceptions, observer reports for other areas indicate full compliance with the requirements to hold offal on board or to discharge on the opposite side to where the line was hauled. In Subarea 48.3, the *Argos Helena* was observed discharging offal during one set and in Subarea 58.6, offal was discharged during setting on 6% of sets of the *Koryo Maru No. 11*.

Discard of hooks

7.52 Observers on board eight vessels reported that fishing gear, snoods and hooks, were occasionally being disposed of at sea. Observers reported hooks being present in discards on eight vessels; on seven of these this was reported as a rare event. However, the report for the *Jacqueline* indicated that this was a daily occurrence.

Night setting

7.53 In Subareas 58.6 and 58.7, 83% of sets occurred at night, down from 98 and 99% in the past two years. The *Koryo Maru No. 11* undertook 23 day sets (32%) and the *South Princess* 7 day sets (3%). In Division 58.5.2, 99% of sets occurred at night. In Subarea 48.3, 98% of sets occurred at night. Only one vessel, *Argos Georgia*, undertook a substantial number of day sets (55 sets, 19%).

7.54 In Subareas 48.6, 88.1, 88.2 and Divisions 58.4.2 and 58.4.3b, 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 (paragraph 7.56).

Line weighting – Spanish system

7.55 This year there was 87% compliance (13 of 15 cruises) with the required line-weighting regime in Subarea 48.3. This compared to full compliance in the previous year. The two vessels that did not comply (*Ibsa Quinto* and *Paloma V*) used 7 kg every 40 m and 9 kg every 96 m respectively. Conservation Measure 25-02 requires either 6 kg every 20 m or 8.5 kg every 40 m. The single Spanish-system vessel fishing in Subareas 58.6 and 58.7 fully complied.

7.56 In Subareas 48.6 and 88.1, 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). All vessels met this requirement. The Working Group noted that the sink rates on the *Arnela* and *No. 707 Bonanza* were considerably higher than sink rates on other vessels using the same weighting regime (Figure 7.1). There was no obvious reason for this.

Line weighting – autoline system

7.57 In Subareas 48.6, 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). All vessels met this requirement. The Working Group noted that the sink rate achieved using the line weighting regime on the *Antarctic III* seemed high (Figure 7.1). WG-FSA-98/44 reported that weights of 6 kg used at spacings above about 70 m are unlikely to result in a measurable increase in sink rate of the line as compared to an unweighted line. The observer reported the vessel used 10 kg every 270 m.

General

7.58 The Working Group expressed concern that compliance with streamer line specifications had dropped considerably since last year. The lower level of compliance may in some cases be due to lack of awareness of the changes to Conservation Measure 25-02. The majority of the vessels that failed to fully comply this year would have complied under the previous specifications. However, the vessels that fully complied this year have demonstrated that the changes are practical and able to be implemented. The Working Group requested that vessel operators be reminded of the new specifications.

7.59 The majority of vessels that are still undertaking day sets in areas where this is prohibited have fished in the Convention Area for a number of years, and are familiar with Conservation Measure 25-02. The Working Group noted its disappointment that these vessels were still not fully complying with this requirement.

7.60 However, the Working Group was encouraged by the high compliance relating to offal discharge, line weighting and line sink rate requirements. The Working Group encouraged the few remaining non-compliant vessels to fully implement these measures.

7.61 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), 13 of 40 vessels (33%) fully complied with all measures at all times throughout the Convention Area. This compares to 48% last year. The fully compliant vessels were the *Burdwood*, *Isla Sofía*, *Janas* (Australia), *Janas* (New Zealand), *Eldfisk*, *Gudni Olafsson*, *San Aotea II*, *Yantar*, *Piscis*, *American Warrior*, *Frøyanes*, *Avro Chieftain* and *San Liberatore*. As was noted last year, some vessels failed to comply by small margins, and the Working Group recommended that vessels should be advised to exceed the standards to prevent compliance failure.

Implementation of Conservation Measure 25-03

7.62 Conservation Measure 25-03 prohibits the discharge of offal during the shooting or hauling of trawl gear. Four of eight vessels fishing in Subarea 48.3 were observed discharging offal during net shooting or hauling: *Betanzos* (9% shots and hauls), *Robin M Lee* (12% shots), *Dongsan Ho* (9% hauls) and *InSung Ho* (3% shots) (Table 7.14). This level of compliance is not as high as 2003, when only two vessels discharged offal during shooting or hauling of nets.

7.63 Dr L. Pshenichnov (Ukraine) observed that the definition of offal in conservation measures, particularly in Conservation Measure 25-02 and conservation measures applying to new and exploratory fisheries, would be improved if it was indicated that offal included discarded bait and fish by-catch (except as specified in measures relating to the live release of skates and rays).

Research into and experiences with mitigation measures

Streamer lines

7.64 The streamer line requirement was changed substantially in 2003 (Conservation Measure 25-02) to reflect the importance of the aerial extent (which supports individual branched streamers of the streamer line) as a key component to streamer line effectiveness.

7.65 The Working Group noted that information on the aerial extent of the streamer line and on the number of streamer lines deployed, was not collected consistently by fishery observers in 2003/04. It also noted that the degree to which recommended practices within the appendix of the conservation measure were followed in 2003/04 could not be determined. These included the recommendations that efforts be made to maintain the towed object directly behind the streamer line attachment point to the vessels such that the aerial extent be maintained over the hookline and that branched streamers extend to the water in the absence of wind and swell.

7.66 The Working Group recommended that steps be taken to ensure that information on the aerial extent and the number of streamer lines deployed be collected consistently in the future (see SC-CAMLR-XXII, Annex 5, paragraphs 10.26 and 10.27). This information is fundamental to monitoring the proper deployment of streamer lines and to future improvements to the conservation measure.

7.67 The Working Group noted that it intended to revise Conservation Measure 25-02 as soon as adequate data on the aerial extent of streamer lines becomes available from the fishery.

Dyed bait and stealth gear

7.68 Mrs Neves reported that a subset of pelagic fishers in Brazil has been voluntarily using blue-dyed bait together with streamer lines for the past three years and that blue-dyed bait will be among the proposed mitigation measures required under Brazil's NPOA. A pilot study showed no birds were caught and fish catch was highest when blue-dyed bait and a streamer line were used, compared to four albatrosses killed when no mitigation was used. SEAP (Special Secretariat of Aquaculture and Fisheries of the Presidency of the Republic) is planning more extensive research on the efficacy of blue-dyed bait and streamer lines in 2005.

7.69 The Working Group recollected that research in the Japanese southern bluefin tuna fishery found that blue-dyed bait was more effective than a streamer line at reducing seabird by-catch and suggested that the combination of both measures could substantially reduce the incidental catch of seabirds in tuna longline fisheries. This research also reported that, with the exception of southern bluefin tuna on one vessel, tuna catch was unaffected when blue-dyed bait was used.

7.70 The Working Group noted that dying bait at sea is very difficult and the lack of commercially available dyed bait greatly limits wide adoption of dyed bait as a seabird mitigation measure in pelagic fisheries.

7.71 Acknowledging that research results on the effect of dyed bait on seabirds, target catch and other protected species such as turtles have yielded mixed results across fisheries, Mr B. Baker noted that Australia is hoping to fund a study to assess the reflectance spectrum of dyes currently used to camouflage baits, and therefore to assess how the various dyes appear to seabirds. Because birds are particularly sensitive to UV wavelengths (light beyond the scope of human vision) and many dyes are active in the UV range, baits that appear white to humans may in fact appear very differently to seabirds. Thus dyes thought to be cryptic may in fact be conspicuous, suggesting that the successes and failures of dyed bait to date may be due to other mechanisms. Spectroradiometric techniques can also be used to quantify the rate of absorption and retention of dyes and to assess the appearance of the dyed baits at various depths in the water column. This research could rapidly advance the efficacy of dyed bait and stealth gear and possibly other mitigation applications to seabird conservation in fisheries.

7.72 WG-FSA-04/88 provided data showing that the rate of seabird by-catch (primarily white-chinned petrels) was significantly less on three of four vessels when white hooklines were used compared to black hooklines. Based on these results, white hooklines were required in Subarea 58.6 and Division 58.5.1 in 2003/04. The Working Group noted that these results were not intuitive and remain difficult to explain.

Line weighting

7.73 WG-FSA-04/72 presented important evidence, complementary to that in WG-FSA-03/23, on the effectiveness of longlines containing 50 g lead/m integrated weight and a single streamer line in reducing the mortality of white-chinned petrels (*Procellaria aequinoctialis*) and sooty shearwaters (*Puffinus griseus*) – while not affecting fish catch – in the New Zealand ling (*Genypterus blacodes*) autoline fishery. White-chinned petrels and sooty shearwaters are two of the most difficult seabird species in the world to deter from baited hooks and are considered a worst-case scenario from a gear performance perspective. Information presented in WG-FSA-04/72 strongly supports inclusion in Conservation Measure 24-02 of provisions that autoline vessels use IWLs in the Convention Area.

7.74 IWLs sinking instantly when set and at an average of 0.24 m/s (range 0.2–0.3 m/s) to 20 m depth – compared to unweighted (normal) longlines (UWLs; average 0.11 m/s; range 0.06–0.15 m/s) – reduced white-chinned petrel mortality by 98% in 2002 and 93% in 2003. The reduction in mortality of sooty shearwaters in 2003 was 60%. Catch rates of white-chinned petrels were 0.005 birds/thousand hooks and 0.011 birds/thousand hooks in 2002 and 2003 respectively. Sink profiles through the water column, and sink rates to 20 m depth of IWLs were very similar to sink profiles for autolines deployed under the provisions of Conservation Measure 24-02 (Figure 7.2).

7.75 Catch rates of ling by UWL (208 ± 71 kg/thousand hooks) and IWL (197 ± 81 kg/thousand hooks) were similar ($\chi^2 = 0.09$; d.f. = 1; P = 0.767; $n = 52$ pairs of UWLs and IWLs). Similarly, catch rates of all non-target fish species were not affected by IWLs. It was noted, however, that sample sizes for differences between IWLs and UWLs in catch rates of fish species were small. Compared to UWLs with external weights attached in accordance with Conservation Measure 24-02, IWLs may increase catch rates of *D. eleginoides* by up to one-third (WG-FSA-03/23).

7.76 The effectiveness of IWLs (in combination with streamer lines) in reducing mortality of white-chinned petrels has also been demonstrated in 2003/04 by France in Division 58.5.1, further demonstrating that very large reductions in seabird mortality can be achieved by use of IWLs by autoline vessels in the Convention Area.

7.77 Operationally, there are considerable advantages to IWLs. IWLs coil more uniformly and run through magazine racks more efficiently than UWLs. Compared to UWLs with external weights attached (necessary to comply with the provisions of Conservation Measure 24-02), IWLs are less time consuming to haul since there are no line weights to retrieve and stow. This also has implications for crew safety, since there are no external weights to be manually delivered from hauling to setting positions on vessels, which can be a hazardous practice in rough sea conditions.

7.78 Disadvantages to IWLs include the additional weight (magazine supports may have to be strengthened on some vessels), the higher purchase price than UWLs and the fact that currently there is only one international manufacturer producing IWLs with the specifications of the line used in the experiments reported here.

7.79 The Working Group acknowledged the importance of this new information and its relevance to modifications to Conservation Measure 24-02 to permit the use of IWLs by autoline vessels in the Convention Area in the 2004/05 fishery.

Proposed line-weighting trial in Subareas 88.1 and 88.2

7.80 WG-FSA-03/17 sought permission to conduct an IWL-weighting trial in Subareas 88.1 and 88.2. The trial sought to determine the difference, if any, between IWLs and UWLs in the catch rates of *D. eleginoides* and non-target fish species. The purpose of the trial was to gather information of relevance to line-weighting provisions for autoline vessels in the Convention Area and to aid in the promulgation of integrated weight gear in autoline fisheries outside the Convention Area. The trial was supported by the provisions of Conservation Measure 24-03.

7.81 For a variety of reasons, principally the large extent of sea-ice in Subareas 88.1 and 88.2 in the 2002/03 season and the number of seamounts on the fishing grounds (not conducive to conducting the trial), the trial could not be undertaken. Since it is not intended to conduct the trial in the 2004/05 season, it is not necessary to maintain Conservation Measure 24-03 and the Working Group recommended that it should lapse.

Underwater setting

7.82 Dr Robertson informed the Working Group of cooperative research by Dr H. Sakai, a mechanical engineer from Tokyo University of Marine Science and Technology and currently on sabbatical at the Australian Antarctic Division, who is developing an underwater setting device designed for high-seas tuna fisheries. The device uses a conveyor belt concept whereby a baited hook attached to a traditional snood is impaled on a pin, transported down the vertical plane of the conveyor, and released subsurface from the pin at a depth 3 to 4 m below the surface – beyond the propeller wash of a typical Japanese longline vessel.

7.83 The Working Group encouraged this work and noted that Dr Sakai's design differs from that of the previous underwater setting device trialled in multiple pelagic fisheries, which has had limited adoption in pelagic fisheries.

Proposed removal of the night-setting requirement in Division 58.5.2

7.84 WG-FSA-04/73 sought support to allow line-setting operations by autoline vessels fishing in Division 58.5.2 to occur at any time of the day/night cycle. The proposal formed part of an adaptive approach to management, which considers the risk status of the fishery, knowledge on the effectiveness of mitigation measures, mitigation performance record of the vessel, seabird mortality levels and assessment of the likely effects of individual mitigation measures to total mitigation response.

7.85 Since the introduction of longline fishing in Division 58.5.2 in 2002, seabird by-catch mitigation requirements have exceeded those required by CCAMLR. Evidence from Subarea 48.3, where both the hooking effort and number and abundance of longline-vulnerable seabird species is far greater than in Division 58.5.2, suggested that winter fishing with appropriate mitigation presents a very low risk to seabirds. This is supported by the results of the first two years of longline fishing in Division 58.5.2: a total of 2.2 million hooks have been set and no seabirds caught during line-setting operations. Possible reasons why seabirds have not been caught are the very low abundance of longline-vulnerable seabird species on the fishing grounds between May and September, night setting, the requirement for a minimum line sink rate, the use of paired streamer lines and no offal discharge. Evidence from IWL experiments presented in WG-FSA-04/72 suggested that the absence of seabird mortality in Division 58.5.2 is due to the low incidence of longline-vulnerable seabirds in winter, the minimum line sink rate and the use of streamer lines. Removal of the night-setting requirement is unlikely to result in an increased risk to seabirds in Division 58.5.2.

7.86 The Working Group supported the proposed recommendations that autoline vessels fishing in Division 58.5.2:

- restrict fishing to the period from 1 May to 14 September (as currently required);
- use paired streamer lines during all sets of longlines (as currently required);
- retain on board fish offal and discards (as currently required);
- be permitted to set longlines at any time in the day/night cycle;
- comply with the provisions of Conservation Measure 24-02 or use longlines containing 50 g lead/m integrated weight such that lines sink to 10 m depth at no less than 0.2 m/s, with a preferred average rate of no less than 0.24 m/s;
- abide by all other seabird conservation provisions in Conservation Measure 25-02;
- in the event that three seabirds are caught during daylight setting of lines, vessels must revert to night setting of longlines (as currently applies under Conservation Measure 24-02).

7.87 However, the Working Group noted that it would be premature at this stage to carry forward these provisions to other subareas and divisions until the effect of this adaptive approach to the management of seabird by-catch in Division 58.5.2 is known.

Research requirements

7.88 The Working Group expressed concern about the lack of empirical information on the effectiveness of certain mitigation measures that are routinely recommended to reduce seabird mortality in fisheries operating both inside and outside the Convention Area. Particularly important is the need to undertake manipulative experiments on the effectiveness of streamer lines in deterring from baited hooks deep-diving species such as white-chinned petrels, grey petrels and *Puffinus* species of shearwaters. These taxa include many globally threatened species to which information on the effectiveness of streamer lines and other mitigation measures would be especially relevant.

7.89 The Working Group also highlighted the importance of conducting experiments in a manner that allowed quantification of the contribution to by-catch reduction of measures used both singly and in concert – that is by adopting experimental designs aimed at de-coupling the effects of mitigation treatments. The Working Group believed that the results of such experiments should be applicable to a large number of fisheries operating in both northern and southern hemispheres, and would provide relevant fisheries management authorities with much-needed confidence in attempts to decisions regarding seabird-safe longline fishing practices.

7.90 The Working Group encouraged researchers to consider these points when conducting research on Convention Area seabirds and mitigation measures applicable to this area.

Revision of Conservation Measures 24-02 and 25-02 (2003)

7.91 The Working Group in its 2003 review of Conservation Measure 25-02 noted that changes to the measure were likely to be proposed in 2004 to make line-weighting prescriptions mandatory for autoline vessels (SC-CAMLR-XXII, Annex 5, paragraph 6.93). Such recommendations were dependent on the outcomes of trials of IWLs within New Zealand waters (paragraphs 7.73 to 7.79) and in Subareas 88.1 and 88.2 (paragraphs 7.80 and 7.81), and the collation of existing information describing weighting regimes for standard autoline gear.

7.92 The Working Group considered proposing changes to Conservation Measure 25-02 to accommodate line-weighting provisions for autoline vessels (both external weighting and IWLs), but recognised that no additional information on various external weighting regimes for autoline vessels had been provided and suggested that a revision of Conservation Measure 25-02 in 2004 would be premature.

7.93 The Working Group recommended that research be undertaken in 2004/05 on the sink rate of externally weighted autolines to allow a more informed revision of Conservation Measure 25-02 in 2005, with the intention of combining Conservation Measures 24-02 and 25-02, if possible. Research to explore relating the current values of line sink rate to values that include both vessel speed and sink rate is also planned. This would allow more flexible prescriptions to be developed for the conservation measure.

7.94 The Working Group recognised, however, that the results of the New Zealand trial (WG-FSA-04/72) proved that IWLs (50 g/m) are highly effective as a seabird by-catch mitigation method (in areas of high risk of seabird by-catch) without affecting fishing efficiency. The Working Group agreed that IWLs should be endorsed as a viable alternative to the provisions of Conservation Measure 24-02, which currently requires the attachment of external weights to UWLs.

7.95 The Working Group recommended that Conservation Measure 24-02 be revised, via the addition of an extra protocol, to accommodate the use of IWLs as an alternative line-weighting option. In reviewing the entire conservation measure, the Working Group recommended additional changes be made at the same time based on tabled papers and other available information to simplify implementation of line-weighting regimes in the Convention Area.

Experimental trials

7.96 Conservation Measure 24-02 was initially adopted to allow experimental line-weighting trials. The measure is now applied in most new and exploratory fisheries in high latitudes to allow daytime setting, subject to line sink rate targets being met and specified seabird by-catch limits. The measure has also been adopted in some mid-latitude fisheries to extend fishing seasons.

7.97 The Working Group recommended that Conservation Measure 24-02 now be considered part of the suite of tools available for mitigating seabird by-catch in the Convention Area, rather than confined to new and exploratory fisheries or to experimental contexts.

Longline sink rate testing prior to entering the CCAMLR Convention Area

7.98 The requirement to set five longlines with four sample points on each longline to ensure fishers' ability to comply with this measure prior to entering the Convention Area is an unnecessary burden given the constant line sink rate monitoring regime in place in the fishery. However, some pre-fishery longline sink rate testing is recommended to ensure vessels are fully able to comply with CCAMLR requirements prior to entering the fishery.

7.99 Accordingly, the Working Group proposed that these requirements be made clear in all conservation measures and that the requirement for five pre-fishery test lines be reduced to setting two pre-fishery longlines with four sample points on each longline.

7.100 The length of the longline used determines the likely minimum line sink rate (WG-FSA-01/44). The Working Group recommended that line sink rate tests should be undertaken on longlines of the maximum length planned to be used during fishing in the Convention Area.

7.101 The placement of a TDR or bottle immediately adjacent to a weight on externally weighted longlines will give a rapid line sink rate result. The slowest sink rates are recorded midway between attached weights. As the target is a minimum line sink rate of 0.3 m/s (for externally weighted lines), line sink rate tests should always involve placement of TDR or bottle midway between attached weights.

7.102 Noting that fishing gear may be lost during line sink rate testing and not replaced prior to entry to the fishery, and that not all gear on board a vessel may be used during longline sink rate testing, the Working Group recommended that longline gear of the same specifications be required rather than specifying the same longline gear.

7.103 The Working Group noted that one distinct advantage of the bottle-test method was the ability to calculate an answer immediately after the test and provide that result to the fishing vessel to allow modification of practice at the time of the set if required. Text to clarify this aspect of the bottle test is recommended.

Longline sink rate monitoring whilst fishing in CCAMLR waters

7.104 The Working Group recommended that one sink rate test every 24 hours is sufficient to monitor ongoing compliance of the longline sink rate during the voyage, in conjunction with the four sample points on one longline every seven days.

7.105 The Working Group reiterated that the 0.3 m/s longline sink rate for externally weighted longlines was a minimum requirement rather than a target.

7.106 The Working Group recommended that longline sink rate tests be reported to the relevant national agency daily, and to CCAMLR at the end of the fishing season.

Protocol for IWL

7.107 The use of IWLs requires that line sink rate standards be reduced to 0.2 m/s for this type of gear only. As IWLs begin to sink immediately, and have a linear sink profile, an IWL sink rate of 0.2 m/s is assumed to be of equivalent conservation benefit to a UWL achieving a sink rate of 0.3 m/s by attaching external weights.

7.108 The Working Group recommended the addition of a new protocol for vessels monitoring longline sink rate with either TDRs or bottle tests. The new protocol applies to IWLs with integrated weights of no less than 50 g/m and designed to sink instantly with a linear profile at greater than 0.2 m/s without the addition of external weights.

7.109 The Working Group noted that either longline sink rate test method could be used on IWLs and recommended that the new protocol be worded to allow both bottle testing and TDR testing.

7.110 In the conduct of longline sink rate tests for IWLs, the Working Group noted that as no external weights are attached, tests can be undertaken anywhere on the middle one-third of the longline, and the requirement to test midway between weights is not relevant.

7.111 Taking account of the foregoing information and suggestions, the Working Group prepared a draft revision of Conservation Measure 24-02.

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

7.112 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.

7.113 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.

7.114 As no information is available on seabird by-catch rates from the unregulated fishery, estimates have been made by bootstrapping the observed catch rates from fishing operations in 1996/97. The fleet 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. The method used to prepare estimates of the incidental mortality of seabirds during IUU fishing within the Convention Area is described in full in SC-CAMLR-XXIII/BG/23 and in SC-CAMLR-XXII, Annex 5, paragraphs 6.112 to 6.117.

7.115 The Working Group agreed that the following values should be applied to the toothfish removals data to estimate seabird by-catch in IUU *Dissostichus* spp. fisheries in the Convention Area in 2004, and also agreed that these values should be used to generate similar estimates for previous years. The resulting median and 95% confidence intervals for seabird by-catch rates (birds/thousand hooks) for the unregulated fishery are shown below. It should be noted that where by-catch rates are not available for a regulated fishery within a statistical area, the rate for an adjacent area of similar level of risk (SC-CAMLR-XXIII/BG/23) has been used. Thus, because a regulated fishery has never existed in Division 58.4.3 the rate applied is that for Division 58.4.4.

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
58.4.3, 58.4.4	Summer	0.27	0.33	0.87
	Winter	0.006	0.006	0.042
88.1	Summer	0.27	0.33	0.87
	Winter	Not applicable, access not possible in winter		

7.116 The estimates of potential unregulated seabird by-catch in the Convention Area in 2003/04 and comparison with estimates for previous years are provided in detail in SC-CAMLR-XXIII/BG/23.

7.117 The overall estimated total for the whole Convention Area in 2003/04 indicates a potential seabird by-catch in the unregulated fishery of 5 311 (95% confidence interval 4 352–14 166) seabirds. The values for this and previous years are summarised in respect of different parts of the Convention Area in Table 7.15.

7.118 In comparison with estimates for previous years, calculated in identical fashion, the value for 2003/04 is the lowest reported since estimates started in 1996. The 2003/04 value is about 30% of the values for 2003 (SC-CAMLR-XXIII/BG/23). This presumably reflects a commensurate reduction in toothfish removals or changes in the areas from where IUU fishing occurs.

7.119 Based on the data since 1996 (SC-CAMLR-XXIII/BG/23), an estimated total of 176 063 (95% confidence interval 143 289–516 934) seabirds have been killed by these vessels. Of these:

(i) 39 457 (95% confidence interval 31 904–125 492) were albatrosses, including individuals of four species listed as globally threatened using the IUCN threat classification criteria (BirdLife International, 2004);

(ii) 6 974 (95% confidence interval 5 695–19 557) were giant petrels, including one globally threatened species;

(iii) 110 404 (95% confidence interval 90 001–317 264) were white-chinned petrels, a globally threatened species.

7.120 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.

7.121 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) although considerably reduced from previous years, such levels of mortality probably still continue to be unsustainable for some of the populations of albatrosses and giant and white-chinned petrels breeding in the Convention Area.

7.122 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

7.123 Chile, New Zealand and Uruguay were the only countries submitting new information about incidental mortality of seabirds outside the Convention Area.

7.124 Chile presented the results of the incidental mortality assessment, conducted in 2002, for its *D. eleginoides* industrial fishery (WG-FSA-04/13). The total number of birds estimated killed was 2 162 (0.343 birds/thousand hooks), most of which (96%) were black-browed albatrosses presumed to breed in the Chilean EEZ. The vessels involved in the assessment used no mitigation measures. Although part of this fleet also fishes in Subarea 48.3 during winter, they relax their mitigation measures in Chile presumably, in part, because they are not mandatory there. In addition, the greater depth of the fishing grounds in Chile (up to 2 000 m) is stated to impose serious restrictions for the line-weighting regime and to preclude applying the same regime as required in the Convention Area (Conservation Measure 25-02). Consequently, further development on mitigation measures in Chile is required. In view of these results, Chile is elaborating its NPOA-Seabirds in order to reduce the present levels of incidental mortality (WG-FSA-04/14).

7.125 Chile also presented an assessment of the incidental mortality of seabirds in its domestic fleet (boats <18 m long) fishing for austral hake and *D. eleginoides* in the southern Chilean EEZ (WG-FSA-04/54). The impact of the domestic austral hake fishery is minimal, capturing 23 birds in 1999 with an overall catch rate of 0.030 birds/thousand hooks. During 2002, the domestic *D. eleginoides* fishery caught a total of 437 birds, with an overall catch rate of 0.047 birds/thousand hooks. All birds caught were white-chinned petrels, doubtless from populations breeding in the Convention Area.

7.126 Uruguay presented a report on an exploratory fishery conducted in its EEZ between August and November 2001 (WG-FSA-04/38), as was encouraged last year (SC-CAMLR-XXII, Annex 5, paragraph 6.130). During this short exploratory fishery 2 175 birds were killed. The fishing gear used was a modification of the traditional bottom Spanish longline, using floats attached to the mother line, resulting in a zigzag configuration on the sea bottom. This configuration greatly increased the time that hooks remain near the surface, resulting in very high seabird mortality rates (>3 birds/thousand hooks), mainly of white-chinned petrels (50%), presumably from the South Georgia population. Vessels fished during day and night and streamer lines were used in only 8% of the sets. This fishery no longer exists in Uruguay; however, this kind of gear configuration is possibly used in other South American countries, with potential high levels of incidental seabird mortality. The Working Group encouraged the assessment and development of appropriate mitigation for such fisheries, which have the potential to kill many birds from the Convention Area.

7.127 New Zealand presented an assessment of incidental seabird mortality in four major commercial fishing operations in its EEZ for the seasons 2000/01, 2001/02 and 2002/03 (WG-FSA-04/55 to 04/57). Incidental mortality rates were different for each fishery. Pelagic longlining for tuna has low overall seabird mortality (54 and 136 birds in 2000/01 and 2002/03 respectively) and catch rates (0.026 and 0.048 birds/thousand hooks in 2000/01 and 2002/03 respectively) throughout the study period, presumably reflecting high compliance with mitigation measures. Demersal longlining for ling has substantially reduced its catch from 2 367 in 2000/01 to 543 in 2002/03, reflecting a significant reduction in the overall bird catch rate (up to 0.218 in 2000/01 and <0.08 birds/thousand hooks in 2002/03) due to a substantial increase in their line-weighting regime. Trawl fisheries, particularly for squid, are still presenting high mortality rates (0.097 and 0.058 birds per trawl in 2000/01 and 2002/03 respectively) and overall catches (1 651 birds in 2000/01 and 1 110 birds in 2002/03). Most of the birds caught breed in New Zealand waters; however, a high proportion of the birds caught each year were white-chinned petrels (27–52%) and grey petrels (13–19%, but 1% in 2001/02), species known to breed in the Convention Area.

7.128 Mrs Neves reported on the high levels of incidental seabird mortality in Brazilian waters, involving more than 10 000 albatrosses and petrels per year during the late 1990s, including three species that breed in the Convention Area (wandering albatross, white-chinned petrel and southern fulmar). These estimates only relate to incidental mortality arising from the domestic demersal and pelagic fleets. Additionally, a chartered foreign longline fleet operates off the Brazilian coast, of which fishing effort is much higher than that of the domestic fleet. SEAP (Special Secretariat of Aquiculture and Fisheries of the Presidency of the Republic) is already coordinating a National Observers Program that includes 100% coverage of the chartered fleet. Mrs Neves also mentioned that mitigation measures, such as blue-dyed baits and streamer lines, should be adopted as an obligation, in agreement with Brazil's NPOA-Seabirds which is ready for signature.

7.129 Brazil was requested to provide the Working Group with data on the above topic, particularly in respect of by-catch rates for seabird species breeding in the Convention Area.

Research into the status and distribution of seabirds

7.130 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 Australia (WG-FSA-04/81), New Zealand (WG-FSA-04/53) and the USA (WG-FSA-04/22). Reference to research on albatrosses by

Chile was included in WG-FSA-04/12 and 04/13, and research by Uruguay in WG-FSA-04/39 and by the UK in WG-FSA-04/71. Of countries known to be conducting relevant research, no reports were received from Argentina, France, South Africa and the UK.

7.131 Previously, the USA's research summary included details of current research into methods to monitor and mitigate seabird by-catch. This initiative was considered by the Working Group as an important contribution to its work. Consequently, as in previous years, 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 again was the only Member to provide this information, the Working Group reiterated the request for inclusion of mitigation research in national research reports.

7.132 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 on an annual basis. As in previous years, only Australia and New Zealand provided this information (WG-FSA-04/53 and 04/81), so 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.

7.133 Information on population dynamics and foraging studies provided to date has been summarised in SC-CAMLR-XXIII/BG/22, which updates SC-CAMLR-XXII/BG/18. All Members were again requested to provide more comprehensive and representative national research reports so that appropriate assessments can be undertaken.

7.134 Last year the Working Group recommended, in order to streamline and achieve more complete and representative reporting, that the group would review the report templates and that the Secretariat would forward a reminder to all Members to submit reports during the intersessional period (SC-CAMLR-XXII, Annex 5, paragraph 6.137). Australia was the only Member to submit substantive revisions to the report templates. Provision of seabird population status and foraging range information was restricted to Australia and New Zealand (WG-FSA-04/53 and 04/81 respectively). Consequently, comprehensive application of the revised formats remains outstanding. All Members are again requested to provide comprehensive and contemporary information so that assessments encompassing the Convention Area can be undertaken.

7.135 The most recent assessments of the global conservation status of albatrosses, giant petrels and *Procellaria* petrels were reflected in SC-CAMLR-XXII/BG/18. This summary shows the current status of the 20 seabird species that have been identified as being at risk from longline fisheries in the Convention Area. The conservation status of these species is unchanged from that summarised last year (SC-CAMLR-XXII, Annex 5, paragraph 6.144) and comprises two species that are Critically Endangered, five species that are Endangered, nine Vulnerable species and four species currently listed as Near-Threatened.

7.136 In order to monitor these threatened species and more effectively mitigate the threats they face, the Working Group has previously encouraged Members to undertake a range of activities and initiatives with respect to increasing the understanding of albatross and petrel population status and distribution (SC-CAMLR-XXII, Annex 5, paragraph 6.146).

7.137 Observations of seabird and marine mammals observed during toothfish longline fishing operations in Subareas 88.1 and 88.2 from 2000 to 2002 are summarised in WG-FSA-04/42. Few birds were seen diving on baits during fishing, although a greater number attended the haul. The presence of species in proximity to vessels was noted by SSRU, following the CCAMLR protocol of observing abundance within a 500 m^2 area behind the vessel. Albatross species observed within the Convention Area included some species not previously seen at these southern latitudes (northern giant petrel and sooty albatross). The Working Group considered the utility of these seabird abundance data, and concluded that except for specific operations, and involving highly trained observers, error in the seabird identifications and application of methodology made the data gathered using these protocols difficult to interpret. It was recommended that when a need to gather seabird abundance data is identified, a review of appropriate recording methods be undertaken. Until then, this task could be removed from observer duties, until such time as new data collection protocols are available.

7.138 Records of seabird species occurring in Uruguayan waters and the South Atlantic Ocean collected between 1994 and 2003 were reported in WG-FSA-04/39. Twenty-two species were identified in the Atlantic Ocean, in an area between 20°–55°S and 30°–60°W. These records provide useful information of the presence of seabirds including those vulnerable to fishery interactions, in waters adjacent to the Convention Area.

7.139 WG-FSA-04/46 described the distribution of seabirds on the Alaskan fishing grounds derived from post-haul seabird counts conducted in the course of longline fish stock assessment surveys. The protocol consists of counting all birds by species within a 50 m hemisphere at the stern of the vessel immediately prior to, or immediately after, the last hook is hauled, when seabirds are most aggregated and easily enumerated. This simple protocol takes no more than 10 minutes to complete and is easily learned and performed by observers with minimal seabird experience. These data yield estimates of the seabird species present or absent in specific areas at specific times and the relative distribution of the common species on the fishing grounds. These data, however, are not comparable with traditional ship transect abundance estimates, and are of limited use for measuring change in seabird populations.

7.140 The Working Group acknowledged that the current CCAMLR observer protocol for enumerating seabirds within a 500 m square at the stern of the vessel is difficult to perform by fisheries observers. These data are collected inconsistently by CCAMLR observers, and the resulting data have yet to be analysed or used. The simpler post-haul protocol may yield consistent data useful for CCAMLR management purposes.

7.141 WG-FSA-04/12 presented data on grey-headed albatross diet at Diego Ramírez Islands, Chile. The report supplied evidence that during the breeding season this albatross population has minimal interaction with fishing operations in southern Chile, feeding mostly on *M. hyadesi* which is distributed at the Antarctic Polar Front. This is further supported by the at-sea distribution and high survival of breeding grey-headed albatrosses at Diego Ramírez Islands presented in WG-FSA-02/18.

7.142 The areas used by grey-headed and Campbell albatrosses during foraging flights in the chick-rearing period from Campbell Island are described in WG-FSA-04/59. A small number of individuals of both species were satellite-tracked during trips to the Polar Front, where both species fed on *M. hyadesi*. Campbell albatrosses travelled into Subareas 88.1 and 88.2, whereas grey-headed albatrosses foraged in Subarea 88.1 and passed just north of Subarea 88.2. The findings confirm that these albatrosses, breeding at Campbell Island, should be considered in the risk assessments for CCAMLR areas in the Ross Sea.

7.143 The foraging areas of black-browed and grey-headed albatrosses breeding on Macquarie Island are reported in WG-FSA-04/49 with respect to overlap with local MPAs. This recognises that MPAs are often established to protect threatened top-order predators, but there are few data that can be used to evaluate their effectiveness in achieving this purpose. The spatial extent of the MPAs around Macquarie Island appears to adequately cover much of the foraging distribution of Macquarie Island black-browed albatrosses during the breeding season; however most of this was in the EEZ not covered by the Macquarie Island Marine Park. Grey-headed albatrosses spent significantly more time in waters outside these areas and are at higher risk from fisheries activities and other threats. Both species foraged in waters inside the Convention Area, black-browed and grey-headed albatrosses spending 5 and 12% of their respective foraging time in Subarea 88.1. Further information on albatross movements is required to assess the efficacy of MPAs in protecting foraging habitats outside the breeding season.

7.144 Prof. J. Croxall (UK) reported that the BirdLife International Seabird Conservation Programme has established a GIS database for archiving and analysing satellite and geolocation tracking data for albatrosses and petrels. The first global procellariform tracking workshop was held in South Africa in September 2003 and a meeting to finalise the workshop report was held in Uruguay in August 2004. The final report will be published in November 2004. Of considerable interest to CCAMLR will be the consolidated information on the pelagic distribution of albatross and petrel populations and the extent to which these data can be used to quantify the marine areas used by these birds and the location of fishing effort. This information will also assist in the identification of RFMOs with prime responsibility for the management of fisheries with significant risk of incidental by-catch of albatrosses and petrels.

7.145 It was recommended that the Working Group request BirdLife International to analyse the data for all southern hemisphere species to determine the proportion of time that each relevant species (and source population where appropriate and feasible) spends in each part (area, subarea, division, subdivision as appropriate) of the Convention Area. Such information should contribute substantially to clarifying distribution in relation to the risk assessments for the Convention Area in respect of longline fisheries (e.g. SC-CAMLR-XXIII/BG/21).

7.146 The population dynamics of Campbell and grey-headed albatrosses breeding at Campbell Island were described for 1984 to 1996 (WG-FSA-04/58). During this period, the Campbell albatross population trends increased at rates of 1–2% at different colonies. In a preceding era, declines in this population were noted by comparing counts of photographs from the 1940s–1990s, and ground counts from 1984–1996. These declines coincided with mortality of this species in the longline fishing activities for tuna in the New Zealand zone, where the species was caught. The Working Group noted that the survival rates reported for adult Campbell albatrosses (94.5%) are considerably higher (by 3%) than survival rates reported for the closely related black-browed albatross.

7.147 Grey-headed albatrosses at Campbell Island were found to be in decline during the period from 1984 to 1996, at rates of 3.0–4.8% per annum in different colonies. Comparison of historical photo-count data for this species showed that decreases in breeding numbers to around 11–25% of initial counts during the period from the 1940s to the 1990s had occurred.

7.148 Trends in breeding numbers and survival of black-browed and grey-headed albatrosses breeding on Macquarie Island are described in WG-FSA-04/48. Population dynamics and trends of both populations appear to have remained relatively stable since the 1970s. There is no conclusive evidence of survival varying over time and it is unlikely that these populations have been impacted significantly by extra mortality due to fisheries activities. This is in contrast to most other populations of these species and may be attributed to their foraging ranges not overlapping significantly with areas of high fisheries activities. However, both species forage in areas of both legal and illegal fishery operations. Due to their extremely small population size (45 pairs and 95 pairs breeding each year for black-browed and grey-headed albatrosses respectively (WG-FSA-04/81)), these populations remain extremely vulnerable to any increase in mortality rate.

7.149 The wandering albatross is a globally threatened species and the Macquarie Island breeding population is particularly vulnerable as it comprises fewer than 20 breeding pairs (WG-FSA-04/50). Demographic trends and population numbers show that the population status has varied significantly during the 1900s. Breeding numbers declined from a peak in 1964 to near extinction levels in the mid-1980s. Underlying this decline was a significant decrease in juvenile survival and, to a lesser extent, adult survival. These survival changes were coincident with changes in fishing effort in the eastern Indian Ocean. Breeding numbers slowly increased on Macquarie Island through the 1980s, reaching a total of 19 pairs in the mid-1990s, and the population remains at this level today. Trends in population numbers and survival are most similar to those observed in Indian Ocean populations. The very small population size of wandering albatrosses on Macquarie Island makes the population extremely vulnerable to any activities that elevate mortality rates.

7.150 Black-browed albatrosses breeding at Gonzalo Island in southern Chile have been surveyed on six occasions since 1980 (WG-FSA-04/13). The census results suggest a decrease in the population between 1980 and 1997, followed by an increase in numbers from 1997 to 2002. The most recent population estimate in 2002 would indicate an increase in numbers from 2001 estimates that exceeds the maximum natural rate of increase. The Working Group considered the data and suggested that while they illustrate broad population trends (and a clear increase in numbers between 1999 and 2001), differences in survey methodology between some of the years confound other annual estimates of rates of population change.

