SC-CAMLR-XVI

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE SIXTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
27 – 31 OCTOBER, 1997

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Abstract

This document presents the adopted report of the Sixteenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 27 to 31 October 1997. 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 SIXTEENTH MEETING
OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 27 to 31 October 1997)

OPENING OF THE MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Dr D. Miller (South Africa) from 27 to 31 October 1997 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, 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 Chairman welcomed to the meeting observers from Finland, the Antarctic and Southern Ocean Coalition (ASOC), the Food and Agricultural Organization of the United Nations (FAO), the World Conservation Union (IUCN) and the International Whaling Commission (IWC) and encouraged them to participate in the meeting as appropriate.

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

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

- Mr T. Ichii (Japan), Fishery Status and Trends;
- Dr P. Penhale (USA), Species Monitored in the CCAMLR Ecosystem Monitoring Program;
- Dr J. Croxall (UK), Assessment of Incidental Mortality;
- Dr K. Kerry (Australia), Marine Mammal and Bird Populations;
- Dr S. Nicol (Australia), Krill Resources;
- Dr A. Constable and Mr R. Williams (Australia), Fish Resources;
- Dr G. Watters (USA), Crab Resources;
- Dr I. Everson (UK), Squid Resources, and all items relating to WG-EMM;
- Dr R. Holt (USA), Ecosystem Monitoring and Management;
- Mr R. Williams (Australia), Management under Conditions of Uncertainty about Stock Size and Sustainable Yield;
- Dr G. Kirkwood and Dr G. Parkes (UK), New and Exploratory Fisheries; and
- Secretariat, all other matters.

Adoption of the Agenda

1.6 The Provisional Agenda had been circulated prior to the meeting and was adopted without amendment (Annex 3).

Report of the Chairman

Intersessional Meetings of Working Groups

1.7 The Chairman noted that Members had continued their work during the intersessional period, with several meetings taking place. The Chairman expressed his gratitude to the USA for hosting the meetings of WG-EMM and associated subgroups.

1.8 The third meeting of WG-EMM was held from 21 to 31 July 1997 in San Diego, USA, and was chaired by its Convener, Dr Everson. The Subgroup on Statistics and the Workshop on International Coordination met from 14 to 18 July, and were chaired by Dr Watters and Dr S. Kim (Republic of Korea) respectively.

1.9 WG-FSA met in Hobart, Australia, from 13 to 24 October 1997, and was chaired by its Convener, Dr de la Mare.

1.10 Two ad hoc groups continued their work during the intersessional period. Reports of the IMALF group and the group dealing with fish by-catch in krill fisheries were considered by WG-FSA.

1.11 The Chairman expressed his thanks to conveners, Members, rapporteurs and the Secretariat for contributing to the success of these meetings.

1.12 The report of WG-EMM is attached as Annex 4 and that of WG-FSA as Annex 5.

Intersessional Activities of CCAMLR Members

1.13 The Chairman advised of the following intersessional activities of CCAMLR Members:

(i) vessels from 10 Member countries participated in commercial fishing;

(ii) nine scientific cruises, mainly fisheries research surveys, were conducted in the Convention Area;

(iii) eight Members carried out CEMP-related research programs; and

(iv) 43 scientific observation programs were carried out by scientific observers nominated in accordance with the CCAMLR Scheme of International Scientific Observation and also by national scientific observers.

Scientific Committee Representation at Meetings of Other International Organisations

1.14 The Scientific Committee was represented as an observer at the following international meetings during the intersessional period:

(i) ICES Symposium – Seabirds in the Marine Environment (22 to 24 November 1996, Glasgow, UK) – Dr J. Croxall (UK);

(ii) International Symposium on Environmental Research in the Antarctic (3 to 4 December 1996, Tokyo, Japan) – Dr M. Fukuchi (Japan);

(iii) Seventeenth Session of the Coordinating Working Party on Fishery Statistics (3 to 7 March 1997, Hobart, Australia) – Dr W. de la Mare (Convener, WG-FSA) and the Secretariat;

(iv) CCSBT's Ecologically Related Species Working Group (ERSWG) (3 to 6 June 1997, Canberra, Australia) – Dr E. Sabourenkov (Secretariat);

(v) 'Antarctica and Global Change: Interactions and Impacts' (13 to 18 July 1997, Hobart, Australia) – Prof. P. Quilty (Australia);

(vi) Ninth Meeting of the SCAR Group of Specialists on Environmental Affairs and Conservation (GOSEAC) (July 1997, Bremerhaven, Germany) – Dr E. Fanta (Brazil);

(vii) ICES Annual Science Conference (25 September to 3 October 1997, Baltimore, Maryland, USA) – Dr I. Lutchman (UK);

(viii) 1997 Annual Meeting of the IWC Scientific Committee (29 September to 11 October 1997, Bournemouth, UK) – Mr T. Ichii (Japan);

(ix) SCAR Workshop on Evolutionary Biology of Antarctic Organisms (6 to 8 October 1997, Padua, Italy) – Dr E. Fanta (Brazil).

New Publications

1.15 In addition to the publication of annual reports of CCAMLR meetings, the following were published during the intersessional period:

(i) *CCAMLR Science*, Volume 4;
(ii) *CCAMLR Scientific Abstracts, 1996*;
(iii) extensively revised edition of *CEMP Standard Methods*;
(iv) *Scientific Observers Manual*; and
(v) *Statistical Bulletin*, Volume 9.

Preliminary Consideration of the Scientific Committee Budget

1.16 The Scientific Committee considered an outline of the proposed working budget for 1998. The draft was presented in a format similar to that used in previous years. Further discussion of the Scientific Committee budget is given in paragraphs 14.1 to 14.7.

FISHERY STATUS AND TRENDS

Krill

2.1 The catch of krill (*Euphausia superba*) for the 1997 split-year totalled 82 508 tonnes, i.e. 19% less than in the 1996 split-year (101 707 tonnes). This total is almost exclusively made up of catches taken by Japan, Poland and Ukraine (Tables 1 and 2). Almost all catches were taken in Subareas 48.1 and 48.3. No commercial catches were taken in Areas 58 and 88 (SC-CAMLR-XVI/BG/1 Rev. 2).

2.2 Dr Everson inquired about the availability of information on krill catches by Panama for the 1997 split-year. The Secretariat explained that it had made an official inquiry to Panama about the catch data for the 1997 split-year but no information had been received so far. It noted that it had received catch data from Panama for the 1995 and 1996 split-years.

2.3 The Scientific Committee was informed that the fishing plans of Japan and Poland for 1998 were similar to the fishing operations of those countries last season (i.e. about 60 000 tonnes and four vessels, and about 20 000 tonnes and four vessels, respectively). Ukraine planned a joint operation with Canada in Area 48 using two vessels. The Republic of Korea planned to deploy one trawler and take about 4 400 tonnes of krill. Uruguay noted its intention to operate in two subareas of Area 48. Russia may resume krill fishing using three vessels in Area 48.

2.4 Dr Everson informed the Scientific Committee that a UK company planned to fish for krill during December 1997 and January 1998 and take about 1 000 tonnes in total divided between Subareas 48.1, 48.2 and 48.3. The same company indicated that it was currently considering using a single large vessel to catch up to 45 000 tonnes during 1998 from the same subareas.

2.5 Dr Holt indicated that companies in the USA had expressed an interest in fishing for krill, although at present no actual plan had been formulated.

2.6 In recent years krill catches have been reported from localities outside, but adjacent to, the Convention Area. There is no routine mechanism for this information to be received within the normal timetable for reporting catch and effort data. It is possible that a similar situation has arisen this year (Annex 4, paragraph 2.2). The Scientific Committee endorsed the WG-EMM request that the Secretariat identify the nationality of vessels fishing in those areas, and seek information from those Members on any krill catches which may have been taken in adjacent waters.

2.7 When originally described, Subarea 48.1 extended northwards to latitude 55°S between longitudes 50° and 60°W (Everson, 1977 – Figure 11.2(a)) (see Figure 1). Significant catches of krill from outside the Convention Area have been reported from this region, bounded by latitudes 55° and 60°S and longitudes 50° and 60°W. Consequently, the Scientific Committee recommended that Members undertaking krill fishing be asked to supply data from this area in accordance with the conservation measures for krill fishing in Area 48.