7.151 South Georgia is an important breeding location for four albatross species. Surveys of all known breeding sites of three of these species (wandering, black-browed and grey-headed albatrosses) were carried out at South Georgia in the 2003/04 breeding season (WG-FSA-04/71). In total an estimated 1 553 pairs of wandering albatrosses, 75 500 pairs of black-browed albatrosses and 47 800 pairs of grey-headed albatrosses were breeding at South Georgia in the 2003/04 season. A combination of ground counts and boat-based digital photography provided comprehensive population estimates for remote and inaccessible locations that were both time and cost effective. The Working Group welcomed the application of the new survey methodologies and endorsed their use at other sites.

7.152 Comparison of population trends reported for Bird Island and for other South Georgia colonies show that the trends at Bird Island colonies are representative for the South Georgia region. Populations of all three species have declined since the 1980s. Black-browed albatrosses have decreased by 4% per annum from 1989 to 2003, and grey-headed albatrosses have decreased by 2.9% per annum from 1990 to 2003. The decline in wandering albatrosses is even more pronounced, 30% (1.8% per annum) since the previous comprehensive survey in 1984. The magnitude of these population decreases is alarming, given the long time span and the consistent downward pattern. Of particular concern is the acceleration since 1997 in the rate of decrease of wandering albatrosses at Bird Island which now averages 4.5% per annum. If these sustained population declines are not halted or reversed, the long-term survival of the populations of these albatross species at South Georgia is in jeopardy.

7.153 Prof. Croxall informed the Working Group that Prof. H. Caswell and Dr C. Hunter (USA) have been holding discussions and a workshop to consider the development of new population models for albatrosses. The first steps towards developing a basic life-cycle model to use as a framework for parameter estimation and demographic analyses for albatrosses and petrels took place at a meeting of a group of procellariiform biologists and statisticians from France, New Zealand, UK and the USA, held at Woods Hole Oceanographic Institute (USA) in September 2004. A further meeting is scheduled for 2005 to further develop and apply the demographic analyses.

7.154 The Working Group noted that the Third International Albatross and Petrel Conference was held in Montevideo, Uruguay, in August 2004. Oral and poster sessions conducted during the meeting included molecular ecology and systematics, general biology and behaviour, population dynamics, population dynamics and status, feeding ecology and foraging areas, and incidental mortality and mitigation. A volume of abstracts of the oral and poster presentations was made available for consultation by the Working Group. Members of the Working Group welcomed the staging of the conference, and encouraged publication of the presentations and asked the organisers and/or sponsors to facilitate access to an electronic version of the abstracts volume.

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

Agreement on the Conservation of Albatrosses and Petrels (ACAP)

7.155 This Agreement came into force on 1 February 2004 (WG-FSA-04/51) and the first meeting of the six Parties (Australia, New Zealand, Ecuador, Spain, South Africa and the UK) that have currently ratified the Agreement will take place in Hobart, Australia, from 10 to 12 November 2004. A scientific meeting will precede the Meeting of Parties on 8 and 9 November for the purpose of providing early advice on recent scientific developments of relevance to the conservation of albatrosses and petrels, and to advise on priority activities to implement the ACAP Action Plan.

7.156 The Working Group noted that CCAMLR had been invited to attend the meeting as an official observer and that the Secretariat, assisted by the Convener of WG-IMAF, had tabled a paper reviewing CCAMLR's work of potential relevance to ACAP (CCAMLR-XXIII/BG/23). The Working Group looked forward to the development of close links between ACAP and CCAMLR, particularly in respect of the many elements of mutual interest to the two bodies.

7.157 The Working Group again encouraged 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. The Working Group also encouraged Parties to ACAP to establish its advisory committee and commence implementation of its Action Plan as soon as possible.

7.158 The Working Group recognised that some of the data and information currently compiled and maintained by CCAMLR (e.g. on the status, population trends and distribution of albatrosses and petrels) would be of considerable interest and relevance to the work of ACAP. Indeed, some such data might better be maintained on a global or southern hemisphere basis by ACAP, providing that Members of CCAMLR could enjoy unrestricted access and use. Those attending the first Meeting of Parties of ACAP with experience of CCAMLR were encouraged to bring these issues to the early attention of ACAP.

FAO's International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA-Seabirds)

7.159 FAO submitted a status report on the implementation of IPOA-Seabirds (WG-FSA-04/15), reporting the information summarised last year in SC-CAMLR-XXII, Annex 5, paragraph 6.173. New and updated information is available on the FAO's webpage at www.fao.org/figis/servlet/static?dom=org&xml=ipoa_seabirds.xml. FAO intends to prepare a technical paper, based on its Fisheries Circular No. 937, that will mainly focus on a review of the various studies carried out to test the performance and efficacy of mitigation measures.

7.160 Last year the Commission noted summaries of progress with certain FAO NPOA-Seabirds (SC-CAMLR-XXII, Annex 5, paragraph 6.174; SC-CAMLR-XXII, paragraphs 5.31 and 5.32) and concurred that progress with implementation was still very slow (CCAMLR-XXII, paragraph 5.15).

7.161 The Working Group noted the following new information regarding the status of development of NPOA-Seabirds:

(i) Mr J. Arata reported on the status of Chile's NPOA-Seabirds (WG-FSA-04/14). The NPOA is in development by a collaborative working group including representatives from the fishing industries, scientists and government agencies. A set of suitable mitigation measures has been identified and evaluations are being conducted on the efficacy of streamer lines and line weighting regimes. The draft NPOA will be available at www.fip.cl.

(ii) Mrs Neves reported that Brazil's NPOA-Seabirds has been completed. The preliminary version was prepared by Instituto Albatroz, a non-governmental organisation dedicated to the albatross conservation issue, and BirdLife International – Programa do Brasil, and supported by FAO. This version was submitted to 34 scientists, governmental and non-governmental representatives, and vessel owners, for discussion during a national workshop in April 2004.

Brazil's NPOA-Seabirds identifies several procellariform species known to be incidentally taken in Brazilian longline fisheries, including three that breed in the Convention Area (wandering albatross, white-chinned petrel and southern fulmar). Several mitigation measures are identified for use by Brazilian longline vessels (streamer lines, blue-dyed bait and night setting). The NPOA-Seabirds establishes a goal of reducing the by-catch of the migratory species to 0.001 birds/thousand hooks.

The final version of Brazil's NPOA will be available at www.projetoalbatroz.com.br/planacao and final approval and signature by IBAMA (Brazilian Institute of the Environment) and by SEAP (Special Secretariat of Aquaculture and Fisheries of the Presidency of the Republic) is planned for November 2004.

(iii) New Zealand's NPOA was finalised in April 2004 and is available at www.doc.govt.nz.

(iv) The Falkland/Malvinas Plans of Action for both longlines and for squid and finfish trawl fisheries were finalised and implemented in 2004.

(v) Although not a member of FAO, Taiwan has indicated that it is preparing an NPOA-Seabirds.

7.162 In December 2003, the South American Workshop on Implementation of NPOA-Seabirds and Conservation of Albatrosses and Petrels was held in Futrono, Chile, and jointly sponsored by FAO and BirdLife International (SC-CAMLR-XXIII/BG/7). Participants from CCAMLR nations included: Argentina, Brazil, Chile, New Zealand, Norway, Peru, Spain, UK, USA and Uruguay. South American participants reported on progress of seabird by-catch assessments of longline fisheries, mitigation measures in use or being evaluated, and development of NPOAs. Several of the reports reflected the by-catch of albatross and petrel species from the Convention Area. Workshop recommendations addressed fishery assessments, mitigation research and a continued collaboration between FAO and BirdLife International, including holding a third workshop in 2005.

7.163 The Working Group commended this South American regional group for its collaborative efforts, which represent a successful initiative to address the issue in an effective and meaningful manner.

7.164 The Working Group was encouraged that some progress has occurred on NPOA development and continued to highlight the need for nations and fishing entities to develop and implement effective NPOAs for fisheries that interact with seabirds from the Convention Area.

RFMOs, tuna commissions and international governmental organisations

7.165 For several years the Commission has tried to collaborate with those RFMOs with responsibilities for areas adjacent to the Convention Area where seabirds from the Convention Area, are, or may be, killed, in order to promote the adoption by these RFMOs of appropriate mitigation measures for the fisheries actually or potentially involved (CCAMLR-XXII, paragraph 5.17). 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).

7.166 Intersessionally, the CCAMLR Secretariat requested Members (particularly those nominated as CCAMLR observers) to provide feedback on discussions concerning seabird by-catch and potential cooperation and data exchange (COMM CIRC 04/54). Information was received on CCSBT, IATTC and ICCAT.

7.167 The CCAMLR Observer reported on the fifth meeting of the CCSBT ERSWG held in Wellington, New Zealand, in February 2004 (WG-FSA-04/33 Rev. 1). The meeting was attended by member countries of CCSBT (Australia, Japan, Republic of Korea, New Zealand and Fishing Entity of Taiwan) and Indonesia attended as an observer. The meeting involved sharing of information on national projects relating to mitigation research, data collection and education. The report of the meeting is pending approval from the Commission, which will be meeting from 19 to 22 October 2004. The CCAMLR Observer noted that there would be items of relevance to CCAMLR in the papers tabled, in particular data on incidental capture of seabirds that breed in the CCAMLR Convention Area. The Working Group requested the CCAMLR Secretariat obtain and circulate copies of the report and papers tabled at the meeting from the CCSBT Secretariat.

7.168 The CCAMLR Observer to ICCAT (European Community) briefly referenced the ICCAT Resolution on Incidental Mortality of Seabirds (02-14) in its submitted report (CCAMLR-XXIII/BG/25), but no substantive discussion on this topic occurred at ICCAT's annual meeting in Dublin, Ireland, in November 2003.

7.169 Ms K. Rivera reported that the USA will sponsor a booth on by-catch at the 2004 annual meeting of ICCAT in New Orleans, USA, in November. Information about the incidental mortality of seabirds and sea turtles in longline fisheries will be provided as well as effective and practicable mitigation methods that have been identified for each.

7.170 The IATTC Secretariat conveyed that although no discussion of seabirds occurred at its 2004 annual meeting, seabird by-catch was discussed at the meeting of the IATTC's Bycatch Working Group in Kobe, Japan, in January 2004. The minutes of the Bycatch Working Group indicated that the USA explained its efforts with regard to mitigating the effects on seabirds of fisheries around Hawaii, and proposed that the pertinent provisions of the IATTC by-catch resolution should also apply to seabirds. Japan, Spain and the Fishing Entity of Taiwan reported on their efforts to reduce seabird mortality associated with longline fisheries in the Pacific.

7.171 As a result of an examination two years ago of fisheries data provided by IOTC, the Working Group noted that the 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).

7.172 Thus, the CCAMLR Secretariat sent a request in November 2002, via the IOTC Secretariat, to delegations at the annual IOTC meeting which represented countries that are also CCAMLR Members. The request was to ensure that the issue of seabird by-catch be included for consideration by IOTC. The request was repeated in June 2004 (COMM CIRC 04/54). No response to this has been received to date.

7.173 The Working Group continued to be discouraged by the lack of progress on the seabird by-catch issue at pertinent RFMOs.

Other international organisations and initiatives, including non-governmental organisations

7.174 A status report of Southern Seabird Solutions' activities was received (WG-FSA-04/35) detailing some of its activities, such as: its establishment as a charitable trust, fostering exchange of crew and technologies between fleets in different countries (e.g. New Zealand and France); 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 (e.g. 'Fishing the Seabird Smart Way' video).

7.175 The Working Group again commended the work of Southern Seabird Solutions as it recognised the value of this group to aiding in reductions of seabird by-catch of birds breeding in the Convention Area. The Working Group encouraged active participation in Southern Seabird Solutions by CCAMLR Members.

7.176 Prof. Croxall reported that the BirdLife International Global Seabird Programme has several ongoing activities of note that relate to albatrosses and petrels that breed in the Convention Area:

(i) a review of the environmental performance of RFMOs, including CCAMLR, in respect of by-catch mitigation, especially albatrosses;

(ii) a report analysing global data on the distribution of albatrosses and petrels as revealed by remote-recording and a review of implications of marine conservation;

(iii) publication of the report from the technical workshop co-hosted with FAO in Chile in December 2003 (SC-CAMLR-XXIII/BG/7) and further development of NPOA initiatives;

(iv) publication of results of a technical workshop for Asian nations, particularly distant-water fleets, in Taiwan in January 2004;

(v) a variety of projects collecting observer data on seabird by-catch and trialling mitigation techniques, particularly in southern America and Africa.

7.177 The Working Group commended BirdLife International for these numerous activities and was 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.

7.178 The Third International Conference on Albatrosses and Petrels was held in Montevideo, Uruguay, in August 2004 (paragraph 7.154). Many of the conference participants were from CCAMLR nations.

7.179 The Working Group noted the forthcoming workshop at the Fourth International Fisheries Observer Conference in Sydney, Australia, on 8 November 2004 – 'Development of Best Practices for the Collection of Longline Data to Facilitate Research and Analysis to Reduce By-catch'. The workshop will focus on identifying important elements for programs that collect data on protected species' interactions, including seabirds. Such data collection is critical in efforts to accurately monitor levels of by-catch in fisheries and in the development of effective programs to reduce such interactions. The Working Group encouraged the participation by CCAMLR nations at this workshop and conference and feedback to CCAMLR of relevant information.

Incidental mortality of seabirds in relation to new and exploratory fisheries

Assessment of risk in CCAMLR subareas and divisions

7.180 As in previous years, the Working Group assessed the numerous proposals for new and exploratory fisheries and the potential for these fisheries to lead to substantial increases in seabird incidental mortality.

7.181 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.

7.182 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-XXII/BG/17).

7.183 This year new data derived from a satellite tracking study was provided on the at-sea distribution of grey-headed and Campbell albatrosses that breed on Campbell Island (WG-FSA-04/59). In addition, all references to the Amsterdam albatross were deleted from the assessments as there is no empirical evidence to support the occurrence of this species within the Convention Area. This information was used to update the assessment of potential risk of interaction between seabirds and longline fisheries for Subareas 88.1 and 88.2. The revised assessments incorporating new information made available at the meeting (with changes/additions underlined) have been issued as SC-CAMLR-XXIII/BG/21.

New and exploratory longline fisheries operational in 2003/04

7.184 Of the 29 proposals last year for new and exploratory longline fisheries in 16 subareas and divisions, only 15 were actually undertaken: by Australia in Division 58.4.2; by Australia in Division 58.4.3b; by Japan in Subarea 48.6; by Argentina, Republic of Korea, New Zealand, Norway, Russia, South Africa, Spain, Ukraine, UK, USA and Uruguay in Subarea 88.1; and by New Zealand in Subarea 88.2.

7.185 No seabird by-catch was reported to have been observed in fisheries in Divisions 58.4.2 and 58.4.3b and Subareas 48.6 and 88.2 and only one incident of an individual seabird by-catch was reported observed in Subarea 88.1. Clearly the strict adherence in Subareas 48.6 and 88.2 and Divisions 58.4.2 and 58.4.3b 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. The less than 100% compliance reported from Subarea 88.1 this year does not appear to be linked to the observed mortality, as the vessel involved was reported as fully compliant with Conservation Measures 24-02 and 25-02.

New and exploratory longline fisheries proposed for 2004/05

7.186 The Working Group reviewed the risk assessment framework used historically for providing advice on new and exploratory fishery proposals (SC-CAMLR-XXII/BG/17). Several inconsistencies in the approach were noted; in particular subareas with identical risk levels have had different seabird by-catch mitigation requirements applied in the conservation measures.

7.187 As part of the review of the risk assessment framework, the Working Group considered its historical advice on observer coverage levels and suggested observer coverage levels appropriate for monitoring by-catch and mitigation in relation to risk assessment level.

7.188 The Working Group emphasised that reported values for observer coverage of incidental seabird mortality during hauling and setting must reflect the number of hooks directly observed by scientific observers (not the number of hooks hauled whilst the observer is working).

7.189 Recently, where one observer is used, coverage of 60–80% of the set and 20–30% of the haul is generally achieved; where two observers are used, coverage of 85–100% of the set and 35–45% of the haul is generally achieved. In general, in areas where risk of incidental mortality is assessed as average to high (risk levels 3–5), the Working Group agreed that higher levels of observer coverage of both the haul and set would usually be appropriate. The recommended levels of observer coverage, related to assessed risk level, are incorporated into Table 7.16.

7.190 The Working Group confirmed the general approach, updated the framework to standardise the application of mitigation measures across subareas that are assessed as having the same risk level, and incorporated an assessment of recommended levels of observer coverage. The updated framework is set out in Table 7.17. The standardisation is also incorporated into SC-CAMLR-XXIII/BG/21 (the update of SC-CAMLR-XXII/BG/17).

7.191 In respect of the actual levels of risk adopted in SC-CAMLR-XXII/BG/17, no changes were suggested in SC-CAMLR-XXIII/BG/21. Some minor changes to distributional information have been corrected (see paragraph 7.183). It was noted that the risk levels published last year for Divisions 58.4.1 and 58.4.2 (SC-CAMLR-XXII, Annex 5, Table 6.9) were incorrect and should have been levels 2 and 3 respectively.

7.192 Thirty-five applications for new and exploratory longline fisheries, submitted by 13 countries, were received by CCAMLR in 2004. The areas for which these proposals were received were:

Subarea 48.6	Japan, Republic of Korea, New Zealand
Division 58.4.1	Chile, Republic of Korea, New Zealand, Spain, Ukraine
Division 58.4.2	Chile, Republic of Korea, New Zealand, Spain, Ukraine
Division 58.4.3a	Australia, Republic of Korea, Spain
Division 58.4.3b	Australia, Chile, Japan, Republic of Korea, Spain
Subarea 88.1	Argentina, Australia, New Zealand, Norway, Russia, South Africa, Spain, Ukraine, UK, Uruguay
Subarea 88.2	Argentina, New Zealand, Norway, Russia.

7.193 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-XXIII/BG/21. A summary of risk level, risk assessment, the Working Group's recommendations relating to mitigation measures, including fishing season and any inconsistencies between these and the proposals for new and exploratory longline fisheries in 2004, is set out in Table 7.16.

7.194 The only obvious inconsistency needing resolution is:

- The UK proposals for Subareas 88.1 and 88.2 note the intention to comply with the provisions of Conservation Measure 24-02 to permit day setting of longlines, and deploy streamer lines in accordance with the appendix to Conservation Measure 25-02. However, the status of compliance with Conservation Measure 25-02 is unclear, as is the intent to seek derogation to the night-setting requirements of this conservation measure by implementing the provisions of Conservation Measure 24-02, as approved last year in Conservation Measure 41-09.

7.195 The UK confirmed that it was its intention to comply with all necessary CCAMLR conservation measures, including Conservation Measure 25-02 in full, together with any such modifications as were adopted by the Commission.

7.196 Dr M. Naganobu indicated that Japan wished to maintain its proposal to fish in Subarea 48.6 from December to August inclusive (despite the fishing season last year having been restricted to 1 March to 31 August north of 60°S (Conservation Measure 41-04)) and noted that this extension to the fishing season would not conflict with the advice provided by ad hoc WG-IMAF.

7.197 In previous years, fishing proposals in high-latitude exploratory fisheries in subareas with average or less risk (risk levels 1–3) have obtained an exemption from the requirement of Conservation Measure 25-02 to set longlines at night (SC-CAMLR-XXII, Annex 5, paragraph 6.208). Such 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. Any vessel catching a total of three (3) seabirds was to immediately revert to night setting in accordance with Conservation Measure 25-02.

7.198 Also in recent years, fishing proposals in high-latitude exploratory fisheries in divisions with average risk (risk level 3) have obtained an exemption from the requirement to fish during a specified season where this is recommended (e.g. Conservation Measure 41-06). Such 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. Additionally, should a total of three (3) seabirds be caught by a vessel operating under the exemption, the vessel would cease fishing immediately and not be permitted to fish during the protected season for the remainder of the fishing year.

7.199 In reviewing the risk assessment framework, the Working Group suggested that in future, such exemptions should be considered within the risk assessment framework and should apply automatically on the basis of assessed risk level, rather than on a case-by-case basis as in the past. Advice on risk levels to which these exemptions should apply is noted in Table 7.16.

7.200 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 low to average risk. In all instances where the provisions of Conservation Measure 24-02 are applied, there remains the need for continued review of performance with respect to incidental mortality of seabirds during fishing operations. The Working Group recommended that any vessel operating under the provisions of this conservation measure, and which catches a total of three (3) seabirds, as defined in SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217, shall revert to night setting in accordance with Conservation Measure 25-02. Similar provisions were specified for the 2003/04 season in Conservation Measures 41-04, 41-05, 41-09, 41-10 and 41-11.

7.201 With respect to the prescription of a seabird by-catch level, the Working Group noted the successful implementation of the definition of the status of birds 'caught' (SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217). The Working Group recommended the continued use of the definition and requested feedback from scientific observers on the ability to apply this definition whilst at sea.

7.202 The Working Group recommended that reference to this definition be appended to each conservation measure which specifies maximum permitted levels of seabird by-catch. Failure to do so last year clearly created some confusion (e.g. COMM CIRC 04/18), which may have resulted in incorrect categorisation and reporting of the status of birds caught and released alive.

Other incidental mortality

Interactions involving marine mammals with longline fishing operations

7.203 One southern elephant seal (*Mirounga leonina*) mortality was observed on the *Janas* (Australia), fishing in Division 58.5.2. One incidental mortality of a whale was observed, possibly a minke whale (*Balaenoptera acutorostrata*) although its identification has yet to be confirmed. The whale was entangled in the mainline of the *Piscis* in Subarea 88.1 (WG-FSA-04/6 Rev. 1).

7.204 Interactions between seabirds and marine mammals and observed fishing operations for toothfish were reported for Subareas 88.1 and 88.2 for the years 2000 to 2002 (WG-FSA-04/42). Marine mammal captures were limited to two cetaceans (humpback whale and another small cetacean) that were tangled in lines. Both were released alive. These data had previously been reported to the Working Group.

Interactions involving marine mammals and seabirds with trawl fishing operations

Data for 2003/04

7.205 Marine mammals captured in icefish trawl fisheries for 2003/04 were summarised in WG-FSA-04/7 Rev. 1. In Subarea 48.3, no marine mammal captures were observed. In Division 58.5.2, three Antarctic fur seals were reported dead, recovered from the codend.

7.206 Eight trawl vessels targeting icefish were observed in the CCAMLR Convention Area in 2003/04 (WG-FSA-04/7 Rev. 1). 100% of vessels were observed. In Subarea 48.3, 87 seabirds were killed and 136 were released alive. The birds involved were mainly white-chinned petrels (68%) and black-browed albatrosses (24%). In Division 58.5.2, seven seabirds were caught and all were released alive (Table 7.18).

7.207 In Subarea 48.3, the Working Group noted that for four of the six vessels, mortalities of seabirds were 16–18 birds, close to the per-vessel limit of 20 birds. This was due to the active management of the fishery, whereby vessels received daily reports as they approached this limit.

7.208 In reviewing performance of vessels between years, the Working Group noted that the *Argos Vigo* consistently had a higher seabird by-catch rate than others (Table 7.18). Other vessels that had notably high by-catch rates in at least one year include *Sil, InSung Ho, Dongsan Ho, Robin M Lee* and *Betanzos*.

7.209 The Working Group noted that seabird mortality totals and rates of capture had substantially increased since the previous year. In the 2004 season, 87 birds were killed, more than double the 42 seabirds killed in 2003. Previously 68 birds were observed killed in 2002 and 92 in 2001. When scaled to fishing operation and catch limit in Subarea 48.3, it appeared that seabird mortality rates had increased. In 2004, 30 birds were killed per 1 000 tonnes (catch limit 2 887 tonnes), compared to 18 birds per 1 000 tonnes (catch limit 2 181 tonnes) in 2003, 12 birds per 1 000 tonnes (catch limit 5 557 tonnes) in 2002, and 14 birds per 1 000 tonnes in 2001 (catch limit 6 760 tonnes).

7.210 When expressed as the number of birds killed per trawl observed, a similar pattern emerges. In 2004, the mean number of birds killed per trawl was 0.37 birds (238 trawls), compared to 0.20 birds in 2003 (182 tows), 0.16 birds in 2002 (431 trawls) and 0.29 birds in 2001 (315 trawls).

7.211 The Working Group noted with concern that birds caught were likely to be breeding individuals, due to the timing of the fishery. This would therefore have a greater effect on populations of the species concerned, due to the disruption of breeding pairs, and likely death of chicks, as well as the removal of breeding-age individuals from the population.

7.212 The Working Group also noted that the 87 birds observed killed in trawling operations in Subarea 48.3 in 2004 is a substantially higher number than the 18 birds estimated killed in longline fishing operations in the same subarea in 2004.

7.213 The Working Group noted that the species concerned are all listed as globally threatened. The species reported killed include black-browed albatrosses (Endangered) and grey-headed albatrosses and white-chinned and southern giant petrels (Vulnerable). More black-browed albatrosses were killed in 2004 than in the previous three years, and a greater number of white-chinned petrels were killed in 2004 than in all years. The black-browed albatross population at South Georgia is currently decreasing at a rate of 4% per annum (WG-FSA-04/71).

7.214 Given these factors, the Working Group recommended a reduction in by-catch limits, at both the vessel level and for the wider icefish trawl fishery in Subarea 48.3. The following options were proposed:

(i) To reduce the per-vessel limit of seabirds from 20 birds killed per vessel to 10 birds killed per vessel.

or

(ii) To set vessel limits based on the threatened status of the seabird species. The Working Group recommended setting a limit for globally Endangered species (including black-browed albatrosses) at three (3) birds, and a second limit of five (5) birds for species listed as Vulnerable (including grey-headed albatrosses and white-chinned petrels). A limit for non-listed species would be set at 12, resulting in maintenance of the 20 bird limit per vessel.

and

(iii) To introduce an annual seabird mortality limit that would apply to all vessels in the icefish fishery in Subarea 48.3. It was noted that similar limits had been effectively employed to limit by-catch of skates, where the subarea limit was lower than the sum of the total of the individual vessel limits for vessels fishing in an area. The Working Group recommended a limit of 15 birds for Endangered species, and 25 birds for Vulnerable species. A total limit for each subarea would be 100 birds.

7.215 Means of employing area-specific total by-catch limits within a fishery were discussed, with recognition of the desirability of allowing increased fishing access to vessels that were shown to perform better than others in limiting seabird mortalities.

7.216 In further discussion Dr Agnew observed that while supportive of the aims of paragraph 7.214, the considerable current difficulties of devising effective mitigation of seabird by-catch in this fishery in Subarea 48.3 meant that options (i) and (ii) above could have the effect of prematurely and unnecessarily closing the fishery to many vessels, including those with good past records. He indicated, however, that option (iii), coupled with sensitive management of its application, might be an appropriate response to consider at this stage. He believed that all three options should be considered as alternatives rather than suggesting that option (iii) should be regarded as additional or complementary to options (i) and (ii).

7.217 Drs Constable and R. Holt (USA), while recognising the potential difficulties posed for the management of this fishery by some of the options set out in paragraph 7.214, nevertheless felt that all of these options should be retained for further discussion at the Scientific Committee.

Mitigation measures and experiences

7.218 All vessels in the icefish fishery in Subarea 48.3 used a variety of mitigation measures in attempts to reduce the number of bird mortalities. These included:

(i) Streamer lines – a variety of different streamer lines (paired and single) were trialled, with one vessel also trialling the Brady bird baffler. Observers reported that these devices were of little use in reducing seabird activity around the codend, with some reporting birds being tangled in the streamers or being attracted to them. The main problem reported by observers was the fact that the effective coverage was not far enough to get to the codend, which can be up to 50 m away from the stern of the vessel. There were also problems with the streamers being tangled in the trawl warps.

(ii) Acoustic devices – bells and strings of cans were used to scare birds away from the vessel during shooting and hauling, but were found to be ineffective.

(iii) Water jets – high-pressure water jets were used on several occasions, but were only effective up to 5 m from the stern of the vessel. This distance is not far enough to prevent birds from landing on the codend. It was also noted that increasing the pressure of the water jet could also harm birds or force them onto the net.

(iv) Net weights – several observers reported the use of weights, ranging from a few kilograms on the codend up to 500 kg on each wing of the net, to reduce the amount of time the net was at the surface during shooting and hauling, and thereby reducing the opportunities for birds to get caught in the mesh. It was not clear how effective these experiments had been.

(v) Net cleaning – most observers felt that cleaning the net before shooting was one of the most effective methods of reducing birds from being attracted to the net.

7.219 Specific measures trialled on the *Robin M Lee* in 2003/04 in Subarea 48.3 were reported in WG-FSA-04/80. Three birds were killed, entangled during the shooting of the net following the use of fish oil to deter birds, some of which fell onto the net before deployment. Measures to avoid birds becoming entangled during setting and hauling were examined. Tori lines with an aerial extent of 140 m were recommended, to enable coverage of the zone where large meshes are exposed at the surface during setting. The large meshes (200–800 mm) are considered to pose greatest risk to seabirds. Binding of the body of the net at 2 m intervals down the net using biodegradable string was trialled, to mitigate seabird entanglements during shooting of the net. This was used with the intention of increasing the net sink rate as it reduces open mesh available for seabirds to become entangled in. The bindings were designed to break when trawl doors opened, but in the four sets made the bindings were insufficiently strong to avoid the net opening at the surface. Recommendations on deployment of the method in the future were made.

7.220 A proposal was submitted to test these mitigation techniques in Subarea 48.3 in 2004/05, requiring relaxing of the restriction on seabird mortality to 40 birds for the vessel (Appendix to WG-FSA-04/80). The Working Group supported the proposal.

7.221 WG-FSA-04/79 reported the results of the first attempt to compare the effectiveness of mitigation measures to reduce seabird mortalities resulting from strikes with warp cables on a factory trawler. Both streamer lines and a warp scarer were significantly more effective at reducing the rate of seabird contacts with warp cables (0.29 and 0.93 heavy contacts per hour respectively) than the Brady bird baffler and a control of no deterrent (9.71 and 17.46 heavy contacts per hour respectively). Seabird mortalities resulting from strikes reflect this same hierarchy (control 0.70; Brady bird baffler 0.14 birds/haul; warp scarer 0.06 birds/haul; and streamer lines 0 birds/haul). The steamer line deterrent performed marginally better than the warp scarer. Economic aspects of the deterrent devices were also discussed with minimal costs identified for warp scarers and streamer lines.

7.222 Dr E. Melvin (USA) reported that in a limited trial in the Alaskan pelagic trawl fishery in the Bering Sea, approximately 1 000 gallons of pollock oil was discharged into the starboard discharge plume for 15 minutes to determine if seabirds avoided fish oil. The fish oil appeared to eliminate seabirds from the starboard sector of the vessels out beyond 100 m for at least 30 minutes post application. This approach should be further tested in carefully designed experiments as a mitigation alternative provided potential detrimental effects to seabirds can be ruled out. The Working Group cautioned that further ad hoc trials of fish oil should be discouraged.

7.223 The USA submitted an annotated bibliography of research on trawl operations and seabird interactions and of cooperative research programs between fishing operators and researchers to address seabird mortalities in trawl fisheries (WG-FSA-04/47). The Working Group commended the initiative, noting that a similar review of research on longline mitigation would be useful. The Working Group encouraged the development of an internet-based bibliographic summary of research on mitigation of seabird mortality.

7.224 The Working Group noted that the UK had submitted a proposal to conduct exploratory bottom trawling for icefish in Subarea 48.3 (CCAMLR-XXIII/16) in order to mitigate the effects of trawl fishing using current fishing gear (see SC-CAMLR-XXII, Annex 5, paragraphs 6.242 and 6.243).

Interactions involving marine mammals and krill fishing operations

2002/03 season

7.225 Last year, anecdotal reports indicated that some trawlers fishing for krill frequently caught Antarctic fur seals, some of which were killed (SC-CAMLR-XXII, Annex 5, paragraphs 6.226 and 6.229). Further evaluation for Subarea 48.3 required reports from scientific observers, which were unavailable at that time.

7.226 In Subarea 48.3 in 2002/03, international observers were present on 6 of 9 (66%) of krill fishing cruises.

7.227 Observers on board two vessels reported incidental mortalities of Antarctic fur seals: *Dongsan Ho* – 25 dead, 4 released alive; *Top Ocean* – 2 dead, 11 released alive. The observer on board the *Dongsan Ho* attributed the high seal mortality to a lack of experience as the vessel was new to the fishery. In an attempt to reduce the seal mortality, diamond-shaped holes were cut across the net and the winch speed was increased during shooting to allow the net to drop vertically through the water. The two dead seals from the *Top Ocean* drowned during the same haul, which occurred when the net could not be retrieved in time due to a mechanical malfunction (WG-FSA-04/7 Rev. 1).

7.228 Overall, for Area 48 in 2002/03, combining data from scientific observers and Reports of Members' Activities, 114 fur seals were caught, 53 being killed and 61 released alive.

2003/04 season

7.229 During the 2003/04 season, one krill trawl operation was observed in Area 48 on the US-flagged vessel *Top Ocean* by a Ukrainian international scientific observer. A total of 683 trawls was conducted, with 521 (76%) being observed (WG-FSA-04/7 Rev. 1).

7.230 A total of 142 fur seals was observed killed and 12 seals were released alive. The vessel used several different net configurations described in the observer's cruise report in an attempt to reduce seal by-catch.

7.231 In addition, the UK deployed scientific observers for short periods (2–4 weeks) between June and August on 6 of 9 vessels fishing for krill in Subarea 48.3 (WG-FSA-04/83). This report, chiefly focusing on entrapment mitigation issues, indicated that a minimum of 292 fur seals were entrapped (185 on *Top Ocean*, 83 on *InSung Ho*, 13 on *Nitake Maru*, 11 on *Atlantic Navigator*, none on *Esperanza* and *Konstruktor Koshkin*).

7.232 Some inconsistencies were identified in the information submitted to CCAMLR from the vessel *Top Ocean*. In particular, the number of seals reported as entrapped was inconsistent among the Captain's cruise report, the Captain's daily log, the CCAMLR observer's daily log and the observations of the UK observer.

7.233 The international observer was on board the vessel *Top Ocean* from 21 February to 21 September 2004. Trawling for krill was conducted in Subarea 48.3 from 8 to 15 June and 23 June to 2 August 2004. The UK observer was present on the vessel in Subarea 48.3 from 20 June to 20 July 2004.

7.234 The international observer reported that fur seals were always present in association with the vessel in Subarea 48.3; however no seal entrapments were reported on trawls occurring from 8 to 15 June 2004. Of the 142 observed Antarctic fur seal mortalities on the *Top Ocean*, 138 were reported between 23 June and 2 August 2004, coincident with the presence of the UK observer.

7.235 Mitigation measures were introduced on the vessel on 3 July 2004, including several modifications of the two trawl nets. The international observer's summary report indicated that only three seal mortalities were observed after successful implementation of the mitigation measures. However, the daily log of this observer indicated that 34 seals were killed between 3 July and 2 August 2004. Notes in the mitigation section of the CCAMLR observer's summary report refer to seal mortality on trawls that were not included in the daily log of the observer.

7.236 Due to the unknown extent of incidental mortality associated with the krill trawl fisheries, the Working Group recommended that the Commission require an observer on board krill trawl vessels to guide future management efforts. The Working Group noted that reliable data on seal incidental mortality can only be obtained through scientific observers. Current observer data are inconsistent and inadequate for this purpose. It is essential that observer data forms are completed in an accurate, consistent and comprehensive manner, in particular the sections addressing incidental mortality.

7.237 The Working Group noted that it would be helpful if the UK submitted the original data collected by its observers in 2004 to the CCAMLR Secretariat.

Mitigation

7.238 As recommended by the Working Group in the 2003 report of WG-FSA (SC-CAMLR-XXII, Annex 5, paragraph 6.230), some Members investigated and documented the use of mitigation devices to reduce seal entrapment in krill trawl nets. The Working Group commended these parties for their efforts and requested them to continue reporting on the efficacy of seal-exclusion devices.

7.239 In 2002/03, Japan tested two seal-exclusion methods (NISSUI and MARUHA) on two krill trawl ships, described in WG-FSA-04/17. The NISSUI system consisted of an escapement panel with large mesh size (1.6 m^2), fitted on the top of the net with an area of 6 x 4 m; a sloping panel of 300 mm mesh was fitted below the escapement panel. The MARUHA net system consisted of an escapement hatch (1.5 x 2.1 m) in the top of the net; a sloping panel made of 150–200 mm mesh was fitted below the hatch. Both systems allow fish to pass through to the codend, while guiding large organisms to the escapement panel or hatch in the top of the net. In the description of the seal-exclusion devices, a recommendation was made that the wings of the trawl net are put to one side and the mouth of the trawl net is closed when setting or hauling. There were no records of seal entanglements in the 2002/03 krill fishing season on either vessel.

7.240 Dr Naganobu indicated that the NISSUI and MARUHA systems had both proved very effective on vessels in the Japanese krill fishery; he encouraged other vessels fishing for krill to consider using these systems.

7.241 The UK submitted a report from scientific observers on krill fishing vessels around South Georgia (WG-FSA-04/83). Various methods were tested to mitigate seal mortality associated with krill trawls, including physical barriers, physical barriers with escape hatches, prefabricated seal-exclusion devices and modification of gear configuration. Several of the tested methods were effective at reducing or preventing seal mortality on individual vessels after the exclusion methods were implemented, as compared to seal entrapments recorded before the exclusion measures were implemented.

7.242 The Working Group recommended that the information on various seal-exclusion devices described in WG-FSA-04/17 and 04/83 be combined into a single document describing each of the methods tried, including information regarding their success. This paper should be distributed to CCAMLR Members and other interested organisations to encourage further testing of the effectiveness of the various methods for preventing seal mortality or injury associated with krill trawl fishing.

7.243 Given the increasing evidence of seal entrapment in krill fisheries, and the apparent efficacy of some of the seal-exclusion methods tested this year, the Working Group recommended that krill fishing vessels employ gear modifications that reduce seal entrapment, mortality and injury. At this time, a particular design cannot be recommended due to the lack of sufficient data on any specific method. The Working Group advised Members to exercise caution in design and implementation of seal-exclusion devices based on experiences with marine mammal exclusion devices used outside CCAMLR waters, as it is possible that animals escaping from the net through some exclusion devices are seriously injured. The Working Group discouraged use of seal-exclusion devices that would allow moribund animals to fall out of the bottom of the net, as this would lead to inaccurate estimates of seal incidental mortality.

Other business

7.244 Prof. Croxall and Mr Baker were retiring as Convener and Deputy Convener respectively at the end of the present meeting. They were thanked for all their work for ad hoc WG-IMAF over many years. The Working Group recommended that Ms Rivera and Mr N. Smith (New Zealand) should be appointed as Co-conveners of WG-IMAF.

Advice to the Scientific Committee

General

7.245 The plan of intersessional work (Appendix D) summarises requests to Members and others for information of relevance to the work of the Working Group (paragraphs 7.1 to 7.3). 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 7.4).

Incidental mortality of seabirds during regulated longline fishing in the Convention Area in 2004

7.246 (i) For Subarea 48.3, the total estimated seabird by-catch in 2004 was 18 birds at a rate of 0.001 birds/thousand hooks, a slight increase compared with last year but values are still the second lowest yet recorded for this area (paragraphs 7.8 and 7.9 and Tables 7.1 to 7.3).

(ii) Within the South African EEZ in Subareas 58.6 and 58.7, the total estimated seabird by-catch was 39 birds at a rate of 0.025 birds/thousand hooks, increased values over the previous two years. The total estimated seabird by-catch rate is only 20% of that in 2001 (paragraphs 7.10 and 7.11 and Tables 7.1 to 7.3).

(iii) A single seabird was observed killed in Subarea 88.1 after seven successive years of zero incidental mortality. No incidental mortality of seabirds was observed in Subarea 88.2 (for the third successive year) (paragraph 7.12), nor in Subarea 48.6, Divisions 58.4.3b, 58.5.2 (first year of longline fishing in these areas) and 58.4.2 (for the second successive year) (paragraph 7.13 and Tables 7.1 to 7.3).

(iv) These totals represent slight increases in the estimated seabird by-catch in parts of the Convention Area, compared with the data reported in the last two years (paragraph 7.9 and Table 7.3).

7.247 Historical data from longline fishing in the French EEZs in Subarea 58.6 and Division 58.5.1 was received for the 2001/02 and 2002/03 fishing seasons (paragraphs 7.16 to 7.19 and Tables 7.5 to 7.8). The reported totals of birds killed in these two years are based on retention of all birds brought on board each vessel, rather than on subsampling by observing some proportion of the total hooks set (paragraphs 7.20 and 7.21).

(i) In Subarea 58.6 (Crozet) in 2001/02, 1 243 birds were reported killed during setting of 7.4 million hooks, at a rate of 0.167 birds/thousand hooks. In 2002/03, 720 birds were reported killed during the setting of 6.6 million hooks, at a rate of 0.109 birds/thousand hooks, a decrease in annual by-catch rate of 53% (paragraphs 7.16 to 7.19).

(ii) In Division 58.5.1 (Kerguelen) in 2001/02, 10 814 birds were reported killed during setting of 11.5 million hooks, at a rate of 0.936 birds/thousand hooks. In 2002/03, 13 926 birds were reported killed during the setting of 26.9 million hooks, at a rate of 0.518 birds/thousand hooks, a decrease in annual by-catch rate of 45% (paragraphs 7.16 to 7.19).

7.248 Intersessionally, by-catch data analysis, collaborative interactions and experiments formed the basis for technical recommendations for changes to fishing practices (paragraphs 7.35 and 7.36).

(i) France commissioned an analysis of the 2001/02 and 2002/03 data (paragraph 7.22). Findings included: seabird mortality was mainly of white-chinned petrels (93%) in October and between January and April, followed by grey petrels (5%) caught between April and November; higher seabird catch rates occurred around Kerguelen, the more heavily fished area; autoline vessels caught many times more birds than vessels using the Spanish system; and a significant part of the mortality of white-chinned and grey petrels is explained by season, area and method of fishing.

(ii) Collaborative interactions and mitigation experiments (paragraph 7.35) included: testing of IWLs, technical exchange of mitigation information, evaluation of coloured hookline, and initiation of a study on the population status of white-chinned and grey petrels on Kerguelen and Crozet.

7.249 In 2004, existing fishing practices (on offal discharge, night setting, line weighting, and streamer lines) were revised to further require: use of two streamer lines that adhere to the provisions of Conservation Measure 25-02, fishery closure during February, use of white-coloured hookline and a line-weighting regime of 8 kg/120 m on autoliners (paragraphs 7.39 and 7.40).

7.250 Data from the 2003/04 fishing season were also submitted to CCAMLR (paragraphs 7.23 to 7.30) with data to February 2004 reported as for the two previous years. From March onward, data were recorded as by-catch observed on a proportion of the hooks set. Combining the totals of birds reported killed during the first half of the fishing season with the number of birds estimated killed in the second half of the season indicates that 342 birds and 3 666 birds were killed in Subarea 58.6 and Division 58.5.1 respectively (paragraph 7.28 and Tables 7.9 and 7.10). Compared to last year this represents reductions in birds killed of 42.5% (66.4% if reported data only are used) in Subarea 58.6 and 73.7% (85.1% if reported data only are used) for Division 58.5.1 (paragraph 7.29 and Table 7.11).

7.251 Whereas the changes in fishing regulations and practices and subsequent reductions in number of birds killed and by-catch rates are substantial, continued improvements are possible and necessary as these rates and totals still remain at levels which are a cause of serious concern and threat to the populations involved (paragraphs 7.36 and 7.42 to 7.44). It is recommended that:

(i) IWL and weighting regimes that will ensure that longlines sink at >0.25 m/s be used (paragraph 7.45(ii));

(ii) standards for streamer lines as outlined in Conservation Measure 25-02 be complied with (paragraph 7.45(iii));

(iii) observer coverage and duties should be sufficient to ensure that at least 25% of hooks are observed on every vessel (paragraph 7.45(v));

(iv) fishery closures in high-risk periods during seabird breeding seasons be maintained (paragraph 7.45(vi));

(v) France supply 2000/01 data so that a comprehensive conspectus of the history of seabird by-catch in this fishery is possible (paragraph 7.34);

(vi) France conduct an analysis to evaluate vessel-specific factors contributing to high levels of by-catch (paragraph 7.25).

Implementation of Conservation Measures 24-02,
25-02, 25-03, 41-09 and 41-10

7.252 Reported compliance with the streamer line component of Conservation Measure 25-02 dropped considerably since last year, possibly due to lack of awareness of the changes to the measure. The majority of the vessels that failed to fully comply this year would have complied under the previous specifications (paragraph 7.58). Vessel operators should be reminded of the new specifications. Also, it is of concern that for the first time since a single incident in 2002/03, two vessels in Subareas 88.1 and 88.2 failed to comply with the offal discharge prohibition. Compliance with Conservation Measure 25-02 is summarised as follows:

(i) Streamer lines – compliance with streamer line design was 64% compared with 92% last year (paragraph 7.47). Vessels in Subareas 48.6, 58.6, 58.7 and Divisions 58.4.2, 58.4.3b and 58.5.2 used streamer lines on all sets; in Subarea 48.3, seven of 16 vessels undertook sets without using a streamer line; and in Subareas 88.1 and 88.2, six vessels undertook some sets without using a streamer line (paragraph 7.49 and Table 7.12).

(ii) Offal discharge – in Subareas 88.1 and 88.2, two vessels did not comply with requirements to not discharge offal (Conservation Measures 41-09 and 41-10). One vessel in Subarea 48.3 and one vessel in Subarea 58.6 were observed discharging offal during the set (paragraphs 7.50 and 7.51 and Table 7.13).

(iii) Discard of hooks – fishing gear, snoods and hooks, were occasionally being disposed of at sea on eight vessels. Hooks were present in discards on eight vessels, a daily occurrence on one of them (paragraph 7.52).

(iv) Night setting – in Subareas 58.6 and 58.7 compliance was 83%, compared to 98 and 99% in the past two years; in Division 58.5.2 compliance was 99%; in Subarea 48.3 compliance was 98% (paragraph 7.53).

(v) Line weighting (Spanish system) – in Subarea 48.3 compliance was 87% compared to 100% last year; the single Spanish-system vessel fishing in Subareas 58.6 and 58.7 fully complied (paragraph 7.55).

(vi) Line weighting (autoline system) – the requirement to achieve a line sink rate of 0.3 m/s when fishing in daylight in Subareas 48.6, 88.1 and 88.2 and Division 58.4.2 was met by all vessels (paragraph 7.57 and Figure 7.1).

7.253 In relation to overall compliance with Conservation Measure 25-02, 13 of 40 vessels (33%) fully complied with all measures at all times throughout the Convention Area, compared to 48% last year (paragraph 7.61). Some vessels failed to comply by small margins and it was re-emphasised that vessels should be advised to exceed the standards to prevent compliance failure.

7.254 With respect to Conservation Measure 25-03, four of eight vessels did not comply with the prohibition of discharge of offal during the shooting and hauling of gear. This level of compliance is not as high as 2003, when only two vessels discharged offal (paragraph 7.62 and Table 7.14).

Revision of Conservation Measures 24-02 and 25-02 and related matters

7.255 With respect to future improvements to Conservation Measure 25-02:

(i) consistently collected data on the aerial extent of the streamer line is a key requirement for improving this element of the conservation measure (paragraph 7.66);

(ii) research on the sink rate of externally weighted autolines is essential to allow mandatory line-weighting regimes for autoliners to be included in the conservation measure (paragraph 7.93 and Figure 7.2).

7.256 However, with respect to Conservation Measure 24-02, the success of trials of IWLs, reducing white-chinned petrel by-catch by 98% in 2002 and 92% in 2003 in New Zealand areas comparable to the highest risk levels in the Convention Area (paragraph 7.74), coupled with successful trials in Division 58.5.1 (paragraph 7.76) enables a protocol for using IWLs in new and exploratory fisheries to be added to the conservation measure (paragraphs 7.94 and 7.95).

7.257 The rationale for this new element of Conservation Measure 24-02 and other proposed changes to the measure are described in paragraphs 7.95 to 7.110.

7.258 The Working Group supported a request for exemption from night-setting requirements for autoline vessels operating in Division 58.5.2 in 2005, subject to the conditions proposed in paragraph 7.86.

Assessment of incidental mortality of seabirds during IUU longline fishing in the Convention Area

7.259 The methods used to estimate seabird by-catch associated with IUU fishing were the same as revised and adopted last year. IUU removals were reported for the first time from Division 58.4.3 and this was allocated the same seabird by-catch rate as Division 58.4.4 (paragraphs 7.113 to 7.115).

7.260 The much lower estimates of IUU toothfish removals are directly reflected in the estimates of IUU seabird by-catch which, at 5 311 birds (95% confidence interval 4 352–14 166 birds) is the lowest ever reported for the Convention Area and 30% less than the value for 2003 (paragraph 7.117 and Table 7.15). Full data, including all historical data, are provided in SC-CAMLR-XXIII/BG/23.

7.261 Nevertheless, the Working Group concluded that even these reduced levels of IUU seabird by-catch were of substantial concern and likely unsustainable for some of the populations concerned (paragraph 7.121). The Commission was encouraged to continue to take action in respect of seabird mortality caused by IUU fishing (paragraph 7.122).

Incidental mortality of seabirds during longline fishing outside the Convention Area

7.262 New data on mortality of seabirds outside the Convention Area relevant to fisheries and/or seabirds within the Convention Area was presented as follows:

(i) In 2002 the Chilean domestic fishery for *D. eleginoides* caught 437 seabirds at a rate of 0.047 birds/thousand hooks; all were white-chinned petrels doubtless from breeding populations in the Convention Area (paragraph 7.125).

(ii) Chilean longline vessels which operate both in Subarea 48.3 and in the Chilean EEZ relax seabird mitigation matters in the latter, partly because regulations are not mandatory and partly because they appear unable to use the CCAMLR line-weighting provisions in the areas where they fish domestically (paragraph 7.124).

(iii) An exploratory longline fishery in Uruguay using modified Spanish-system gear killed 2 175 seabirds, including seabirds from the Convention Area, at very high by-catch rates; although the fishery in Uruguay is discontinued, similar fishing practices may be used elsewhere in the region (paragraph 7.126).

(iv) New Zealand summarised seabird by-catch data from major fisheries within its EEZ between 2000/01 and 2002/03. By-catch rates in tuna fisheries were low (0.026–0.048 birds/thousand hooks) due to good compliance with mitigation measures; rates in ling fisheries improved from 0.218 to <0.08 birds/thousand hooks due to increased line-weighting requirements. Squid trawl fishery by-catch rates ranged from 0.058 to 0.097 birds/trawl. Although most birds caught originated from New Zealand, some white-chinned and grey petrels were probably from the Convention Area (paragraph 7.127).

(v) Brazil was requested to supply details of by-catch rates in fisheries in its EEZ, especially as they affect bird species breeding in the Convention Area (paragraphs 7.128 and 7.129).

Research into the status and distribution of seabirds at risk

7.263 In response to the revised reporting format devised intersessionally, national research summaries and details of data on status, trends and distribution (at sea) of albatross and petrel populations had been received only from Australia, New Zealand and the USA (paragraph 7.130). Reports from other Members were essential to enable the linking of data on fishing effort and seabird by-catch with population dynamics and foraging range. Argentina, France, South Africa and the UK were particularly urged to make relevant data available as soon as possible (paragraphs 7.130 to 7.134).

7.264 There had been no changes since last year to the global conservation status (as reviewed annually by BirdLife International on behalf of IUCN) of albatross and petrel species of relevance to the Convention Area (paragraph 7.135).

7.265 New data on foraging range and areas of grey-headed, black-browed and Campbell albatrosses are summarised in paragraphs 7.141 to 7.143. Data in a global review by BirdLife International of remote-recorded at-sea distributions of albatrosses and petrels will be of considerable relevance to CCAMLR and BirdLife is requested to provide results from appropriate analyses (paragraphs 7.144 and 7.145).

7.266 Data on long-term population trends of Campbell (1–2% per annum increase) and grey-headed (3–5% per annum decrease) albatrosses at Campbell Island, of grey-headed, black-browed and wandering albatrosses (all stable but very small populations) at Macquarie Island and of black-browed albatrosses in southern Chile (increasing 1999 to 2001) are reported (paragraphs 7.146 to 7.150). Summary data are incorporated into SC-CAMLR-XXIII/BG/22.

7.267 A comprehensive survey of all colonies of black-browed, grey-headed and wandering albatrosses throughout South Georgia indicated:

(i) continuing declines for all species;

(ii) that trends at the Bird Island colonies monitored annually are representative of the overall South Georgia population;

(iii) that the rate of decline in wandering albatrosses may be increasing (paragraphs 7.151 and 7.152).

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

7.268 Information was reported on current international initiatives under the auspices of:

(i) ACAP – now in force; CCAMLR attending inaugural meeting as observer, tabling paper summarising work of relevance to ACAP and hoping to develop close links (paragraphs 7.155 to 7.158);

(ii) FAO (NPOA-Seabirds) – noting the adoption of plans by New Zealand and Falkland/Malvinas Islands, the completion of a draft plan by Brazil and progress towards plans by Chile and Taiwan (paragraphs 7.161 to 7.163);

(iii) RFMOs – recollecting renewed attempts last year for more effective collaboration (SC-CAMLR-XXII, paragraph 5.28), progress with the main tuna commissions was regarded as discouraging (paragraphs 7.165 to 7.173);

(iv) NGOs – new initiatives with Southern Seabird Solutions and BirdLife International of considerable interest to CCAMLR were commended and Members urged to collaborate (paragraphs 7.174 to 7.177);

(v) the potential importance of feedback to CCAMLR from the forthcoming Fourth International Fisheries Observer Conference was noted (paragraph 7.179).

Incidental mortality of seabirds in relation to new and exploratory fisheries

7.269 Of the 29 applications for exploratory longline fisheries for 2003/04, 15, relating to Divisions 58.4.2 (1), 58.4.3b (1) and Subareas 48.6 (1), 88.1 (11) and 88.2 (1) were undertaken (paragraph 7.184).

7.270 Only in Subarea 88.1 was any seabird by-catch (1 bird) reported and this cannot be attributed to any failure of compliance with the suite of mitigation measures employed, which remain highly effective at avoiding seabird by-catch in these areas (paragraph 7.185).

7.271 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 as SC-CAMLR-XXIII/BG/21. There were no changes this year to levels of risk (paragraphs 7.181 to 7.183 and 7.191 and Figure 7.3).

7.272 However, a substantial review of the summary presentation of advice to simplify and improve consistency was undertaken and incorporated into SC-CAMLR-XXIII/BG/21 and is summarised in Table 7.16 (paragraphs 7.186 to 7.190).

7.273 The 35 proposals by 13 Members for new and exploratory fisheries in seven subareas/divisions of the Convention Area in 2004/05 were addressed in relation to the advice in SC-CAMLR-XXIII/BG/21 and Table 7.17. The results, summarised in Table 7.16, indicate that, with the single potential inconsistency resolved at the meeting, all are in conformity with advice relating to incidental mortality of seabirds (paragraphs 7.194 and 7.195).

7.274 Issues relating to:

(i) exemptions from setting longlines at night;

(ii) exemptions in respect of recommended closed seasons;

(iii) maintaining maximum permitted seabird by-catch levels as in Conservation Measure 24-02, with reversion to the provisions of Conservation Measure 25-02 when these are reached;

(iv) including reference to the definition of birds caught (as adopted last year) in all relevant conservation measures;

are addressed in SC-CAMLR-XXIII/BG/21 and/or in paragraphs 7.197 to 7.202.

Interactions involving marine mammals and seabirds and trawl finfish fishery operations

7.275 Three Antarctic fur seals were reported killed in the icefish fishery in Division 58.5.2. The only seabird mortality observed in trawl fishing operations in 2003/04 was in the icefish fishery in Subarea 48.3 where 87 seabirds were killed and another 136 released alive (paragraph 7.206 and Table 7.18).

7.276 In this fishery, following reduction in total birds killed in each of the last three years, values had more than doubled in 2004. Mortality rates were nearly double those last year (paragraphs 7.209 and 7.210 and Table 7.18).

7.277 Despite extensive attempts to devise and improve mitigation measures for use in this fishery, limited success was reported (paragraphs 7.218 and 7.219).

7.278 Taking into account the increase in by-catch, the status of the birds killed and the continued difficulties with mitigation, the Working Group made various suggestions as to how the situation might be improved, including:

(i) a reduction in the vessel seabird by-catch limit;

(ii) an overall seabird by-catch limit for all vessels in this fishery;

(iii) supporting an application for further trials of mitigation measures in 2004/05, including a relaxation of the vessel seabird by-catch limit (paragraphs 7.211 to 7.217).

Interactions involving marine mammals and krill fishing operations

7.279 Revised data for 2002/03 indicate that a minimum of 114 Antarctic fur seals were caught in krill fishing operations in Area 48, 53 of which were killed and 61 released alive (paragraph 7.228).

7.280 Data for 2003/04 comprise a report from Area 48 of the international scientific observer on the *Top Ocean* which records 154 seals entrapped, of which 142 were killed and reports from UK observers on six vessels (including *Top Ocean*) in Subarea 48.3 which indicated entrapment of 292 seals (paragraphs 7.229 to 7.231).

7.281 A variety of mitigation devices, including those developed by Japan in recent years and tested in 2002/03, were used on vessels fishing for krill (paragraphs 7.238 to 7.241). Each device either greatly reduced or eliminated entrapment of fur seals (paragraphs 7.239 to 7.241).

7.282 The Working Group recommended that:

(i) information on all devices should be combined and circulated to CCAMLR Members and other interested parties (paragraph 7.242);

(ii) every vessel fishing for krill should employ a device for excluding seals or facilitating their escape from the trawl net (paragraph 7.243);

(iii) observers should be required on krill trawl vessels to collect reliable data on seal entrapment and on the effectiveness of devices used to mitigate this (paragraph 7.236);

(iv) noting experiences on the *Top Ocean* this year (paragraphs 7.232 to 7.235), data forms should be completed accurately, consistently and comprehensively by all observers (paragraph 7.236);

(v) the UK be requested to submit their observer data to the Secretariat (paragraph 7.237).

Other

7.283 Ms Rivera and Mr Smith should be appointed a Co-conveners of WG-IMAF, following the retirements of Prof. Croxall and Mr Baker.

ILLEGAL, UNREGULATED AND UNREPORTED (IUU) FISHING IN THE CONVENTION AREA

8.1 WG-FSA identified the following issues on IUU fishing:

(i) development of standard methods for estimating total removals of toothfish inside and outside the Convention Area including, where applicable, CCAMLR, national and IUU catches;

(ii) review of compliance-related estimates of IUU catches in the Convention Area and estimates of total toothfish removals for both inside and outside the Convention Area.

8.2 With respect to the first issue, the Working Group suggested that intersessionally further work could be done on the practical application and development of models to all fishing grounds with adequate levels of Monitoring Control and Surveillance (MCS) activities.

8.3 Two models were considered, the Agnew–Kirkwood model originally presented in WG-FSA-02/4 and a model described in WG-FSA-04/63. Similar to the Agnew–Kirkwood model, the new model uses the distribution of observed IUU activity and the pattern of observational effort to provide an estimate of the level of IUU activity that occurred. Simulation studies presented in WG-FSA-04/63 have indicated that the two methods produce quantitatively similar results in cases where there are more than zero observations. The study indicated that the new model could be developed to produce a distribution of estimated catch as well as a point estimate.

8.4 The Working Group also considered that the existing compliance-data-based methodology could be further improved if each of the compliance-related reports used for the calculation of IUU catches be accompanied with additional information to aid in the interpretation of the estimated IUU catch. In particular, an estimate of the level of observation directed to IUU activity would aid in understanding the number of vessels sighted and reported.

8.5 The Working Group recommended that SCIC be asked to develop a measure of the proportion of fishable time and fishable area which could be considered to be under effective monitoring for IUU activity. This measure would include the proportions of fishable season and region that are monitored by fishery patrols, the fishery and remote observation.

8.6 WG-FSA further recommended that SCIC be asked to consider whether qualitative information could be provided for each of the regions suitable so that they can be classified as either unmonitored, slightly monitored or heavily monitored with an indication as to whether the level of monitoring has increased or decreased significantly from the previous year.

8.7 With reference to paragraph 8.1(ii), the Working Group investigated possible causes in the observed drop in IUU catch estimates for toothfish in the Convention Area in relation to the decrease of CDS-reported catches from high seas outside the Convention Area.

8.8 Among possible reasons for declining CDS-reported catches from outside the Convention Area, in particular in Areas 47, 51 and 57, the Working Group considered:

(i) stocks may have become depleted;

(ii) re-flagging of fishing vessels to Flags which are not parties to the CDS, i.e. resulting in fewer CDS reports received;

(iii) impact of CCAMLR measures on the reduction of IUU fishing and continued monitoring of the world trade in toothfish.

8.9 The Working Group also considered that possible reasons for declining estimates of IUU catches in the Convention Area could include:

(i) shifting of IUU fishing activity to areas outside of fishing grounds where licensed vessels operate and surveillance is most intense, e.g. BANZARE Bank area, which results in fewer observations used to estimate IUU catches;

(ii) inadequacy of current level of MCS activities in distant parts of the Convention Area;

(iii) impact of CCAMLR measures on the reduction of IUU fishing and continued monitoring of the world trade in toothfish.

8.10 Based on the information available, the Working Group found it impossible to identify which of these reasons were most likely responsible for the decline. It decided to use estimates of total removals of toothfish, including estimates of IUU catches in the Convention Area, as contained in Tables 3.2 and 3.3. WG-FSA noted that if additional data justifying the revision of the abovementioned estimates were available at the 2005 meeting of WG-FSA, these estimates should be revised.

8.11 WG-FSA further considered whether new information on toothfish distribution and catches on high seas outside the Convention Area could be used to verify catches previously reported via CDS from these areas but considered by the Scientific Committee, in particular for Area 51, as most likely to have been taken illegally from inside the Convention Area (SC-CAMLR-XX, paragraphs 2.12 and 2.13).

8.12 WG-FSA has in the past expressed some doubt over whether Areas 47, 51 and 57 could support the level of catches apparently reported from them, given that there is limited seabed area within the relevant depth ranges for toothfish. The only information from Area 51 that the Working Group had to make an assessment of this problem is WG-FSA-04/19, which reported that average CPUE in Area 51 was 0.042 kg/hook which would equate to a daily catch rate of less than 0.4 tonnes/day (setting a maximum of 10 000 hooks/day). Catch rates reported in CDS data for 2003 for Areas 47, 51 and 57 are an order of magnitude higher than this, about 3 tonnes/day with a range from 2 to 6 tonnes per day. For comparison, estimated catch rates in the IUU fisheries in Divisions 58.5.1, 58.5.2 and Subareas 58.6 and 58.7 are between 2 and 5 tonnes per day (Table 3.2).

8.13 IUU catches in the Convention Area estimated previously by WG-FSA with the same method are presented in Table 8.1. From the table, the total IUU catch from the Indian Ocean sector over the period from 2000 to 2004 during which the CDS was in operation, is 39 307 tonnes. The total catch reported in CDS data from Areas 51 and 57 for this period is 38 672 tonnes. If Area 47 is included, the total rises to 44 632 tonnes. Thus it would seem that if it is the case that catches from these areas were predominantly taken from within the Convention Area, they may have been already included in the current estimates of IUU fishing used by the Working Group.

BIOLOGY, ECOLOGY AND DEMOGRAPHY OF TARGET AND BY-CATCH SPECIES

New biological information

9.1 In addition to information which was pertinent to the assessment of stocks and which had been dealt with in Fishery Reports and/or section 3, 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 biological understanding of these species. Papers addressed the following subject areas:

(i) diet of *D. eleginoides* (WG-FSA-04/43) and *D. mawsoni* (WG-FSA-04/31 and 04/89);

(ii) diet (WG-FSA-04/44), ageing methods (WG-FSA-04/70) and population biology (WG-FSA-04/40 and 04/41) of *C. gunnari*;

(iii) the *D. mawsoni* fishery in the Ross Sea, including spawning information (WG-FSA-04/34), population biology (WG-FSA-04/89) and population genetics (WG-FSA-04/32) of *D. mawsoni*; new information on by-catch species (WG-FSA-04/27 and 04/89); ichthyoplankton sampling (WG-FSA-04/30); and a marine biodiversity initiative (WG-FSA-04/60);

(iv) biology of icefish species (WG-FSA-04/26, 04/89 and 04/90).

In addition, WG-FSA-04/10 provided a detailed review of icefish biology.

9.2 The Working Group welcomed the submission of papers dealing with biology and ecology of target and non-target species and encouraged Members to continue to provide this information. Information relevant to target species will be incorporated into species profiles.

9.3 The Working Group noted that submitted papers also contained valuable data on by-catch species that is not carried forward in CCAMLR documentation.

Matters arising from biology and ecology papers

9.4 In WG-FSA-04/30 a new seven-stage maturity-scale system was proposed for *D. mawsoni* to extend the five-stage maturity scale of Kock and Kellermann (1991) widely in use in CCAMLR. The Working Group felt that the data presented were still insufficient to reach such a far-ranging conclusion and change a maturity scale which is easy to use even by less-experienced workers and provides sufficient data for the purpose of CCAMLR.

9.5 WG-FSA-04/70 compared age estimates in *C. gunnari* derived from CMIX analysis and by direct ageing of otoliths. Considerable differences in age estimates between the two methods were revealed. Differences could be due to the growth parameter used to seed CMIX or errors in ageing from otoliths. To address this issue, a proposal to hold an age determination workshop on *C. gunnari* in Russia in 2005 was tabled (paragraphs 9.8 to 9.12).

Species profiles

9.6 The Working Group thanked Dr Everson for his work in preparing and maintaining the species profiles for *C. gunnari* and toothfish. The Working Group noted that the profiles are a valuable tool in preparing for assessments and considered it important that they are updated annually with new information either presented to, or generated by, the Working Group.

9.7 The Working Group recommended that the species profiles be annually updated in time for the meeting of WG-FSA-SAM. Dr M. Collins (UK) agreed to coordinate the updating of the toothfish profile. The Working Group recorded that a coordinator is needed for updating the icefish profile.

Age Determination Workshop on *Champsocephalus gunnari*

9.8 The first workshop on the determination of age in Antarctic fish held in Moscow in 1986 was unable to resolve the major uncertainties surrounding the age determination in *C. gunnari*. A subsequent exchange of otoliths between different laboratories revealed considerable differences between readers which could not be reconciled at that time (Kock, 1989) and age estimates remained questionable.

9.9 Given that a considerable amount of new information has been brought to bear on the life cycle of the species in the last 15 years, in particular on fish living in the northern parts of its distributional range in the Atlantic and Indian Ocean sectors, and that ageing techniques have become much more developed and sophisticated since then, the Working Group recommended that a second workshop be held on the age determination of the species preferably in June 2005 at a venue yet to be decided. Countries (contact person in brackets) which are likely to participate are: Australia (Mr R. Williams), Germany (Dr K.-H. Kock), Russia (VNIRO: Dr K. Shust; AtlantNIRO: Dr Zh. Frolkina), Spain (Dr García Santamaría), Ukraine (Dr L. Pshenichnov), UK (Dr M. Belchier) and the USA (Dr J. Ashford). Other Members are invited to participate.

9.10 The workshop will require material from as much of the geographical length range of the species as possible. In addition to the otoliths, ancillary information, such as length compositions of smaller fish exhibiting distinct peaks which could be related to age, should be brought to the workshop. This material could aid in the identification of the first age classes.

9.11 A timetable will be developed for tasks to be completed before, during and after the workshop. In order to be most efficient it is envisaged that not more than 12–15 scientists familiar with the reading of otoliths of Antarctic fish, in particular icefish, take part in the workshop. In preparation for the workshop, AtlantNIRO offered to interested scientists to circulate 50 recently collected otoliths of *C. gunnari* prepared in the 'Russian' way for age reading well in advance of the workshop, in order to:

- familiarise scientists with the specifics of icefish otoliths
- develop protocols for the preparation of otoliths for age determination
- develop protocols for reading icefish otoliths.

A similar kind of preparation had proven to be successful in the 'Workshop on Estimating Age in Patagonian Toothfish' in Norfolk, Virginia, USA, 23 to 27 July 2001 (SC-CAMLR-XX, Annex 5, Appendix H).

9.12 The workshop is considered to be a first step in reconciling difficulties inherent in the age determination of *C. gunnari*. As a second step it is envisaged that a regular exchange of otoliths among interested laboratories would be established. This procedure has proven to be successful in the case of *Dissostichus* spp. following results from the Norfolk workshop. If the workshop and the subsequent exchange of otolith material prove to be successful, a manual will be prepared which describes how otoliths of *C. gunnari* might be aged in a standard fashion. It is envisaged that *C. gunnari* will become part of the CCAMLR otolith exchange network.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

10.1 To satisfy the requirements of CCAMLR Article II.3(b) and (c), an ecosystem-directed approach to management is needed.

10.2 Thus, during WG-EMM-04, a Workshop on Plausible Ecosystem Models for Testing Approaches to Krill Management was held at the University of Siena, Siena, Italy, from 12 to 16 July 2004, being convened by Dr Constable (Annex 4, Appendix D).

10.3 Specifications that could be used to develop the modelling framework in which plausible models of the Antarctic marine ecosystem could be simulated, and scenarios that could be explored are to:

(i) develop several ecosystem models that can relate to each other
(ii) seek the input from different experts
(iii) interact with WG-FSA and ad hoc WG-IMAF.

10.4 The workshop noted that the attributes of Antarctic marine ecosystem models would vary with:

(i) the target species (krill, icefish, toothfish, squids or crabs);

(ii) the by-catch species;

(iii) the feeding habits of target species, their predators and related species;

(iv) the environmental characteristics (oceanographic features, feeding grounds, climate, geographical features);

(v) fisheries (fishing method, fishers' behaviour).

10.5 Conceptual representations of ecosystems would have to consider:

(i) a flexibility of the framework taking into consideration how each taxon might be influenced by the rest of the ecosystem;

(ii) detailed or general representation of different taxa to simulate, respectively, local-scale effects of fishing, or the effects on a wider area or wider temporal scale;

(iii) structural uncertainties related to lack of data;

(iv) information on a food-web model.

10.6 The workshop recognised the lack of expertise to develop models centred on target species other than krill, and requested that WG-FSA review current information with a view to develop models centred on toothfish and icefish (Annex 4, Appendix D, paragraph 7.3).

10.7 However, WG-EMM agreed that priority should be given to the development of ecosystem models centred on krill, and their predator–prey interactions, including those involving icefish. Demersal and bathypelagic species such as *Dissostichus* spp., *Macrourus* spp., skates and rays may need to be considered in the future.

Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM)

10.8 The Working Group supported the proposal by WG-EMM to establish a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) to advise the Scientific Committee on protocols to be used in acoustic surveys and analyses (Annex 4, paragraph 4.92). The terms of reference for this group are set out in paragraph 13.7.

New information on icefish diet reported to WG-FSA-04

10.9 The feeding habits of Channichthyidae and their interactions with predators were reviewed (WG-FSA-04/10). Young icefish are pelagic or migrate in the water column feeding mainly on krill and other euphausiids and fish. Adult icefish can be grouped with respect to their diet in three groups:

(i) those that depend on krill or other euphausiids during all their life, such as *C. gunnari*, taking fish only to a small extent;

(ii) species that feed on krill and benthic and mesopelagic fish;

(iii) and species that feed primarily on various notothenioids and less often on mesopelagic fish.

10.10 The proportion of food items varies with size, age, geographical region and season. Feeding interactions of *C. gunnari* were studied around the South Georgia region, in Subarea 48.3 (WG-FSA-04/41), based on trawling, acoustic and juvenile fish surveys carried out from 1986 to 2002. They showed a strong relationship between krill distribution and vertical migration, and the icefish distribution pattern. Juvenile and adult icefish use pelagic foraging areas, but the proportions of the different food items that are taken in varied: in the south the proportion was 70% krill, 15% juvenile *C. gunnari*, and 2% *Lepidonotothen larseni* and amphipods, while in the northeast krill was slightly lower (60%), and the amphipod proportion was higher (15%), with low proportions of myctophids and juvenile *C. gunnari* (2%). The lowest proportion of krill was obtained in the northwest (50%), and a high proportion of myctophids (35%) and amphipods (40%) was recorded. There is also a significant variability between the stomach content of fish of different sizes in different strata (near-bottom icefish 25–29 cm take 60% krill and 35% amphipods, while 33–35 cm icefish feed on 90% krill; in pelagic waters they feed on 95% krill).

10.11 In the same region (Subarea 48.3) the diet patterns of *C. gunnari* between South Georgia and Shag Rocks were compared (WG-FSA-04/44). The main food items were reported to be *E. superba* and five other Euphausiacea, six species of pelagic amphipods, mainly *T. gaudichaudii*, *Antarctomysis* sp., copepods, decapods, Channichthyidae, *L. larseni*, *Patagonotothen guntheri* and nototheniid larvae, and seven species of Myctophidae. A greater proportion of fish, mainly *P. guntheri*, was taken at Shag Rocks by the age 4+ *C. gunnari*.

Ecosystem effects of trawling

10.12 The relationship between the icefish (*C. aceratus*) and the sea floor benthic community (macrobenthic organisms serpulid polychaetes, crinoids, sea stars, anemones, sabellid polychaetes, brittle stars), with respect to nesting behaviour and parental care in Subarea 48.6, was described in WG-FSA-04/26. The authors pointed out that given the vulnerability of spawning grounds and their associated macrofauna to damage by bottom trawling and the associated impact on recruitment to adult fish populations, appropriate management of icefish fisheries should exclude, or severely restrict, fishing techniques that damage the seabed.

10.13 Studies on the composition of benthic communities and benthopelagic species composition in different regions are important for ecosystem-based models with respect to target species. WG-FSA-04/61 studied the composition of demersal fish and benthic communities in Subareas 48.3, 48.4 and 48.6, obtained during the ICEFISH cruise by trawling (paragraph 3.23). Differences were detected in faunal composition between island groups such as South Sandwich where different icefish were present, and Bouvetøya where no icefish were found.

Available information on ecosystem interactions

10.14 In response to the request of WG-EMM to concentrate efforts initially on icefish, it was noted that a great deal of relevant information is contained in the species profiles, the by-catch data and those derived from ad hoc WG-IMAF on marine birds that interact with fisheries. Dr S. Kasatkina (Russia) pointed out that there is extensive data in WG-FSA and WG-EMM background papers (e.g. WG-CEMP-92/50, 93/13, 94/32, 94/33, 95/87, 96/11, 96/32, 96/43, WG-EMM-99/27, WG-FSA-92/12, 92/26, 93/17, 93/18, 93/24, 94/27, 95/36, 97/38, 97/35, 99/63, 99/64, 99/65, 03/54, 03/55, 03/61, 03/74), and in *CCAMLR Science* that is directed to icefish biology and its interaction with the ecosystem (e.g. *CCAMLR Science,* Vol. 1, p. 129; Vol. 2, pp. 1, 21, 35; Vol. 3, p. 111; Vol. 5, pp. 63, 79, 103, 245; Vol. 6, p. 117; Vol. 7, pp. 1, 75; Vol. 8, pp. 107, 119, 133; Vol. 9, p. 49; Vol. 10, pp. 1, 15). Dr Kock noted that there was a large body of information on icefish in the South Georgia ecosystem that could be used for such work.

10.15 Information on various species of icefish in the diet of toothfish is reported in papers WG-FSA-04/31, 04/43 and 04/88 (see also section 9).

10.16 Ecosystem interactions involving by-catch species can be found in section 6.

10.17 WG-FSA encouraged Members to submit papers on interactions between krill and icefish, and icefish with other species to the next WG-EMM meeting.

10.18 The Working Group agreed that Members specialising in icefish research should be invited to send experts to participate in the next workshop on plausible ecosystem models. To address small-scale spatial and temporal interactions it was suggested that a joint acoustic and trawl survey be undertaken to collect synoptic data on biology of target and by-catch species. This would help to better understand the icefish–krill system.

10.19 The Working Group requested that Members consider how knowledge of ecosystem interactions involving icefish might contribute to the development of a long-term management procedure for icefish (paragraph 4.15(vii)) and what requirements there might be for monitoring.

10.20 Dr Constable reported that the Australian Antarctic Division has undertaken ecosystem research in the vicinity of Heard and McDonald Islands in January 2004. This intensive study involved estimating the distribution and abundance of *C. gunnari* and Myctophidae, their food items and their predators as well as studying the oceanography, primary production and zooplankton. Acoustic methods were used to estimate abundance of krill, fish and zooplankton and will be used to help understand how to differentiate between krill swarms and icefish. The study also aimed to determine the dependence of land-based predators (fur seals, macaroni penguins, king penguins) on their prey including icefish, by investigating the foraging activities of these predators. This year fur seals were found to be dependent on icefish. The study will be used to develop a food-web model of the system.

10.21 Dr Shust pointed out that there is enough data that would allow taking into consideration the differences between the ecosystem of the Atlantic Ocean sector and the Pacific Ocean sector, with regard to food chains. In Subareas 88.1 and 88.2, high latitude and depths have to be taken into account, while this is not the case in Subareas 48.1, 48.2 and 48.3.

Interaction with other organisations

10.22 Dr E. Fanta (Brazil) drew members' attention to the International Polar Year for which the SCAR Life Sciences Standing Scientific Group is planning a Circum-Antarctic Census of Marine Life for the 2007/08 season. The Working Group noted that many national Antarctic programs will be undertaking surveys and research cruises at that time, which might be integrated with CCAMLR surveys to the mutual benefit of both programs.

Advice to the Scientific Committee

10.23 The Working Group recommended that the Scientific Committee support the proposal by WG-EMM, endorsed by WG-FSA, to establish a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM).

10.24 The Working Group recommended that an icefish-centred ecosystem monitoring program, coordinated with the krill-centred monitoring program be developed.

10.25 The Working Group encouraged Members to carry out ecosystem-based research activities in any areas where icefish populations occur. Key areas that may form the core of the program could be South Georgia and Heard and McDonald Islands.

10.26 The Working Group considered that data derived from the icefish ecosystem monitoring program, and the results of research activities, could provide data for an ecosystem model centred on icefish that would be related to other Antarctic marine ecosystem models.

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

General Matters

11.1 Current observation requirements as detailed in conservation measures are summarised in Table 11.1.

11.2 Information collected by scientific observers was summarised in WG-FSA-04/6 Rev. 1, 04/7 Rev. 1 and 04/8 Rev. 1.

11.3 WG-FSA noted that the quality and quantity of observer data collected continued to improve. The Working Group commended all the observers that worked in the CCAMLR Convention Area in 2003/04 for their hard work.

11.4 At the same time, WG-FSA noted some continued problems related to inconsistent completion of data fields by observers (WG-FSA-04/6 Rev. 1, paragraph 11) and the lack of records in some sections of the forms (e.g. fish by-catch data).

11.5 The observer logbook forms and cruise report format have been updated as required and distributed to all Members and technical coordinators on 15 March 2004 (COMM CIRC 04/27). All but two of the logbooks were submitted using the electronic versions of the forms; however, several of them used old versions.

11.6 Some aspects of the observer duties were removed from the manual in 2003 taking into account data usage. Tasks removed concerned observation on meteorological conditions, and observations of birds and marine mammals during night setting.

11.7 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, and should ensure that observers are aware of the correct data fields when recording data. In particular, observers need to be reminded to familiarise themselves with changes to the cruise reports, logbooks and associated instructions, and that all data fields requested need to be completed.

11.8 In 2003 the Working Group discussed the topic on observer safety (SC-CAMLR-XXII, Annex 5, paragraphs 10.9 and 10.10). Discussions at WG-FSA-03 were drawn to the attention of the Scientific Committee that had agreed that it did not have primary competency to comment on this issue and, therefore, referred it to the Commission (SC-CAMLR-XXII, paragraph 2.7). The Commission noted the issue (CCAMLR-XXII, paragraph 4.5) and consequently Resolution 20/XXII was adopted.

11.9 No comments were received from scientific observers on safety issues during the 2003/04 season. However, the Working Group acknowledged the resolution adopted by the Commission last year, and suggested that action continue to be taken to ensure observer safety at sea.

Implementation of the observer program

11.10 The Working Group considered the following issues:

(i) the collection of data during the 2003/04 season and amendments which were identified as important by WG-FSA and ad hoc WG-IMAF;

(ii) the proposed review of the *Scientific Observers Manual*;

(iii) the work priorities of scientific observers on board fishing vessels;

(iv) the current list of research priorities identified in the past by the Scientific Committee.

11.11 The Working Group made a number of recommendations as described below.

Data collected during the 2003/04 season

11.12 Data collected by scientific observers during the 2003/04 season were used in stock assessments, by-catch estimation and analyses of seabird mortality arising from fishing operations. The types of data collected by observers are reviewed in WG-FSA-04/64. In order to improve quality and completeness of data collected by scientific observers, the Working Group considered several datasets received from observers during 2003/04.