Fish

2.8 The total reported catch of finfish in the Convention Area during the 1997 split-year was 10 562 tonnes (Table 3), mainly (97%) *Dissostichus eleginoides* (10 337 tonnes). The bulk of catches was taken by Chile and France in Subarea 48.3 and Division 58.5.1 respectively, and by South Africa in Subareas 58.6 and 58.7 (SC-CAMLR-XVI/BG/1 Rev. 2) (Table 4).

2.9 The Scientific Committee drew attention to the substantial amount of unreported catches of *D. eleginoides*, in particular in the Indian Ocean sector (Area 58). The total reported catch of *D. eleginoides* from EEZs outside the CCAMLR Convention Area and from inside the CCAMLR Convention Area was 32 991 tonnes in the 1997 split-year (see Annex 5, Appendix D, Table D.1). In addition, the unreported catch derived from landings in ports of southern Africa and Mauritius was estimated to be 74 000 to 82 200 tonnes. The total catch was estimated by WG-FSA to be 107 000 to 115 000 tonnes (Annex 5, paragraph 3.20). It was thought that about 130 000 tonnes of *D. eleginoides* were available on the world market.

2.10 Based on sightings of longliners, their known fishing capacities, and catch and effort data from licensed fisheries, estimates for the various subareas and divisions add up to only 38 000 and 42 800 tonnes (Annex 5, Appendix D, Table D.4), i.e. approximately 50% of the landings. WG-FSA was unable to reconcile the two estimates of the amount of unreported catches at the present stage (Annex 5, paragraph 3.21).

2.11 The discrepancy between the landing figures and estimates of catches based on sightings may be attributable to underestimation of the total amount of fishing activities based on sightings.

2.12 Information from recent landings and sightings of vessels in Divisions 58.5.1 and 58.5.2 provided strong evidence that unregulated fishing in the 1998 split-year will continue at a similar level to 1997 (Annex 5, paragraph 3.22).

2.13 The Scientific Committee expressed great concern that continuing high levels of unregulated fishing, especially in the Indian Ocean sector with such levels being five- or six-times greater than in the regulated fishery, will affect the sustainability of the *D. eleginoides* stocks being targeted. It also noted that WG-FSA took unreported catches into account in developing management advice on the assumption that unregulated catches can be brought under control. Further discussion on unreported catches is contained in paragraphs 5.100, 5.108 to 5.111, 5.130 and 5.138.

2.14 A commercial catch of 216 tonnes of *Champsocephalus gunnari* was taken by one vessel from Australia in Division 58.5.2 during the 1996/97 season (Annex 5, paragraph 4.273).

2.15 Australia reported interest in continuing the *C. gunnari* fishery in Division 58.5.2 for the coming season. France stated its intention to take a limited catch (<100 tonnes) of *C. gunnari* in Division 58.5.1 in the next season. The UK indicated an interest in pursuing this fishery in Subarea 48.3 if the Commission makes management advice for this fishery along the line suggested by WG-FSA (Annex 5, paragraphs 4.210 and 4.211). Russia indicated that it may be carrying out a survey as well as taking limited catches in Subarea 48.3.

2.16 Catches of fish by-catch species were reported in SC-CAMLR-XVI/BG/1 Rev. 2. Skates (32 tonnes) and *Macrourus* spp. (15 tonnes) accounted for most of the by-catch.

Crabs

2.17 There was no fishery for crabs in the CCAMLR Convention Area in the 1996/97 season and no additional data on crabs have been reported to the Secretariat.

Squid

2.18 In the Republic Korea/UK new fishery for *Martialia hyadesi* in Subarea 48.3, a Korean fishing vessel caught 28 tonnes of squid in June (i.e. 1997 split-year) and a further 53 tonnes since then, making a total of 81 tonnes so far this year (SC-CAMLR-XVI/BG/10).

2.19 The level of effort in this fishery was relatively low this year partly because catches of squid elsewhere in the South Atlantic had been very large so economic motivation for this fishery was modest (SC-CAMLR-XVI/BG/10). This lack of effort may extend for the coming season since the price of this type of squid will remain relatively low in line with the depressed demand for squid in general.

2.20 Currently the improvements in the processing of *M. hyadesi* catches would indicate that its market value is likely to become substantially higher than had previously been thought, which may affect the future prospects for this fishery as well as associated catch levels (SC-CAMLR-XVI/BG/10).

2.21 Further discussion on the *M. hyadesi* fishery is given in paragraphs 9.3, 9.15 to 9.18.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

Scientific Observations Conducted in the 1996/97 Fishing Season

3.1 Last year, the Commission confirmed that 100% observer coverage under the CCAMLR Scheme of International Scientific Observation should continue to apply to all longline fisheries for *D. eleginoides*. It was also agreed that new fisheries should have 100% observer coverage. In new fisheries for *Dissostichus* spp., observers should be appointed under the CCAMLR scheme. In the fishery for *M. hyadesi*, observers should be appointed, if possible, under the scheme.

3.2 The following activities were reported during the 1997 split-year:

(i) twelve longline vessels (16 cruises) fished for *Dissostichus* spp. in the fisheries in Subareas 48.3 and 88.1, and all cruises carried international scientific observers;

(ii) nine longline vessels fished for *D. eleginoides* within the South African EEZ at the Prince Edward Islands (Subareas 58.6 and 58.7) and national scientific observers were deployed on 11 out of 14 cruises in the EEZ;

(iii) one vessel (two cruises) jigged for *M. hyadesi* in Subarea 48.3, and carried an international scientific observer on each cruise; and

(iv) two trawlers (three cruises) fished for *D. eleginoides* in Division 58.5.2 with all cruises carrying international scientific observers.

3.3 The Scientific Committee noted that the introduction of technical coordinators had greatly improved the coordination and submission of information by scientific observers and the submission of observer logbook data. Technical coordinators now provided a single point of contact in Member countries for clarifying, or elaborating, issues arising from observer activities.

3.4 However, the Scientific Committee noted that some technical problems still remained, and included: difficulties in tracking scientific observers and their data because only about 45% of the bilateral scientific observer arrangements had been submitted to the Secretariat (Annex 5, paragraph 3.29); delays in submitting the observer data largely due to the late closure of the longline fisheries (Annex 5, paragraph 3.28); and lengthy processing of data because approximately 25% of the data submissions used non-CCAMLR formats and codes (Annex 5, paragraph 3.29). In addition, some observer logbooks did not contain all the data required under the scheme.

3.5 The Scientific Committee noted that data submission which did not conform to CCAMLR formats or codes strained the resources available for data processing within the Secretariat.

3.6 The Scientific Committee noted the feedback in reports of scientific observers, and endorsed WG-FSA's proposal regarding the resolution of problems in data collection and recording. It tasked the Secretariat with addressing issues under paragraph 3.31 in Annex 5 during the intersessional period. The Scientific Committee also endorsed the establishment of a task group to address issues raised in paragraph 3.33 in Annex 5, and related matters, during the intersessional period. Dr Sabourenkov (Science Officer) was appointed as coordinator of the task group, and the terms of reference and an action plan were developed during the meeting (Annex 6).

3.7 The Scientific Committee noted that some scientific observers had reported that several vessels appeared unaware of CCAMLR conservation measures, including the setting of longlines during night-time only and the use of streamer lines (Conservation Measure 29/XV) (Annex 5, paragraph 3.37), and the prohibition of the use of plastic packaging bands (Conservation Measure 64/XV) (Annex 5, paragraph 3.38).

3.8 The Scientific Committee noted that the summary of observers' activities in Annex 5, Table 6 contained information on both international and national observers. Dr E. Balguerías (Spain) and Dr Miller confirmed that the scientific observer aboard *Garoya* was South African, and not Spanish as indicated in Table 6.

3.9 Dr Holt informed the Scientific Committee that the two US-flagged vessels reported fishing in Subareas 58.6 and 58.7 (*American Champion* and *Mr B*) had not been licensed by the USA to fish in CCAMLR waters, and did not carry international scientific observers.