Streamer lines

11.13 In 2003 data were requested from observers on the aerial extent of streamer lines to monitor the effects of changes in Conservation Measure 25-02 (SC-CAMLR-XXII, Annex 5, paragraphs 10.26 and 10.27). Limited data were collected during the various 2003/04 fisheries and the Working Group reiterated the need to collect this data during 2004/05.

11.14 The Working Group noted that some data reported by observers on the number of streamer lines deployed while line setting actually related to the number of streamers attached to the streamer line and noted that the requirement to report data on the number of streamer lines should be clarified by technical coordinators when briefing observers.

11.15 In reviewing the implementation of Conservation Measure 25-02, the following additional specifications for data needed were agreed:

(i) recording the aerial extent of the streamer line to the nearest metre, this distance is the length of the streamer line measured from the stern of the vessel to the point at which the streamer line first touches the surface of the water;

(ii) recording the presence or absence of a towed object attached to the outboard end of the streamer line;

(iii) recording if individual branched streamers extend to the water in the absence of wind and swell;

(iv) recording if the towed object is maintained immediately astern of the attachment point of the streamer line to the vessel;

(v) recording if the aerial extent of the streamer line is maintained above the hookline during line setting.

Conversion factors

11.16 The Working Group noted that for longliners (WG-FSA-04/6 Rev. 1, Table 5) the main processing method for *Dissostichus* spp. was headed, gutted and tailed (HGT) with some observers also recording CF data for headed and gutted (HAG) product. CFs for filleted

(FLT) and headed, gutted and tailed (HGT) *M. whitsoni* were reported by three observers. For trawlers (WG-FSA-04/7 Rev. 1, Table 5) the only processing method for *D. eleginoides* was HGT. For *C. gunnari* and *P. georgianus* the processing method was always whole (WHO).

Hooks in offal

11.17 The Working Group noted that data on hooks in offal are currently requested in the cruise report, but not the electronic logbook. To allow a more informed response to the issue of hooks in offal, the Working Group recommended that observers collect summary information about hooks in offal in the same format as that used for fishing gear in the electronic logbook form L8.

By-catch

11.18 Discussions of the Working Group related to by-catch and observer data are presented in paragraphs 6.50, 6.78, 6.81 to 6.86 and 6.90 of this report.

Tagging programs

11.19 Discussions of the Working Group related to tagging programs and observer data are presented in paragraphs 3.47(xii) and 3.48.

Sub-sampling methods for observers

11.20 In 2003, the intersessional subgroup on longline sub-sampling methods for observers had identified four key targets for the observer sub-sampling methodology that were not currently available. Consequently 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 (SC-CAMLR-XXII, Annex 5, paragraphs 10.29 and 10.30).

11.21 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 (SC-CAMLR-XXII, Annex 5, paragraph 10.31). Furthermore, the Working Group recommended that observer experience with any sub-sampling method be reported in observer cruise reports (SC-CAMLR-XXII, Annex 5, paragraph 10.33).

11.22 It was noted that observers have reported no data on any of the above matters during the 2003/04 season and no action has been reported by any Member on the development of sub-sampling methodologies. Therefore, the Working Group reiterated its recommendations encouraging observers and Members to provide the needed information and to undertake the studies leading to the development of adequate methods for longline sub-sampling.

Estimating seabird abundance

11.23 During the meeting the Working Group reviewed the application of one current research priority – estimation of seabird abundance at sea (see also paragraph 7.137).

11.24 WG-FSA-04/46 described the distribution of seabirds on the Alaskan fishing grounds derived from post-haul seabird counts conducted in the course of longline fish stock assessment surveys. The protocol consists of counting all birds by species on the water and in the air within a 50 m radius of the vessel's stern immediately prior to, or immediately after, the last hook is hauled, when seabirds are most aggregated and easily enumerated. This simple protocol takes no more than 10 minutes to complete and is easily learned and performed by observers with minimal seabird experience. These data yield estimates of the seabird species present or absent in specific areas at specific times and the relative distribution of the common species on the fishing grounds. These data, however, are not comparable with traditional ship transect abundance estimates, and are of limited use for measuring change in seabird populations.

11.25 The Working Group acknowledged that the current CCAMLR observer protocol for enumerating seabirds within 500 m of the stern of the vessel is difficult to perform by fisheries observers, these data are collected inconsistently by CCAMLR observers, and the resulting data have yet to be analysed or used by the Commission. The simpler post-haul protocol may yield consistent data useful for CCAMLR management purposes.

11.26 The Working Group recommended that until such time as a standardised protocol could be developed, any requirement for observers to quantify seabird abundance during the set and haul be removed from the manual. In particular, the data collection associated with the L4 IMAF form in the electronic logbooks will need revision.

Seabird captures in longline fisheries

11.27 The Working Group noted that observer data describing interactions involving seabirds with longline fishing operations do not currently include the activity within the fishing event when the capture occurs. To help better understand and mitigate interactions involving seabirds with longline fishing operations, these data are required, and the Working Group recommended that they be collected in 2004/05.

Seabird captures in trawl fisheries

11.28 The Working Group noted that observer data describing interactions involving seabirds with trawl fishing operations do not currently include the activity within the fishing event when the capture occurs. To help better understand and mitigate interactions involving seabirds with trawl fishing operations, these data are required, and the Working Group recommended that they be collected in 2004/05.

11.29 Additional data are to be collected on the stage during the fishing operation that the seabird was caught. The stages of interest are: during net setting, during the haul, during net retrieval, or, not able to be determined. The period of the tow could be defined as the time from the start of the net fishing (net at fishing depth and mouth of net open) to the end of the net fishing (beginning of net being retrieved from fishing depth). Haul can be defined as the period from the end of fishing until the time when the trawl doors are at the quarters, and net retrieval as the time from the end of haul to the codend being hauled on deck. This may be best achieved by adding to the electronic logbook form T6 a column for these data to be associated with each seabird capture. Useful descriptions of the trawl fishing method to help clarify data recording are contained in SC-CAMLR-XXII/BG/28.

Electronic monitoring

11.30 WG-FSA-04/23 reported on a pilot study in Alaska, which identifies electronic monitoring as a practical approach for assessing seabird interactions with trawl third-wire cables (also called netsonde or net monitor cables). The approach may also be able to be used for monitoring seabird interactions with trawl warp cables. The authors noted that the approach could potentially be used to measure compliance with seabird by-catch mitigation measures.

11.31 WG-FSA-04/24 reported on a feasibility study in Alaska, in a fishery where observers cannot usually be placed on vessels due to small vessel size, which found that electronic monitoring systems could be used to evaluate compliance with the use of some seabird by-catch mitigation measures. The authors noted that one of the key limitations is the inability of the current technology to identify seabirds to the species level, although identification to small seabird/large seabird classifications was possible.

11.32 Participants indicated that other electronic monitoring systems were in various stages of development and that some showed promise in being able to identify seabirds to the species level.

11.33 The Working Group noted that key issues yet to be resolved in utilising electronic monitoring systems include how to robustly analyse the large volumes of data collected (even where time-lapse data are collected), and how to move monitoring from post-trip analyses to real-time analyses.

11.34 The Working Group noted that electronic monitoring is a rapidly evolving field of technical research and that its greatest future utility appeared to be in monitoring compliance with conservation measures.

Review of the *Scientific Observers Manual*

11.35 Based on a recommendation received from WG-FSA, the Scientific Committee and the Commission agreed that there should be a major review of the *Scientific Observers Manual* (SC-CAMLR-XXII, Annex 5, paragraph 10.45; SC-CAMLR-XXII, paragraph 2.10 and CCAMLR-XXII, paragraphs 4.5 and 6.17(iv)). The review refers to consideration of the manual format, structure and contents.

11.36 WG-FSA noted that a timeframe for the review has not yet been identified. It was also noted that after a review is completed, the Scientific Committee would need to consider provision to the Secretariat of necessary funds for the translation, production and distribution of the revised manual.

11.37 The Secretariat consulted intersessionally with technical coordinators and members of WG-FSA and WG-EMM in order to clarify potential shortcomings of the current manual and to elaborate a plan of work on the proposed review (WG-FSA-04/16). Several reasons for the proposed review of the manual were identified in the consultation. In general, the key need was that following extensive development and additions over many years, the manual is now due for an overhaul of its structure and contents (as it is also done periodically for other CCAMLR manuals and guidelines).

11.38 WG-FSA recommended that in order to accomplish the proposed review, the Scientific Committee and its working groups should first review research priorities for different fisheries, target and by-catch species and the types of data to be collected to allow research priorities to be met. An initial assessment of data collected by observers, an assessment of whether the collected data are used and the source of the data request are given in Table 11.2. This initial review needs additional input from other working groups and technical coordinators. The next stage of the review would be to determine whether existing data collection and recording protocols meet the identified data collection requirements. This phase should include development of clear guidance on prioritisation of observer tasks where requested data collection exceeds the time available to the observer at sea. The final stage of the review would be consideration of the most appropriate structure, format and contents of the manual.

11.39 WG-FSA also agreed that in future, proposals for adding data collection tasks for scientific observations should be submitted in a standard format including a description of the data collection objectives, data collection protocols and data usage.

11.40 At this meeting, WG-FSA was not able to undertake the review of the manual and estimated that the proposed review of the manual could require more than one intersessional period. The Secretariat was requested to arrange for intersessional work in consultation with Mr Smith and Dr E. Balguerías (Spain), technical coordinators of national observer programs and, as required, with other members of WG-FSA/ad hoc WG-IMAF and WG-EMM. The Working Group noted that additional resources, possibly including external consultants, may be needed to undertake the review in a comprehensive and timely manner.

11.41 In the absence of agreed terms of reference for the revision of the *Scientific Observers Manual*, the Working Group noted the key reasons put forward for the review outlined in WG-FSA-04/16, paragraph 7, and agreed that the Secretariat would continue to address these in 2004/05.

11.42 The Working Group noted that additional resources, possibly including input from contracted consultants outside the Secretariat, may be required to ensure that the revision is undertaken in a comprehensive and timely manner.

11.43 The Secretariat advised that such consultant input could be estimated at comprising approximately 20 working days in 2005/06 and would cost about A$7 200. This would be additional to the A$20 000 allocated in the 2004/05 budget for Secretariat involvement in the manual's revision. That money will be utilised for text compilation, formatting and translation, as well as the time of key Secretariat personnel.

11.44 It was drawn to the Working Group's attention that the two activities outlined in paragraph 11.43 may not coincide. In the absence of a clear directive from the Commission on procedures for the carry-over of funds for multi-year tasks under the current accrual budgeting procedure, the Working Group understood that the sequence of events potentially envisaged above may not be feasible.

11.45 However, the Working Group recognised, and advised the Scientific Committee, that should it be possible to allocate both budgetary amounts identified above to the 2005 and 2006 financial years, then there would be a strong need to develop clear terms of reference for any work to be undertaken by a contracted consultant. These terms of reference would need to be developed by the Working Group in consultation with the Scientific Committee Chair and the Executive Secretary.

11.46 Results of intersessional work conducted in 2004/05 should be reported by the Secretariat to the 2005 meetings of WG-EMM and WG-FSA/ad hoc WG-IMAF.

Current research and observer work priorities

11.47 WG-FSA noted that it had requested WG-FSA-SAM to identify data which are essential for stock assessment purposes in order to help prioritise observer workload (SC-CAMLR-XXII, Annex 5, paragraph 10.11). Due to the overall workload at the recent meeting of WG-FSA-SAM and the current meeting of WG-FSA, it was not possible to undertake this task.

11.48 The Working Group noted that this task still needed to be completed and could usefully be incorporated into the proposed process for review of the *Scientific Observers Manual*.

11.49 The Working Group noted that the current list of priorities in the *Scientific Observers Manual* does not relate specifically to new and exploratory fisheries, and that a list of observer priorities for new and exploratory fisheries is required.

11.50 The Working Group noted that a current list of priorities does not exist for incidental mortality of seabirds and marine mammals associated with fishing and that a list of observer priorities for incidental mortality associated with fishing is required. However, recommended levels of observer coverage required to monitor potential incidental mortality in new and exploratory fisheries have been identified by the Working Group in 2004 (paragraphs 7.187 to 7.190).

11.51 The Working Group noted that a current list of priorities does not exist for fish and invertebrate by-catch sampling and that a list of observer priorities for fish and invertebrate by-catch sampling is required.

11.52 The Working Group noted that a section for observer priorities is contained within each of the new Fishery Reports, and encouraged Members to develop that section of the Fishery Report in the intersessional period.

Observer conference

11.53 Dr Fanta called the attention of the Working Group to the Fourth International Fisheries Observer Conference to be held from 8 to 11 November 2004 in Sydney, Australia.

11.54 The conference will discuss the role of observer programs for management, compliance and scientific purposes within the broader context of fisheries monitoring systems. It will address some of the key issues related to the delivery of observer programs, from the perspective of governments, service providers, the fishing industry and observers. It will also explore the current applications, limitations and future uses of scientific data, and data collection from observer programs.

11.55 The Working Group noted that the discussions and output from the conference should be of interest for the implementation of the CCAMLR Scheme of International Scientific Observation (see also paragraph 7.179). It noted that the Secretariat had prepared a paper describing the scheme and the CCAMLR experience with observers (WG-FSA-04/64); it supported the participation of Secretariat staff in the conference to present the paper, and to report back to CCAMLR on matters of interest in the future implementation of the scheme.

Information relevant to SCIC

11.56 The Working Group had attempted to verify, by crosschecking cruise reports and electronic logbooks, observer information in Secretariat papers WG-FSA-04/6, 04/7 and 04/8 relating to monitoring the implementation of conservation measures. The review resulted in the issuing of revisions to all three papers.

11.57 However, unlike previous years, this year the Working Group has not comprehensively assessed all CCAMLR scientific observer reports to compile and analyse additional data on compliance with relevant conservation measures. While this was mainly due to the large volume of observer reports received this year, the Working Group felt it was inappropriate for it to carry out this type of analysis. WG-FSA recommended that SCIC could take initial responsibility for this function in future, given its role and expertise in relation to compliance matters.

11.58 Observer information on the monitoring of the implementation of conservation measures is contained in two sources:

(i) Secretariat papers WG-FSA-04/6 Rev. 1, 04/7 Rev. 1 and, in particular, 04/8 Rev. 1;

(ii) discussions of ad hoc WG-IMAF, in particular paragraphs 7.46 to 7.63.

11.59 The Working Group also noted that the information and advice in CCAMLR-XXIII/BG/8 and SC-CAMLR-XXIII/BG/1 was relevant to SCIC.

11.60 The Working Group noted recent developments in electronic monitoring (paragraphs 11.31 to 11.35) and suggested that SCIC consider electronic monitoring as a potential additional tool for monitoring compliance with conservation measures in future.

Advice to the Scientific Committee

11.61 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) only current versions of cruise reports and logbook forms be used for reporting to CCAMLR, and electronically wherever possible (paragraph 11.7);

(ii) recording of hooks in offal and the fate of such material on a daily basis in longline fisheries (paragraph 11.17);

(iii) reporting of experience with sub-sampling methods (paragraph 11.22);

(iv) discontinuation of requirements to quantify seabird abundance during the set and haul of longlines, and requirement be removed from the manual (paragraph 11.26);

(v) collection of data in longline fisheries describing whether seabirds are caught during the set or the haul in form L5(vi) (paragraph 11.27);

(vi) collection of data in trawl fisheries describing when during the trawl fishing activity seabirds are caught (paragraph 11.29);

(vii) incorporation of the definition of dead seabirds contained in SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217 (paragraph 7.201);

(viii) clarification of instructions on hooks observed for seabird by-catch to ensure only hooks directly observed for seabird by-catch, as distinct from hooks hauled whilst the observer is in the fish factory, are recorded in logbooks (paragraph 7.188);

(ix) reporting of longline sink rate test data for longline fisheries from testing during fishing in the Convention Area in the electronic logbook form L10 (paragraph 7.106);

(x) accurate reporting of by-catch data (paragraph 6.50);

(xi) reporting on methods or strategies of fishing that minimise non-target fish by-catch (paragraph 6.77);

(xii) collecting accurate information on cut-offs of rajids (paragraph 6.89);

(xiii) incorporation of instructions for tagging and reporting on tag releases and tag recaptures (paragraphs 3.47(viii) and 3.48);

(xiv) tagging protocol in the manual to be updated to reflect the recommendations on tagging (paragraph 3.47(xii)).

11.62 The Working Group recalled the recommendation made by the Scientific Committee at its meeting last year requesting Members to undertake additional analyses of CFs to improve estimates of total removals from all fisheries (SC-CAMLR-XXII, paragraph 2.5). No action has been taken on this matter during the intersessional period and the Working Group therefore reiterated its request encouraging Members to initiate these studies to improve estimates of total removals from all fisheries (paragraph 11.17).

11.63 The Working Group recommended that all changes to the content and format of the *Scientific Observers Manual* should be coordinated through the technical coordinators. Further, technical coordinators should ensure that scientific observers are made aware of changes to the content and format of the *Scientific Observers Manual* prior to deployment.

11.64 The Working Group suggested that action continue to be taken to ensure observer safety at sea (paragraph 11.9).

11.65 The Working Group recommended that the proposed intersessional review of the *Scientific Observers Manual* be undertaken, including a review of observer priorities, and that additional resources be sought to undertake this task (paragraphs 11.40 to 11.45).

11.66 The Working Group recommended the participation of Secretariat staff in the Fourth International Fisheries Observer Conference to be held from 8 to 11 November 2004 in Sydney, Australia, and noted the importance of feedback from that conference on the implementation of the CCAMLR Scheme of International Scientific Observation (paragraph 11.55).

11.67 The Working Group suggested that the Scientific Committee inform SCIC of the information identified by WG-FSA as relevant to its business, and that it may wish to further investigate electronic monitoring as a potential additional tool for monitoring compliance with conservation measures in future (paragraphs 11.56 to 11.60).

FUTURE ASSESSMENTS

12.1 The Working Group considered future assessment work in light of the discussion and outcomes of this year's meeting. It agreed that there is an urgent need to evaluate methods for assessing sustainable yield of *D. eleginoides* in Subarea 48.3. In that respect and in light of the need to develop an assessment method for *D. mawsoni* in Subarea 88.1, it also agreed that WG-FSA-SAM should meet during the intersessional period and focus on evaluating assessment methods for *Dissostichus* spp.

12.2 In order to better understand the requirements from WG-FSA-SAM and to improve the efficiency of the work of WG-FSA, the Working Group considered what was required to be done before an assessment method would be used by WG-FSA to help provide advice on harvest strategies, including catch limits, to the Scientific Committee. It noted the discussion under Item 4 on the main parts of evaluating methods (paragraph 4.39(iii)). Following a general discussion, the Working Group requested that WG-FSA-SAM consider the process required for the Working Group to agree on the use and implementation of assessment methods in the work of the Working Group.

12.3 With respect to the role of WG-FSA-SAM, the Working Group agreed that it would be desirable for it to correspond regularly in order to develop and agree on the use of assessment methods by WG-FSA by the end of its intersessional meeting. In that respect, the Working Group did not consider it appropriate to have to discuss and agree on, during the course of its meeting, the use of methods unless it was generally understood and agreed that developments between the time of the WG-FSA-SAM meeting and WG-FSA would achieve consensus on the first day and the process of implementation was agreed.

12.4 The Working Group agreed that WG-FSA-SAM should consider the following topics as priority for evaluating assessment methods for *Dissostichus* spp. at its intersessional meeting:

(i) implementation of assessments with respect to CCAMLR decision rules
(ii) fishery-independent recruit surveys
(iii) use of mark–recapture data in assessments
(iv) catch-at-age estimation
(v) standardisation of CPUE
(vi) integrated assessment procedures
(vii) spatially explicit assessment models.

12.5 It recognised that each of these topics could form a substantial amount of work on their own. However, it encouraged Members to make submissions on these topics with the view to evaluating them for use by the Working Group to deliver advice on harvest strategies to the Scientific Committee.

12.6 With respect to the implementation of assessments, the Working Group noted that three main software packages would be useful to explore for delivering components of, or all of, the assessment procedures – AD Model Builder (Otter Research, 2000), CASAL (Bull et al., 2004) and the GYM (Constable and de la Mare, 2003). Other forms of implementing software, including spatially explicit models, such as Fish Heaven (Ball and Williamson, 2002), would be useful to have available for evaluation work. The Working Group agreed that assessments with the potential to integrate a variety of data sources would be useful to explore at the coming meeting, such as that which can be achieved in CASAL.

12.7 An important part of the evaluation work will be to continue the evaluation of survey designs and to further explore the means of estimating the abundance of recruits from these surveys, including the use of CMIX, age–length keys and other approaches. The Working Group noted the need to review the means by which data from stratified random surveys are pooled to give estimates of abundance.

12.8 The Working Group also agreed that a spatial analysis of the distribution of the fishing effort in Subarea 48.3 is important and requested WG-FSA-SAM begin this process and to examine more closely the following issues:

(i) the number of tags required in the tagging experiment and an exploration of assumptions of mixing and recapture rates;

(ii) the potential for the CPUE series to be hyper-stable.

12.9 The Working Group agreed that assessment methods other than those listed above could be explored if they were sufficiently mature for evaluation by WG-FSA-SAM. These could include the use of depletion experiments in assessments as well as methods for estimating length-at-age relationships.

12.10 The Working Group agreed that the work of WG-FSA-SAM should be supported by representatives from each of the main laboratories working on assessment methods for WG-FSA. Nominated representatives are: Dr Constable (Australia), Mr A. Dunn (New Zealand), Drs Gasyukov, Jones and Kirkwood. As Convener, Dr Hanchet undertook to consult with these representatives to find a new coordinator for WG-FSA-SAM (paragraph 13.4(i)).

FUTURE WORK

Intersessional work

13.1 Future work identified by the Working Group is summarised in Table 13.1 and Appendix D (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.

13.2 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 2004/05 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.

13.3 The Working Group reminded participants that membership to the subgroups was open.

13.4 The subgroups, and their coordinators listed in brackets, for the intersessional period are:

(i) WG-FSA-SAM (Dr Jones). This subgroup will interact and coordinate activities in the middle of the year (as detailed in Item 12);

(ii) a subgroup to review, and where necessary assess, the biology and demography of species considered by the Working Group (Drs Collins and Kock);

(iii) a subgroup on by-catch (Ms E. van Wijk (Australia) and Dr 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 otolith exchange (CON) (Dr Belchier);

(vi) a subgroup on tagging (Mr Dunn, Drs Davies and Belchier);

(vii) a subgroup on scientific observers (Mr Smith and Dr Balguerías);

(viii) a subgroup on ecosystem interactions (Drs Fanta and Kock).

13.5 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.

13.6 The responsibilities for coordinating the intersessional activities of ad hoc WG-IMAF are set out in Appendix D.

Proposed terms of reference for SG-ASAM

13.7 The Working Group recommended that the Scientific Committee should consider the following terms of reference for SG-ASAM, which extend the terms of reference proposed by WG-EMM (Annex 4, paragraph 4.93):

(i) to develop, review and update as necessary, protocols on:

  (a) the design of acoustic surveys to estimate biomass of nominated species;

  (b) the analysis of acoustic survey data to estimate the biomass of nominated species, including estimation of uncertainty (bias and variance) in those estimates;

  (c) the archiving of acoustic data, including data collected during acoustic surveys, acoustic observations during trawl surveys, and in situ target strength measurements;

(ii) to evaluate results of acoustic surveys carried out in the CCAMLR Convention Area during the previous year;

(iii) to estimate target strength and its statistical characteristics for key species in the CCAMLR Convention Area;

(iv) to use data from acoustic surveys to investigate ecological interactions and produce information for ecosystem monitoring and management.

13.8 An immediate issue for WG-FSA to be addressed by SG-ASAM is the acoustic protocol for assessing *C. gunnari* in Subarea 48.3, including:

(i) discrimination of *C. gunnari* from other acoustic scatterers
(ii) further improvements in target strength estimates for *C. gunnari*
(iii) age-specific patterns in daily vertical distribution of *C. gunnari*
(iv) combination of trawl and acoustic indices for stock assessment.

External review of GYM

13.9 In the interests of continuing the development and review of its assessment tools, WG-FSA requested last year that the Data Manager supervise an independent external review of the GYM software and manual (SC-CAMLR-XXII, Annex 5, paragraph 9.18). The amount of funds required to conduct the external review in 2004 was unknown to WG-FSA, however, experience relative to obtaining invited experts to WG-EMM indicated that the cost could be approximately US$3 000 (SC-CAMLR-XXII, Annex 5, paragraph 9.19).

13.10 WG-FSA noted that the Secretariat had called for expressions of interest for the review in March 2004. However, no formal feedback or expressions of interest had been received and the review could not be conducted. This matter had been considered at the meeting of WG-FSA-SAM (WG-FSA-04/4, paragraphs 4.1 to 4.12). The subgroup had agreed that the scope of the review required clearer definition and that the funds set aside for a review in 2004 may have been inadequate.

13.11 As a result, WG-FSA recommended that the Scientific Committee retain the funds for the review of the GYM until WG-FSA-SAM can further consider the scope of the review and a costing can be better estimated. Developments would be reviewed by WG-FSA at its 2005 meeting, with a view of undertaking a review in 2006.

Meeting of WG-FSA-SAM

13.12 WG-FSA agreed that full consideration of the intersessional work of WG-FSA-SAM would require more than a five-day meeting in 2005. However, the practicality of holding a meeting in association with WG-EMM and limits on participants' time meant that the 2005 meeting could only be held over five days.

13.13 WG-FSA agreed that the participation of an invited expert at the 2005 meeting of WG-FSA-SAM would provide advice on the evaluation assessment methods. It was also recognised that such an expert would provide advice at WG-EMM's workshop scheduled in the week following the meeting of WG-FSA-SAM. WG-FSA requested the Coordinator of WG-FSA-SAM to liaise with the conveners of the WG-EMM workshop to identify a suitable person.

13.14 WG-FSA recommended that the Scientific Committee request funding for an invited expert.

13.15 The Secretariat was requested to work with the WG-FSA Convener and the coordinator of WG-FSA-SAM to review, as possible, topics of relevance to the intersessional meeting of the subgroup.

13.16 The Working Group requested that the Secretariat participate in the next intersessional WG-FSA-SAM meeting in the same manner as last year through the attendance at the meeting by the Data Manager, Dr Ramm, and by one other Secretariat staff member to assist with preparing the report in the last two days of the meeting.

13.17 The Working Group requested that the coordinator of WG-FSA-SAM, with the assistance of the representatives of the subgroup, develop a work program to help with preparation for the meeting, including the following timetable:

- mid-November – circulate to members of the Working Group and the Scientific Committee, a draft plan of work leading to the meeting of WG-FSA-SAM and a draft agenda for discussion;
- mid-February – assess progress on the work plan, determine a preliminary agenda for the WG-FSA-SAM meeting based on expected completion of contributions to the subgroup, and circulate a progress report;
- mid-May – update the progress report and circulate, where possible, the outcomes of work for consideration by WG-FSA-SAM;
- mid-June – deadline for submission of papers.

OTHER BUSINESS

14.1 Dr Fanta announced that from 25 to 29 July 2005 the IXth SCAR International Antarctic Biology Symposium will be held in Curitiba, Brazil. Information can be found at www.pucpr.br/scarbiologysymposium.

14.2 It is an event that takes place every four years, and congregates Antarctic biologists, from senior to young scientists, and students. Keynotes will give the state of the art of Antarctic biology, and the papers presented orally or as posters will be published in *Polar Biology*.

14.3 The theme of the Symposium is: 'Evolution and biodiversity in the Antarctic' therefore providing space for all aspects of Antarctic biology. Dr Fanta is the local organiser of the event, and welcomes scientists of CCAMLR to present their research results. Dr S. Nicol (Australia) was invited as one of the keynote speakers to bring CCAMLR's view on ecosystem models, monitoring and management to the meeting. This event will allow a closer cooperation between the SCAR and the CCAMLR communities.

Rules for the submission of meeting papers

14.4 WG-FSA noted the guidelines for the submission of papers to the Scientific Committee (SC-CAMLR-XXIII/5 Rev. 1). With respect to last year's request from the Committee (SC-CAMLR-XXII, paragraphs 12.32 and 12.33), the Working Group was unable to offer any comment as it was felt that the guidelines were a matter for consideration by the

Scientific Committee. However, WG-FSA agreed that it would be beneficial to have all guidelines relating to the submission of documents to the Scientific Committee and its working groups collated into a single reference document.

14.5 WG-FSA considered the Secretariat's proposal for dealing with published papers submitted to meetings (SC-CAMLR-XXIII/5 Rev. 1, Annex 1). WG-FSA recommended that the status quo should be retained.

ADOPTION OF THE REPORT

15.1 The report of the meeting and associated background documents SC-CAMLR-XXIII/BG/21, BG/22 and BG/23 were adopted.

CLOSE OF MEETING

16.1 In closing the meeting, the Convener thanked all participants and subgroup coordinators for developing the work of WG-FSA. On behalf of WG-FSA, Dr Hanchet also thanked outgoing conveners Dr Constable (WG-FSA-SAM) and Prof. Croxall and Mr Baker (WG-IMAF) for providing expertise and direction to those aspect of the Working Group's agenda. Dr Hanchet also thanked the Secretariat staff for a successful meeting and for their contribution to the work of WG-FSA. The Working Group noted that Mr Williams (past convener) was retiring in 2005; Mr Williams was thanked for his significant contribution to the understanding of Antarctic fish and fisheries.

16.2 The Working Group welcomed Dr Jones in his new role as Coordinator of WG-FSA-SAM, and Ms Rivera and Mr Smith in their new roles as co-conveners of WG-IMAF.

16.3 Dr Holt, on behalf of WG-FSA, thanked Dr Hanchet for his work in his first year as Convener and for his leadership. Dr Holt also thanked Mrs C.-P. Martí, Spanish Representative to the Commission, for taking the time to participate in the meeting. WG-FSA had also greatly appreciated Dr Everson's contribution to the restructuring of the meeting and reformatting the report. Dr Everson's initiative has resulted in a significant improvement in the way WG-FSA conducts its work and the presentation of results and advice to the Scientific Committee.

16.4 The meeting was closed.

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Table 3.1: Total reported catches (tonnes) of target species in fisheries conducted in the Convention Area in the 2003/04 season. Source: catch and effort reports submitted by 24 September 2004.

Target species	Region	Fishery	Gear	Fishing season		Conservation measure	Catch (tonnes) of target species		Catch (% limit)
				Start	End		Total	Limit	
Champsocephalus gunnari	48.3		Trawl	01-Dec-03	30-Nov-04	42-01 (2003)	2 685	2 887	93
	58.5.2		Trawl	01-Dec-03	30-Nov-04	42-02 (2003)	51	292	17
Dissostichus spp.	48.3		Longline	01-May-04	21-Aug-04	41-02 (2003)	4 482[1]	4 420	101
	48.3		Pot	01-Dec-03	21-Aug-04	see above			
	48.4		Longline	01-May-04	21-Aug-04	41-03 (1999)	0	28	0
	48.6 north of 60°S	Exploratory	Longline	01-Mar-04	31-Aug-04	41-04 (2003)	7	455	1
	48.6 south of 60°S	Exploratory	Longline	15-Feb-04	15-Oct-04	see above			
	58.4.1	Exploratory	Longline	01-Dec-03	30-Nov-04	41-11 (2003)	0	800	0
	58.4.2	Exploratory	Longline	01-Dec-03	30-Nov-04	41-05 (2003)	20	500	4
	58.4.3a	Exploratory	Longline	01-May-04	31-Aug-04	41-06 (2003)	0	250	0
	58.4.3a	Exploratory	Trawl	01-Dec-03	30-Nov-04	see above			
	58.4.3b	Exploratory	Longline	01-May-04	31-Aug-04	41-07 (2003)	7	300	2
	58.4.3b	Exploratory	Trawl	01-Dec-03	30-Nov-04	see above			
	58.5.1 (French EEZ)		Longline	ns	ns	ns	3 436[2]	ns	-
	58.5.2		Longline	01-May-04	30-Nov-04	41-08 (2003)	2 269	2 873	73
	58.5.2		Trawl	01-Dec-03	30-Nov-04	see above			
	58.6 (French EEZ)		Longline	ns	ns	ns	441[2]	ns	-
	58.6 (South Africa EEZ)		Longline	ns	ns	ns	55	ns	-
	58.7 (South Africa EEZ)		Longline	ns	ns	ns	50	ns	-
	88.1	Exploratory	Longline	01-Dec-03	31-Aug-04	41-09 (2003)	2 166	3 250	67
	88.2 south of 65°S	Exploratory	Longline	01-Dec-03	06-Mar-04	41-10 (2003)	375	375	100
Euphausia superba	48		Trawl	01-Dec-03	30-Nov-04	51-01 (2002)	87 133[3]	4 000 000	2
	58.4.1		Trawl	01-Dec-03	30-Nov-04	51-02 (2002)	0	440 000	0
	58.5.2		Trawl	01-Dec-03	30-Nov-04	51-03 (2002)	0	450 000	0
Lithodidae	48.3		Pot	01-Dec-03	30-Nov-04	52-01 (2003)	1	1 600	0
Macrourus spp.	58.4.3a	Exploratory	Trawl	01-Dec-03	30-Nov-04	43-02 (2003)	0	26	0
	58.4.3b	Exploratory	Trawl	01-Dec-03	30-Nov-04	43-03 (2003)	0	159	0
Martialia hyadesi	48.3	Exploratory	Jig	01-Dec-03	30-Nov-04	61-01 (2003)	0	2 500	0
four species[4]	58.4.2	Exploratory	Trawl	01-Dec-03	30-Nov-04	43-04 (2003)	0	2 000	0

1 Revised total following correction advised on 10 September 2004 (previous total was 4 488 tonnes, e.g. CCAMLR-XXIII/38).
2 Catches to August 2004.
3 One Vanuatu-flagged vessel fished; no data have been submitted.
4 *Chaenodraco wilsoni*, *Lepidonotothen kempi*, *Trematomus eulepidotus* and *Pleuragramma antarcticum*.
ns Not specified by CCAMLR.

Table 3.2: Estimated effort, catch rates and total catches from IUU fishing for *Dissostichus* spp. in the Convention Area in the 2003/04 season. Detailed calculations are in SCIC-04/3 Rev. 2 (see also SC-CAMLR-XXII, Annex 5, Table 3.3).

Region	Estimated number of IUU vessels				Estimated IUU fishing effort					Estimated IUU catch	
	Sighted[1]	Otherwise reported[2]	Extrapolated[3]	Total	Trip duration (days)[4]	Trips per vessel	Total days fished to 1-Oct-04	Total days fished to 30-Nov-04 (A)	Mean catch rate (tonnes/day) (B)[5]	To 1-Oct-04	To 30-Nov-04 (A x B)
48.3				0		1.0	0	0	3.1	0	0
58.4.2	3	1	0	4	41	1.5	246	246	0.8	197	197[7]
58.4.3	4	1	0	5	41	1.5	308	308	0.8	246	246[7]
58.4.4			0	0	40	2.5	0	0	1.1	0	0[7]
58.5.1	2		0.4	2.4	30	1.9	114	137	4.7	536	643
58.5.2	2		0.4	2.4	30	2.0	118	142	4.5	531	637
58.6	4[6]	1	1	6	40	1.0	200	240	1.9	380	456
58.7		1	0.2	1.2	40	1.5	60	72	0.8	48	58
88.1		2	0	2	40	1.0	80	80	3.0	240	240[7]
88.2	0	0								0	0
								Total IUU catch		2 177	2 477
								Adjusted Total IUU catch[8]			2 622

[1] From reports of vessel sightings submitted by Members.
[2] From information reported via other sightings, port inspections or fishing vessels/traders.
[3] Calculated pro rata for 1 October to 30 November 2004.
[4] Estimates of the duration of fishing trips for IUU vessels have been agreed and used by WG-FSA for a number of years.
[5] Mean catch rates per day have been taken from the five-day catch and effort database, where available. CDS data have been used otherwise.
[6] On 11 October 2004, based on information submitted by South Africa, one more vessel was added to Subarea 58.6.
[7] Based on expert advice received from WG-FSA-04, ice conditions prevent any fishing in Divisions 58.4.2 and 58.4.4 and Subarea 88.1 during October and November. Therefore, estimations for the period 1 December to 1 October next year are representative for the whole fishing season, i.e. to 1 December 2004.
[8] According to a report submitted by Mauritius, the *Lugalpesca* transhipped 145 tonnes of undocumented toothfish during December 2003. WG-FSA noted that no information was available to allocate the catch to any specific area. Therefore, the catch was added to the overall total.

Table 3.3: Reported catch (tonnes) of *Dissostichus* spp. and estimated catch from IUU fishing in the Convention Area, and catch reported in the CDS in areas outside the Convention Area in the 2002/03 and 2003/04 seasons.

2002/03 season

Inside	Subarea/Division	Reported catch	IUU catch	Total CCAMLR	*Catch limit*
	48.3	7 528	0	7 528	*7 810*
	48.4	0			*28*
	48.6	0			*910*
	58.4.2	117	113	230	*500*
	58.4.3 (a and b)	0			*550*
	58.4.4	0	128	128	*0**
	58.5.1	5 291	7 825	13 116	*0**
	58.5.2	2 844	1 512	4 356	*2 879*
	58.6	571	354	925	*0**
	58.7	219	138	357	*0**
	88.1	1 831	0	1 831	*3 760*
	88.2	106	0	106	*375*
	Total inside	18 507	10 070	28 577	
Outside	Area	CDS catch EEZ	CDS catch high seas	Total outside CCAMLR	
	41	6 633	3 368	10 001	-
	47	0	3 852	3 852	-
	51	0	3 629	3 629	-
	57	0	871	871	-
	81	38	1	39	-
	87	5 511	234	5 745	-
	Total outside	12 182	11 955	24 137	-
Global total				52 714	

2003/04 season (to October 2004)

Inside	Subarea/Division	Reported catch	IUU catch	Total CCAMLR	*Catch limit*
	48.3	4 482	0	4 482	*4 420*
	48.4	0			*28*
	48.6	7			*910*
	58.4.2	20	197	217	*500*
	58.4.3 (a and b)	7	246	253	*550*
	58.4.4	0	0	0	*0**
	58.5.1	3 436	643	4 079	*0**
	58.5.2	2 269	637	2 906	*2 873*
	58.6	496	456	952	*0**
	58.7	50	58	108	*0**
	88.1	2 166	240	2 406	*3 250*
	88.2	374	0	374	*375*
	Area unknown	0	145	145	-
	Total inside	13 307	2 622	15 922	

(continued)

Table 3.3 (continued)

Outside	Area	CDS catch EEZ	CDS catch high seas	Total outside CCAMLR	
	41	3 698	2 644	6 342	-
	47	0	797	797	-
	51	0	108	108	-
	57	0	18	18	-
	81	0	0	0	-
	87	3 522	179	3 701	-
	Total outside	7 220	3 746	10 966	-
Global total				26 888	

Reported catch: 2002/03 from STATLANT data; 2003/04 catch and effort reports to 24 September 2004, except data for France reported to August 2004.
IUU catch: From SCIC-04/3 Rev. 2
CDS estimate: Data submitted to the CDS by 10 October 2004. The allocation between EEZ and high seas is based on the Secretariat's knowledge of vessel activity such as licence information, vessel size and trip duration.
Catch limits agreed by the Commission.
* Outside EEZs

Table 3.4: Research surveys notified by Members and estimated catch of species listed in Conservation Measure 24-01.

Member	Survey				Estimated catch (tonnes)	Comment*			
	Vessel	Period	Region	Purpose		a	b	c	d
Germany	RV *Polarstern*	Nov–Dec 2005	48.1	Survey on the abundance of demersal fish fauna, probably in the Elephant Island area. Continued work on seabirds, cephalopods and seals.				√	
Japan	MS *Shirase*	14 Nov 2004–13 Apr 2005	58	Physical, chemical and biological oceanography with emphasis on primary production research.					√
	RTV *Umitaka Maru*	Jan–Feb 2005	58.5.1	Marine science observations.					√
	RV *Hakuho Maru*	Dec 2004–Jan 2005	88.1	Survey will include marine geochemistry and dynamics of the ocean bio-system.					√
	RV *Kaiyo Maru*	Dec 2004–Jan 2005	88.1	Survey will include oceanographic observations, biological sampling, acoustic and sighting surveys.					√
New Zealand	*Avro Chieftain*	23 Jan–31 Apr 2005	88.3	Characterise the fishery, in particular selectivity and CPUE analysis and tag–recapture and tag data analysis.	<135		√		
UK	FPRV *Dorada*	Jan 2005	48	Investigate the utility of acoustic methods for assessing mackerel icefish stocks.				√	
	RRS *James Clark Ross*	Late 2004 – early 2005	48	Three krill surveys as part of the BAS Variability Project.				√	

* a – including no more than 10 tonnes of *Dissostichus* spp.
b – including no more than 100 tonnes of *Dissostichus* spp.
c – not specified by Member
d – not applicable

Table 6.1: Catch rates of *Macrourus whitsoni* and *Bathyraja eatonii* in bottom trawls during the BioRoss survey.