3.10 The Scientific Committee noted the discussion of WG-FSA regarding the timing of, and responsibility for, submissions of catch and effort, biological and observer data (Annex 5, paragraph 3.10). The Working Group recognised the concern expressed by Members that the current schedule for submitting these data may result in expensive data transmissions or delays in cases where vessels undertook prolonged fishing trips (SC-CAMLR-XVI/BG/21). WG-FSA had discussed the requirements for vessels carrying observers to report biological data and the possibility that observers collect these data as part of their own observations and submissions.

3.11 The Scientific Committee confirmed that its primary concern was that the right data be collected reliably and submitted in time for consideration by WG-FSA; from a scientific point of view, the source of these data was unimportant. However, the provision of fisheries information may be of concern to the Commission in the context of the responsibility of Flag States, and this matter was referred to SCOI.

3.12 The Scientific Committee discussed the requirements for observer reports, and agreed that observers should submit reports for all cruises undertaken, and the format and contents of reports should follow the guidelines given in the Part I, Section 5 of the *Scientific Observers Manual*.

3.13 The Scientific Committee endorsed the recommendation of WG-FSA that prior to future meetings the Secretariat prepare, where possible, tables along the lines developed by WG-FSA summarising the trips conducted by scientific observers and information in their reports. In addition, the Secretariat should maintain an inventory for the observer logbook dataset (Annex 5, paragraph 10.8). The Scientific Committee also agreed that the Secretariat should consider developing simple stand-alone programs for data entry, primarily for use in the field (Annex 5, paragraph 10.11).

3.14 The Scientific Committee endorsed the recommendation of WG-EMM that time-budget data for the krill fishery be collected, where feasible, and submitted to the Secretariat (Annex 4, paragraph 2.11).

3.15 The Scientific Committee noted the growing appreciation of the work of scientific observers, the duties they performed, and the information they collected. This year, observer reports and logbook data were analysed by the working groups, in particular WG-FSA, and provided a greater understanding of the fishery operations, the biology of the target species, and the level of incidental mortality.

3.16 The Scientific Committee agreed to write to the technical coordinators thanking them and commending all the scientific observers who had submitted reports to CCAMLR for their efforts (Annex 5, paragraph 3.27).

Publication of the *Scientific Observers Manual*

3.17 Advance copies of the revised *Scientific Observers Manual* were circulated to Members in December 1996 so that the manual could be used during the 1996/97 season. The *Scientific Observers Manual* was later published in the four languages and circulated to technical coordinators of the national observer programs. The manual was published in a loose-leaf format to facilitate updates and amendments.

3.18 The Scientific Committee noted that a number of difficulties experienced by observers in fulfilling or reporting their tasks (Annex 5, paragraph 3.31) could easily be resolved, and recommended that the Secretariat issue the appropriate changes and corrections to the *Scientific Observers Manual* via the technical coordinators.

3.19 The Scientific Committee recommended that other matters raised by observers (Annex 5, paragraphs 3.33 and 3.35) should be considered by the observer task group (paragraph 3.6). In addition, future feedback and suggestions from observers should be regularly reviewed with a view to improving the scheme's efficiency.

Advice to the Commission

3.20 The Scientific Committee noted that the current schedule for submitting fine-scale catch, effort and biological data may result in expensive data transmissions or delays in cases where vessels undertook prolonged fishing trips (Annex 5, paragraph 3.10). WG-FSA had discussed the requirements for vessels carrying observers to report fine-scale biological data, and the possibility that observers collect these data as part of their own observations and submissions. WG-FSA agreed that vessels carrying observers need not collect or submit fine-scale biological data provided that the responsibility for data collection and reporting these data is clearly specified in the bilateral observer agreements.

3.21 The Commission should therefore consider to what extent Flag State responsibility for submission of data required by CCAMLR would allow for observers to submit such data directly to the Secretariat.

DEPENDENT SPECIES

Species Monitored by CEMP

Report of WG-EMM

4.1 Dr Everson introduced those sections of the WG-EMM report dealing with dependent species and with species studied under CEMP.

4.2 Papers concerning population sizes and the demography of dependent species are summarised in Annex 4, paragraphs 4.1 to 4.5.

Methods for Monitoring the Performance of Dependent Species

4.3 The Subgroup on Monitoring Methods in 1996 (SC-CAMLR-XV, Annex 4, Appendix I) proposed several new methods and suggested areas where changes were required. These revisions were incorporated into the *CEMP Standard Methods*.

4.4 The Scientific Committee noted that WG-EMM made a number of recommendations for action related to methods for which comments had been received in tabled papers or in the report of the Subgroup on Statistics.

(i) Method A5 – duration of foraging trips. The Scientific Committee endorsed the WG-EMM recommendation that the Data Manager should review the existing data, and revise the standard method appropriately, in consultation with the originators of the data. Once this has been done, sample size appropriateness should be reviewed (Annex 4, paragraph 8.52).

(ii) Method A8 – chick diet. WG-EMM discussed potential biases in diet studies, whereby the fish component may be underestimated. WG-EMM recommended that a paragraph on this topic could be incorporated the next time standard methods are reviewed (Annex 4, paragraph 8.54).

The Scientific Committee referred this item to the Subgroup on Monitoring Methods.

(iii) Method B5 – Antarctic petrel population size and breeding success. Norway has submitted the data collected from Svarthamaren to the Secretariat (Annex 4, paragraph 8.59). It was noted that similar data for this species are held by Dutch and US scientists working with Australia.

The Scientific Committee endorsed the WG-EMM recommendation that the Data Manager should contact these scientists to determine whether some of their data would meet the criteria for submission to CEMP.

(iv) Method C1 – Antarctic fur seal foraging trip duration (Annex 4, paragraph 8.60). WG-EMM discussed bias which might be introduced by excluding from analysis data for which less than six trips had been completed and agreed that the simulation of different sampling regimes could provide a guide to the most appropriate method for measuring foraging trip duration.

The Scientific Committee recommended that WG-EMM take this item forward to next year.

(v) Method C2 – Antarctic fur seal pup growth. Possible modifications to take account of the pups which die were discussed (Annex 4, paragraph 8.62).

The Scientific Committee recommended that WG-EMM take this item forward to next year.

(vi) the Scientific Committee noted the recent serological evidence for the presence of infectious bursal virus in Antarctic penguins (Annex 4, paragraph 8.63).

It was noted that undetected outbreaks of such diseases might have implications for interpreting CEMP data.

New CEMP Methods

4.5 A draft new method A3B – breeding population size from aerial photography – was discussed (Annex 4, paragraph 8.64). It was recommended that a revised draft method be submitted to WG-EMM next year.

4.6 Preliminary draft methods for estimating survival and pregnancy rates in Antarctic fur seals were considered (Annex 4, paragraphs 8.65 and 8.66). With regard to estimating survival rate, WG-EMM was not in favour of methods based on age structures but recommended that a mark-recapture method be developed (Annex 4, paragraph 8.66 to 8.85).

4.7 A draft method – C4 Antarctic fur seal diet – was discussed and suggestions for revisions made (Annex 4, paragraph 8.67). The Scientific Committee recommended that WG-EMM take this forward next year.

4.8 The Subgroup on Statistics made recommendations concerning the development of methods for measuring at-sea behaviour (Annex 4, paragraph 8.69). A significant problem with setting up a standard method of analysis is the likelihood that methods will continue to be refined with time and that summary parameters derived from data on at-sea behaviour may become outdated. To avoid this, it was suggested that data should be submitted in both a raw and analysed format. The Scientific Committee endorsed the recommendation of WG-EMM that the Secretariat and suppliers of the data should develop software to derive monitoring parameters from these data.

4.9 WG-EMM addressed proposed methods on minke whales (Annex 4, paragraph 8.71) by briefly reviewing the elements of a proposal concerning body fat condition and stomach content mass of minke whales. While these indices are appropriate in concept, the spatial and temporal scales over which they integrate information are uncertain and hard to relate to those of land-based predators, and therefore need further study. The Scientific Committee agreed that WG-EMM lacked the expertise to review these methods further and agreed to discuss this issue further under Agenda Item 11 in relation to cooperation with the IWC.

4.10 WG-EMM noted that methods for monitoring crabeater seals had been proposed by APIS and agreed that these, with small modifications, could form the basis for a CEMP standard method (Annex 4, paragraph 8.72).

4.11 WG-EMM requested that the SCAR Group of Specialists on Seals provide CCAMLR with a copy of the report of the 1996 APIS Workshop on Survey Design as soon as possible. The completion of the development of survey methods should be possible after the planned APIS survey in the summer of 1999.

4.12 WG-EMM recommended that a proposed method using data on the diet and reproductive performance of Antarctic blue-eyed shags (*Phalacrocorax bransfieldensis*) to provide information on the relative abundance of coastal fish populations be drafted for consideration at the next WG-EMM meeting. Dr E. Barrera-Oro (Argentina) informed the Scientific Committee that Argentina would present a paper on this draft method at the next meeting of WG-EMM.

4.13 WG-EMM noted that the results from the Antarctic Site Inventory Project (ASIP) might be of interest to CCAMLR and agreed that ASIP should be requested to provide WG-EMM with a list of its sites and, in due course, submit a paper to CCAMLR when about five years of consecutive data are available from most sites.

4.14 WG-EMM agreed that there should be standardisation of tagging procedures for Antarctic fur seals and recommended that a standard method for tagging fur seals should be prepared (Annex 4, paragraphs 8.82 to 8.85).

4.15 WG-EMM agreed on a system of site-specific colour coding of tags (Annex 4, paragraph 8.87).

4.16 WG-EMM agreed that information on tagging would be submitted to the SCAR Antarctic Seal Tagging Database which is located at the National Marine Mammal Laboratory, Seattle, USA.

Consideration of CEMP Sites

Management Plans

4.17 In accordance with Conservation Measure 18/XIII, which requires a review of CEMP management plans every five years in order to determine whether changes are required and whether continued protection is necessary, the Seal Island CEMP site (Conservation Measure 62/XI) was discussed by WG-EMM (Annex 4, paragraphs 8.39 to 8.42).

4.18 Based on a recommendation by WG-EMM, the USA submitted a revised Seal Island CEMP site management plan (SC-CAMLR-XVI/BG/27).

4.19 Dr Holt reported that the revised management plan took into account the reduced level of scientific research at the site during the phase out of US research there, which was necessitated by safety concerns.

4.20 The Scientific Committee endorsed WG-EMM's recommendation that the revised Seal Island CEMP site management plan be approved and site protection be extended for five years.

New CEMP Sites

4.21 Dr Everson summarised the discussion of the ad hoc Subgroup on the Protection of Sites regarding Norway's request to the Commission for the designation of a CEMP site at Bouvet Island (Annex 4, paragraphs 8.42 and 8.43). The Scientific Committee agreed with positive comments on the extension of the CEMP research program to Subarea 48.6, due in particular to the increased interest in fishing in the area (SC-CAMLR-XVI/BG/4).

4.22 The Scientific Committee endorsed WG-EMM's recommendation that Bouvet Island be accepted as a CEMP site.

4.23 It was noted that site protection has been provided through national legislation in Norway, therefore site protection under Conservation Measure 18/XIII may not be required.

4.24 Dr T. Øritsland (Norway) noted that logistical considerations may prevent scientists from conducting the CEMP research program at Bouvet Island site as frequently as desirable. Additionally, Dr Øritsland confirmed the four-mile territorial limit around Bouvet Island.

Review of Existing CEMP Sites

4.25 WG-EMM reviewed the status of work at existing CEMP sites to assess whether research programs at several sites were short-term efforts or long-term commitments (Annex 4, paragraphs 8.44 and 8.45).

4.26 As far as WG-EMM could determine, sites where data on dependent species are being collected annually according to CEMP standard methods are as follows:

Subarea 48.1:	Anvers Is, Esperanza Station, Cape Shirreff, Stranger Point, Admiralty Bay and Seal Island
Subarea 48.2:	Signy Island and Laurie Island
Subarea 48.3:	Bird Island
Subarea 48.6:	Bouvet Island and Svarthamaren
Division 58.4.2	Béchervaise Island and Syowa Station
Subarea 58.7:	Marion Island
Subarea 88.1:	Edmonson Point and Ross Island

Data Requirements

Existing Standard Methods

4.27 WG-EMM had not identified a need for any revision of the *CEMP Standard Methods* at this stage. When the *CEMP Standard Methods* is next revised, topics requiring further consideration should include those listed in Annex 4, paragraphs 8.48 to 8.75.

4.28 The Scientific Committee noted that, as requested by WG-EMM (Annex 4, paragraph 10.16), the revised edition of the *CEMP Standard Methods* had now been circulated, incorporating revised versions of Tables 1 to 4.

4.29 WG-EMM recommended that Members holding appropriate datasets evaluate sampling regimes and sample sizes for standard methods as described in Annex 4, paragraphs 8.49, 8.52 to 8.53 and 8.60 to 8.62.

Potential Standard Methods

4.30 Revisions of the proposed new standard methods for penguin breeding population size (A3B), Antarctic fur seal adult female survival rate and pregnancy rate (C3), and Antarctic fur seal diet (C4) should be submitted to next year's meeting (Annex 4, paragraphs 8.64 to 8.67).

4.31 A draft standard method on tagging of Antarctic fur seals should be prepared (Annex 4, paragraph 8.85) and submitted to next year's meeting.

4.32 Members conducting research on fur seals should note the colour combinations for tags prescribed for the sites at Cape Shirreff, Bouvet Island, Bird Island, South Georgia and elsewhere (Annex 4, paragraph 8.87). Members tagging fur seals should ensure that data are submitted to the SCAR Antarctic Seals Tagging Database (Annex 4, paragraph 8.88).

4.33 The suggestion that data on at-sea behaviour collected according to the standard method set out in Section 4 of Observation Protocols and Techniques should be submitted in both raw and analysed data format (Annex 4, paragraphs 8.69 and 8.70) requires the development of instructions which should be submitted to WG-EMM as soon as possible, taking account of the methodological investigations recommended by the Subgroup on Statistics (Annex 4, Appendix D, paragraph 7.13).

4.34 The Secretariat should request from the SCAR Group of Specialists on Seals the report of the APIS Workshop on Survey Design (Annex 4, paragraph 8.74), together with relevant details from Australian shipboard and helicopter surveys and UK pilot studies with fixed-wing aircraft in order to develop a standard method for monitoring crabeater seal abundance.

Advice to the Commission

4.35 The Scientific Committee recommended that the Commission:

(i) approve the revised management plan for the Seal Island CEMP site and extend site protection for five years; and

(ii) approve Bouvet Island as a CEMP monitoring site.

Assessment of Incidental Mortality

Incidental Mortality in Longline Fisheries

4.36 The Scientific Committee reviewed the report of WG-FSA, which incorporated work undertaken both intersessionally and at the meeting of the ad hoc WG-IMALF. It endorsed the report, commenting specifically only on those items where recommendations or advice had been directed to the Scientific Committee (Annex 5, paragraph 7.148).

4.37 The Scientific Committee encouraged more members of WG-IMALF to attend at the start of the WG-FSA meeting in order to assist with data analysis and discussion from the outset (Annex 5, paragraph 7.1). It noted the addition of three new members to WG-IMALF and the request to Members to review their nominees to the group (Annex 5, paragraph 7.2).

Intersessional Work

4.38 The Scientific Committee recommended:

(i) that the Secretariat should revise certain details of the *Scientific Observers Manual* and the associated logbook for scientific observers (Annex 5, paragraphs 7.6, 7.9 and 7.40); and

(ii) that the Secretariat should send copies of the newly published CCAMLR booklet *Fish the Sea Not the Sky* to companies believed to be engaged in longline fishing in the Convention Area and adjacent regions, with the request that additional copies of the booklet be obtained from CCAMLR and placed on board all their vessels (Annex 5, paragraph 7.11).

4.39 Noting the constructive dialogue with and useful data provided by CCSBT-ERSWG (Annex 5, paragraphs 7.13, 7.103 to 7.106), the Scientific Committee recommended:

(i) that reciprocal observership be arranged for the 1998 meetings of CCSBT-ERSWG and CCAMLR WG-FSA; and

(ii) that CCAMLR supply CCSBT with data on longline fishing effort for *Dissostichus* in the Convention Area (Annex 5, paragraphs 7.14 and 7.15).