Species	Area	Depth range (m)	No. of trawls	Catch rate (kg/km^2)		
				Mean	SD	Range
M. whitsoni	SSRU 881E	85–574	13	12	22	0–71
		764–1 444	4	103	99	0–199
	SSRU 881H	130–556	24	39	108	0–460
		636–866	6	4 235	4 852	0–10 351
B. eatonii	SSRU 881E	85–574	13	0	0	0–0
		764–1 444	4	0	0	0–0
	SSRU 881H	130–556	24	99	182	0–568
		636–866	6	255	288	0–629

Table 6.2: Estimated seabed area between 600 and 1 800 m, *Macrourus* spp. CPUE by SSRU (over all years of fishery), 2003/04 *Macrourus* spp. catch, and indicative catch limits (assuming a total catch limit of 520 tonnes) under the three different by-catch management strategies discussed.

SSRU	Area (km^2)	*Macrourus* spp. CPUE (kg/hook)	2003/04 *Macrourus* spp. catch[†] (tonnes)	2003/04 catch limit (tonnes)	Proportional catch limit (tonnes)	Fixed catch limit (tonnes)
A						
B	4 318	0.005	0	20	3*	20
C	4 444	0.006	1	36	3*	20
D						
E	14 797	0.050	32	20	93	150
F						
G	7 110	0.028	16	20	25	150
H	19 245	0.018	43	126	43	150
I	30 783	0.049	266	124	188	150
J	43 594	0.005	0	51	26	20
K	24 695	0.045	0	120	140	150
L	16 807	0.000	0	29	0*	20
Total	165 793		358			

† From CCAMLR-XXIII/38, Appendix 3.

* Very low catch limits could be replaced with a catch limit of 20 tonnes for ease of monitoring.

Table 6.3: By-catch (tonnes) estimates from longline fisheries for the 2003/04 season. This table provides information for all rajids and *Macrourus* spp., and is derived from fine-scale (haul-by-haul) data. TOA – *Dissostichus mawsoni,* TOP – *Dissostichus eleginoides*.

	Subarea/Division									
	48.3	48.6	58.4.2	58.4.3b	58.5.2	58.6	58.7	88.1	88.2	Total
Total rajid	5.88		0.04	0.11	61.71			22.62	0.09	90.46
Total *Macrourus* spp.	29.94	0.27	0.63	0.13	42.33	0.06	0.44	318.80	36.55	429.15
Target TOA			19.65	6.27				2165.05	374.49	2565.46
Target TOP	4571.31	6.57	0.13	0.53	551.75	45.81	29.23	12.26	0.02	5217.60
Total rajid as % of target	0.13		0.20	1.67	11.18			1.04	0.02	1.16
Total *Macrourus* spp. as % of target	0.65	4.05	3.18	1.92	7.67	0.13	1.51	14.64	9.76	5.51

Table 6.4: By-catch (tonnes) estimates from trawl fisheries for the 2003/04 season. This table provides information for all rajids and *Macrourus* spp., and is derived from fine-scale (haul-by-haul) data. TOP – *Dissostichus eleginoides*, ANI – *Champsocephalus gunnari*.

	Division 58.5.2		Total
Target species:	ANI	TOP	
Total rajids	2.92	4.85	7.77
Total *Macrourus* spp.	0.75	2.14	2.88
Target TOP	143.41	1578.61	1722.01
Target ANI	50.38	0.31	50.69
Total rajids as % of target	1.51	0.31	0.44
Total *Macrourus* spp. as % of target	0.38	0.14	0.16

Table 6.5: An example of a proposed risk categorisation, using information on sleeper sharks (*Somniosus* spp.) in Division 58.5.2 presented in WG-FSA-03/69.

Life history characteristics	
Geographical distribution	*Somniosus* spp. have been reported in the southern hemisphere from the South American continental shelf from Uruguay to Patagonia, South Africa, New Zealand, south of Tasmania, Macquarie Island and around Heard and McDonald Islands. Tagging of *S. pacificus* in Alaska suggests that sleeper sharks may have relatively small home ranges.
Depth distribution	Occurs in deep water and on continental shelves and slopes. Fishery by-catch occurs at 415–759 m at Heard and McDonald Islands.
Age/growth	No age estimates are available. Probably long-lived and very slow growing. Tagging studies of *S. microcephalus* around Greenland have shown that this species may be one of the slowest growing cartilaginous fishes with annual growth rates of around 1 cm. Maximum length around 600 cm, possibly greater.
Reproduction	Very little information available. Probably ovoviviparous. Size-at-maturity may be greater than 400 cm.
Diet	In the Tasman Sea and around Macquarie Island, cephalopods occurred in 80% of stomachs of *S. antarcticus*, fish in 47%, marine mammals in 33%, birds in 7% and other items in 13%.
Vulnerability to fishing	
Overlap between distribution and fishing	Uncertain because distribution records are limited by the spread of fishing effort. Occurs as by-catch in trawl and longline fisheries for *Champsocephalus gunnari* and *Dissostichus* spp. in Division 58.5.2.
Co-occurrence with exploited species	Overlap in geographical and depth distribution with *C. gunnari* and *Dissostichus* spp. Documented as feeding on these species.
Trawl or longline catchability	Highly skewed sex ratio in catches of *S. antarcticus* around Heard and Macquarie Islands. Females predominate in catches by 4:1 at Macquarie Island and by 5:1 at Heard and McDonald Islands.
Catch	Average catch of about eight sharks per year in Division 58.5.2. Catches of *Somniosus* spp. reported to FAO from the northern hemisphere ranged from 19 to 157 tonnes. CPUE of *Somniosus* spp. caught as by-catch in Prince William Sound ranged from 1 to 21 sharks per hundred hooks.
Population status	No information.
Conservation measures and mitigation	Animals tagged and released where possible.
Category*	3

(continued)

Table 6.5 (continued)

***Explanation of the status categories** (based on Castro et al., 1999)

Category 1: Exploited species that cannot be placed on any of the subsequent categories, because of lack of data.
Category 2: Species pursued in directed fisheries, and/or regularly found in by-catch, whose catches have not decreased historically, probably due to their higher reproductive potential.
Category 3: Species that are exploited by directed fisheries or by-catch, and have a limited reproductive potential, and/or other life history characteristics that make them especially vulnerable to overfishing, and/or that are being fished in their nursery areas.
Category 4: Species in this category show substantial historical declines in catches and/or have become locally extinct.
Category 5: Species that have become rare throughout the ranges where they were formerly abundant, based on historical records, catch statistics, or experts' reports.

Table 6.6: Available information on the fate of rajids from observer data for all fisheries.

		Number	%
Longline records		149	
	Cut off line	114	77
	Lost at surface or dropped off	16	11
	Unknown	19	13

Table 7.1: Reported and 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 2003/04 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)			No. of birds caught						Observed seabird mortality (birds/thousand hooks)			Streamer line in use %		Offal discharge during	
			N	D	Total	%N	Obs.	Set	% observed	Dead N	Dead D	Alive N	Alive D	Total N	Total D	N	D	Total	N	D	Set (%)	Haul (%)
Subarea 48.3																						
Globalpesca I	8/5–18/7/04	Sp	43	1	44	98	194.1	387.0	50	0	0	0	0	0	0	0	0	0	100	100		O (0)
Isla Camila	1/5–30/6/04	Sp	115	1	116	99	147.7	524.3	28	0	0	0	0	0	0	0	0	0	75	100		O (1)
Isla Santa Clara	1/5–23/7/04	Sp	175	2	177	99	285.2	1144.7	24	1	0	1	0	2	0	0.004	0	0.004	100	100		O (100)
Isla Sofía	1/5–4/7/04	Sp	136	0	136	100	264.7	771.6	34	0	0	0	0	0	0	0	0	0	100			O (82)
Polarpesca I	1/5–14/8/04	Sp	295	4	299	99	309.3	1412.7	21	0	0	0	0	0	0	0	0	0	99	100		O (98)
Tierra del Fuego	3/5–14/8/04	Sp	178	0	178	100	254.0	1095.0	23	0	0	0	0	0	0	0	0	0	98			O (99)
Ibsa Quinto	2/5–25/6/04	Sp	57	0	57	100	329.8	1308.1	25	0	0	1	0	1	0	0	0	0	96			O (100)
Viking Bay	1/5–13/7/04	Sp	145	0	145	100	204.9	789.9	25	0	0	5	0	5	0	0	0	0	100			O (82)
Argos Georgia	2/5–15/8/04	Sp	233	55	288	81	595.6	1227.6	48	0	0	0	0	0	0	0	0	0	100	98		O (99)
Argos Helena	2/5–16/8/04	Auto	352	0	352	100	461.0	1736.4	26	1	0	6	0	7	0	0.002	0	0.002	100		(<1)	O (3)
Burdwood	5/5–17/8/04	Sp	194	0	194	100	423.2	1483.7	28	3	0	0	0	3	0	0.007	0	0.007	100*			O (3)
Jacqueline	3/5–7/7/04	Sp	54	0	54	100	268.4	970.5	27	0	0	0	0	0	0	0	0	0	98			O (98)
No. 22 InSung	1/5–19/8/04	Sp	202	3	205	99	406.5	1890.1	21	0	0	0	0	0	0	0	0	0	100	100		O (99)
Isla Alegranza	2/5–23/7/04	Sp	139	0	139	100	333.7	1302.4	25	0	0	2	0	2	0	0	0	0	98			O (96)
Paloma V	21/7–19/8/04	Sp	53	0	53	100	143.6	509.8	28	0	0	0	0	0	0	0	0	0	100			O (96)
Koryo Maru No. 11	12/5–20/8/04	Sp	181	1	182	99	321.4	1723.5	18	0	0	0	0	0	0	0	0	0	100	100		O (86)
Total						98	4943.1	18277.3	28							0.001	0	0.001				
Subarea 48.6																						
Shinsei Maru No. 3	7/3–21/3/04	Sp	12	17	29	41	40.4	173.8	23	0	0	0	0	0	0	0	0	0	100	100		O (0)
Total						41	40.4	173.8	23							0	0	0				
Divisions 58.4.2, 58.4.3b																						
Eldfisk	30/11/03–24/1/04	Auto	0	70	70	0	125.0	319.7	39	0	0	0	0	0	0	0	0	0		100		O (0)
Total						0	125.0	319.7	39							0	0	0				
Division 58.5.2																						
Janas	30/4–24/6/04	Auto	141	0	141	100	291.0	881.6	33	0	0	0	0	0	0	0	0	0	100			O (0)
Janas	20/7–10/9/04	Auto	133	3	136	98	244.9	716.7	34	0	0	0	0	0	0	0	0	0	100	100		O (0)
Total						99	535.9	1598.3	34							0	0	0				
Subareas 58.6, 58.7, Area 51																						
Koryo Maru No. 11	19/2–30/3/04	Sp	50	23	73	68	263.8	700.8	37	0	1	10	1	10	2	0	0.012	0.004	100	100	(6)	O (91)
South Princess	19/5–7/7/04	Auto	231	7	238	97	175.4	637.6	27	10	0	0	0	10	0	0.058	0	0.057	100	100		S (0)
Total						90	439.2	1338.4	32							0.028	0.012	0.025				

(continued)

Table 7.1 (continued)

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks (thousands)			No. of birds caught						Observed seabird mortality (birds/thousand hooks)			Streamer line in use %		Offal discharge during	
			N	D	Total	%N	Obs.	Set	% observed	Dead N	Dead D	Alive N	Alive D	Total N	Total D	N	D	Total	N	D	Set (%)	Haul (%)
Subareas 88.1, 88.2																						
Antarctic II	7/2–4/3/04	Auto	11	69	80	14	141.9	275.5	51	0	0	0	0	0	0	0	0	0	18	93		(0)
Antarctic III	1/1–3/3/04	Auto	8	174	182	4	510.6	550.7	92	0	0	0	0	0	0	0	0	0	100	100		(0)
Arnela	29/12/03–3/3/04	Sp	0	119	119	0	331.4	923.8	35	0	0	0	0	0	0	0	0	0		98	(4)*	O (24)
Argos Helena	21/2–7/3/04	Auto	0	36	36	0	73.2	154.4	47	0	0	0	0	0	0	0	0	0		100		(0)
No. 707 Bonanza	10/1–3/3/04	Sp	2	83	85	2	791.8	795.8	99	0	0	0	0	0	0	0	0	0	50	98		(0)
No. 829 Yeon Seong	30/1–3/3/04	Sp	8	38	46	17	399.6	506.3	78	0	0	0	0	0	0	0	0	0	100	100		(0)
Gudni Olafsson	27/12/03–10/2/04	Auto	0	76	76	0	221.4	509.0	43	0	0	0	0	0	0	0	0	0		100		(0)
San Aotea II	12/12/03–21/2/04	Auto	0	134	134	0	241.1	641.2	37	0	0	0	0	0	0	0	0	0		100		(0)
Volna	15/12/03–9/3/04	Sp	1	104	105	1	332.8	802.4	41	0	0	0	0	0	0	0	0	0	100	100		(0)
Yantar	15/12/03–9/3/04	Sp	1	116	117	1	928.8	994.7	93	0	0	0	0	0	0	0	0	0	100	100		(0)
Mellas	2/1–3/3/04	Sp	20	72	92	22	445.0	490.3	90	0	0	0	0	0	0	0	0	0	100	100		(0)
Simeiz	15/12/03–7/3/04	Sp	4	106	110	4	802.9	862.4	93	0	0	0	0	0	0	0	0	0	100	100		(0)
Sonrisa	10/2–4/3/04	Auto	0	10	10	0	55.6	62.6	88	0	0	0	0	0	0	0	0	0		100		(0)
Piscis	12/1–7/3/04	Sp	16	82	98	16	646.3	781.4	82	0	1	0	0	0	1	0	0.002	0.002	100	100		(0)
Punta Ballena	11/1–3/3/04	Auto	3	68	71	4	134.0	438.9	30	0	0	0	0	0	0	0	0	0	67	94		(0)
America I	12/12/03–5/3/04	Sp	7	101	108	6	368.0	627.3	58	0	0	0	1	0	1	0	0	0	100	94		(0)
American Warrior	8/1–3/3/04	Auto	0	118	118	0	232.0	689.0	33	0	0	0	0	0	0	0	0	0		100		(0)
South Princess	15/12/03–4/3/04	Auto	1	199	200	1	313.6	755.2	41	0	0	0	0	0	0	0	0	0	100	99		(0)
Frøyanes	23/1–4/3/04	Auto	3	128	131	2	319.5	609.5	52	0	0	0	0	0	0	0	0	0	100	100		(0)
Avro Chieftain	1/12/03–19/3/04	Auto	19	165	184	10	495.3	977.4	50	0	0	0	0	0	0	0	0	0	100	100		(0)
Janas	12/12/03–24/2/04	Auto	0	118	118	0	321.9	648.8	49	0	0	0	0	0	0	0	0	0		100		(0)
San Liberatore	1/2–6/3/04	Auto	1	113	114	1	261.5	505.4	51	0	0	0	0	0	0	0	0	0	100	100		(0)
Total						5	8368.2	13602.0	61							0	<0.001	<0.001				

Table 7.2: Estimated total seabird mortality for those vessels where seabird mortalities were observed in Subareas 48.3, 58.6, 58.7, 88.1 and 88.2 during the 2003/04 season.

Vessel	Hooks observed (thousands)	Hooks set (thousands)	Percentage of hooks observed	% Night sets	Estimated number of birds caught dead		
					Night	Day	Total
Subarea 48.3							
Isla Santa Clara	285.2	1144.7	24	99	5	0	5
Argos Helena	461	1736.4	26	100	3	0	3
Burdwood	423.2	1483.7	28	100	10	0	10
Subtotal					18	0	18
Subareas 58.6, 58.7							
Koryo Maru No. 11	263.8	700.8	37	68	0	3	3
South Princess	175.4	637.6	27	97	36	0	36
Subtotal					36	3	39
Subareas 88.1, 88.2							
Piscis	646.3	781.4	82	16	0	1	1
Subtotal					0	1	1
Total					54	4	58

Table 7.3: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subareas 48.3, 58.6, 58.7, 88.1 and 88.2 from 1997 to 2004.

Subarea	Year							
	1997	1998	1999	2000	2001	2002	2003	2004
Subarea 48.3								
Estimated by-catch	5 755	640	210*	21	30	27	8	18
By-catch rate	0.23	0.032	0.013*	0.002	0.002	0.0015	0.0003	0.001
Subareas 58.6, 58.7								
Estimated by-catch	834	528	156	516	199	0	7	39
By-catch rate	0.52	0.194	0.034	0.046	0.018	0	0.003	0.025
Subareas 88.1, 88.2								
Estimated by-catch	-	0	0	0	0	0	0	1
By-catch rate	-	0	0	0	0	0	0	0.0001

* Excluding *Argos Helena* line-weighting experiment cruise.

Table 7.4: Species composition of birds killed in longline fisheries in Subareas 48.3, 58.6, 58.7, 88.1 and 88.2 during the 2003/04 season. N – night setting; D – daylight setting (including nautical dawn and dusk); DIC – grey-headed albatross; DIM – black-browed albatross; MAH – northern giant petrel; MAI – southern giant petrel; PRO – white-chinned petrel; PRX – petrels unidentified; () – % composition.

Vessel	Dates of fishing	No. birds killed by group						Species composition (%)				
		Albatrosses		Petrels		Total		DIC	DIM	MAH	MAI	PRO
		N	D	N	D	N	D					
Subarea 48.3												
Isla Santa Clara	1/5–23/7/04	1	0	0	0	1	0		1 (100)			
Argos Helena	2/5–16/8/04	1	0	0	0	1	0	1 (100)				
Burdwood	5/5–17/8/04	0	0	3	0	3	0				3 (100)	
Subareas 58.6, 58.7												
Koryo Maru No. 11	19/2–30/3/04	0	0	0	1	0	1					1 (100)
South Princess	19/5–7/7/04	0	0	10	0	10	0			4 (40)	6 (60)	
Subareas 88.1, 88.2												
Piscis	12/1–7/3/04	0	0	0	1	0	1				1 (100)	
Total (%)		2	0	13	2	15	2	1 (6)	1 (6)	4 (23)	10 (59)	1 (6)

Table 7.5: Reported and observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2001/02 season (September to August). Sp – Spanish method; Auto – autoliner; N – night-time setting; D – daytime setting (including dawn and dusk); NC – not collected.

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 (%)
											Dead		Alive		Total							
			N	D	Total	%N	Obs.	Set	% Observed		N	D	N	D	N	D	N	D	Total	N	D	
Subarea 58.6																						
Ship 1	3/7–24/7/02	Auto	42	0	42	100	NC	495.0	NC	NC	2	0	NC	0	2	0	0.004	0	0.004	100	0	(0)
Ship 2	15/4–14/5/02	Auto	108	0	108	100	NC	502.0	NC	NC	77	0	NC	0	77	0	0.153	0	0.153	100	0	(0)
Ship 3	11/9–26/9/01	Auto	36	0	36	100	NC	347.3	NC	NC	1	0	NC	0	1	0	0.003	0	0.003	100	0	(0)
Ship 3	20/3–18/5/02	Auto	119	0	119	100	NC	1 348.2	NC	NC	152	0	NC	0	152	0	0.113	0	0.113	100	0	(0)
Ship 5	4/10–18/10/01	Auto	27	0	27	100	NC	318.1	NC	NC	34	0	NC	0	34	0	0.107	0	0.107	100	0	(0)
Ship 5	6/5–26/6/02	Auto	131	0	131	100	NC	1 155.2	NC	NC	60	0	NC	0	60	0	0.052	0	0.052	100	0	(0)
Ship 7	29/11–2/12/01	Auto	5	0	5	100	NC	50.0	NC	NC	11	0	NC	0	11	0	0.220	0	0.220	100	0	(0)
Ship 7	11/3–27/3/02	Auto	29	0	29	100	NC	308.0	NC	NC	388	0	NC	0	388	0	1.260	0	1.260	100	0	(0)
Ship 7	21/6–14/7/02	Auto	54	0	54	100	NC	512.0	NC	NC	6	0	NC	0	6	0	0.012	0	0.012	100	0	(0)
Ship 8	24/1–29/3/02	Auto	207	0	207	100	NC	1 206.0	NC	NC	314	0	NC	0	314	0	0.260	0	0.260	100	0	(0)
Ship 9	25/9–30/9/01	Sp	5	0	5	100	NC	61.3	NC	NC	0	0	NC	0	0	0	0.000	0	0.000	100	0	(0)
Ship 9	7/12–25/12/01	Sp	18	0	18	100	NC	252.0	NC	NC	11	0	NC	0	11	0	0.044	0	0.044	100	0	(0)
Ship 9	22/2–19/3/02	Sp	28	0	28	100	NC	336.0	NC	NC	186	0	NC	0	186	0	0.554	0	0.554	100	0	(0)
Ship 9	14/5–18/5/02	Sp	6	0	6	100	NC	50.4	NC	NC	0	0	NC	0	0	0	0.000	0	0.000	100	0	(0)
Ship 9	1/6–15/7/02	Sp	60	0	60	100	NC	491.4	NC	NC	1	0	NC	0	1	0	0.002	0	0.002	100	0	(0)
Total						100	NC	7 432.8	NC		1 243	0	NC	0	1 243		0.167	0	0.167			
Division 58.5.1																						
Ship 1	18/3–26/5/02	Auto	132	0	132	100	NC	1 575.5	NC	NC	1 318	0	NC	0	1 318	0	0.837	0	0.837	100	0	(0)
Ship 2	17/5–8/6/02	Auto	61	0	61	100	NC	423.8	NC	NC	106	0	NC	0	106	0	0.250	0	0.250	100	0	(0)
Ship 2	28/6–28/7/02	Auto	80	0	80	100	NC	603.5	NC	NC	91	0	NC	0	91	0	0.151	0	0.151	100	0	(0)
Ship 3	30/9–3/11/01	Auto	74	0	74	100	NC	795.9	NC	NC	1 213	0	NC	0	1 213	0	1.524	0	1.524	100	0	(0)
Ship 3	14/12/01–14/1/02	Auto	56	0	56	100	NC	764.4	NC	NC	28	0	NC	0	28	0	0.037	0	0.037	100	0	(0)
Ship 5	21/10–6/12/01	Auto	116	0	116	100	NC	1 079.0	NC	NC	447	0	NC	0	447	0	0.414	0	0.414	100	0	(0)
Ship 5	25/4/01–2/5/02	Auto	19	0	19	100	NC	173.9	NC	NC	13	0	NC	0	13	0	0.075	0	0.075	100	0	(0)
Ship 5	11/1–18/3/02	Auto	151	0	151	100	NC	1 501.7	NC	NC	4 811	0	NC	0	4 811	0	3.204	0	3.204	100	0	(0)
Ship 7	4/12/01–31/1/02	Auto	81	0	81	100	NC	1 059.0	NC	NC	1 292	0	NC	0	1 292	0	1.220	0	1.220	100	0	(0)
Ship 7	1/4–15/5/02	Auto	93	0	93	100	NC	688.0	NC	NC	966	0	NC	0	966	0	1.404	0	1.404	100	0	(0)
Ship 8	22/9–27/11/01	Auto	237	0	237	100	NC	1 331.4	NC	NC	338	0	NC	0	338	0	0.254	0	0.254	100	0	(0)
Ship 8	16/5–17/6/02	Auto	112	0	112	100	NC	662.4	NC	NC	93	0	NC	0	93	0	0.140	0	0.140	100	0	(0)
Ship 9	2/10–17/11/01	Sp	46	0	46	100	NC	535.5	NC	NC	62	0	NC	0	62	0	0.116	0	0.116	100	0	(0)
Ship 9	24/3–22/4/02	Sp	41	0	41	100	NC	360.5	NC	NC	36	0	NC	0	36	0	0.100	0	0.100	100	0	(0)
Total						100	NC	11 554.3	NC		10 814	0	NC	0	10 814		0.936	0	0.936			

* The number of observed hooks has not been collected and the rates given are from the total number of hooks set.

Table 7.6: Species composition of birds killed in longline fisheries in Subarea 58.6 and Division 58.5.1 during the 2001/02 season (September to August). PRO – white-chinned petrel; MXB – giant petrel; PCI – grey petrel; DAC – cape petrel; PTZ – unidentified petrel; DIC – grey-headed albatross; DIM – black-browed albatross; ALZ – unidentified albatross; EUC – macaroni penguin; EDJ – king penguin; PYP – gentoo penguin; UNK – unknown; () – % composition.

Vessel	Dates of fishing	No. birds killed by group								Species composition (%)											
		Petrels		Albatrosses		Penguins		Total		PRO	MXB	PCI	DAC	PTZ	DIC	DIM	ALZ	EUC	EDJ	PYP	UNK
		N	D	N	D	N	D	N	D												
Subarea 58.6																					
Ship 1	3/7–24/07/02	2	0	0	0	0	0	2	0			2 (100)									
Ship 2	15/4–14/05/02	59	0	18	0	0	0	77	0	33(42.9)	20 (26.0)	6 (7.8)			17 (22.1)						1 (1.3)
Ship 3	11/9–26/09/01	1	0	0	0	0	0	1	0	1 (100)											
Ship 3	20/3–18/05/02	152	0	0	0	0	0	152	0	152 (100)											
Ship 5	4/10–18/10/01	34	0	0	0	0	0	34	0	34 (100)											
Ship 5	6/5–26/06/02	56	0	0	0	0	0	60	0		38 (63.3)	16 (26.7)		2 (3.3)							4 (6.7)
Ship 7	29/11–02/12/01	11	0	0	0	0	0	11	0	3(27.3)	8 (72.7)										
Ship 7	11/3–27/03/02	388	0	0	0	0	0	388	0	388 (100)											
Ship 7	21/6–14/07/02	6	0	0	0	0	0	6	0		1 (16.7)	4 (66.7)	1 (16.7)								
Ship 8	24/1–29/03/02	312	0	2	0	0	0	314	0	312(99.4)							2 (0.6)				
Ship 9	25/9–30/09/01	0	0	0	0	0	0	0	0												
Ship 9	7/12–25/12/01	11	0	0	0	0	0	11	0	11 (100)											
Ship 9	22/2–19/03/02	179	0	5	0	2	0	186	0	179(96.2)					4 (2.2)	1 (0.5)			1 (0.5)	1 (0.5)	
Ship 9	14/5–18/05/02	0	0	0	0	0	0	0	0												
Ship 9	1/6–15/07/02	1	0	0	0	0	0	1	0			1 (100)									
Division 58.5.1																					
Ship 1	18/3–26/05/02	1304	0	14	0	0	0	1318	0	1271(96.4)		33 (2.5)			14 (1.1)						
Ship 2	17/5–08/06/02	106	0	0	0	0	0	106	0		5 (4.7)	101(95.3)									
Ship 2	28/6–28/07/02	91	0	0	0	0	0	91	0		12 (13.2)	79 (86.8)									
Ship 3	30/9–03/11/01	1213	0	0	0	0	0	1213	0	1212(99.9)		1 (0.1)									
Ship 3	14/12/01–14/01/02	28	0	0	0	0	0	28	0	28 (100)											
Ship 5	21/10–06/12/01	447	0	0	0	0	0	447	0	447 (100)											
Ship 5	25/4/01–02/05/02	12	0	1	0	0	0	13	0			11 (84.6)		1 (7.7)			1 (7.7)				
Ship 5	11/1–18/03/02	4797	0	14	0	0	0	4811	0	4790(99.6)	1 (0.02)	5 (0.1)	1 (0.02)		1 (0.02)	13 (0.3)					
Ship 7	4/12/01–31/01/02	1286	0	4	0	1	0	1292	0	1286(99.5)						4 (0.3)		1 (0.1)			1 (0.1)
Ship 7	1/4–15/05/02	965	0	1	0	0	0	966	0	949(98.2)	3 (0.3)	13 (1.3)					1 (0.1)				
Ship 8	22/9–27/11/01	338	0	0	0	0	0	338	0			338 (100)									
Ship 8	16/5–17/06/02	92	0	0	0	0	0	93	0	8 (8.6)		84 (90.3)									1 (1.1)
Ship 9	2/10–17/11/01	62	0	0	0	0	0	62	0	62 (100)											
Ship 9	24/3–22/04/02	36	0	0	0	0	0	36	0	36 (100)											
Total (%)		11989	0	59	0	3	0	12057	0	11202 (92.9)	88 (0.7)	694 (5.8)	2 (0.02)	3 (0.02)	36 (0.3)	18 (0.15)	4 (0.3)	1 (0.01)	1 (0.01)	1 (0.01)	7 (0.06)

Table 7.7: Reported and observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2002/03 season (September to August). Sp – Spanish method; Auto – autoliner; N – night-time setting; D – daytime setting (including dawn and dusk); NC – not collected.

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	N	D	N	D	N	D	Total	N	D	
Subarea 58.6																						
Ship 1	25/9–10/12/02	Auto	145	0	145	100	NC	1553.4	NC	-	231	0	NC	0	231	0	0.149	0	0.149	100	0	(0)
Ship 2	9/9–3/10/02	Auto	82	0	82	100	NC	412.5	NC	-	36	0	NC	0	36	0	0.087	0	0.087	100	0	(0)
Ship 2	13/1–3/2/03	Auto	67	0	67	100	NC	424.1	NC	-	95	0	NC	0	95	0	0.224	0	0.224	100	0	(0)
Ship 2	26/2–10/3/03	Auto	45	0	45	100	NC	315.0	NC	-	158	0	NC	0	158	0	0.502	0	0.502	100	0	(0)
Ship 2	14/7–30/7/03	Auto	43	0	43	100	NC	323.8	NC	90.00	1	0	NC	0	1	0	0.003	0	0.003	100	0	(0)
Ship 3	5/12/02–10/2/03	Auto	127	0	127	100	NC	1454.8	NC	-	73	0	NC	0	73	0	0.050	0	0.050	100	0	(0)
Ship 5	13/4–30/5/03	Auto	103	0	103	100	NC	1027.8	NC	-	44	0	NC	0	44	0	0.043	0	0.043	100	0	(0)
Ship 6	13/12/02–3/1/03	Auto	50	0	50	100	NC	292.4	NC	-	53	0	NC	0	53	0	0.181	0	0.181	100	0	(0)
Ship 7	3/4–13/5/03	Auto	86	0	86	100	NC	789.3	NC	90.25	29	0	NC	0	29	0	0.037	0	0.037	100	0	(0)
Total						100	NC	6593.0	NC		720	0	NC	0	720	0	0.109	0	0.109			
Division 58.5.1																						
Ship 1	13/1–29/03/03	Auto	160	0	160	100	NC	2250.0	NC	85.01	2 028	0	NC	0	2 028	0	0.901	0	0.901	100	0	(0)
Ship 1	7/5–17/07/03	Auto	191	0	191	100	NC	1792.8	NC	86.20	274	0	NC	0	274	0	0.153	0	0.153	100	0	(0)
Ship 2	6/10–06/11/02	Auto	101	0	101	100	NC	730.8	NC	-	1 366	0	NC	0	1 366	0	1.869	0	1.869	100	0	(0)
Ship 2	25/11/02–09/01/03	Auto	126	0	126	100	NC	1077.4	NC	-	98	0	NC	0	98	0	0.091	0	0.091	100	0	(0)
Ship 2	13/3–06/05/03	Auto	153	0	153	100	NC	1300.5	NC	-	357	0	NC	0	357	0	0.275	0	0.275	100	0	(0)
Ship 2	28/5–11/07/03	Auto	120	0	120	100	NC	1073.8	NC	90.00	23	0	NC	0	23	0	0.021	0	0.021	100	0	(0)
Ship 3	1/9/02–30/10/03	Auto	129	0	129	100	NC	1356.6	NC	-	145	0	NC	0	145	0	0.107	0	0.107	100	0	(0)
Ship 3	19/3–18/06/03	Auto	200	0	200	100	NC	2090.5	NC	-	1 391	0	NC	0	1 391	0	0.665	0	0.665	100	0	(0)
Ship 4	19/10/02–11/01/03	Sp	123	0	123	100	NC	768.4	NC	-	107	0	NC	0	107	0	0.139	0	0.139	100	0	(0)
Ship 4	15/2–04/05/03	Sp	138	0	138	100	NC	999.1	NC	-	307	0	NC	0	307	0	0.307	0	0.307	100	0	(0)
Ship 4	4/6–30/08/03	Sp	202	0	202	100	NC	1101.1	NC	-	27	0	NC	0	27	0	0.025	0	0.025	100	0	(0)
Ship 5	10/9–13/11/02	Auto	141	0	141	100	NC	1386.0	NC	-	710	0	NC	0	710	0	0.512	0	0.512	100	0	(0)
Ship 5	19/12/02–04/03/03	Auto	167	0	167	100	NC	1854.0	NC	-	285	0	NC	0	285	0	0.154	0	0.154	100	0	(0)
Ship 5	1/6–07/07/03	Auto	75	0	75	100	NC	832.5	NC	-	131	0	NC	0	131	0	0.157	0	0.157	100	0	(0)
Ship 6	1/9–10/11/02	Auto	190	0	190	100	NC	1094.2	NC	-	1 469	0	NC	0	1 469	0	1.343	0	1.343	100	0	(0)
Ship 6	5/1–20/02/03	Auto	113	0	113	100	NC	818.2	NC	-	2 079	0	NC	0	2 079	0	2.541	0	2.541	100	0	(0)
Ship 6	2/4–14/06/03	Auto	214	0	214	100	NC	1453.1	NC	-	174	0	NC	0	174	0	0.120	0	0.120	100	0	(0)
Ship 6	26/7–30/08/03	Auto	77	0	77	100	NC	607.2	NC	-	120	0	NC	0	120	0	0.198	0	0.198	100	0	(0)
Ship 7	4/9–07/11/02	Auto	124	0	124	100	NC	1289.7	NC	91.60	859	0	NC	0	859	0	0.666	0	0.666	100	0	(0)
Ship 7	15/12/02–23/02/03	Auto	159	0	159	100	NC	1642.5	NC	-	1 909	0	NC	0	1 909	0	1.162	0	1.162	100	0	(0)
Ship 7	16/5–23/06/03	Auto	76	0	76	100	NC	854.1	NC	89.41	10	0	NC	0	10	0	0.012	0	0.012	100	0	(0)
Ship 7	9/8–02/09/03	Auto	55	0	55	100	NC	512.1	NC	-	57	0	NC	0	57	0	0.111	0	0.111	100	0	(0)
Total						100	NC	26884.4	NC		13 926	0	NC	0	13 926	0	0.518	0	0.518			

* Data from a sample of hooks.

† The number of observed hooks has not been collected and the rates given are from the total number of hooks set.

Table 7.8: Species composition of birds killed in longline fisheries in Subarea 58.6 and Division 58.5.1 during the 2002/03 season (September to August). PRO – white-chinned petrel; MXB – giant petrel; PCI – grey petrel; DAC – cape petrel; PTZ – unidentified petrel; DIC – grey-headed albatross; DIM – black-browed albatross; EUC – macaroni penguin; PVF – unidentified penguin; UNK – unknown; () – % composition.

Vessel	Dates of fishing	No. of birds killed by group								Species composition (%)									
		Albatrosses		Petrels		Penguins		Total		PRO	MXB	PCI	DAC	PTZ	DIC	DIM	EUC	PVF	UNK
		N	D	N	D	N	D	N	D										
Subarea 58.6																			
Ship 1	25/9–10/12/02	0	0	231	0	0	0	231	0	227 (98.3)	4 (1.7)								
Ship 2	9/9–3/10/02	0	0	31	0	0	0	36	0	19 (52.8)	3 (8.3)	9 (25.0)							5 (13.9)
Ship 2	13/1–3/2/03	1	0	93	0	1	0	95	0	93 (97.9)						1 (1.1)		1 (1.1)	
Ship 2	26/2–10/3/03	2	0	156	0	0	0	158	0	156 (98.7)						2 (1.3)			
Ship 2	14/7–30/7/03	0	0	1	0	0	0	1	0			1 (100)							
Ship 3	5/12/02–10/2/03	0	0	71	0	1	0	73	0	70 (95.9)	1 (1.4)						1 (1.4)		1 (1.4)
Ship 5	13/4–30/5/03	0	0	44	0	0	0	44	0	25 (56.8)	8 (18.2)	11 (25.0)							
Ship 6	13/12/02–3/1/03	9	0	44	0	0	0	53	0	19 (35.8)	25 (47.2)					9(17.0)			
Ship 7	3/4–13/5/03	0	0	29	0	0	0	29	0	29 (100)									
Division 58.5.1																			
Ship 1	13/1–29/3/03	0	0	2028	0	0	0	2028	0	2028 (100)									
Ship 1	7/5–17/7/03	0	0	274	0	0	0	274	0	1 (0.4)		273 (99.6)							
Ship 2	6/10–6/11/02	3	0	1363	0	0	0	1366	0	1363 (99.8)					1 (0.1)	2 (0.1)			
Ship 2	25/11/02–9/1/03	4	0	93	0	0	0	98	0	93 (94.9)						4 (4.1)			1 (1.0)
Ship 2	13/3–6/5/03	2	0	355	0	0	0	357	0	350 (98.0)	1 (0.3)	4 (1.1)			1 (0.3)	1 (0.3)			
Ship 2	28/5–11/7/03	0	0	23	0	0	0	23	0	22 (95.7)			1 (4.3)						
Ship 3	1/9/02–30/10/03	0	0	145	0	0	0	145	0	144 (99.3)		1 (0.7)							
Ship 3	19/3–18/6/03	12	0	1379	0	0	0	1391	0	1176 (84.5)	1 (0.1)	200 (14.4)	2 (0.1)		5 (0.4)	7 (0.5)			
Ship 4	19/10/02–11/1/03	0	0	107	0	0	0	107	0	107 (100)									
Ship 4	15/2–4/5/03	0	0	307	0	0	0	307	0	299 (97.4)		8 (2.6)							
Ship 4	4/6–30/8/03	0	0	27	0	0	0	27	0			27 (100)							
Ship 5	10/9–13/11/02	0	0	710	0	0	0	710	0	704 (99.2)		6 (0.8)							
Ship 5	19/12/02–4/3/03	0	0	284	0	0	0	285	0	284 (99.6)									1 (0.4)
Ship 5	1/6–7/7/03	0	0	131	0	0	0	131	0			130 (99.2)		1 (0.8)					
Ship 6	1/9–10/11/02	16	0	1412	0	0	0	1469	0	1432 (97.5)	13 (0.9)		4 (0.3)		1 (0.1)	15 (1.0)			4 (0.3)
Ship 6	5/1–20/2/03	23	0	2056	0	0	0	2079	0	2055 (98.8)	1 (0.04)				2 (0.1)	21 (1.0)			
Ship 6	2/4–14/6/03	0	0	174	0	0	0	174	0	172 (98.9)	1 (0.6)	1 (0.6)							
Ship 6	26/7–30/8/03	2	0	119	0	0	0	120	0	4 (3.3)	1 (0.8)	113 (94.2)	1 (0.8)		1 (0.8)				
Ship 7	4/9–7/11/02	0	0	856	0	0	0	859	0	857 (99.8)			1 (0.1)						1 (0.1)
Ship 7	15/12/02–23/2/03	1	0	1908	0	0	0	1909	0	1908 (99.9)						1 (0.1)			
Ship 7	16/5–23/6/03	0	0	10	0	0	0	10	0			10 (100)							
Ship 7	9/8–2/9/03	0	0	57	0	0	0	57	0	4 (7.0)		52 (91.2)	1 (1.8)						
Total (%)		75	0	14518	0	2	0	14646	0	13641 (93.10)	59 (0.40)	846 (5.78)	10 (0.07)	1 (0.01)	11 (0.08)	63 (0.43)	1 (0.01)	1 (0.01)	13 (0.09)

Table 7.9: Reported and observed incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subarea 58.6 and Division 58.5.1 during the 2003/04 season (September to August). Sp – Spanish method; Auto – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); NC – not collected.