4.40 The Scientific Committee asked the Secretariat to request from France reports on monitoring programs for seabirds particularly those which existence is at risk from longline fishing (Annex 5, paragraph 7.18), further information from New Zealand (Annex 5, paragraph 7.20) and regular updates on the progress of relevant studies from all Members (Annex 5, paragraph 7.24).

4.41 The Scientific Committee noted that:

(i) based on a recent review using the new IUCN criteria, five species of albatross breeding in the Convention Area are now classified as globally threatened (and one as near-threatened) (Annex 5, paragraphs 7.26 and 7.27); and

(ii) thirteen species of albatross (six of which breed in the Convention Area) were added to Appendices 1 and 2 of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 1997 (Annex 5, paragraph 7.29).

4.42 Accordingly, the Scientific Committee recommended that:

(i) Members individually, and where possible, collaboratively, take note of potential new opportunities and responsibilities in respect of their obligations to protect officially designated globally threatened taxa and those on the appendices to the CMS (Annex 5, paragraphs 7.28 and 7.30); and

(ii) the Secretariat inform the secretariats of the CMS and of the Convention on Biodiversity (CBD) of CCAMLR's work in relation to albatross conservation (Annex 5, paragraphs 7.31 and 7.32).

Incidental Mortality of Seabirds during Longline Fishing in the Convention Area

4.43 The Scientific Committee noted that it had been impossible to improve the analysis and conclusions from the 1996 data during the intersessional period because few additional relevant data had been submitted (Annex 5, paragraphs 7.33 to 7.36); the minimum total estimated seabird mortality associated with longline fishing in the Convention Area in 1995/96 was therefore still about 1 600 birds (all in Subarea 48.3).

4.44 The Scientific Committee noted substantial improvements in the quality and quantity of data submitted in 1997 and in the quality of the reports of scientific observers (Annex 5, paragraphs 7.38 and 7.40). There were, however, still some problems with the late submission of data and reports (Annex 5, paragraph 7.39).

4.45 It was recognised, however, that with the fishing season for *Dissostichus* extending into late August and some scientific observers spending most of the period from March to August at sea, it was often difficult to get reports to CCAMLR in advance of the start of the WG-FSA meeting.

4.46 While it was agreed that priority attention should in future be given to data from within the July–June split-year (other data being processed and analysed as time permitted), it was noted that:

(i) monthly reporting of incidental mortality is required under Conservation Measure 117/XV; and

(ii) the prompt transmission to the Secretariat of C2 forms would enable substantial work to be done before the WG-FSA meeting and in advance of receiving reports from scientific observers.

4.47 In reviewing data for 1997, the Scientific Committee noted that no data are available from the unregulated vessels longlining in the Convention Area. Such unregulated fishing will add substantially to incidental seabird mortality (see paragraph 4.54).

4.48 In reviewing the results of the analysis by WG-FSA of the 1997 data on seabird incidental mortality in Subarea 48.3 (Annex 5, paragraphs 7.45 to 7.58), the Scientific Committee noted that:

(i) in respect of Conservation Measure 29/XV there was:

   (a) much improvement (compared with 1996) in night-time settings (Annex 5, paragraph 7.51);

   (b) poor compliance with the requirement to use streamer lines (Annex 5, paragraph 7.52);

   (c) poor compliance with the requirement to discharge offal on the opposite side to the haul (Annex 5, paragraph 7.53);

(ii) rates of seabird by-catch for most cruises/vessels were broadly similar to last year, but a few cruises gave higher values, resulting in a minimum (see Annex 5, paragraphs 7.80 and 7.81) estimated total mortality of 5 755 seabirds this year, considerably higher than last year (1 618 seabirds);

(iii) much of this seabird mortality reflects a lack of compliance with Conservation Measure 29/XV; some elements, however, were less easy to explain; and

(iv) the species involved are principally black-browed albatross (40%; mainly caught during the day and twilight) and white-chinned petrel (48%; caught both during the day and at night – the latter when the use of streamer lines was minimal throughout the fishery).

4.49 The Scientific Committee noted that the single set of data available for Division 58.5.1 (from two Ukrainian vessels) (Annex 5, paragraphs 7.62 to 7.64) indicated that the seabird by-catch rate was substantially reduced once night-time setting was implemented.

4.50 In relation to Subarea 58.6 (outside the waters adjacent to the Crozet Islands) and Subarea 58.7 (Annex 5, paragraphs 7.65 to 7.79), the Scientific Committee noted that:

(i) in respect of Conservation Measure 29/XV there was:

   (a) poor compliance with the requirement to set at night, with 55% of sets in daytime (Annex 5, paragraphs 7.67 and 7.73);

   (b) poor compliance with the requirement to use streamer lines (Annex 5, paragraphs 7.71 and 7.74);

   (c) evidence that about half the vessels discharged offal on the same side as the haul (Annex 5, paragraph 7.75);

(ii) rates of seabird by-catch averaged 0.289 birds per thousand hooks, probably largely reflecting a lack of compliance with Conservation Measure 29/XV, resulting in a minimum (see Annex 5, paragraphs 7.80 and 7.81) total estimated seabird mortality of 879 seabirds;

(iii) catch rates:

(a) at night, were an order of magnitude less than during the day (0.012 and 0.138 birds per thousand hooks respectively);

(b) were 40-fold greater in October to April than in May to June (0.363 and 0.009 birds per thousand hooks respectively);

(c) of species other than white-chinned petrel, within 100 km of the Prince Edward Islands were six-times greater than between 100 and 200 km from these islands; and

(iv) species mainly affected were white-chinned petrels (73%) and grey-headed/ yellow-nosed albatrosses (23%) – the two albatrosses both threatened species.

4.51 The Scientific Committee noted various requirements for intersessional work, especially for the Scientific Observer Data Analyst to complete entry and analysis of some data (particularly for Subareas 58.6 and 58.7) and to resolve any discrepancies in the data with those who submitted or collected it (Annex 5, paragraphs 7.42, 7.44, 7.56 and 7.60).

4.52 In reviewing the results of the analysis of the 1997 data on incidental mortality of seabirds in the Convention Area, the Scientific Committee expressed serious concern at the poor level of compliance with Conservation Measure 29/XV. It drew the attention of the Commission to a number of suggestions that were made as to how better compliance with this conservation measure might be achieved:

(i) improved education of fishing companies, vessel captains, fishing masters and crew (see Annex 5, paragraph 7.133). It was noted that the circulation of *Fish the Sea Not the Sky* was intended to assist in this (paragraph 4.38(ii)). Prof. C. Moreno (Chile) noted that in 1996, when a special course was held in Chile for captains of longline fishing vessels, compliance with the Conservation Measure 29/XV had been good and seabird mortality much reduced compared with 1997, when it had not been possible to hold the course.

There was general support for encouraging Members of the Commission to seek international support for improving their training of captains, fishing masters and observers in respect of the use of measures to reduce by-catch of seabirds in longline fisheries;

(ii) preferential access to the fishery of vessels which have a good record of compliance with relevant CCAMLR conservation measures;

(iii) access to the fishery only of vessels which are able to comply fully with CCAMLR conservation measures (e.g. constructed so as to allow offal to be discharged on the opposite side to the haul).

It had apparently been claimed that there were technical and/or financial constraints which precluded some vessels complying with this element of Conservation Measure

29/XV. It was agreed that Members should request more explicit information on this topic from fishing companies. In the meantime, the Scientific Committee took the view that failure to make provision for offal discharge in order to comply with Conservation Measure 29/XV should preclude such vessels from fishing in the Convention Area; and

(iv) in-port inspection prior to the departure of vessels for fishing grounds to ensure that they fully understand all relevant CCAMLR conservation measures, that they possess tori poles and streamer lines of CCAMLR specification and that they can comply in full with offal discharge requirements.

4.53 It was noted, however, that in-port inspections prior to the departure of vessels could be difficult to achieve for Members with fleets operating in distant waters which rarely returned to their home ports.

4.54 The Scientific Committee noted that, even at a conservative estimate of 16 500 to 26 800 seabirds, the level of seabird by-catch in the unregulated fishery for *D. eleginoides* in Subareas 58.6/58.7 (and probably also in Divisions 58.5.1 and 58.5.2) in 1996/97 was at least 20 times greater than that for the regulated fishery (Annex 5, paragraphs 7.85 to 7.94). Its impact on white-chinned petrels and albatrosses is entirely unsustainable (Annex 5, paragraph 7.95) for the populations concerned (including those of at least two globally threatened species) – principally those at breeding sites in the Indian Ocean (Prince Edward Islands, Crozet, Kerguelen, Heard/McDonald Islands) (Annex 5, paragraph 7.95).

4.55 The Scientific Committee recommended that the Commission take the strongest possible action to eliminate unregulated fishing (Annex 5, paragraph 7.96). Those responsible for undertaking unregulated fishing in the Convention Area are simultaneously causing the likely collapse of the populations of several species of albatross and of white-chinned petrels, as well as the potential collapse of the *Dissostichus* stocks.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

4.56 The Scientific Committee noted:

(i) information concerning the nature and extent of longline fishing for various fish species in the Southern Ocean, including areas adjacent to the Convention Area (Annex 5, paragraphs 7.107 to 7.109);

(ii) data on seabird by-catch outside the Convention Area, indicating that for some species in some areas there is substantial mortality of seabird species breeding within the Convention Area (Annex 5, paragraphs 7.99 to 7.117); and

(iii) results of analyses of data on seabird by-catch in longline fishing for southern bluefin tuna in relation to environmental variables and the use of mitigating measures, which are of considerable relevance to CCAMLR (Annex 5, paragraph 7.110 to 7.113).

4.57 In responding to the request to New Zealand for relevant information (Annex 5, paragraph 7.115), Dr Robertson indicated that in the tuna longline fishery within the New Zealand EEZ for the 1996/97 fishing year (ending 30 September 1997), 414 sets (1 016 000 hooks) were observed by scientific observers; 366 birds were observed caught. This fishery involved New Zealand vessels and Japanese-chartered vessels. The observed incidental catch rate was 0.88 birds per set or 0.36 birds per thousand hooks. These were all observations on vessels using tori poles and most of them were setting at night.

4.58 It was hoped that full information from this fishery could be provided next year in a paper to WG-FSA and that the results of the analyses of previous years' data would also be available.

4.59 The Scientific Committee recommended that the Commission should urge those responsible for regulating longline fishing in the areas immediately to the north of the Convention Area adjacent to Subareas 48.3 and 48.6, Division 58.5.1 and Subareas 58.6, 58.7 and 88.1 to adopt the provisions of Conservation Measure 29/XV and to consider restricting the fishing season to periods outside the main breeding season of albatrosses and petrels (Annex 5, paragraph 7.130).

4.60 At the time of adopting the report, Mr K. Katsuyama (Japan) stated that although Japan shares the concern expressed in the preceding paragraph, the Commission should be cautious in addressing issues which do not fall into its competence.

4.61 The Scientific Committee noted the results indicating that the mortality of albatrosses and white-chinned petrels in the period May to August was more than ten times less than that in March and April (Annex 5, paragraphs 7.82 and 7.83). It endorsed the recommendation that, from the perspective of achieving a significant reduction in seabird by-catch, the start of the longline fishing season in the Convention Area should be delayed until after 1 May (Annex 5, paragraph 7.84).

Assessment of Incidental Mortality in Relation to New and Exploratory Fisheries

4.62 The Scientific Committee noted the advice from WG-IMALF concerning action to minimise the risk of seabird by-catch in the areas for which proposals had been made for new or exploratory longline fisheries (Annex 5, paragraphs 7.118 to 7.126). It agreed to review this advice in conjunction with that arising from other evaluations of these fisheries conducted by WG-FSA (Annex 5, paragraphs 4.1 to 4.91) and in the light of comments offered in Annex 5, paragraphs 7.128 and 7.129.

Research into Mitigating Measures and Experience with their Implementation

4.63 The Scientific Committee noted the various comments in relation to techniques known or potentially useful in reducing seabird by-catch, especially relating to the effectiveness of streamer lines (when correctly used), the importance of correctly weighted longlines, some potential advantages of using artificial bait and forthcoming data on sinking rates of different types of bait (Annex 5, paragraphs 7.132 to 7.135).

4.64 The Scientific Committee reviewed the provisions of footnotes 3 and 6 of Conservation Measure 29/XV in the light of the comments in Annex 5, paragraphs 7.135 and 7.141 (see also Annex 5, paragraph 7.147).

4.65 It concluded that:

(i) as the recommendation in footnote 3 (weighting of longline) is based on the only empirical study so far undertaken on such vessels (WG-FSA-95/58), it would be inappropriate to include different, or additional, recommendations without further scientific study. However, it was recommended that this footnote should be incorporated into the main text of the conservation measure; and

(ii) although testing of streamer line design was now accorded a lower priority than correct deployment and operation of the CCAMLR design, it was unnecessary to modify either element 6 or footnote 6 of Conservation Measure 29/XV at present.

4.66 In particular, the Scientific Committee commended New Zealand and Norway for their pioneering research into underwater setting of longlines, encouraged them to undertake further development and testing and requested Members to report on their experiences in using these or similar devices (Annex 5, paragraphs 7.142 to 7.146).

4.67 The Scientific Committee noted that once such techniques were proved to be effective under commercial conditions, vessels using them would be eligible for numerous advantages (e.g. potential exemption from the provisions of Conservation Measure 29/XV, relaxation of fishing season restrictions, preferential access to fisheries, etc.), by virtue of their ability to avoid incidental mortality of albatrosses and petrels.

Other Incidental Mortality in Longline Fisheries

4.68 The report of WG-FSA indicated that three Antarctic fur seals were killed in longline fishing in Subarea 48.3; three others were entangled but freed themselves. Two sperm whales and one minke whale became entangled in longlines in Subarea 58.6/58.7 but broke free (Annex 5, paragraphs 8.1 and 8.2, and Tables 35 and 36).

Incidental Mortality in Trawl Fisheries

4.69 The report of WG-FSA indicated that past observations had provided no evidence of incidental mortality of seabirds or marine mammals associated with trawl fisheries for *D. eleginoides* in Divisions 58.5.2 and 58.4.3 (Annex 5, paragraph 4.73).

4.70 In CCAMLR-XVI/MA/4 France stated that because the trawlers fishing for *D. eleginoides* in Division 58.5.1 in 1996/97 used a cable-less netsonde system there was no incidental mortality of seabirds.

4.71 In CCAMLR-XVI/BG/8 Japan reported that krill fishing vessels caught one Antarctic fur seal and one penguin in Subarea 48.1 and one Antarctic fur seal in Subarea 48.3. One seal and one penguin in Subarea 48.1 died; the other seal was released alive.

Incidental Mortality in Jig Fisheries

4.72 In CCAMLR-XVI/BG/15 the UK reported that, in the course of jig fishing for the squid *M. hyadesi* in Subarea 48.3, four gentoo penguins were caught and released alive.

Marine Debris

4.73 The Scientific Committee confined its discussion of this item to reports of direct interaction between marine debris and living resources. Reports of surveys of marine debris will, as usual, be considered by the Commission.

4.74 SC-CAMLR-XVI/BG/6 reported the results of the survey of entanglement of Antarctic fur seals at Bird Island, South Georgia (Subarea 48.3) for the sixth consecutive winter (1996) and eighth consecutive summer (1996/97). In winter, 17 seals were observed entangled, double the number in 1995 and the third highest total so far. As usual most (88%) entanglements were of juveniles; however one-third were of females, an unusually high proportion. Synthetic fishing line (47%), fishing net (24%) and packaging bands (18%) were the main entangling materials. In summer, 27 seals (mainly juvenile females) were recorded entangled, the third lowest total and a 21% reduction from 1996. The proportion of entanglements in fishing line (41%) was much greater than in recent years, with fishing net (22%) commensurately reduced and packaging bands (33%) similar to last year. The paper noted that whereas the relatively low level of entanglements in summer is encouraging, the increase in winter records is discouraging, with fishing vessels the only likely source of debris at this time. The evidence of continued use and discarding of packaging bands within the Convention Area is of particular concern.