Vessel	Dates of fishing	Method	Sets deployed				No. of hooks (thousands)			Hooks baited* (%)	No. of birds 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	
											N	D	N	D	N	D						
Subarea 58.6																						
Ship 1	14/1–25/2/04	Auto	69	0	69	100	NC	680.4	NC	NC	12†	0	0	0	12	0	0.018	0	0.018	100	0	(0)
Ship 2	7/9–28/9/03	Auto	61	0	61	100	NC	466.9	NC	NC	11†	0	4	0	15	0	0.024	0	0.024	100	0	(0)
Ship 2	2/2–9/2/04	Auto	25	0	25	100	NC	156.3	NC	NC	32†	0	0	0	32	0	0.205	0	0.205	100	0	(0)
Ship 3	24/11–17/12/03	Auto	38	0	38	100	NC	467.3	NC	82.00	4†	0	7	0	11	0	0.009	0	0.009	100	0	(0)
Ship 4	24/1–31/1/04	Sp	15	0	15	100	NC	84.4	NC	100.00	5†	0	0	0	5	0	0.059	0	0.059	100	0	(0)
Ship 5	13/9–1/10/03	Auto	43	0	43	100	NC	410.4	NC	NC	3†	0	0	0	3	0	0.007	0	0.007	100	0	(0)
Ship 5	3/2–26/2/04	Auto	52	0	52	100	NC	455.5	NC	NC	157†	0	35	0	192	0	0.345	0	0.345	100	0	(0)
Ship 6	1/2–23/2/04	Auto	86	0	86	100	NC	418.5	NC	NC	9†	0	1	0	10	0	0.022	0	0.022	100	0	(0)
Ship 7	25/11–7/12/03	Auto	18	0	18	100	NC	261.5	NC	94.00	9†	0	3	0	12	0	0.034	0	0.034	100	0	(0)
							NC	3401.0	NC		242	0	50	0	292	0	0.080					
Ship 1	15/7–25/7/04	Auto	24	0	24	100	45.2	221.9	20.4	NC	0	0	4	0	4	0	0.000	0	0.000	100	0	(0)
Ship 2	2/5–17/5/04	Auto	40	0	40	100	69.0	273.0	25.3	88.92	0	0	1	0	1	0	0.000	0	0.000	100	0	(0)
Ship 2	29/7–4/8/04	Auto	19	0	19	100	41.2	125.0	33.0	90.00	0	0	0	0	0	0	0.000	0	0.000	100	0	(0)
Ship 3	17/6–16/7/04	Auto	62	0	62	100	191.7	588.0	32.6	88.41	2	0	0	0	2	0	0.010	0	0.010	100	0	(0)
Ship 4	13/8–31/8/04	Sp	37	0	37	100	62.4	260.6	23.9	100.00	0	0	0	0	0	0	0.000	0	0.000	100	0	(0)
Ship 4	20/4–29/4/04	Sp	18	0	18	100	32.9	132.8	24.8	100.00	0	0	0	0	0	0	0.000	0	0.000	100	0	(0)
Ship 5	17/7–20/7/04	Auto	9	0	9	100	22.5	64.5	34.9	89.22	0	0	0	0	0	0	0.000	0	0.000	100	0	(0)
Ship 7	7/6–29/6/04	Auto	56	0	56	100	27.1	469.9	5.8	95.00	1	0	0	0	1	0	0.037	0	0.037	100	0	(0)
Ship 7	9/3–27/3/04	Auto	50	0	50	100	26.7	412.7	6.5	95.00	5	0	0	0	5	0	0.186	0	0.185	100	0	(0)
							518.7	2548.3	20.4		8	0	5	0	13	0	0.026					
Division 58.5.1																						
Ship 1	24/9–14/12/03	Auto	200	0	200	100	NC	1927.8	NC	NC	700†	0	0	0	700	0	0.363	0	0.363	100	0	(0)
Ship 1	1/3–7/4/04	Auto	83	0	83	100	NC	922.5	NC	NC	68†	0	0	0	68	0	0.074	0	0.074	100	0	(0)
Ship 2	30/9–11/11/03	Auto	108	0	108	100	NC	1033.8	NC	NC	109†	0	5	0	114	0	0.105	0	0.105	100	0	(0)
Ship 2	29/11/03–29/1/04	Auto	161	0	161	100	NC	1321.3	NC	90.00	61†	0	0	0	61	0	0.046	0	0.046	100	0	(0)
Ship 3	4/9–21/10/03	Auto	89	0	89	100	NC	1099.4	NC	86.00	46†	0	3	0	49	0	0.042	0	0.042	100	0	(0)
Ship 3	21/12/03–31/1/04	Auto	81	0	81	100	NC	1078.4	NC	84.00	37†	0	1	0	38	0	0.034	0	0.034	100	0	(0)
Ship 4	19/10/03–19/1/04	Sp	170	0	170	100	NC	1313.2	NC	100.00	144†	0	15	0	159	0	0.110	0	0.110	100	0	(0)
Ship 5	3/10–7/12/03	Auto	161	0	161	100	NC	1536.3	NC	NC	58†	0	0	0	58	0	0.038	0	0.038	100	0	(0)
Ship 5	13/1–31/1/04	Auto	48	0	48	100	NC	408.1	NC	NC	86†	0	27	0	113	0	0.211	0	0.211	100	0	(0)
Ship 5	1/3–28/3/04	Auto	72	0	72	100	NC	700.4	NC	NC	164†	0	5	0	169	0	0.234	0	0.234	100	0	(0)
Ship 6	1/9–18/10/03	Auto	122	0	122	100	NC	1058.4	NC	79.00	349†	0	0	0	349	0	0.330	0	0.330	100	0	(0)
Ship 6	3/12/03–29/1/04	Auto	138	0	138	100	NC	1211.4	NC	NC	31†	0	0	0	31	0	0.026	0	0.026	100	0	(0)
Ship 7	1/9–27/10/03	Auto	102	0	102	100	NC	1314.6	NC	93.00	67†	0	0	0	67	0	0.051	0	0.051	100	0	(0)
Ship 7	10/12/03–31/1/04	Auto	94	0	94	100	NC	1264.2	NC	91.00	149†	0	2	0	151	0	0.118	0	0.118	100	0	(0)
							NC	16189.7	NC		2069	0	58	0	2217	0	0.127					

(continued)

Table 7.9 (continued)

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 (%)
											Dead		Alive#		Total							
			N	D	Total	%N	Obs.	Set	% Observed		N	D	N	D	N	D	N	D	Total	N	D	
Division 58.5.1 (continued)																						
Ship 1	14/5–11/7/04	Auto	114	0	114	100	298.6	1241.9	24.0	NC	14	0	4	0	18	0	0.047	0	0.047	100	0	(0)
Ship 2	4/3–28/4/04	Auto	146	0	146	100	288.3	1211.6	23.8	92.40	119	0	6	0	125	0	0.413	0	0.413	100	0	(0)
Ship 2	6/6–26/7/04	Auto	118	0	118	100	280.9	1029.6	27.3	89.40	31	0	33	0	64	0	0.110	0	0.110	101	0	(0)
Ship 3	11/3–15/5/04	Auto	122	0	122	100	398.3	1587.6	25.1	95.05	79	0	4	0	83	0	0.198	0	0.198	100	0	(0)
Ship 3	19/7–10/8/04	Auto	47	0	47	100	141.1	422.1	33.4	88.82	12	0	0	0	12	0	0.085	0	0.085	100	0	(0)
Ship 4	9/3–16/4/04	Sp	62	0	62	100	120.2	515.5	23.3	100.00	25	0	30	0	55	0	0.208	0	0.208	100	0	(0)
Ship 4	2/5–28/6/04	Sp	88	0	88	100	161.2	530.4	30.4	100.00	5	0	25	0	30	0	0.031	0	0.031	100	0	(0)
Ship 4	23/7–9/8/04	Sp	27	0	27	100	50.6	215.8	23.4	100.00	0	0	0	0	0	0	0.000	0	0.000	100	0	(0)
Ship 5	7/5–14/7/04	Auto	152	0	152	100	454.5	1481.1	30.7	89.72	2	0	0	0	2	0	0.004	0	0.004	100	0	(0)
Ship 6	7/4–28/6/04	Auto	199	0	199	100	429.4	1730.7	24.8	79.45	27	0	12	0	39	0	0.063	0	0.063	100	0	(0)
Ship 7	30/3–4/6/04	Auto	140	0	140	100	92.5	1549.8	6.0	95.30	20	0	1	0	21	0	0.216	0	0.216	100	0	(0)
							2715.6	11516.1	23.6		334	0	115	0	449	0	0.125					

* Data from a sample of hooks.
† The number of observed hooks has not been collected and the values given are from the total number of hooks set (birds reported).
\# Seabirds caught during hauling (thus during the day) and released alive.

Table 7.10: Species composition of birds killed in longline fisheries in Subarea 58.6 and Division 58.5.1 during the 2003/04 season (September to August). N – night-time setting; D – daytime setting (including nautical dawn and dusk); PRO – white-chinned petrel; MAH – northern giant petrel; PCI – grey petrel; DAC – cape petrel; PND – petrel non-determined; () – % composition.

Vessel	Dates of fishing	No. birds killed by group						Species composition (%)				
		Albatrosses		Petrels		Total		PRO	MAH	PCI	DAC	PND
		N	D	N	D	N	D					
Subarea 58.6												
Ship 1	14/1–25/2/04	0	0	12	0	12	0	12 (100.0)*				
Ship 1	15/7–25/7/04	0	0	0	0	0	0					
Ship 2	7/9–28/9/03	0	0	11	0	11	0	3 (27.3)*		7 (63.6)*		1 (9.1)*
Ship 2	2/2–9/2/04	0	0	32	0	32	0	32 (100.0)*				
Ship 2	2/5–17/5/04	0	0	0	0	0	0					
Ship 2	29/7–4/8/04	0	0	0	0	0	0					
Ship 3	24/11–17/12/03	0	0	4	0	4	0	4 (100.0)*				
Ship 3	17/6–16/7/04	0	0	2	0	2	0			2 (100.0)		
Ship 4	24/1–31/1/04	0	0	5	0	5	0	5 (100.0)*				
Ship 4	20/4–29/4/04	0	0	0	0	0	0					
Ship 4	13/8–31/8/04	0	0	1	0	1	0			1 (100.0)		
Ship 5	13/9–1/10/03	0	0	3	0	3	0	3 (100.0)*				
Ship 5	3/2–26/2/04	0	0	157	0	157	0	157 (100.0)*				
Ship 5	17/7–20/7/04	0	0	0	0	0	0					
Ship 6	1/2–23/2/04	0	0	9	0	9	0	9 (100.0)*				
Ship 7	25/11–7/12/03	0	0	9	0	9	0	9 (100.0)*				
Ship 7	9/3–27/3/04	0	0	5	0	5	0	5 (100.0)				
Division 58.5.1												
Ship 1	24/9–14/12/03	0	0	700	0	700	0	699 (99.9)*		1 (0.1)*		
Ship 1	1/3–7/4/04	0	0	68	0	68	0	68 (100.0)*				
Ship 1	14/5–11/7/04	0	0	14	0	14	0			14 (100.0)		
Ship 2	30/9–11/11/03	0	0	109	0	109	0	106 (97.2)*	2 (1.8)*	1 (0.9)*		
Ship 2	29/11/03–29/1/04	0	0	61	0	61	0	61 (100.0)*				
Ship 2	4/3–28/4/04	0	0	119	0	119	0	117 (98.3)		2 (1.7)		
Ship 2	6/6–26/7/04	0	0	31	0	31	0			31 (100.0)		
Ship 3	4/9–21/10/03	0	0	46	0	46	0	39 (84.8)*		7 (15.2)*		
Ship 3	21/12/03–31/1/04	0	0	37	0	37	0	37 (100.0)*				
Ship 3	11/3–15/5/04	0	0	79	0	79	0	74 (93.7)		5 (6.3)		
Ship 3	19/7–10/8/04	0	0	12	0	12	0			12 (100.0)		
Ship 4	19/10/03–19/1/04	0	0	144	0	144	0	143 (99.3)*	1 (0.7)*			
Ship 4	9/3–16/4/04	0	0	25	0	25	0	25 (100.0)				
Ship 4	2/5–28/6/04	0	0	5	0	5	0			5 (100.0)		
Ship 4	23/7–9/8/04	0	0	0	0	0	0					
Ship 5	3/10–7/12/03	0	0	58	0	58	0	58 (100.0)*				
Ship 5	13/1–31/1/04	0	0	86	0	86	0	86 (100.0)*				
Ship 5	1/3–28/3/04	0	0	164	0	164	0	162 (98.8)*		2 (1.2)*		
Ship 5	7/5–14/7/04	0	0	2	0	2	0			2 (100.0)		
Ship 6	1/9–18/10/03	0	0	349	0	349	0	322 (92.3)*		21 (6.0)*	6 (1.7)*	
Ship 6	3/12–29/12/03	0	0	31	0	31	0	31 (100.0)*				
Ship 6	7/4–28/6/04	0	0	27	0	27	0	21 (77.8)		6 (22.2)		
Ship 7	1/9–27/10/03	0	0	67	0	67	0	49 (73.1)*		18 (26.9)*		
Ship 7	10/12/03–31/1/04	0	0	149	0	149	0	149 (100.0)*				
Ship 7	30/3–4/6/04	0	0	20	0	20	0	18 (90.0)		2 (10.0)		
Total (%)		0	0	2654	0	2654	0	2504 (94.3)	3 (0.1)	140 (5.3)	6 (0.2)	1 (0.0)

* The number of observed hooks has not been collected and the values given are from the total number of hooks set.

Table 7.11: Annual reports of seabirds killed and the associated by-catch rates (number of birds killed per thousand hooks) in the longline fisheries for *Dissostichus* spp. in the French EEZs in Subarea 58.6 and Division 58.5.1. Data for the 1998/99 and 1999/2000 seasons are from WG-FSA-01/21, Appendix 1. In 2003/04, the number of birds estimated killed is based on the proportion of hooks observed (see paragraph 7.23). na – not applicable.

2003/04

Area	Number of birds reported killed	Number of birds estimated killed	Hook effort			By-catch rate		Total birds killed
			Reported cruises	Estimated cruises		Birds reported/ thousand hooks	Birds estimated/ thousand hooks	
				Total	Observed			
Subarea 58.6	242	100	3 401.0	2 548.3	518.7	0.080	0.026	342
Division 58.5.1	2 069	1 597	16 189.7	11 516.1	2 715.6	0.127	0.125	3 666
Total	**2 311**	1 697	19 590.7	14 064.4	2 234.3	0.118	0.106	**4 008**

2002/03

Area	Number of birds reported killed	Number of birds estimated killed	Total	Hook effort (thousands)	By-catch rate (birds reported/thousand hooks)
Subarea 58.6	720	na	720	6 593	0.109
Division 58.5.1	13 926	na	13 926	26 884.4	0.518
Total	14 646	na	**14 646**	**33 477.4**	0.437

2001/02

Area	Number of birds reported killed	Number of birds estimated killed	Total	Hook effort (thousands)	By-catch rate (birds reported/thousand hooks)
Subarea 58.6	1 243	na	1 243	7 432.8	0.167
Division 58.5.1	10 814	na	10 814	11 554.3	0.936
Total	12 057	na	**12 057**	**18 987.1**	0.635

(continued)

Table 7.11 (continued)

1999/2000

Area	Number of birds reported killed	Number of birds estimated killed	Total	Hook effort (thousands)	By-catch rate (birds reported/thousand hooks)
Subarea 58.6	360	na	360	1 931	0.186
Division 58.5.1	1 897	na	1 897	6 167.4	0.308
Total	2 257	na	**2 257**	**8 098.4**	0.279

1998/99

Area	Number of birds reported killed	Number of birds estimated killed	Total	Hook effort (thousands)	By-catch rate (birds reported/thousand hooks)
Subarea 58.6	1 326	na	1 326	1 789.0	0.741
Division 58.5.1	4 967	na	4 967	1 682.5	2.95
Total	6 293	na	**6 293**	**3 471.5**	1.81

Table 7.12: Compliance, as reported by observers, of streamer lines with the minimum specifications set out in Conservation Measure 25-02 (2003) during the 2003/04 season. Y – yes; N – no; - – no information; A – autoliner; Sp – Spanish.

Vessel name	Dates of fishing	Fishing method	Compliance with CCAMLR specifications	Compliance with details of streamer line specifications				Length of streamers (m)	Streamer line in use %	
				Attachment, height above water (m)	Total length (m)	No. streamers per line	Spacing of streamers per line (m)		Night	Day
Subarea 48.3										
Globalpesca I	8/5–18/7/04	Sp	N	N (5)	-	-	Y (3)	-	100	100
Isla Camila	1/5–30/6/04	Sp	N	Y (7)	Y (150)	10	Y (5)	N (1–6)	75	100
Isla Santa Clara	1/5–23/7/04	Sp	Y	Y (7)	Y (185)	8	Y (5)	Y (1–7.7)	100	100
Isla Sofía	1/5–4/7/04	Sp	Y	Y (7.4)	Y (150)	9	Y (5)	Y (1–6.5)	100	
Polarpesca I	1/5–14/8/04	Sp	Y	Y (7)	Y (151)	7	Y (5)	Y (1–7)	99	100
Tierra del Fuego	3/5–14/8/04	Sp	Y	Y (7)	Y (153)	5	Y (5)	Y (1–6.5)	98	
Ibsa Quinto	2/5–25/6/04	Sp	Y	Y (7)	Y (157)	6	Y (5)	Y (1–6.5)	96	
Viking Bay	1/5–13/7/04	Sp	N	N (6.3)	N (83)	50	Y (1.5)	N (0.8)	100	
Argos Georgia	2/5–15/8/04	Sp	N	Y (7)	Y (150)	5	Y (5)	N (1.5–5)	100	98
Argos Helena	2/5–16/8/04	A	Y	Y (7.7)	Y (160)	7	Y (5)	Y (1–7.5)	100	
Burdwood	5/5–17/8/04	Sp	Y	Y (7)	Y (150)	-	Y (5)	Y (1–6.5)	100	
Jacqueline	3/5–7/7/04	Sp	Y	Y (7.9)	Y (157)	29	Y (5)	Y (1–7.2)	98	
No. 22 InSung	1/5–19/8/04	Sp	Y	Y (7.1)	Y (200)	9	Y (5)	Y (1–6.5)	100	100
Isla Alegranza	2/5–23/7/04	Sp	Y	Y (7.7)	Y (167)	7	Y (5)	Y (1–6.5)	98	
Paloma V	21/7–19/8/04	Sp	Y	Y (7)	Y (150)	11	Y (5)	Y (1–6.5)	100	
Koryo Maru No. 11	12/5–20/8/04	Sp	N	Y (8)	Y (150)	2	Y (5)	N (5)	100	100
Subarea 48.6										
Shinsei Maru No. 3	7/3–21/3/04	Sp	N	Y (7)	Y (158)	5	Y (5)	N (2–5)	100	100
Subareas 58.6, 58.7										
Koryo Maru No. 11	19/2–30/3/04	Sp	N	N (5)	Y (177)	6	Y (5)	Y (1–6.5)	100	100
South Princess	19/5–7/7/04	A	Y	Y (7)	Y (150)	14	Y (5)	Y (1–6.5)	100	100
Subareas 88.1, 88.2										
Antarctic II	7/2–4/3/04	A	Y	Y (7)	Y (200)	6	Y (5)	-	18	93
Antarctic III	1/1–3/3/04	A	N	N (6)	Y (150)	5	Y (5)	-	100	100
Arnela	29/12/03–3/3/04	Sp	N	N (6.5)	Y (180)	12	Y (5)	Y (1–6.6)		98

(continued)

Table 7.12 (continued)

Vessel name	Dates of fishing	Fishing method	Compliance with CCAMLR specifications	Compliance with details of streamer line specifications				Length of streamers (m)	Streamer line in use %	
				Attachment, height above water (m)	Total length (m)	No. streamers per line	Spacing of streamers per line (m)		Night	Day
Argos Helena	21/2–7/3/04	A	Y	Y (7)	Y (150)	7	Y (5)	Y (1–7.5)		100
No. 707 Bonanza	10/1–3/3/04	Sp	N	Y (7.5)	Y (150)	36	Y (4)	N (1–4)	50	98
No. 829 Yeon Seong	30/1–3/3/04	Sp	N	Y (7)	Y (150)	10	Y (5)	N (1–4)	100	100
Gudni Olafsson	27/12/03–10/2/04	A	Y	Y (7)	Y (150)	15	Y (5)	Y (1.5–8)		100
San Aotea II	12/12/03–21/3/04	A	Y	Y (7.6)	Y (150)	11	Y (5)	Y (1–7.5)		100
Volna	15/12/03–9/3/04	Sp	N	N (5)	N (130)	5	Y (2)	N (1–3)	100	100
Yantar	15/12/03–9/3/04	Sp	Y	Y (7)	Y (150)	6	Y (5)	Y (1–6.5)	100	100
Mellas	2/1–3/3/04	Sp	N	Y (7)	N (125)	12	Y (5)	N (1–5)	100	100
Simeiz	15/12/03–7/3/04	Sp	N	N (5.2)	Y (150)	9	Y (4)	N (1–4)	100	100
Sonrisa	10/2–4/3/04	A	N	Y (7.4)	N (70)	30	Y 5)	N (1–3.5)		100
Piscis	12/1–7/3/04	Sp	Y	Y (7)	Y (150)	7	Y (5)	-	100	100
Punta Ballena	11/1–3/3/04	Sp	Y	Y (11)	Y (150)	28	Y (5)	-	67	94
America I	12/12/03–5/3/04	Sp	Y	Y (7.3)	Y (155)	6	Y (5)	Y (2–6.5)	100	94
American Warrior	8/1–3/3/04	A	Y	Y (9)	Y (150)	11	Y (5)	Y (2–6.5)		100
South Princess	15/12/03–4/3/04	A	N	Y (7)	Y (158)	10	Y (3)	N (2–5.2)	100	99
Frøyanes	23/1–4/3/04	A	Y	Y (7)	Y (150)	11	Y (5)	Y (1–7)	100	100
Avro Chieftain	1/12/03–19/3/04	A	Y	Y (7)	Y (150)	40	Y (2.5)	Y (1–7)	100	100
Janas	12/12/03–24/2/04	A	Y	Y (7.2)	Y (150)	19	Y (5)	Y (2–8)		100
San Liberatore	1/2–6/3/04	A	Y	Y (10)	Y (150)	14	Y (4.5)	Y (1–8)	100	100
Division 58.5.2										
Janas	30/4–24/6/04	A	Y	Y (7)	Y (150)	19	Y (4.5)	Y (1–6.5)	100	
Janas	20/7–10/9/04	A	Y	Y (7)	Y (150)	15	Y (5)	Y (1–7)	100	100
Divisions 58.4.2, 58.4.3b										
Eldfisk	30/11/03–24/1/04	A	Y	Y (7)	Y (150)	17	Y (4.5)	Y (1–6.5)		100

Table 7.13: Summary of scientific observations relating to compliance with Conservation Measure 25-02 (2003), based on data from scientific observers from the 1996/97 to the 2003/04 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/thousand hooks)	
	Compliance %	Median weight (kg)	Median spacing (m)			Overall	Attached height	Total length	No. of streamers	Distance apart	Night	Day
Subarea 48.3												
1996/97	0 (91)	5.0	45	81	0 (91)	6 (94)	47 (83)	24 (94)	76 (94)	100 (78)	0.18	0.93
1997/98	0 (100)	6.0	42.5	90	31 (100)	13 (100)	64 (93)	33 (100)	100 (93)	100 (93)	0.03	0.04
1998/99	5 (100)	6.0	43.2	80[1]	71 (100)	0 (95)	84 (90)	26 (90)	76 (81)	94 (86)	0.01	0.08[1]
1999/00	1 (91)	6.0	44	92	76 (100)	31 (94)	100 (65)	25 (71)	100 (65)	85 (76)	<0.01	<0.01
2000/01	21 (95)	6.8	41	95	95 (95)	50 (85)	88 (90)	53 (94)	94 94	82 (94)	<0.01	<0.01
2001/02	63 (100)	8.6	40	99	100 (100)	87 (100)	94 (100)	93 (100)	100 (100)	100 (100)	0.002	0
2002/03	100 (100)	9.0	39	98	100 (100)	87 (100)	91 (100)	96 (100)	100 (100)	100 (100)	<0.001	0
2003/04	87 (100)	9.0	40	98	100 (100)	69 (94)	88 (100)	93 (94)	[7]	100 (100)	0.001	0
Subarea 48.6												
2003/04	100 (100)	7.0	20	41[6]	No discharge	0 (100)	100 (100)	100 (100)	[7]	0 (100)	0	0
Divisions 58.4.2, 58.4.3b												
2002/03	Auto only	na	na	24[5]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2003/04	Auto only	na	na	0[5]	No discharge	100 (100)	100 (100)	100 (100)	[7]	100 (100)	0	0
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
2003/04	Auto only	na	na	99	No discharge	100 (100)	100 (100)	100 (100)	[7]	100 (100)	0	0
Subareas 58.6, 58.7												
1996/97	0 (60)	6	35	52	69 (87)	10 (66)	100 (60)	10 (66)	90 (66)	60 (66)	0.52	0.39
1997/98	0 (100)	6	55	93	87 (94)	9 (92)	91 (92)	11 (75)	100 (75)	90 (83)	0.08	0.11
1998/99	0 (100)	8	50	84[2]	100 (89)	0 (100)	100 (90)	10 (100)	100 (90)	100 (90)	0.05	0
1999/00	0 (83)	6	88	72	100 (93)	8 (100)	91 (92)	0 (92)	100 (92)	91 (92)	0.03	0.01
2000/01	18 (100)	5.8	40	78	100 (100)	64 (100)	100 (100)	64 (100)	100 (100)	100 (100)	0.01	0.04
2001/02	66 (100)	6.6	40	99	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2002/03	0 (100)	6.0	41	98	50 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	<0.01	0
2003/04	100 (100)	7.0	20	83	100 (100)	50 (100)	50 (100)	100 (100)	[7]	100 (100)	0.03	0.01

(continued)

Table 7.13 (continued)

Subarea/time	Line weighting (Spanish system only)			Night setting (% Night)	Offal discharge (%) opposite haul	Streamer line compliance (%)					Total catch rate (birds/thousand hooks)	
	Compliance %	Median weight (kg)	Median spacing (m)			Overall	Attached height	Total length	No. of streamers	Distance apart	Night	Day
Subareas 88.1, 88.2												
1996/97	Auto only	na	na	50	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1997/98	Auto only	na	na	71	0 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1998/99	Auto only	na	na	1[3]	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
1999/00	Auto only	na	na	6[4]	No discharge	67 (100)	100 (100)	67 (100)	100 (100)	100 (100)	0	0
2000/01	1 (100)	12	40	18[4]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2001/02	Auto only	na	na	33[4]	No discharge	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2002/03	100 (100)	9.6	41	21[4]	1 incidence of offal dumping	100 (100)	100 (100)	100 (100)	100 (100)	100 (100)	0	0
2003/04	89 (100)	9	40	5[4]	24% by 1 vessel	59 (100)	82 (100)	86 (100)	[7]	100 (100)	0	<0.01

1 Includes daytime setting – and associated seabird by-catch – as part of line-weighting experiments on *Argos Helena* (WG-FSA-99/5).
2 Includes some daytime setting in conjunction with use of an underwater-setting funnel on *Eldfisk* (WG-FSA-99/42).
3 Conservation Measure 169/XVII allowed New Zealand vessels to undertake daytime setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.
4 Conservation Measures 210/XIX, 216/XX and 41-09 (2002, 2003) 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 (2002, 2003) permits daytime setting in Division 58.4.2 if the vessel can demonstrate a sink rate of 0.3 m/s.
6 Conservation Measure 41-04 (2003) permits daytime setting in Subarea 48.6 if the vessel can demonstrate a sink rate of 0.3 m/s.
7 Conservation Measure 25-02 (2003) was updated and the requirement for a minimum of five streamers per line was removed.

Table 7.14: Offal discharge observed during net shooting and hauling operations in finfish trawl fisheries in the CCAMLR Convention Area during the 2003/04 season.

Vessel name	Cruise dates	Offal discharged during (%)	
		Net shooting	Net hauling
Subarea 48.3			
Betanzos	26/12/03–22/2/04	8 (9)	8 (9)
Argos Vigo	12/1–29/1/04	0	0
Robin M Lee	14/4–1/5/04	1 (12)	0
Sil	25/1–29/2/04	0	0
Dongsan Ho	6/1–30/1/04	0	3 (9)
Insung Ho	28/12/03–27/1/04	1 (3)	0
Division 58.5.2			
Austral Leader	13/10–19/12/03	0	0
Austral Leader	14/3–12/5/04	0	0
Austral Leader	25/7–23/9/04	0	0
Southern Champion	22/1–23/3/04	0	0
Southern Champion	18/4–30/6/04	0	0

Table 7.15: Estimated total potential seabird by-catch in the IUU *Dissostichus* spp. fishery in the Convention Area from 1996 to 2004. Lower and upper refer to 95% confidence limit.

Subarea/ Division	Year	Estimated total potential seabird by-catch		
		Lower	Median	Upper
48.3	2004	0	0	0
	1996–2003	1 811	3 441	56 031
58.5.1	2004	895	1 092	2 915
	1996–2003	46 988	57 332	153 081
58.5.2	2004	596	727	1 941
	1996–2003	31 857	38 870	103 787
58.4.3	2004	522	636	1 699
58.4.4	2004	0	0	0
	1996–2003	2 866	3 497	9 338
58.6	2004	1 611	1 966	5 249
	1996–2003	43 277	52 803	140 989
58.7	2004	369	450	1 202
	1996–2003	12 106	14 770	39 439
88.1	2004	360	440	1 160
	1996–2003	32	39	104
Totals	2004	4 352	5 311	14 166
	1996–2003	138 937	170 752	502 768
Total		143 289	176 063	516 934

Table 7.16: Summary of IMAF risk assessment in relation to proposed new and exploratory longline fisheries in 2004/05 (five-point risk scale as defined in SC-CAMLR-XXIII/BG/21).

Area	Risk scale	Mitigation requirements	Proposal assessment
48.6 north of ca. 55°S	2 – average to low	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Japan (WG-FSA-04/18 and CCAMLR-XXIII/18), Republic of Korea (CCAMLR-XXIII/20) and New Zealand (CCAMLR-XXIII/25) do not conflict with the IMAF assessment.
48.6 south of ca. 55°S	1 – low	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirement. • No offal dumping at any time.	Proposals from Japan (CCAMLR-XXIII/18), Republic of Korea (CCAMLR-XXIII/20) and New Zealand (CCAMLR-XXIII/25) do not conflict with the IMAF assessment.
58.4.1	2 – average to low	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Chile (CCAMLR-XXIII/12), Republic of Korea (CCAMLR-XXIII/21), Spain (CCAMLR-XXIII/15), New Zealand (CCAMLR-XXIII/26) and Ukraine (CCAMLR-XXIII/30) do not conflict with the IMAF assessment.
58.4.2	3 – average	• Strict compliance with standard seabird by-catch conservation measure. • Restrict longline fishing to April to September (outside the October to March giant petrel breeding season) unless line sink rate requirements are met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Chile (CCAMLR-XXIII/13), Republic of Korea (CCAMLR-XXIII/22), Spain (CCAMLR-XXIII/15), New Zealand (CCAMLR-XXIII/26) and Ukraine (CCAMLR-XXIII/31) do not conflict with the IMAF assessment.
58.4.3a	3 – average	• Strict compliance with standard seabird by-catch conservation measure. • Restrict longline fishing to May through August (outside the September to April albatross, giant petrel and white-chinned petrel breeding season) unless line sink rate requirements are met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Australia (CCAMLR-XXIII/9), Spain (CCAMLR-XXIII/15) and the Republic of Korea (CCAMLR-XXIII/23) do not conflict with the IMAF assessment.

(continued)

Table 7.16 (continued)

Area	Risk scale	Mitigation requirements	Proposal assessment
58.4.3b	3 – average	• Strict compliance with standard seabird by-catch conservation measure. • Restrict longline fishing to May to August (outside the September to April albatross, giant petrel and white-chinned petrel breeding season) unless line sink rate requirements are met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Australia (CCAMLR-XXIII/10), Chile (CCAMLR-XXIII/14), Japan (CCAMLR-XXIII/19), Spain (CCAMLR-XXIII/15) and the Republic of Korea (CCAMLR-XXIII/24) do not conflict with the IMAF assessment.
88.1 north of 65°S	3 – average	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season, but line sink rate requirements to be met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Argentina (CCAMLR-XXIII/8), Australia (CCAMLR-XXIII/11), Norway (CCAMLR-XXIII/6), Spain (CCAMLR-XXIII/15), New Zealand (CCAMLR-XXIII/27), Russia (CCAMLR-XXIII/28), South Africa (CCAMLR-XXIII/34), Ukraine (CCAMLR-XXIII/29) and Uruguay (CCAMLR-XXIII/32) do not conflict with the IMAF assessment. The UK (CCAMLR-XXIII/17) confirmed intention to conform with IMAF assessment in all respects.
88.1 south of 65°S	2 – average to low	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements and seabird by-catch limits. • No offal dumping at any time.	Proposals from Argentina (CCAMLR-XXIII/8), Australia (CCAMLR-XXIII/11), Norway (CCAMLR-XXIII/6), Spain (CCAMLR-XXIII/15), New Zealand (CCAMLR-XXIII/27), Russia (CCAMLR-XXIII/28), South Africa (CCAMLR-XXIII/34), Ukraine (CCAMLR-XXIII/29) and Uruguay (CCAMLR-XXIII/32) do not conflict with the IMAF assessment. The UK (CCAMLR-XXIII/17) confirmed intention to conform with the IMAF assessment in all respects (see paragraph 7.195).
88.2	1 – low	• Strict compliance with standard seabird by-catch conservation measure. • No need for restriction of longline fishing season. • Daytime setting permitted. • No offal dumping at any time.	Proposals from Norway (CCAMLR-XXIII/6), Argentina (CCAMLR-XXIII/8), New Zealand (CCAMLR-XXIII/27) and Russia (CCAMLR-XXIII/28) do not conflict with the IMAF assessment.

Table 7.17: Summary of IMAF assessment of risk to seabirds posed by new and exploratory longline fisheries in the Convention Area (see also Figure 7.3).

Risk level	Mitigation requirements	Observer coverage
1 – low	• Strict compliance with standard seabird by-catch conservation measure.[1] • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements.[2] • No offal dumping.	20% of hooks hauled 50% of hooks set
2 – average to low	• Strict compliance with standard seabird by-catch conservation measure.[1] • No need for restriction of longline fishing season. • Daytime setting permitted subject to line sink rate requirements and seabird by-catch limits.[3] • No offal dumping.	25% of hooks hauled 75% of hooks set
3 – average	• Strict compliance with standard seabird by-catch conservation measure.[1] • Restrict longline fishing to period outside at-risk species breeding season where known/relevant, unless line sink rate requirements are met at all times. • Daytime setting permitted subject to strict line sink rate requirements and seabird by-catch limits.[3] • No offal dumping.	40% of hooks hauled[4] 95% of hooks set
4 – average to high	• Strict compliance with standard seabird by-catch conservation measure.[1] • Restrict longline fishing to the period outside any at-risk species breeding season. • Strict line sink rate requirements at all times. • No daytime setting permitted. • No offal dumping.	45% of hooks hauled[4] 95% of hooks set
5 – high risk	• Strict compliance with standard seabird by-catch conservation measure.[1] • Restrict longline fishing to period outside at-risk species breeding season. • Closed areas as identified. • Strict line sink rate requirements at all times. • No daytime setting permitted. • Strict seabird by-catch limits in place. • No offal dumping.	50% of hooks hauled[4] 100% of hooks set

[1] Conservation Measure 25-02 with the possibility of exemption to paragraph 4 as provided by Conservation Measure 24-02.
[2] Changes required to Conservation Measure 25-02 (2003), paragraph 4.
[3] Requires text similar to Conservation Measure 41-09 (2003), paragraphs 6 and 7.
[4] This is likely to require the presence of two observers.

Table 7.18: Seabird mortality totals and rates (BPT: birds/trawl) and species composition of by-catch, recorded by observers in the CCAMLR Convention Area trawl fisheries over the last four seasons. DIC – grey-headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; PWD – Antarctic prion; DAC – cape petrel; MAI – southern giant petrel.

Season	Area	Vessel	Cruise dates	Trawls observed	BPT	Dead						Total dead	Alive (combined)
						DIC	DIM	PRO	PWD	DAC	MAI		
2001	48.3	*Argos Vigo*	1/2–10/2/01	58	0.64	1	25	11				37	22
		Betanzos	26/11/00–26/2/01	157	0.34	2	21	30				53	16
		Saint Denis	6/12/00–18/1/01	100	0.02	2						2	2
		Total		315	0.29	5	46	41				92	40
2002	48.3	*Argos Vigo*	15/12/01–30/1/02	35	0.49		6	11				17	8
		Robin M Lee	15/12/01–15/2/02	74	0.26		4	15				19	25
		Insung Ho	31/12/01–18/2/02	81	0.26		3	17	1			21	18
		Bonito	15/12/01–9/2/02	67	0.06		2	2				4	1
		Zakhar Sorokin	20/12/01–5/2/02	174	0.04		3	4				7	0
		Total		431	0.16		18	49	1			68	52
	58.5.2	*Austral Leader*	28/3–8/5/02	34	0							0	1
		Total		34	0							0	1
2003	48.3	*Betanzos*	7/12/02–5/3/03	107	0.14	1	1	13				15	11
		Sil	16/12/02–18/1/03	48	0.35		3	14				17	1
		Insung Ho	31/12/02–18/1/03	27	0.15		3	1				4	3
		Total		182	0.20	1	7	28				36	15
	58.5.2	*Austral Leader*	10/4–10/5/03	117	0.03		1	1		2		4	0
		Southern Champion	24/1–20/3/03	44	0.02			1				1	7
		Southern Champion	24/4–18/5/03	277	0.004		1					1	0
		Southern Champion	4/6–15/7/03	301	0							0	4
		Total		739	0.008		2	2		2		6	11
2004	48.3	*Argos Vigo*	12/1–29/1/04	17	1.06		2	16				18	4
		Betanzos	26/12/03–22/2/04	87	0.22		1	18				19	76
		Robin M Lee	14/4–1/5/04	8	0.38			3				3	0
		Sil	25/1–29/2/04	69	0.25	1	3	13				17	22
		Dongsan Ho	6/1–30/1/04	28	0.46		8	4			1	13	4
		Insung Ho	28/12/03–27/1/04	29	0.59		12	5				17	30
		Total		221	0.37	1	26	59			1	87	132
	58.5.2	*Austral Leader*	14/3–12/5/04	366	0							0	1
		Southern Champion	22/1–23/3/04	55	0							0	6
		Total		421	0							0	7

Table 8.1: Estimates of IUU toothfish catches (tonnes) in the CCAMLR Convention Area from the 1996/97 to the 2003/04 fishing seasons.

Fishing season	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Estimated IUU catch	32 673	15 106	5 868	7 644	8 802	11 857	10 070	2 622*
Total reported and IUU catches	45 130	28 518	19 531	25 214	22 598	27 198	26 877	15 929
IUU as % of total catch	72.4	53.0	30.0	30.3	39.0	43.6	37.5	16.5

* Estimated as of 1 October 2004. The estimation will be revised next year in order to take into account any new compliance-related information received for the period to the end of the 2003/04 fishing season, i.e. to 30 November 2004.

Table 11.1: Current observation requirements.

Observer coverage requirement:

Each vessel participating in this fishery shall have at least one scientific observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation, and where possible one additional scientific observer, on board throughout all fishing activities within the fishing period.

Target species	Subarea/Division	Conservation measure
Toothfish	48.3 48.4 58.4.3a 58.4.3b	41-02 41-03 41-06 41-07
Icefish	48.3	42-01
Macrourus spp.	58.4.3a 58.4.3b	43-02 43-03
Chaenodraco wilsoni, *Lepidonotothen kempi,* *Trematomus eulepidotus* and *Pleuragramma antarcticum*	58.4.2	43-04
Crabs	48.3	52-01, 51-02
Squid	48.3	61-01

Observer coverage requirement:

Each vessel participating in this fishery shall have at least one scientific observer, and may include one appointed in accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities within the fishing period.