4.75 In CCAMLR-XVI/BG/26 additional records of entanglements from other locations around South Georgia are presented. The 13 observations of entanglement of marine mammals, between November 1996 and January 1997, included one southern elephant seal and 12 Antarctic fur seals. Of the fur seals, five (42%) were female (three adult, two juvenile) and seven (58%) were male (one adult, six juvenile); seven (58%) were entangled with plastic packaging bands, three (25%) in trawl netting and two (17%) in synthetic rope. All entangling material probably originated from fishing vessels.

4.76 The results of a survey of entanglement of Antarctic fur seals at Signy Island, South Orkney Islands (Subarea 48.2) are reported for the 1996/97 season in SC-CAMLR-XVI/BG/7. Neck collars of man-made debris were seen on 12 seals, all of which were juvenile males. Five entangled seals were observed in an area around Signy Island research station where approximately 1.3% of the fur seal population come ashore, giving an incidence of entanglement of 0.33%. Although synthetic line and packaging bands were the main entangling materials at both sites, a greater proportion of fur seals was entangled in these items at Signy Island (50% and 52% respectively) than at Bird Island (22% and 33% respectively) in the same season.

4.77 In response to a question from Dr V. Siegel (European Community) concerning whether entanglement in packaging bands could reflect unregulated fishing activity in the area, Dr Croxall indicated that male fur seals regularly migrate from South Georgia to Signy Island. Therefore, it was likely that a proportion of the entanglements observed at Signy reflect animals which actually became entangled near South Georgia. However, surveys of marine debris at Signy Island indicate the frequent presence of packaging bands, some uncut. While these also might originate from South Georgia , this would be against the prevailing current systems. This might suggest that fishing vessels using packaging bands have been operating in Subarea 48.2.

4.78 Prof. D. Torres (Chile) presented SC-CAMLR-XVI/BG/33 which reviewed the circumstances of entanglement of 20 Antarctic fur seals observed at Cape Shirreff, South Shetland Islands (Subarea 48.1), between 1988 and 1997. The animals involved comprised nine sub-adult males (45%), four juvenile males (20%), five females (35%) and two pups (10%). Of these, 45% were entangled in plastic debris and packaging bands, the rest in fishing net fragments and nylon ropes; the entangling material was removed from 35% of animals (four females, one juvenile male and two pups). The paper considered that these observations probably underestimate the real incidence of entangled seals in the area. The authors propose to coordinate sightings of entangled seals in the South Shetland Islands area, and recommended that fishing vessels and scientific observers be given further education concerning waste disposal regulations in force in the Convention Area.

4.79 In CCAMLR-XVI/MA/3 Norway reported the observation of 39 entangled seals during surveys at Bouvetøya (Subarea 48.6) during the 1996/97 season. Most animals were entangled in portions of fishing net.

4.80 SC-CAMLR-XVI/BG/5 reports the results of the fourth year of standardised recording of man-made debris associated with seabirds at breeding colonies in Bird Island, South Georgia (Subarea 48.3). Ingested and regurgitated plastic items were reported for wandering albatrosses (three items), grey-headed albatrosses (one item) and white-chinned petrels (two items). Fishing gear was reported in association with grey-headed albatrosses (four squid jigs), black-browed albatrosses (three hooks and line, found next to nests), wandering albatrosses (15 hooks and/or line, eight found next to nests, six in squid pellets and one internally lodged in an adult, and adult regurgitates of nylon line thought to originate from trawlers (three items)) and southern giant petrels (one freshly dead with ingested hook and line; two with lodged hooks and line; one hook in a pellet). Levels of fishing gear associated with southern giant petrels increased (only one previous record) and were similar to previous years for black-browed and grey-headed albatrosses but for wandering albatrosses were halved compared to last year. The evidence of continued discarding of plastic material and the loss of longline fishing gear, especially hooks, remains a cause for concern.

4.81 CCAMLR-XVI/BG/24 reported three observations of entangled animals at Palmer Station, Anvers Island (Subarea 48.1). One subadult male Antarctic fur seal died of entanglement in fish netting. Two adult southern giant petrels with longline hooks embedded in their wings were caught, the hooks removed and the birds released. (WG-FSA-95/58 provides further details and some background information.)

4.82 Prof. Torres suggested that all efforts should be made to free seabirds and marine mammals from entangling debris.

4.83 It was noted that several reports of scientific observers on longline fishing vessels recorded numerous observations of albatrosses and petrels flying around with hooks and fishing line ingested or attached to their bodies. They had clearly been cut free, presumably after becoming entangled at the haul (see also Annex 5, paragraphs 7.53, 7.75 and Table 46).

4.84 The Scientific Committee was concerned that the considerable evidence of seabirds and marine mammals entangled in debris had clearly originated from fishing vessels. In particular, it recognised that the continuing occurrence of entanglement in packaging bands indicated inadequate compliance with Conservation Measure 63/XV, which prohibits the use of packaging bands on fishing vessels in the Convention Area.

4.85 Although some of the debris and packaging bands presumably originate from the unregulated fisheries in the Convention Area, there is clear evidence that many vessels in regulated fisheries are still using packaging bands – and some of them were observed to discard these at sea (Annex 5, paragraph 3.38 and Table 7).

4.86 The Scientific Committee drew the attention of the Commission to these failures to comply with Conservation Measure 63/XV, indicating a need for considerable improvement in informing fishing vessels of the provisions of CCAMLR conservation measures and of the regulations for waste disposal in the Convention Area.

4.87 The Scientific Committee drew to the attention of the Commission that appropriate in-port inspection of vessels prior to departure for fishing grounds (see paragraph 4.52(iv)) might assist vessels in complying with this conservation measure. Reminding fishing companies that excellent alternatives to plastic packaging bands exist might also be timely.

4.88 It was noted that the forthcoming CCAMLR brochure on marine debris (CCAMLR-XVI/BG/29) would be an appropriate place to publicise these issues and concerns.

4.89 The Science Officer informed the Scientific Committee that the new marine debris database is now operational (CCAMLR/XVI/BG/30) and encouraged Members to submit data to it.

Marine Mammal and Bird Populations

4.90 The Scientific Committee at its sixth meeting (SC-CAMLR-VI, paragraphs 8.6 and 8.7) agreed to periodically review the status of all marine mammal and bird populations in the Antarctic, with particular attention to identifying those species whose populations have experienced or are currently experiencing a significant change in abundance. The SCAR Group of Specialists on Seals (SCAR-GSS), the SCAR Bird Biology Subcommittee (SCAR-BBS) and the IWC were asked in 1995 again to provide appropriate information (SC-CAMLR-XIV, paragraph 3.70).

4.91 Reports of SCAR-BBS and IWC were discussed by the Scientific Committee in 1996 (SC-CAMLR-XV, paragraphs 3.66, 3.67, 3.70 to 3.76). However, the report from SCAR-GSS was not available in time for discussion at this meeting, nor the meeting of WG-EMM in 1997 (Annex 4, paragraph 6.73). As a consequence, WG-EMM deferred substantial discussion on both reports until its 1998 meeting.

4.92 SCAR-GSS was requested to provide CCAMLR with its report at the earliest opportunity.

4.93 Some relevant information, supplementary to the information included in the SCAR-BBS review, was provided on the populations of penguins at Marion Island (Annex 4, paragraph 4.2), penguins and fur seals at Bouvet Island (Annex 4, paragraph 4.3) and fur seals and chinstrap penguins at Cape Shirreff, was tabled at the meeting of WG-EMM (Annex 4, paragraphs 4.4 and 4.5).

4.94 Some additional information on current status of seabirds and seals monitored through CEMP are provided in Annex 4, paragraphs 7.20, 7.33 and 7.26 to 7.28.

4.95 Members had provided data on the status and distribution of albatross, giant petrel and white-chinned petrel populations in response to requests by WG-IMALF (Annex 5, paragraph 7.120). These data, which were extensively used during WG-FSA, had been available to SCAR-BBS and were included in its 1996 review (SC-CAMLR-XVI/BG/21).