Target species	Subarea/Division	Conservation measure
Toothfish	58.5.2	41-08
Icefish	58.5.2	42-02

Observer coverage requirement:

Each vessel participating in this fishery shall have at least two scientific observers, one of whom shall be an observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities within the fishing period.

Target species	Subarea/Division	Conservation measure
Toothfish	48.6 58.4.1 58.4.2 88.1 88.2	41-04 41-11 41-05 41-09 41-10

Table 11.2: Initial assessment of data collected by observers, use of collected data and references to examples of use of the observer data.

Data collected by observers	Usage	References to report paragraphs and working papers (2002–2004)
Finfish fishing		
Fish hook removal	√	6.37–6.39, 6.57, 6.108, Table 10.1 (FSA-03)
Haul seabird deterrent	√	6.9, 6.100 (FSA-03)
Vessel and observation program details		
Vessel details	√	WG-FSA-04
Total number of sets undertaken during the observation program		
Total number of sets observed	√	WG-FSA-04
Total number of hooks set	√	6.7 (FSA-03)
Total number of hooks observed	√	6.6 (FSA-03)
Longline description	√	5.280 (FSA-03)
Offal discharge	√	6.37, 6.260 (FSA-03)
Line weighting	√	6.42–6.44, 6.260 (FSA-03)
Streamer line description	√	6.35, 6.260 (FSA-03) Factual data being forwarded to SCIC
Daily work schedule (optional)		
Daily setting observations		
Setting information	√	5.89 (FSA-03)
Alterations to line-setting course		
Details of longline setting	√	5.89, 6.260 (FSA-03)
Extreme environmental conditions (optional)		
Estimated seabird and marine mammal abundance (optional)		
Seabird activity for day setting only (optional)		
Daily hauling observations		
Hauling information	√	5.267 (FSA-03)
Extreme environmental conditions		
Marine mammal interaction with longline	√	6.219–6.223 (FSA-03)
Seabird by-catch	√	6.7, 6.115 (FSA-03)
Catch composition	√	5.267 (FSA-03)
Finfish biological data collection		
Scale/otolith/both	√	CON (WG-FSA-02/51)
Total length (cm)	√	5.89 (FSA-03)
Snout–anus length (cm)		
Wingspan skate/rays (cm)		
Weight (kg)	√	WG-FSA-04/5
Sex	√	WG-FSA-04
Maturity stage		
Gonad weight (grams)		
Conversion factors (fish processing)	√	3.26 (FSA-03)
Finfish and invertebrate by-catch data collection		
% hauls/sets observed for landed by-catch	√	WG-FSA-04
Fate of by-catch (discarded/retained)	√	WG-FSA-04
Numbers of individuals	√	WG-FSA-04
Weight by individuals	√	WG-FSA-04

(continued)

Table 11.2 (continued)

Data collected by observers	Usage	References to report paragraphs and working papers (2002–2004)
Skate and ray (and macrourids) cut-offs form	√	10.12–10.15 (FSA-04)
% hooks observed for cut-offs	√	
Number of individuals cut-off	√	
Tag–release and recapture data	√	FSA-04
TDR and bottle test	√	Conservation Measure 24-02
Finfish maturity and age determination (trawl fishery only)	√	5.93 (FSA-03)
Sightings of fishing vessels	√	Estimates of IUU catches, estimates of IUU seabird by-catch, risk assessment of proposed new and exploratory fisheries
Waste disposal	√	Factual data forwarded to SCIC
Krill fishing		
Marine mammal entanglement	√	3.23 (EMM-04)
Trawl details		
Krill trawl depth	√	3.18 (EMM-04)
Sea-surface temperature	√	3.26 (EMM-04)
By-catch	√	3.26 (EMM-04)
Krill biological data collection		
Length (mm)	√	3.26 (EMM-04)
Sex		
Maturity stage		
Feeding colour		
Pot fishery		
Observed interaction with birds or marine mammals	√	
Incidental mortality of seabirds or marine mammals	√	
Catch composition	√	WG-FSA-01/42, Table 4; WG-FSA-02/14, Table 3
Conversion factors	√	
Paralomis spp. biological data collection		
Length	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Carapace width	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Chelae length	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Weight	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Sex	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Maturity stage	√	5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Rhizocephalan parasites		5.142 (FSA-02), SC-CAMLR-XXI/BG/27
Retained/discarded/damaged		5.142 (FSA-02), SC-CAMLR-XXI/BG/27

Table 13.1: List of tasks identified by WG-FSA for the 2004/05 intersessional period. Tasks identified by ad hoc WG-IMAF are listed in Appendix E. The paragraph numbers (Ref.) refer to this report; E – established practice; Priority: 1 – high priority; 2 – general request; Subgroups: WG-FSA-SAM – Subgroup on Assessment Methods; SGbiology – Subgroup on Biology, Ecology and Demography; SGBycatch – Subgroup on Fish By-catch; CON – CCAMLR Otolith Network.

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	Organisation of the meeting				
1.	Submit papers to WG-FSA-05 in accordance with the deadline.	2.6	1	Members to implement	Coordinate and implement
2.	Circulate list of documents with agenda items at start of meeting.	E	1	Convener to implement	Assist
	Review of available information				
3.	Load fishery surveys reported to CCAMLR.	E	1		Implement
4.	Further develop routine validation procedures for database extractions.	E	1		Implement
5.	Update catch tables in Fishery Reports.	E	1		Implement
6.	Update estimates of reported catches, catches from IUU fishing and total removals by season and area within the Convention Area.	E	1	Members to provide information on IUU fishing by 1 October	Implement
7.	Update estimates of catches reported in CDS data by season and area outside the Convention Area.	E	1		Implement
8.	Update information on scientific observations.	E	1		Implement
9.	Prepare catch-weighted length-frequency plots for Fishery Reports.	E	1		Implement
10.	Provide accurate and consistent data on by-catch.	E	1	Members to implement	Coordinate and implement
11.	Continue tagging rajids.	3.50		Members to implement	
12.	Advise CON on requirements for meeting of WG-FSA-SAM-05.	3.59	1	SAM coordinator to advise, CON to implement	Remind
13.	Develop further the CCAMLR age database, and populate the database with the age–length and associated data provided by CON.	3.60	1	CON convener to liaise with Secretariat	Implement

(continued)

Table 13.1 (continued)

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
	Preparation for assessments				
14.	Future work for development of assessment methods recommended by WG-FSA-SAM-04.	4.15	1	WG-FSA-SAM convenor to remind, Members to implement	
	Assessments and management advice				
15.	Submit fine-scale data from the South African longline fishery in Subareas 58.6 and 58.7.	Table 5.66	2	South Africa to implement	Remind
16.	Submit survey data from Division 58.5.2 in CCAMLR format (form C4).	5.190	1	Australia to implement	Remind
17.	Provide information necessary to develop Fishery Reports for the French fisheries in Division 58.5.1 and Subarea 58.6.	5.176, 5.296	1	France to implement	Remind
18.	Conduct tag–recapture experiments in Subarea 58.6 and Division 58.5.1.	5.182, 5.300	1	France to implement	Remind
19.	Review and provide additional information for Fishery Reports.	E	1	Members to implement	
20.	Develop methods to monitor completion of research sets.	5.20	1		Implement
21.	Submit toothfish tag data and correctly identify research sets in new and exploratory fishery data.	5.92	1	Members to implement	
	Fish and invertebrate by-catch				
22.	Conduct research towards generating population parameters and estimates of standing stock for macrourids and rajids.	6.35	1	Members to implement	
23.	Develop avoidance and mitigation measures for by-catch species.	6.36	2	Members to implement	
24.	Investigate discrepancies in by-catch catches reported in the fine-scale data and catch and effort reports submitted to CCAMLR.	6.48	2	SGBycatch to implement	Coordinate
25.	Develop standard methods to summarise by-catch removals by area.	6.51	2		Implement
26.	Improve the reporting, transferral and extraction of by-catch data.	6.49	1	SGBycatch to implement	Coordinate and implement

(continued)

Table 13.1 (continued)

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
27.	Report by-catch accurately in all data formats.	6.50	1	Members to implement	
28.	Collate information to allow risk characterisation for major by-catch species.	6.57	1	SGBycatch to implement	
29.	Vessels should cut all rajids off lines whilst still in the water, except on request of observer during biological sampling period.	6.65	1	Members to implement	
30.	Members collecting by-catch data in non-standard format should ensure that all data are transferred to CCAMLR database.	6.87	2	Members to implement	Coordinate
	Evaluation of threats arising from IUU activities				
31.	Further develop models for estimating IUU catch.	8.2, 8.3	1	Members to implement	
32.	Provide more detail in compliance-related reports.	8.4–8.6	1	SCIC and Members to provide data	Coordinate
	Biology, ecology and demography of target and by-catch species				
33.	Update the toothfish species profiles.	9.6	1	SGBiology to implement	Assist
34.	Update the icefish species profiles.	9.6	1	SGBiology to implement	Assist
35.	Convene a workshop on the age determination of icefish.	9.8–9.12	1	Members to coordinate and implement	Assist
	Consideration of ecosystem management				
36.	Submit papers on interactions between krill, icefish, and other species to next WG-EMM meeting.	10.17	2	Members to implement	
37.	Encourage specialists in icefish research to participate in the next Workshop on Plausible Ecosystem Models.	10.18	1	Members to implement	
38.	Development of long-term management procedures for icefish within an ecosystem context.	10.19, 4.15(vii)	1	Members to implement	

(continued)

Table 13.1 (continued)

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
39.	Establish a standing Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) to advise on protocols to be used in acoustic surveys and analyses.	10.23	1	Members to implement	Assist
40.	Carry out ecosystem-based research in areas where icefish populations occur.	10.26	1	Members to implement	
	Scheme of International Scientific Observation				
41.	Collect data on the aerial extent of streamer lines.	11.15	2	Technical coordinators to implement	
42.	Collect summary information on hooks occurring in offal.	11.17	2	Technical coordinators to implement	
43.	Review longline sub-sampling methods.	11.20–11.22	1	Members to implement	
44.	Document more clearly events involving seabird captures.	11.27–11.29	2	Technical coordinators to implement	
45.	Review of the *Scientific Observers Manual*.	11.35–11.46	1	Members to implement	Assist
46.	Develop list of observer priorities for all Fishery Reports.	11.52	1	Members to implement	Remind
47.	Present paper at Fourth International Fisheries Observer Conference, and report back to CCAMLR on matters of interest to the future implementation of the scheme.	11.55	1		Implement
	Future assessments				
48.	Correspond regularly in order to develop plan for evaluation of assessment methods by start of WG-FSA-SAM-05.	12.3	1	SAM coordinator to implement	
49.	Make submissions on the prioritised topics given in paragraph 12.4 for evaluation at WG-FSA-SAM-05.	12.4	1	Members to implement	
50.	Explore the application of AD Model Builder, CASAL and GYM in delivering components for the assessment procedures.	12.6	1	Members to implement	

(continued)

Table 13.1 (continued)

	Task	Ref.	Priority	Action required	
				Members/Subgroups	Secretariat
51.	Evaluate survey designs and further explore the means of estimating the abundance of recruits from surveys, including the use of CMIX, age–length keys and other approaches.	12.7	1	Members to implement	
52.	Spatial analysis of distribution of fishing effort in longline fisheries.	12.8	1	Members to implement	
53.	Evaluation of biomass estimates from depletion experiments and methods for estimating length-at-age relationships.	12.9	2	Members to implement	

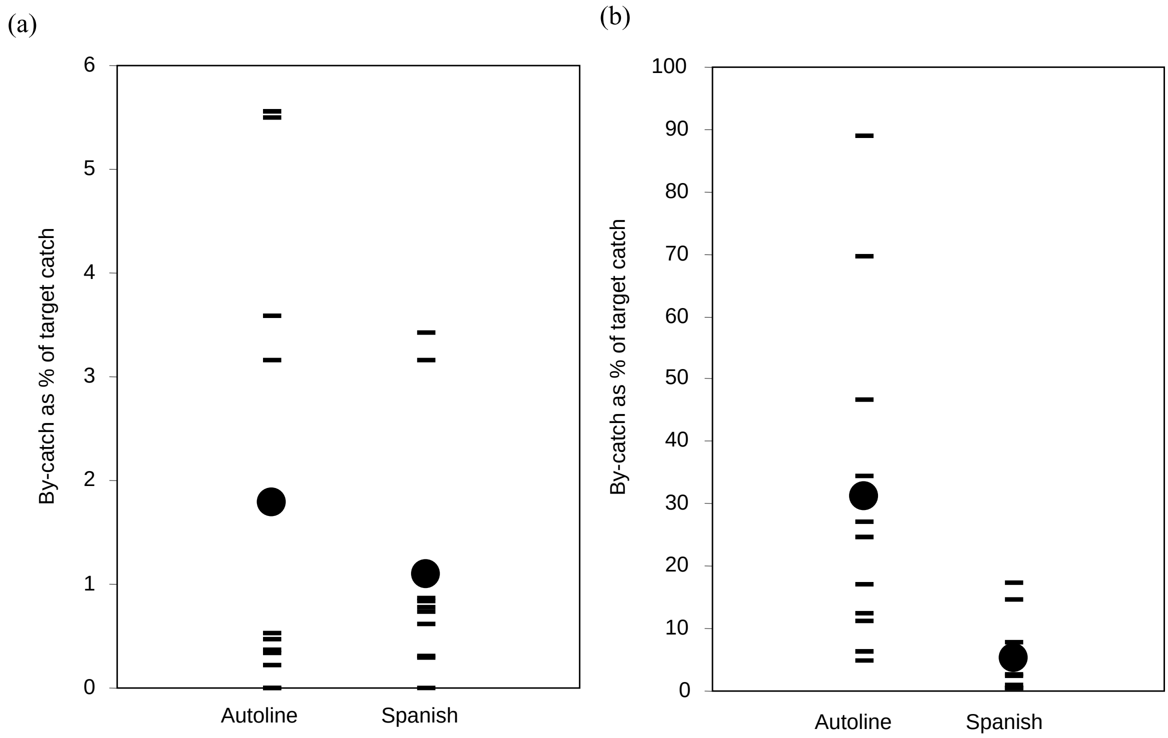

Figure 6.1: By-catch from fine-scale (haul-by-haul) data in Subarea 88.1 expressed as a percentage of target catch for autoline and Spanish system longline gear: (a) rajids (combined skates and rays), and (b) *Macrourus* spp. Each mark represents an individual vessel, with black dots representing the mean for all vessels combined.

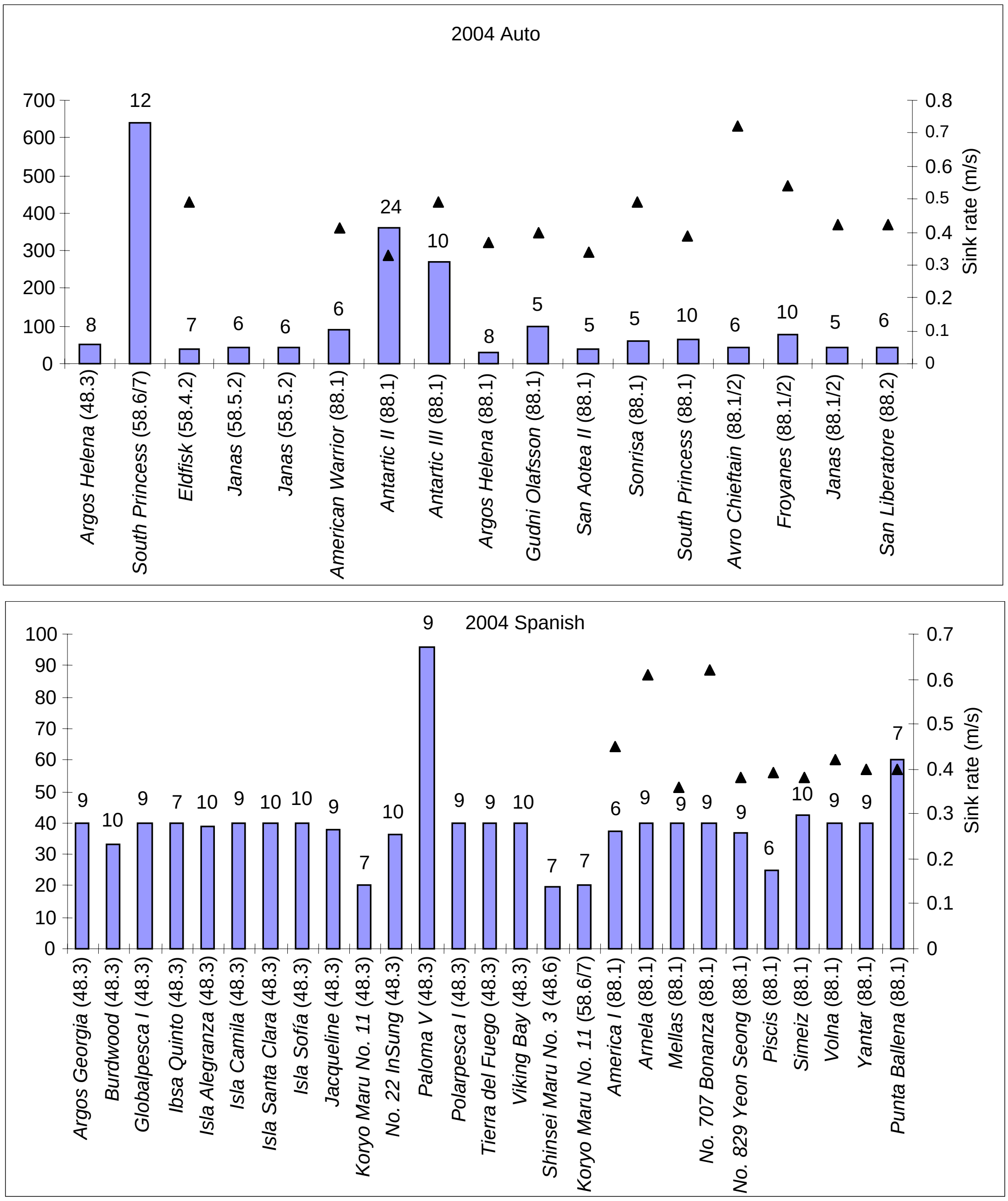

Figure 7.1: Longline weight spacing (y-axis in metres) and weights used (kilograms) by Spanish and autoline systems during the 2003/04 season. ▲ – sink rate (m/s).

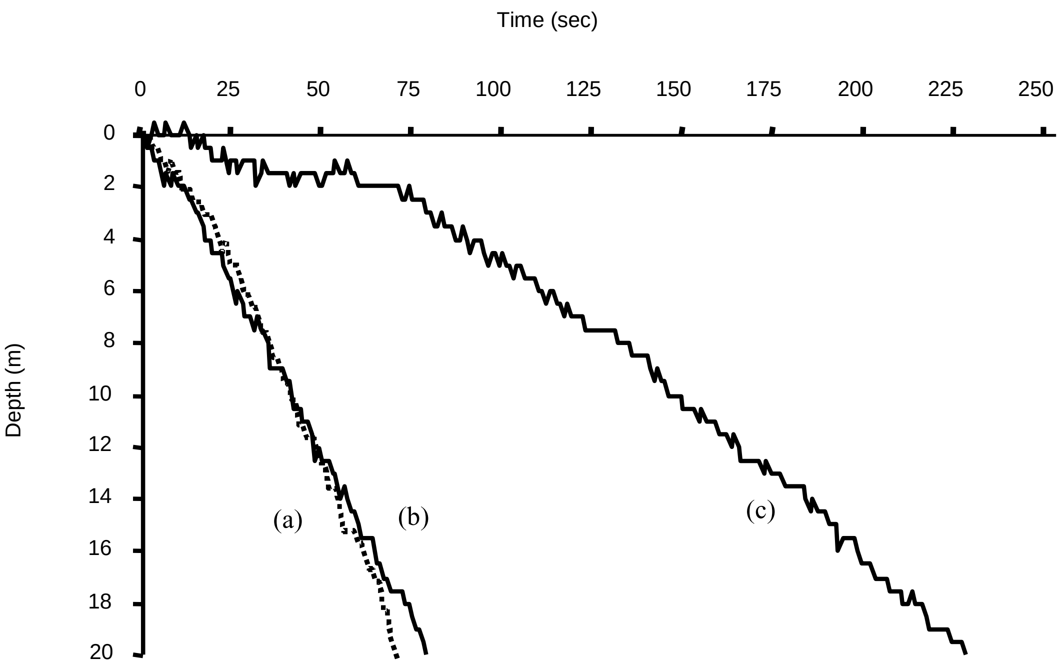

Figure 7.2: Examples of typical sink profiles to 20 m depth of: (a) 11.5 mm diameter UWLs with external weights attached (6 kg/42 m) and set in accordance with the requirements of Conservation Measure 24-02; (b) 9 mm diameter IWL; and (c) 9 mm diameter UWL. Lines were set from the FV *Janas* and sink profiles were determined with time-depth recorders. Sink rate to 20 m depth of UWLs + external weights was 0.29 m/s, slightly less than the 0.3m/s required by Conservation Measure 24-02. Sink rates of IWLs and UWLs shown were 0.25 m/s and 0.1 m/s respectively.

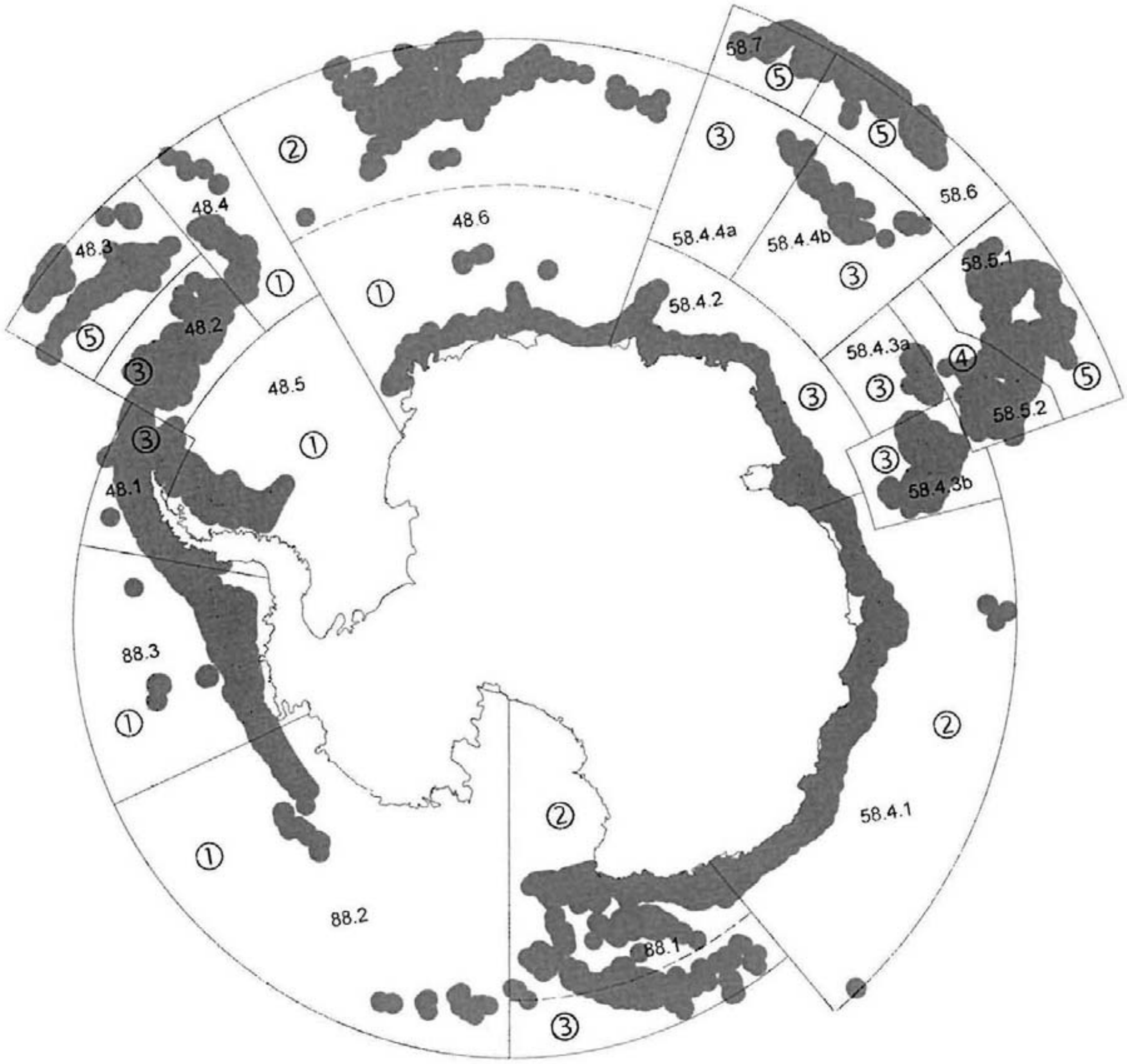

Figure 7.3: Assessment of the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries within the Convention Area. 1: low, 2: average to low, 3: average, 4: average to high, 5: high. Shaded patches represent seabed areas between 500 and 1 800 m.

APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 22 October 2004)

1. Opening of the meeting

2. Organisation of the meeting and adoption of the agenda

    2.1 Organisation of meeting
    2.2 Report restructure

3. Review of available information

    3.1 Data requirements specified in 2003
        3.1.1 Development of the CCAMLR database
        3.1.2 Data processing
        3.1.3 Fishery plans
        3.1.4 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

    3.3 Research information
        3.3.1 Research surveys
        3.3.2 Tagging studies
        3.3.3 Other

    3.4 Biological information

4. Preparation for assessments and assessment timetable

    4.1 Report from the Subgroup on Assessment Methods

    4.2 Status of assessment methods
        4.2.1 Current assessment methods
            Recruitment based long-term yield assessment
            Short-term projections
        4.2.2 New assessment methods
            ASPM (with projection)
            Other methods

4.3 Data to implement assessment methods

4.4 Stock structure assumptions and management boundaries
- 4.4.1 Stock structure
- 4.4.2 Management boundaries

4.5 Assessment timetable

5. Assessments and management advice

5.1 New and exploratory fisheries in 2003/04 and notifications for 2004/05
- 5.1.1 New and exploratory fisheries in 2003/04
- 5.1.2 New and exploratory fisheries notified for 2004/05
- 5.1.3 Progress towards assessments of new and exploratory fisheries
  - 5.1.3.1 Update Fishery Report for Subarea 88.1

5.2 Update Fishery Reports for the following assessed fisheries
- 5.2.1 *Dissostichus eleginoides* South Georgia (Subarea 48.3)
- 5.2.2 *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)
- 5.2.3 *Dissostichus eleginoides* Heard Island (Division 58.5.2)
- 5.2.4 *Champsocephalus gunnari* South Georgia (Subarea 48.3)
- 5.2.5 *Champsocephalus gunnari* Heard Island (Division 58.5.2)
- 5.2.6 *Dissostichus eleginoides* Prince Edward and Marion Islands (Subarea 58.7) and Crozet Islands (Subarea 58.6)

5.3 Assessment and management advice on other fisheries
- 5.3.1 Antarctic Peninsula (Subarea 48.1) and South Orkney Islands (Subarea 48.2)
- 5.3.2 South Sandwich Islands (Subarea 48.4)
- 5.3.3 *Electrona carlsbergi* South Georgia (Subarea 48.3)
- 5.3.4 Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)
- 5.3.5 *Martialia hyadesi* (Subarea 48.3)

6. Fish and invertebrate by-catch

- 6.1 Assessments of the status of by-catch species or groups
- 6.2 Assessments of the expected impact of target species fisheries on by-catch species or groups
- 6.3 Assessment of risk
- 6.4 Consideration of mitigation measures
- 6.5 Scientific observer duties
- 6.6 Advice to the Scientific Committee

7. Incidental mortality of mammals and seabirds arising from fishing (ad hoc WG-IMAF Report)

8. Evaluation of the threats arising from IUU activities (Fish + IMAF)

    8.1 Review of historical trends in IUU activity
    8.2 Evaluation of future threats of IUU activity
    8.3 Advice to the Scientific Committee

9. Biology, ecology and demography of target and by-catch species

    9.1 Review information available to the meeting
    9.2 Update species profiles
    9.3 Identify gaps in the knowledge

10. Considerations of ecosystem management

    10.1 Interactions with WG-EMM
    10.2 Ecological interactions (e.g. multi-species, benthos etc.)

11. Scheme of International Scientific Observation

    11.1 Summary of information extracted from observer reports and/or provided by technical coordinators

    11.2 Implementation of observer program
        11.2.1 *Scientific Observers Manual*
        11.2.2 Sampling strategies
        11.2.3 Priorities
        11.2.4 Observer coverage specified in the current conservation measures

    11.3 Information relevant to SCIC

    11.4 Advice to the Scientific Committee

12. Future Assessments

13. Future Work

    13.1 Data requirements
    13.2 Organisation of intersessional activities in subgroups
    13.3 Plans for WG-FSA-05

14. Other business

15. Adoption of the report

16. Close of the meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 22 October 2004)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 22 October 2004)

WG-FSA-04/1	Provisional Agenda and Provisional Annotated Agenda for the 2004 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-04/2	List of participants
WG-FSA-04/3	List of documents
WG-FSA-04/4	Report of the Subgroup on Assessment Methods (Siena, Italy, 5 to 9 July 2004)
WG-FSA-04/5 Rev. 1	Fishery-related information for WG-FSA-04 Secretariat
WG-FSA-04/6 Rev. 1	A summary of observations on board longline vessels operating within the CCAMLR Convention Area Secretariat
WG-FSA-04/7 Rev. 1	Summary of observations on board trawlers operating in the Convention Area during the 2003/04 season Secretariat
WG-FSA-04/8 Rev. 1	A summary of scientific observations related to Conservation Measures 25-01 (1996), 25-02 (2003) and 25-03 (2003) Secretariat
WG-FSA-04/9	Withdrawn
WG-FSA-04/10	Antarctic icefishes (Channichthyidae) – a unique family of fishes – a review K.-H. Kock (Germany)
WG-FSA-04/11	Etude de la mortalité accidentelle des oiseaux dans la pêcherie à la palangre dans les secteurs de Crozet et Kerguelen en 2001–2003 K. Delord, N. Gasco, H. Weimerskirch and T. Micol (France) (*CCAMLR Science*, submitted)

WG-FSA-04/12	Diet of grey-headed albatrosses at the Diego Ramírez Islands, Chile: ecological implications J. Arata (Chile), G. Robertson (Australia), J. Valencia (Chile), J.C. Xavier (UK) and C.A. Moreno (Chile) (*Antarctic Science*, 16 (3): 263–275 (2004))
WG-FSA-04/13	Seabird by-catch update on industrial Patagonian toothfish fishery in southern Chile J. Arata, C.A. Moreno and R. Hucke-Gaete (Chile)
WG-FSA-04/14	Chilean NPOA-Seabirds: first steps C.A. Moreno and J. Arata (Chile)
WG-FSA-04/15	Note from the FAO Secretariat for the 25th COFI-Meeting; status report on the implementation of IPOA-Seabirds FAO Secretariat
WG-FSA-04/16	CCAMLR Scheme of International Scientific Observation: review of the *Scientific Observers Manual* Secretariat
WG-FSA-04/17	Mitigation measures of fur seal entanglement by Japanese krill vessels Delegation of Japan
WG-FSA-04/18	Proposal for extension of fishing season on the exploratory fishery for *Dissostichus* spp. in Statistical Subarea 48.6 in the 2004/05 season Delegation of Japan
WG-FSA-04/19	Preliminary analyses of data collected during experimental fishing for Patagonian toothfish in international waters of the southwest Indian Ocean (Area 51) L.J. López Abellán (Spain) (*CCAMLR Science*, submitted)
WG-FSA-04/20	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2003/04 S.M. Hanchet, M.L. Stevenson, N.L. Phillips and P.L. Horn (New Zealand)
WG-FSA-04/21	Genetic structuring of Patagonian toothfish populations in the southwest Atlantic Ocean: the effect of the Antarctic Polar Front and deep-water troughs as barriers to genetic exchange P.W. Shaw, A.I. Arkhipkin and H. Al-Khairulla (United Kingdom) (*Molecular Ecology*, in press (2004))

WG-FSA-04/22	United States research under way on seabirds vulnerable to fisheries interactions Delegation of the USA
WG-FSA-04/23	Electronic monitoring of seabird interactions with trawl third-wire cables on trawl vessels – a pilot study H. McElderry, J. Schrader, D. McCullough, J. Illingworth, S. Fitzgerald and S. Davis (USA) (*NOAA Technical Memorandum – NMFS-AFSC-147*)
WG-FSA-04/24	Using digital video monitoring systems in fisheries: applications for monitoring compliance of seabird avoidance devices and seabird mortality in Pacific halibut longline fisheries R.T. Ames, G.H. Williams and S.M. Fitzgerald (USA) (*NOAA Technical Memorandum – NMFS*, accepted)
WG-FSA-04/25	Standardised CPUE analysis of the Antarctic toothfish fishery in CCAMLR Subarea 88.1 from 1988/89 to 2003/04 N.L. Phillips, R.G. Blackwell and S.M. Hanchet (New Zealand)
WG-FSA-04/26	Nesting behaviour of the icefish *Chaenocephalus aceratus* at Bouvetøya Island, Southern Ocean (CCAMLR Subarea 48.6) H.W. Detrich III, C.D. Jones, S. Kim (USA), A.W. North (United Kingdom), A. Thurber (USA) and M. Vacchi (Italy)
WG-FSA-04/27	An exploratory analysis of skate speciation using DNA identification techniques P.J. Smith and S.M. McVeagh (New Zealand)
WG-FSA-04/28 Rev. 1	Geographical differences in the condition, reproductive development, sex ratio and length distribution in Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea, Antarctica (CCAMLR Statistical Subarea 88.1) J.M. Fenaughty (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-04/29	Age and growth of the Antarctic skate (*Amblyraja georgiana*) in the Ross Sea M.P. Francis and C. Ó Maolagáin (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-04/30	Report on the identification of fish eggs and larvae taken in the Ross Sea, Subarea 88.1, autumn/winter 2003 M. van der Poest Clement and M. Lamare (New Zealand)
WG-FSA-04/31	Stomach contents of the Antarctic toothfish (*Dissostichus mawsoni*) from the western Ross Sea, Antarctica D.W. Stevens (New Zealand)

WG-FSA-04/32	Genetic analysis of Antarctic toothfish samples from the Southern Ocean to explore potential stock boundaries P.J. Smith, S.M. McVeagh (New Zealand) and P.M. Gaffney (USA) (*CCAMLR Science*, submitted)
WG-FSA-04/33 Rev. 1	Summary of the Ecologically Related Species Working Group meeting J. Molloy (New Zealand)
WG-FSA-04/34	Information on the spawning of *Dissostichus mawsoni* from Subareas 88.1 and 88.2 in the 2003/04 season G.J. Patchell (New Zealand)
WG-FSA-04/35	Southern Seabird Solutions – an update J. Molloy (New Zealand)
WG-FSA-04/36	Development of an Antarctic toothfish (*Dissostichus mawsoni*) stock model for CCAMLR Subarea 88.1 for the years 1997/98 to 2003/04 A. Dunn, D.J. Gilbert, S.M. Hanchet and B. Bull (New Zealand)
WG-FSA-04/37	Updated ASPM assessment of the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity A. Brandão and D.S. Butterworth (South Africa)
WG-FSA-04/38	Mortalidad incidental de aves en la pesquería de cherna con palangre semipelágico Y.H. Marín, A. Stagi and J. Chocca (Uruguay)
WG-FSA-04/39	Aves marinas registradas en el océano Atlántico sur y sudoccidental durante el período 1994–2003 Y.H. Marín, L.C. Barea, J.F. Chocca y A. Stagi (Uruguay)
WG-FSA-04/40	Population structure of icefish (*Champsocephalus gunnari*) in the South Georgia area (Antarctic) Zh.A. Frolkina and I.A. Trunov (Russia) (*CCAMLR Science*, submitted)
WG-FSA-04/41	On the problem of icefish (*Champsocephalus gunnari*) (Channichthyidae) and krill (*Euphausia superba*) interaction in the South Georgia area S.M. Kasatkina and Zh.A. Frolkina (Russia)
WG-FSA-04/42	Summary of the seabird and marine mammal observations during observed toothfish (*Dissostichus* spp.) longline fishing operations in CCAMLR Subareas 88.1 and 88.2 S.J. Baird (New Zealand)

WG-FSA-04/43	The diet of juvenile toothfish (*Dissostichus eleginoides*) on the South Georgia and Shag Rocks shelf (CCAMLR Subarea 48.3) M.A. Collins, K.A. Ross and M. Belchier (United Kingdom)
WG-FSA-04/44	Patterns in the diet of mackerel icefish (*Champsocephalus gunnari*) on the South Georgia and Shag Rocks shelf (CCAMLR Subarea 48.3) M.A. Collins, R. Mitchell, G. Tarling and M. Belchier (United Kingdom)
WG-FSA-04/45	An interlaboratory comparison of ages estimated for *Dissostichus eleginoides* from the Argentine Sea, southwest Atlantic Ocean M.C. Cassia (Argentina), P.L. Horn (New Zealand) and J.R. Ashford (USA)
WG-FSA-04/46	The distribution of seabirds on the Alaskan longline fishing grounds: 2002 data report E. Melvin, K. Dietrich, K. Van Wormer and T. Geernaert (USA) (*Washington Sea Grant Program*, WSG-TA 04-02)
WG-FSA-04/47	Annotated bibliography: seabird interactions with trawl fishing operations and cooperative research K. Dietrich and E. Melvin (USA) (*Washington Sea Grant Program*, WSG-TA 04-02)
WG-FSA-04/48	Trends in breeding numbers and survival of black-browed (*Thalassarche melanophrys*) and grey-headed albatrosses (*T. chrysostoma*) breeding on Macquarie Island A. Terauds, R. Gales and R. Alderman (Australia) (*Wildlife Research*, CSIRO Publishing Australia, submitted)
WG-FSA-04/49	Foraging areas of black-browed and grey-headed albatrosses breeding on Macquarie Island in relation to marine protected areas A. Terauds, R. Gales, G.B. Baker and R. Alderman (Australia) (*Polar Biology*, submitted)
WG-FSA-04/50	Population and survival trends of wandering albatrosses (*Diomedea exulans*) breeding on Macquarie Island A. Terauds, R. Gales, R. Alderman and G.B. Baker (Australia)
WG-FSA-04/51	Update on the Agreement on the Conservation of Albatrosses and Petrels (ACAP) B. Baker and T. Hewitt (Australia)
WG-FSA-04/52	IMAF report – Southern Seabirds Solution visit to Reunion Island M. McNeill (New Zealand)
WG-FSA-04/53	Review of national research on seabirds in New Zealand S.M. Waugh and A. Connell (New Zealand)

WG-FSA-04/54	Seabird mortality in the artisanal austral hake and Patagonian toothfish longline fisheries in southern Chile C.A. Moreno, P. Rubilar, J. Arata, R. Hucke-Gaete (Chile) and G. Robertson (Australia)
WG-FSA-04/55	Estimation of the incidental capture of seabird species in commercial fisheries in New Zealand waters, 2000/01 S.J. Baird (New Zealand) (*Fisheries Assessment Report*, New Zealand Ministry of Fisheries)
WG-FSA-04/56	Estimation of the incidental capture of seabird species in commercial fisheries in New Zealand waters, 2001/02 S.J. Baird (New Zealand) (*Fisheries Assessment Report*, New Zealand Ministry of Fisheries)
WG-FSA-04/57	Estimation of the incidental capture of seabird species in commercial fisheries in New Zealand waters, 2002/03 S.J. Baird (New Zealand) (*Fisheries Assessment Report*, New Zealand Ministry of Fisheries)
WG-FSA-04/58	Population dynamics of black-browed and grey-headed albatrosses *Diomedea melanophrys* and *D. chrysostoma* at Campbell Island, New Zealand, 1942–96 S.M. Waugh (New Zealand), H. Weimerskirch (France), P.J. Moore and P.M. Sagar (New Zealand) (*Ibis*, 141: 216–225 (1999))
WG-FSA-04/59	Exploitation of the marine environment by two sypatric albatrosses in the Pacific Southern Ocean S.M. Waugh (New Zealand), H. Weimerskirch, Y. Cherel (France), U. Shankar (New Zealand), P.A. Prince (United Kingdom) and P.M. Sagar (New Zealand) (*Mar. Ecol. Prog. Ser*., 177: 243–254 (1999))
WG-FSA-04/60	BioRoss – New Zealand funded marine biodiversity research in the Ross Sea region J. Burgess (New Zealand)
WG-FSA-04/61	Observations of demersal fish, benthic communities and seafloor composition of the Southern Ocean Atlantic sector from the ICEFISH 2004 cruise C.D. Jones, S.J. Lockhart and D.F. Doolittle (USA)
WG-FSA-04/62	Withdrawn
WG-FSA-04/63	An alternative method for estimating the level of illegal fishing using simulated scaling methods on detected effort I. Ball (Australia) (*CCAMLR Science*, submitted)

WG-FSA-04/64	Scientific observations in CCAMLR fisheries – past, present and future Secretariat (*CCAMLR Science*, submitted)
WG-FSA-04/65	Testing the performance of a recompiled version of CMIX to decompose length-density distributions of Patagonian toothfish (*Dissostichus eleginoides*) T.D. Lamb, W.K. de la Mare, A.J. Constable and C.R. Davies (Australia)
WG-FSA-04/66	The Australian exploratory toothfish fishery in CCAMLR Division 58.4.2 and Subdivision 58.4.3b in season 2003/04 D. Erceg and E. van Wijk (Australia)
WG-FSA-04/67	Progress towards validation of ageing of *Dissostichus eleginoides* using otoliths K. Krusic-Golub and R. Williams (Australia)
WG-FSA-04/68	By-catch in Australian fisheries in Divisions 58.5.2, 58.4.2 and 58.4.3 during the 2002/03 and 2003/04 fishing seasons E. van Wijk and R. Williams (Australia)
WG-FSA-04/69	Alternative method of parameters accuracy calculation in CMIX procedure applied to toothfish recruitment estimation P.S. Gasyukov (Russia) (*CCAMLR Science*, submitted)
WG-FSA-04/70	A comparison of two different methods to age mackerel icefish (*Champsocephalus gunnari*) at South Georgia P. Gasyukov (Russia), K.-H. Kock (Germany) and Zh.A. Frolkina (Russia)
WG-FSA-04/71	Report on the status of wandering, black-browed and grey-headed albatrosses at South Georgia S. Poncet (United Kingdom),G. Robertson (Australia), R. Phillips (United Kingdom), K. Lawton (Australia), B. Phalan, J. Croxall and P. Trathan (United Kingdom)
WG-FSA-04/72	Report on the effectiveness of integrated weight (fast sinking) longlines in reducing the mortality of white-chinned petrels and sooty shearwaters in autoline longline fisheries G. Robertson (Australia), N. Smith (New Zealand), B. Wienecke and S. Candy (Australia)
WG-FSA-04/73	Proposal for the removal of night setting requirement for autoline vessels fishing in Division 58.5.2 G. Robertson and B. Baker (Australia)

WG-FSA-04/74	A simulation approach to the evaluation of recruitment surveys for *D. eleginoides* for the Heard Island Plateau region (Division 58.5.2) S.G. Candy, C.R. Davies and A.J. Constable (Australia)
WG-FSA-04/75	Description of an AD Model Builder implementation of the exact time of release and recapture stock assessment model of Tuck et al. (2003) S.G. Candy, A.J. Constable and D. Erceg (Australia)
WG-FSA-04/76	Preliminary assessment of long-term yield of Patagonian toothfish (*Dissostichus eleginoides*) for the Heard Island Plateau region (CCAMLR Division 58.5.2) based on a random stratified trawl survey in May 2004 C.R. Davies, T. Lamb, A.J. Constable and R. Williams (Australia)
WG-FSA-04/77	Preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) for the Heard Island Plateau region (Division 58.5.2) based on a survey in May 2004 C.R. Davies, T. Lamb, A.J. Constable and R. Williams (Australia)
WG-FSA-04/78	Preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 based on a UK survey in January 2004 R.C. Wakeford, D.J. Agnew, M.B. Collins and G.B. Parkes (United Kingdom)
WG-FSA-04/79	Trials to test mitigate devices to reduce seabird mortality caused by warp cable strike on factory trawlers B.J. Sullivan, P. Brickle, T.A. Reid, D.G. Bone and D.A.J. Middleton (United Kingdom)
WG-FSA-04/80	Mitigation trials to reduce seabird mortality in pelagic trawl fisheries (Subarea 48.3) B.J. Sullivan, G.M. Liddle and G.M. Munro (United Kingdom)
WG-FSA-04/81	Research under way in Australia on seabirds vulnerable to fisheries interaction R. Gales, G. Robertson, B. Baker, A. Terauds, R. Alderman and K. Lawton (Australia)
WG-FSA-04/82	Assessment of the status of the toothfish stock in Subarea 48.3 D.J. Agnew and G.P. Kirkwood (United Kingdom)
WG-FSA-04/83	Seal mitigation measures on trawl vessels fishing for krill in CCAMLR Subarea 48.3 J. Hooper, J.M. Clark, C. Charman and D. Agnew (United Kingdom) (*CCAMLR Science*, submitted)

WG-FSA-04/84 Rev. 1	Comparison of the catches and biological characteristics of *Dissostichus mawsoni* in Subarea 88.1 in seasons of 2002/03 and 2003/04 K.V. Shust, N.V. Kokorin and A.F. Petrov (Russia)
WG-FSA-04/85	Fish stock assessment survey in Subarea 48.3, 2004 M. Belchier, M. Purves, M. Collins, S. Hawkins, T. Marlow, R. Mitchell, J. Szlakowski and J. Xavier (United Kingdom)
WG-FSA-04/86	The age structure and growth rate of Patagonian toothfish (*Dissostichus eleginoides*) at South Georgia M. Belchier (United Kingdom)
WG-FSA-04/87	Etat des mesures mises en œuvre par les armements à la pêche français impliqués dans la pêcherie palangrière de légine des TAAF, pour maîtriser la mortalité accidentelle d'oiseaux (France)
WG-FSA-04/88	Mesures adoptées par la France dans les zones 58.6 (Crozet) et 58.5.1 (Kerguelen) afin de réduire la mortalité aviaire – 2003/04 (France)
WG-FSA-04/89	Observer notes (Subarea 88.1) V.G. Prutko (Ukraine)
WG-FSA-04/90	Some peculiarities of *Chionobathyschus dewitti* biology in the Ross Sea L.K. Pshenichnov (Ukraine)
WG-FSA-04/91	Modifications to the Generalised Yield Model in 2004, version GYM501E.EXE A.J. Constable (Australia)
WG-FSA-04/92	Theoretical considerations for estimating the density of cohorts and mean recruitment of Patagonian toothfish (*Dissostichus eleginoides*) based on research trawl survey data C.R. Davies, E.M. van Wijk and A.J. Constable (Australia)

Other Documents

CCAMLR-XXIII/6	Notification of Norway's intention to conduct an exploratory fishery for 2004/05 in Subareas 88.1 and 88.2 Delegation of Norway
CCAMLR-XXIII/8	Notification of Argentina's intention to conduct exploratory fisheries for *Dissostichus* spp. in CCAMLR areas Delegation of Argentina

CCAMLR-XXIII/9	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.3a for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/10	Notification of Australia's intention to conduct an exploratory longline fishery in Division 58.4.3b for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/11	Notification of Australia's intention to conduct an exploratory longline fishery in Statistical Subarea 88.1 for *Dissostichus* spp. Delegation of Australia
CCAMLR-XXIII/12	Notification of Chile to conduct an exploratory longline fishery in Division 58.4.1 for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/13	Notification of intention to conduct an exploratory longline fishery in Division 58.4.2 for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/14	Notification of intention to conduct an exploratory longline fishery in Division 58.4.3b for *Dissostichus* spp. Delegation of Chile
ADDENDUM CCAMLR-XXIII/12 CCAMLR-XXIII/13 CCAMLR-XXIII/14	Notification of Chile to conduct an exploratory longline fishery in Division 58.4.1 (CCAMLR-XXIII/12), Division 58.4.2 (CCAMLR-XXIII/13) and Division 58.4.3b (CCAMLR-XXIII/14) for *Dissostichus* spp. Delegation of Chile
CCAMLR-XXIII/15	Notification of Spain's proposal to conduct exploratory fisheries for toothfish (*Dissostichus* spp.) in CCAMLR Subarea 88.1 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b in the 2004/05 season Delegation of Spain
CCAMLR-XXIII/16	Notification of the intention to conduct an exploratory bottom trawl fishery for icefish in Subarea 48.3 Delegation of the United Kingdom
CCAMLR-XXIII/17	Notification by the United Kingdom of its intention to participate in the exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 during the 2004/05 season Delegation of the United Kingdom
CCAMLR-XXIII/18	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season (Subarea 48.6) Delegation of Japan

CCAMLR-XXIII/19	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3.b) Delegation of Japan
CCAMLR-XXIII/20	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Subarea 48.6) Delegation of the Republic of Korea
CCAMLR-XXIII/21	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.1) Delegation of the Republic of Korea
CCAMLR-XXIII/22	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.2) Delegation of the Republic of Korea
CCAMLR-XXIII/23	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3a) Delegation of the Republic of Korea
CCAMLR-XXIII/24	Notification by the Republic of Korea of its intention to conduct an exploratory fishery for *Dissostichus* spp. in the 2004/05 season (Division 58.4.3b) Delegation of the Republic of Korea
CCAMLR-XXIII/25	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Subarea 48.6 in the 2004/05 season Delegation of New Zealand
CCAMLR-XXIII/26	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Divisions 58.4.1 and 58.4.2 in the 2004/05 season Delegation of New Zealand
CCAMLR-XXIII/27	New Zealand notification to undertake exploratory fishing for *Dissostichus* spp. in CCAMLR Subareas 88.1 and 88.2 in the 2004/05 season Delegation of New Zealand
CCAMLR-XXIII/28	Notification by Russia of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subareas 88.1 and 88.2 Delegation of Russia

CCAMLR-XXIII/29	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/30	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Division 58.4.1 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/31	Notification by Ukraine of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Division 58.4.2 for the 2004/05 season Delegation of Ukraine
CCAMLR-XXIII/32	Notification of an exploratory fishery in Subarea 88.1 Delegation of Uruguay
CCAMLR-XXIII/34	Notification of exploratory fisheries for *Dissostichus* spp. in the 2004/05 season Delegation of South Africa
CCAMLR-XXIII/38	Monitoring CCAMLR fisheries: proposed changes and improvements Secretariat
CCAMLR-XXIII/BG/8	Implementation of fishery conservation measures in 2003/04 Secretariat
CCAMLR-XXIII/BG/9	Summary of current conservation measures and resolutions in force 2003/04 Secretariat
CCAMLR-XXIII/BG/23	CCAMLR and seabirds in the Antarctic marine ecosystem Secretariat (To be submitted to the First ACAP Conference of Parties)
SC-CAMLR-XXIII/5 Rev. 1	Draft rules for the submission of meeting papers to the Scientific Committee Secretariat
SC-CAMLR-XXIII/7	On the management of exploratory toothfish fisheries: the need to amend a number of conservation measures Delegation of Ukraine
SC-CAMLR-XXIII/BG/1	Catches in the Convention Area in the 2002/03 and 2003/04 seasons Secretariat

SC-CAMLR-XXIII/BG/3	Summary of notifications of new and exploratory fisheries in 2004/05 Secretariat
SC-CAMLR-XXIII/BG/7	Observer Report on FAO/Birdlife South American Workshop on Implementation of NPOA-Seabirds and Conservation of Albatrosses and Petrels (Valdivia, Chile, 2 to 6 December 2003) CCAMLR Observer (C.A. Moreno, Chile)
SC-CAMLR-XXIII/BG/19	On experimental approach to extend boundaries of exploratory fishery on Antarctic toothfish (*D. mawsoni*) in the Ross Sea (Subareas 88.1 and 88.2) in the meso- and bathypelagial layers Delegation of Russia
SC-CAMLR-XXIII/BG/20	Structure and distribution of the slope fish community in the vicinity of the sub-Antarctic Prince Edward Archipelago Delegation of South Africa
SCIC-04/3	Estimation of IUU catches of toothfish inside the Convention Area during the 2003/04 fishing season Secretariat
WG-FSA-SAM-04/1	Agenda
WG-FSA-SAM-04/2	List of participants
WG-FSA-SAM-04/3	List of documents
WG-FSA-SAM-04/4	Further development of the fishery plans Secretariat
WG-FSA-SAM-04/5	Update on the external review of the Generalised Yield Model (GYM) software and manual CCAMLR Secretariat
WG-FSA-SAM-04/6	Reorganisation of the WG-FSA report CCAMLR Secretariat
WG-FSA-SAM-04/7	Feasibility of trawl surveys to estimate abundance of juvenile toothfish in Subarea 88.1 R.L. O'Driscoll, B.A. Wood and S.M. Hanchet (New Zealand)
WG-FSA-SAM-04/8	Approaches to monitoring and assessing toothfish in new and exploratory fisheries, with particular reference to Subarea 88.1 S.M. Hanchet and R.L. O'Driscoll (New Zealand)

WG-FSA-SAM-04/9	Application of the bootstrap method in assessment of target strength regression parameters on the basis of *in situ* measurements P.S. Gasyukov and S.M. Kasatkina (Russia)
WG-FSA-SAM-04/10	Revision of icefish (*C. gunnari*) stock estimate in the South Georgia area on the basis of the Russian acoustic trawl survey 2002 S.M. Kasatkina and P.S. Gasyukov (Russia)
WG-FSA-SAM-04/11	On the catchability of bottom trawl in relation to icefish (*C. gunnari*) S.M. Kasatkina and V.F. Ivanova (Russia)
WG-FSA-SAM-04/12	Variants of the ASPM assessment of the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity which attempt to reconcile CPUE and catch-at-length data A. Brandão and D.S. Butterworth (South Africa)
WG-FSA-SAM-04/13	Development of a population model for the assessment of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea A. Dunn, D.J. Gilbert, S.M. Hanchet and B. Bull (New Zealand)
WG-FSA-SAM-04/14	Estimating the level of illegal fishing using simulated scaling methods on detected activity I. Ball (Australia)
WG-FSA-SAM-04/15	Technical specifications of Fish Heaven: version 2.1.5 I. Ball (Australia)
WG-FSA-SAM-04/16	Survey estimates of recruitment of toothfish in Subarea 48.3 D.J. Agnew, J. Moir-Clark, R.C. Wakeford, M. Collins, M. Belchier (United Kingdom)
WG-FSA-SAM-04/17	Alternative assessment methods for toothfish at South Georgia D. Agnew, A. Payne and G. Kirkwood (United Kingdom)
WG-FSA-SAM-04/18	Estimating toothfish biomass in Subarea 48.3 using local depletions D. Agnew and J. Pearce (United Kingdom)
WG-FSA-SAM-04/19	Considerations on the design and evaluation of surveys for estimating recruitment of Patagonian toothfish (*Dissostichus eleginoides)* with preliminary outcomes for the Heard Island plateau region (Division 58.5.2) C.R. Davies, S. Candy and A.J. Constable (Australia)

WG-FSA-SAM-04/20	Does the current South Georgia groundfish survey accurately estimate the standing stock of mackerel icefish? M. Collins, J. Xavier, K. Reid, M. Belchier, C. Goss and D. Agnew (United Kingdom)
WG-EMM-04/18	Development of the acoustic survey database Secretariat
	An initial evaluation of CCAMLR management procedures for the *Dissostichus eleginoides* fisheries C. Holt, A.J. Benson and W.K. de la Mare (Simon Fraser University, Canada)

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Proposed structure of the report of the 2004 meeting of WG-FSA (prepared by Inigo Everson)

ANI 483 structure
ANI 5852 structure
TOP 483 structure
TOP 5852 structure
By-catch structure
New and exploratory activity this season
New and exploratory structure
Observer program structure
Report outline for 2004

APPENDIX D

INTERSESSIONAL WORK PLAN
FOR AD HOC WG-IMAF FOR 2004/05

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMAF FOR 2004/05

The Secretariat will coordinate the intersessional work of the IMAF group. An interim review of work will be conducted in June 2005 and advised to ad hoc WG-IMAF at the time of WG-EMM (July 2005). The outcome of the intersessional work will be reviewed in September 2005 and reported as a tabled paper to WG-IMAF in October 2005.

[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 2004	Place all relevant sections of CCAMLR-XXIII on IMAF page of CCAMLR website and notify IMAF group members, technical coordinators and (via them) scientific observers.
1.2	Circulate papers submitted to WG-FSA on IMAF matters.	Standing request		Dec 2004	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 2004	Commend technical coordinators and all observers for their efforts in the 2003/04 fishing season.
1.4	Review new and exploratory fishery notifications.	Standing request	B. Baker, N. Smith	At submission deadline	Transmit electronic copies of notifications and adopted 2004 table to Mr Baker and Mr Smith to prepare initial draft of IMAF table.
1.5	Prepare agenda for WG-IMAF-05.		Science Officer, Co-Conveners	By 31 Aug 2004	Science Officer to forward electronic version of last year's annotated agenda to Co-Conveners for revision prior to distribution to WG-IMAF.
1.6	Membership of WG-IMAF.	Standing request	Members	Nov 2004/ as required	Request nomination of new members to IMAF, especially Members not currently involved, and request all Members to send their representatives to the next IMAF meeting.
1.7	Submission of papers for WG-IMAF-05.		Members, IMAF members, SODA*	By 0900 26 Sep 2005	Submit papers specifically relevant to agenda items. Request observer and compliance papers from Secretariat at least one week prior to the meeting.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
1.8	Allocation of submitted papers to agenda items and assignment of rapporteuring tasks.	Standing request	Co-Conveners	Before meeting	Prepare list and post on website.
1.9	Preparation for meeting with WG-FSA-05 to discuss issues of mutual interest.	6.38	Co-Conveners, WG-FSA Convener, IMAF members	By 30 Sep 2005	IMAF internal discussions on five topics identified in paragraph 6.38, prior to meeting with WG-FSA-05.
2.	**Members' research and development activities:**				
2.1	Update information on national research programs on albatrosses, giant petrels and white-chinned petrels, using the revised report templates, in relation to: (i) status and trends of populations (ii) foraging range and distribution (iii) genetic profiles (iv) number and nature of by-catch specimens and samples.	Standing request 7.132–7.134	Members, IMAF members, technical coordinators, nominated scientists Dr Gales	Nov 2004/ Sep 2005	Secretariat to provide the revised report templates. Explicit reminder to IMAF members in July 2005.
2.2	Risk assessment of seabird by-catch in the Convention Area.	Standing request	IMAF members	Nov 2004/ Sep 2005	Further work as appropriate to update SC-CAMLR-XXIII/BG/22 for the Scientific Committee. Circulate any new tabled papers relating to seabird at-sea distributions to Co-Conveners, 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	Quinquennial review of status and trends in marine mammal and bird populations.	SC-CAMLR-XXIII/2, 6(ii)	IMAF members		Plan with WG-FSA for the five-year review of status and trends of populations.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
2.4	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: • seabird capture rates in relation to dyed and artificial bait, snoodline and mainline colour, bait depth and sink rates; • optimum configuration of line-weighting regimes and equipment; • experiences with IWLs; • 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.	Standing request	Members, IMAF members, technical coordinators	Nov 2004/ Sep 2005	Request information, collate responses for WG-IMAF-05.
2.5	Methods for preventing seal mortality or injury associated with krill trawl fishing.	7.238, 7.242	Members as appropriate, IMAF members	As soon as report available	Further testing of, and continued reporting on, effectiveness of various mitigation methods and devices; report to WG-IMAF-05.
2.6	Current information on seal mitigation methods.	7.242, 7.282	Secretariat	Nov 2004	Combine into a single document the information on various seal-excluding devices; distribute to CCAMLR Members and other interested organisations.
2.7	Continued experimental trials of mitigation measures in French EEZs.	7.45	France, IMAF scientists	As soon as possible	Report results to WG-IMAF-05.
2.8	Experimental design.	7.89, 7.90	Members as appropriate, IMAF members		Design experiments aimed at decoupling the effects of mitigation treatments.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
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 2005	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Australia, Brazil, Chile, New Zealand, South Africa, UK, Uruguay). Review situation at WG-IMAF-05. Request information from other parties – Members and non-Contracting Parties (e.g. People's Republic of China, Japan, Republic of Korea, Taiwan) and international organisations (especially CCSBT, ICCAT, IOTC) – known to be fishing, or collecting data on fishing, in areas adjacent to the Convention Area. Review at WG-IMAF-05.
3.2	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	Standing request	Members, IMAF members	Sep 2005	Repeat request to all IMAF members, especially to those relevant to item 3.1 above. Review at WG-IMAF-05.
3.3	Reports on use and effectiveness of mitigating measures outside the Convention Area.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2005	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 WG-IMAF-05.
3.4	Reports on nature of observer programs, including observer coverage.	Standing request	Technical coordinators, Members, non-Contracting Parties, international organisations	Sep 2005	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Australia, Brazil, Chile, New Zealand, South Africa, Uruguay, UK). Review situation at WG-IMAF-05. Request information from other parties – Members and non-Contracting Parties (e.g. People's Republic of China, Japan, Republic of Korea, Taiwan) and international organisations (especially CCSBT, ICCAT, IOTC) – known to be fishing, or collecting data on fishing, in areas adjacent to the Convention Area. Review at WG-IMAF-05.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
4.	**Cooperation with international organisations:**				
4.1	2004 meeting of CCSBT-ERSWG; invite CCSBT to attend WG-IMAF.	Standing request 7.167	Science Officer, CCSBT Secretariat	As required	CCAMLR Secretariat to obtain and circulate copies of the report and papers tabled at the 2004 meeting from the CCSBT Secretariat. Invite and nominate observers as decided by the Scientific Committee.
4.2	Cooperation with IATTC, ICCAT and IOTC on specific issues regarding incidental mortality of seabirds.	Standing request	Co-Conveners, Science Officer	Nov 2004/ Sep 2005	Brief CCAMLR observers on desired feedback on IMAF matters (seabird by-catch levels and mitigating measures).
4.3	Collaboration and interaction with all tuna commissions (CCSBT, IATTC, ICCAT, IOTC, WCPFC) and RFMOs with responsibility for fisheries in areas where Convention Area seabirds are killed.	7.165	Relevant Members, CCAMLR observers	Nov 2004 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.
4.4	Progress with NPOAs in respect of FAO IPOA-Seabirds.	Standing request 7.160	Relevant Members, IMAF members	By Sep 2004	Solicit reports to CCAMLR on progress for information and make review.
4.5	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 members	As feasible	Await response to CCAMLR by Japan. Discuss progress at WG-IMAF-05.
4.6	Support for ACAP and attendance at MOP1.	7.157, 7.158	Members as appropriate; Australia		Support establishment of Advisory Committee, implementation of its action plan, and coordinating activities between CCAMLR and ACAP. Report to WG-IMAF-05.
4.7	IUCN Red List: Seabirds	Standing request	Secretariat	Aug 2004	Obtain from BirdLife International, circulate to IMAF members and table for SC-CAMLR-XXIV, any revisions to the conservation status of albatross, *Macronectes* and *Procellaria* species.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
4.8	BirdLife International (BLI)	Standing request 7.144, 7.145, 7.265		Sep 2005	Request information from BLI about its activities of relevance to IMAF, in particular its Seabird Program and 'Save the Albatross Campaign'. BLI submission of reports on global tracking and RFMO evaluation to WG-IMAF-05.
4.9	Southern Seabird Solutions	7.174	Ms Molloy	Sept 2005	Report on progress to WG-IMAF-05.
4.10	Third International Albatross and Petrel Conference	7.154	Secretariat	As soon as possible	Request conference organisers and/or sponsors to facilitate access to an electronic version of the abstracts volume.
4.11	Fourth International Fisheries Observer Conference	7.179	Science Officer, SODA*, Members, IMAF members	Sept 2005	Provide feedback to CCAMLR of relevant information; report at WG-IMAF-05.
5.	**Data acquisition and analysis:**				
5.1	Preliminary analyses of data from the current fishing season.	Standing request	Technical coordinators	Sep–Oct 2005	Standing request: summarise and analyse current year data at a level adequate to facilitate assessment at WG-IMAF-05.
5.2	Acquisition from EEZs and elsewhere as appropriate, of seabird incidental mortality data for trawl fisheries.	Standing request	Members, especially France	Nov 2004/ Sep 2005	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 2000/01 and 2004/05.	7.34, 7.251(v)	France	As soon as possible for 2001/02	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	Analysis of 2003/04 vessel-specific by-catch information.	7.25, 7.251(vi)	France	As soon as possible	Request analysis of the 2003/04 by-catch data to identify factors contributing to high levels of by-catch.
5.5	Status report on implementation of IMAF recommendations regarding mitigation research programs, observer coverage, and implementation of mitigation measures.	7.45, 7.251	France, IMAF members	Sept 2004	Report to WG-IMAF-05.
5.6	Provision of data by Brazil on by-catch of Convention Area seabirds in Brazilian waters.	7.128	Brazil	As soon as possible	Report to WG-IMAF-05.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
5.7	Observations on krill trawl vessels.	7.231, 7.237	UK	As soon as possible	Submit original data collected by UK observers in 2004 on six of the nine vessels fishing for krill in Subarea 48.3.
5.8	Estimates of IUU take of seabirds.		SODA*, IMAF members, Co-Conveners	Before start WG-IMAF-05	Review IUU seabird by-catch estimation method to take account of intersessional work recommended by WG-FSA and prepare 2005 estimates of IUU seabird by-catch using revised methods.
6.	**Scientific observer issues:**				
6.1	Preliminary analysis of data from 2004/05 fisheries.	Standing request	SODA*	IMAF meeting	Produce draft tables equivalent to Tables 7.1 to 7.14 of this report at least one week before WG-IMAF-05.
6.2	Changes to current seabird data collection: (i) better information on when seabirds are caught on longlines; (ii) better information on when seabirds are caught in trawls; (iii) several specifications relating to streamer lines (aerial extent, number of streamer lines, line deployed over hookline etc); (iv) hooks in offal; (v) remove requirement for seabird abundance data; (vi) append definition of bird 'caught'; (vii) number of hooks directly observed.	11.63 11.27 11.28, 11.29 11.15 11.17 11.26 7.201 7.188	IMAF, technical coordinators		IMAF follow through with the Secretariat and technical coordinators to ensure that these changes are incorporated into observer forms and into training/briefing protocols used by technical coordinators.
6.3	Reporting of line sink rate test results.	7.106	IMAF members, technical coordinators	Nov 2004	Reported daily to relevant national agencies and to CCAMLR at end of fishing season.
6.4	Vessel operators reminded of streamer line specifications in Conservation Measure 25-02.	7.58, 7.61	Members, technical coordinators	Nov 2004	Vessel operators advised to exceed standards to prevent compliance failures.

	Task/Topic	Paragraphs of WG-FSA report	Members' assistance[1]	Start/ Completion deadlines	Action
6.5	Definition of 'caught' bird.	7.201, 7.202	IMAF members, technical coordinators, Secretariat	Nov 2004	Request feedback from observers on ability to apply this definition. Secretariat to append this definition (SC-CAMLR-XXII, Annex 5, paragraphs 6.214 to 6.217) to each conservation measure that specifies a maximum permitted level of seabird by-catch.
6.6	Review of *Scientific Observers Manual* and address identified issues: (i) review seabird data collection and protocols; (ii) determine if data collections meet data requirements; (iii) prioritise seabird-related observer tasks.	11.35–11.46, 11.50, 11.65	IMAF/FSA observer subgroup, technical coordinators	Nov 2004	Report, as necessary, to WG-IMAF-05.
7.	**Conservation Measure 25-02:**				
7.1	Revise measure	7.93	IMAF members		Review, especially line-weighting provisions for autoliners, at WG-IMAF-05.
7.2	Research areas: (i) evaluate sink rates of external weighted autolines; (ii) relationship of line sink rate to values that include both vessel speed and sink rate; (iii) integrated-weight line efficacy; (iv) methods for monitoring individual vessel compliance.		IMAF members		Continue research to allow a more informed revision of Conservation Measure 25-02 in 2005, with the intention of combining Conservation Measures 24-02 and 25-02, if possible.

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2004/05 INTERSESSIONAL PERIOD

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2004/05 INTERSESSIONAL PERIOD

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
1.	**Scheme of International Scientific Observation**				
1.1	Maintain a consistent level of international scientific observation on krill fishing vessels.	2.5, 2.19, 3.4	Ongoing	Assist	Implement
1.2	Ensure that only the current versions of cruise reports and logbook forms be used, and that observers are aware of the correct data fields when recording data.	2.7	Ongoing	Assist	Implement through technical coordinators
1.3	Arrange intersessional work on a major review of the format, structure and contents of the *Scientific Observers Manual*.	2.9–2.13	Ongoing	Mr N. Smith and Dr E. Balguerías to coordinate	Participate
1.4	Update, as required, the *Scientific Observers Manual* logbook data recording and reporting sheets, and instructions to scientific observers and technical coordinators.	2.17	Feb	Implement	Distribute
1.5	Participate in the Fourth International Fisheries Observer Conference and report to WG-FSA on issues of importance to the CCAMLR's Scheme.	2.18	Nov 2004, Oct 2005	Implement	
2.	**Ecosystem monitoring and management**				
2.1	Undertake tasks identified by WG-EMM.	Table 3, Annex 4	Jun	Implement	Implement
2.2	Establish a Steering Committee and arrange for intersessional work on the proposed MPA workshop.	3.44–3.53	Jan–Jun	Assist	Implement
2.3	Consider revision of rules and procedures of the WG-EMM Subgroup on Protected Areas.	3.65	Jan–Jun	Subgroup convener	Assist
2.4	Establish a steering committee to further the development of plausible ecosystem models and terms of reference that include coordination of further development of the modelling framework, publication of work, input from the Secretariat, and support of future WG-EMM workshops.	3.84	Jun	Implement	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
2.5	Discuss how an ecosystem monitoring program centred on icefish could be established and what would be needed to build an ecosystem model of such a system.	3.97	Jun	Assist	Implement
3.	**Harvested species**				
3.1	Undertake tasks identified by WG-FSA.	Table 13.1, Annex 5	Sep	Implement	Implement
3.2	Provide observer information on the catch, the fishing methods used and by-catch from the Vanuatu-flagged krill vessel fishing in Area 48 in 2003/04.	4.4	Jun	Assist	Uruguay to provide data and prepare paper for WG-EMM
3.3	Submit krill fishery notifications.	4.9	Jun	Assist	Implement
3.4	Provide information on the economic and technological drivers of the krill fishery.	4.11	Jun		Implement
3.5	Harmonise definitions contained in Fishery Plans with conservation measures.	4.19	Sep	Implement	
3.6	Continue toothfish tagging in all new and exploratory toothfish fisheries, as well as all other fisheries where appropriate.	4.30	Ongoing	Assist	Implement
3.7	Provide contact names for Members' tagging programs to the Secretariat.	4.31	Feb	Assist	Implement
3.8	Continue work on population parameters important for the assessment process and develop papers on the relationship between life history parameters and von Bertalanffy growth parameters.	4.33, 4.34	Sep	Assist	Implement
3.9	Update the Species Profiles using new information either presented to or generated by WG-FSA.	4.39	Sep	Assist	Implement
3.10	Convene an age determination workshop on *C. gunnari*.	4.40, 13.4	2005	Assist	Implement
3.11	Review the set of parameters in the base-case scenario for the assessment of *D. eleginoides* in Subarea 48.3.	4.55, 4.63	Jun	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
3.12	Conduct a tag–recapture experiment adjacent to the Crozet Islands consistent with other toothfish fisheries.	4.80	Ongoing	Assist	France to implement
3.13	Conduct a tag–recapture experiment adjacent to the Prince Edward Islands consistent with other toothfish fisheries.	4.83	Ongoing	Assist	South Africa to implement
3.14	Further consider approaches to combine estimates of biomass from trawl and acoustic surveys	4.91	Jun	Assist	Implement
3.15	Further consider the development of alternative assessment methods that would provide for a robust long-term management procedure for *C. gunnari*.	4.104	Ongoing	Assist	Implement
4.	**New and exploratory fisheries**				
4.1	Develop time series of data based on research sets that could be compared with similar time series of data from normal commercial fishing.	4.124	Sep	Implement	Implement
4.2	Examine the stock structure of *Dissostichus* spp. in Subareas 88.1 and 88.2 in greater detail.	4.150	Sep	Assist	Implement
4.3	Ensure that the required research sets are completed and submitted in a timely and accurate format.	4.162	Ongoing	Assist	Implement
4.4	Tag *Dissostichus* spp. in accordance with the revised tagging protocol and submit data.	4.162	Ongoing	Assist	Implement
4.5	Collect data that will lead towards a formal assessment of *Dissostichus* spp. in Subarea 88.1.	4.166	Sep	Assist	Implement
4.6	Develop a means for estimating abundance and providing assessments of stock status for all exploratory fisheries.	4.168	Sep	Assist	Implement
4.7	Assess the long-term status of by-catch taxa and conduct research aimed at generating population parameters and estimates of standing stock for macrourids and rajids.	4.171–4.186	Sep	Assist	Implement
4.8	Develop avoidance and mitigation measures for by-catch species.	4.200, 4.206	Sep	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
4.9	Collect further data on distribution and abundance of *Macrourus* spp. in Subarea 88.1 in order to revise allocation of catch limits between SSRUs.	4.201	Sep	Assist	Implement
4.10	Accurately report by-catch in all data formats.	4.203	Ongoing	Assist	Implement
4.11	Estimate total removals by area for all by-catch species.	4.203	Sep	Implement	
4.12	Collate information to allow risk characterisation for major by-catch species in the Convention Area.	4.205	Sep	Assist	Implement
4.13	Advise all vessels, where possible, that all rajids should be cut from the lines whilst the rajids were still in the water, except on the request of the scientific observer.	4.207, 4.208	Ongoing	Assist	Implement
4.14	Report on methods or strategies of fishing that minimise non-target fish by-catch.	4.208	Sep	Assist	Implement
5.	**Incidental mortality**				
5.1	Undertake tasks identified by WG-IMAF.	Annex 5, Appendix D	Sep	Implement	Implement
5.2	Make every effort to improve compliance with conservation measures in order to reattain, and preferably exceed, the levels of compliance reported in 2003.	5.14	Ongoing	Assist	Implement
5.3	Collect key data on streamer line aerial extent and sink rate of externally weighted autolines to enable improvements to Conservation Measure 25-02.	5.15	Sep	Assist	Implement
5.4	Provided data on status, trends and distribution (at sea) of albatross and petrel populations.	5.20	Sep	Assist	Implement
5.5	Improve collaboration and cooperation from RFMOs in respect of by-catch of seabirds from the Convention Area.	5.21, 5.22	Ongoing	Implement	Implement
5.6	Use seal excluder devices in the krill fisheries and collect and submit appropriate data.	5.37, 5.43	Sep	Assist	Implement

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
6.	**Additional monitoring and management issues**				
6.1	Suggest procedures to help develop analysis of marine debris and submit pertinent papers.	6.6	Sep	Implement	Implement
6.2	Request ATCM/CEP for information related to methods of monitoring marine debris or marine pollution that might be used in estimating trends.	6.5	Feb	Implement	
6.3	Submit marine debris data collected at Marion Island in 2003/04.	6.14	Jun–Jul	Assist	
6.4	Further refine CCAMLR's requirements for information on the status and trends of marine mammal and bird populations be undertaken and communicate them to SCAR.	6.18	Oct	Assist	WG-IMAF to implement
7.	**Management under conditions of uncertainty about stock size and sustainable yield**				
7.1	Consider acquiring data on toothfish catches and fish size composition from Areas 51 and 57, including the conduct of cooperative surveys in these areas.	7.15	Ongoing	Assist	Implement
8.	**Secretariat supported activities**				
8.1	Ensure that data requests indicate the nature of their proposed work with respect to distinguishing between the work indicated in paragraph 2(a) and 2(b) of the rules.	12.8	Ongoing	Assist	Implement
8.2	Collate guidelines relating to the submission of documents to the Committee and those of its working groups collated into a single reference document.	12.16	Sep	Implement	
8.3	Note that the preferred way of dealing with published papers submitted to working group meetings was for Members to provide the reference in advance of the meeting, and for participants to source the published papers and bring these to the meeting.	12.18	Ongoing	Assist	Implement
8.4	Note that the responsibility for any copyright issue related to the submission of published papers to working group meetings rests with the authors.	12.19	Ongoing	Assist	Implement
8.5	Monitor and report on the use of the *CCAMLR Science* language support fund.	12.10	Ongoing	Implement	

No.	Task	Reference to paragraphs in SC-CAMLR-XXIII	Deadline	Action required	
				Secretariat	Members
9.	**Other tasks**				
9.1	Establish a Subgroup on Acoustic Survey and Analysis Methods.	3.20–3.23, 13.5	2005	Assist	Implement
9.2	Further consider the proposed external review of the GYM.	15.3	Jun	Assist	Implement
9.3	Develop a proposal to conduct a synoptic acoustic survey in the South Atlantic region in the IPY.	15.6	Feb	Assist	Implement

ANNEX 7

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
APEME Steering Committee	Steering Committee on Antarctic Plausible Ecosystem Modelling Efforts
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
ASI	Antarctic Site Inventory
ASIP	Antarctic Site Inventory Project
ASMA	Antarctic Specially Managed Area
ASOC	Antarctic and Southern Ocean Coalition
ASPA	Antarctic Specially Protected Area
ASPM	Age-Structured Production Model
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced Very High Resolution Radiometry

BAS	British Antarctic Survey
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 *Dissostichus* spp.
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CF	Conversion Factor
CircAntCML	Circum-Antarctic Census of Antarctic Marine Life
CITES	Convention on International Trade in Endangered Species
CMIX	CCAMLR’s Mixture Analysis Program
CMS	Convention on the Conservation of Migratory Species of Wild Animals
COFI	Committee on Fisheries (FAO)
COLTO	Coalition of Legal Toothfish Operators
CoML	Census of Marine Life
COMM CIRC	Commission Circular (CCAMLR)

COMNAP	Council of Managers of National Antarctic Programs (SCAR)
CON	CCAMLR Otolith Network
CPD	Critical Period–Distance
CPPS	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	*Dissostichus* Catch Document
DVM	Diel vertical migration
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 *Dissostichus* spp.
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
ECOSIM	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)

EEZ	Exclusive Economic Zone
EIV	Ecologically Important Value
ENSO	El Niño Southern Oscillation
EPOS	European *Polarstern* 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)
GOSSOE	Group of Specialists on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
GRT	Gross Registered Tonnage
GTS	Greene et al., (1990) linear TS versus length relationship
GYM	Generalised Yield Model
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
IPY	International Polar Year
IRCS	International Radio Call Sign
ISO	International Organization for Standardization
ISR	Integrated Study Region
ITLOS	International Tribunal for the Law of the Sea
IUCN	International Union for the Conservation of Nature and Natural Resources – the World Conservation Union
IUU	Illegal, Unregulated and Unreported
IW	Integrated Weight
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
IWL	Integrated weighted line
JAG	Joint Assessment Group
JARPA	Japanese Whale Research Program under special permit in the Antarctic
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
MCS	Monitoring Control and Surveillance
MEA	Multilateral Environmental Agreement
MFTS	Multiple-Frequency Method for in situ TS Measurements
MIA	Marginal Increment Analysis
MIZ	Marginal Ice Zone
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Marine Protected Area
MRAG	Marine Resources Assessment Group (UK)
MSE	Management Strategy Evaluation
MSY	Maximum Sustainable Yield
MV	Merchant Vessel
MVBS	Mean Volume Backscattering Strength
MVP	Minimum Viable Populations
MVUE	Minimum Variance Unbiased Estimate
NAFO	Northwest Atlantic Fisheries Organization
NASA	National Aeronautical and Space Administration (USA)
NASC	Nautical Area Scattering Coefficient
NCAR	National Center for Atmospheric Research (USA)

NEAFC	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
PFZ	Polar Frontal Zone
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
SG-ASAM	Subgroup on Acoustic Survey and Analysis Methods
SIBEX	Second International BIOMASS Experiment
SIC	Scientist-in-Charge
SIOFA	Southern Indian Ocean Fisheries Agreement
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
STC	Subtropical convergence
SWIOFC	Southwest Indian Ocean Fisheries Commission
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 Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNCLOS	UN Convention on the Law of the Sea

UNFSA	the United Nations Fish Stock Agreement is the 1995 United Nations Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
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 *D. eleginoides* (CCAMLR)
WTO	World Trade Organization
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable Bathythermograph
XML	Extensible Mark-up Language
Y2K	Year 2000