4.96 The next review of the status and trends of Antarctic seals and seabirds should occur in the year 2000 and allowance for this will need to be made in the 1998/99 budget.

Changes in Predator Populations caused by Interspecific Interactions

4.97 The Scientific Committee noted that the rapid increase in fur seal numbers has the potential to make some shore-breeding sites less attractive for penguins. This interaction was described from Livingston Island (WG-EMM-97/62). However at South Georgia, gentoo penguins appeared to co-exist at several sites with fur seals. The declines in macaroni penguins at South Georgia and Marion Island had occurred mainly in areas and/or colonies which were inaccessible to fur seals.

Abundance of Seabirds at Sea

4.98 At its 1996 meeting WG-EMM identified the need for quantitative at-sea surveys of seabirds and marine mammals (SC-CAMLR-XV, Annex 4, paragraph 4.92) and noted that a workshop dealing with standardising quantitative surveys of seabird abundance and distribution at sea had been held. The Scientific Committee endorsed the request of WG-EMM (Annex 4, paragraph 10.25) that the Secretariat obtain a copy of the report of this workshop from SCAR-BBS.

Krill

Distribution and Standing Stock

5.1 The Scientific Committee noted WG-EMM's deliberations on features of the distributional behaviour of krill that affect the interpretation of the results of surveys (Annex 4, paragraphs 3.1 to 3.18). Vertical migration, onshore–offshore patterns of abundance, and seasonal and interannual trends in distribution and abundance were seen to be important factors to be taken into account when conducting surveys.

5.2 The Scientific Committee endorsed WG-EMM's repeated request for the development of indices of local krill availability (Annex 4, paragraph 3.20) and it reiterated the importance that it placed on the development of such indices.

5.3 Dr E. Gubanov (Ukraine) advised the Scientific Committee of a research cruise by Ukraine in March/April 1997. A mesoscale study of the pelagic ecosystem in Subarea 48.2 was undertaken in the area 59–60°S and 42–48°W and a fine-scale study was undertaken in Subarea 48.1 at 60°S and 45–47°W. Acoustic and net sampling was undertaken to observe krill, larval fish and other zooplankton. Data have been submitted to CCAMLR. A further survey will be undertaken in the same areas in from January to March 1998 (SC-CAMLR-XVI/BG/9 Rev. 1).

Krill Recruitment

5.4 The Scientific Committee noted that WG-EMM had made considerable progress in assessing krill recruitment from net sampling surveys, particularly in the South Atlantic (Annex 4, paragraph 3.21 to 3.29). It also agreed that the estimation of the proportional recruitment index R_1 from such surveys be drafted as a standard method.

5.5 The Scientific Committee agreed that in addition to the development of a standard method for the assessment of proportional recruitment, another priority task was the development of a reliable predictor of krill recruitment with known statistical properties that could be used in assessments (Annex 4, paragraph 3.27).

5.6 Further, the Scientific Committee agreed that there was a need to determine whether existing recruitment indices for restricted areas reflect more global trends, and the extent to which large-scale environmental processes and smaller-scale population processes affect these indices (Annex 4, paragraph 3.28).

5.7 The Scientific Committee reiterated its request for further analyses to determine how well the measures of krill abundance and proportional recruitment are matched by the output of the krill yield model (Annex 4, paragraph 3.29; SC-CAMLR-XV, paragraph 4.18).

5.8 WG-EMM's considerable discussions on the krill–salp–sea-ice interactions (Annex 4, paragraphs 8.1 to 8.37) were noted with interest by the Scientific Committee and further analyses of these interactions, possibly through the use of multi-variate statistics, were encouraged.

CPUE

5.9 WG-EMM's continued discussions on the interpretation of CPUE data and their incorporation into management advice (Annex 4, paragraphs 3.30 to 3.40). The Scientific Committee encouraged further attempts to combine CPUE with other operational information from fishing vessels to provide an index of relative abundance for assessment purposes.

Methods

5.10 WG-EMM's deliberations on problems and biases in the net sampling of krill and on the developments in the acoustic determination of krill biomass (Annex 4, paragraphs 8.2 to 8.27) were noted. Recalling the quantity of information on these subjects in earlier working group reports, the Scientific Committee recommended that the Secretariat extract the collected advice on these methodologies from the reports of WG-Krill and WG-EMM and present them as a paper to the 1998 meeting of WG-EMM (Annex 4, paragraph 8.30).

5.11 Developments in the analysis of multifrequency acoustics that allow better target identification and progress in the fields of acoustic calibration and acoustic target strength were also noted with interest (Annex 4, paragraphs 8.6 to 8.27). The Scientific Committee welcomed these developments and encouraged further research in these areas.

5.12 The design of acoustic surveys was discussed in detail by WG-EMM (Annex 4, paragraphs 8.32 to 8.37). The Scientific Committee agreed that randomly-spaced parallel survey lines offer a conservative survey design and that this should be borne in mind when planning the synoptic survey for Area 48 (Annex 4, paragraph 8.129). However, this advice in no way reduces the urgency attached to the simulation study designed to determine the appropriate survey design for the planned synoptic survey (Annex 4, paragraphs 8.124 to 129).

Synoptic Survey in Area 48

5.13 Plans for the synoptic survey in Area 48 were well advanced. The Scientific Committee endorsed WG-EMM's recommendations (Annex 4, paragraph 8.121 to 8.129) that:

(i) the survey should proceed in the austral summer of 1999/2000;

(ii) the survey would concentrate its effort in Subareas 48.1, 48.2 and 48.3;

(iii) task groups and a survey steering committee should be set up to deal with specific aspects of the survey; and

(iv) the Secretariat should compile a list of previous agreements on acoustic survey design standardisation.

5.14 The Scientific Committee agreed that the proposed workshop on Area 48 (Annex 4, paragraphs 8.110 to 8.120) was critical for the design and implementation of the Area 48 B_0 survey (see also paragraphs 6.50 to 6.53).

5.15 The Scientific Committee endorsed WG-EMM's request that standard methods for net and acoustic sampling, data storage and analysis for the survey should be specified and developed (Annex 4, paragraphs 8.31 and 8.122).

5.16 Further, the Scientific Committee agreed that the task groups dealing with specific aspects of the survey should develop the survey work plan in time for the planned Area 48 workshop in mid-1998. The survey steering committee should meet in conjunction with the Area 48 workshop and should then prepare an outline survey plan to be considered at WG-EMM's 1998 meeting (Annex 4, paragraphs 8.126 and 10.14).

5.17 The results of the proposed simulation study to determine the appropriate survey design (particularly stratification and placement of transect lines) had not been presented to the Scientific Committee as had been requested by WG-EMM (Annex 4, paragraphs 8.124 to 8.129). Dr Everson reported that two members of the panel tasked with the simulation study, Drs B. Manly and A. Murray, were intending to meet in the UK in April to discuss results and progress on the simulation study.

5.18 The panel requested that the steering committee for the synoptic survey of Area 48 survey supply them with data and guidance as soon as possible so that their work could proceed. The Scientific Committee endorsed this request and urged the steering committee to contact Members with historic datasets so that the panel could continue its work. The results of this simulation should be forwarded to the various task groups and to WG-EMM as soon as possible.

5.19 The Scientific Committee agreed that every effort should be made in the planning for the survey of Area 48 to collect other relevant ecological, environmental and physical data to facilitate wider interpretation of the results (paragraphs 13.8 and 13.9; Annex 4, paragraph 8.109).

Fish Resources

Background Matters to Assessments

5.20 In 1996/97, research surveys were undertaken in Subareas 48.1 (Germany) and 48.3 (UK and Argentina) and Divisions 58.5.1 (France) and 58.5.2 (Australia) (Annex 5, paragraph 3.41).

5.21 Characteristics of the biology and demography of fish species are presented in Annex 5, paragraphs 3.43 to 3.63. Important points considered in the assessments are presented below.

Review of Biological Reference Points for Decision Criteria

5.22 At last year's meeting, the Scientific Committee endorsed the need for future work by WG-FSA to examine further the biological reference points used currently by CCAMLR (SC-CAMLR-XV, paragraph 4.42; Annex 5, paragraph 3.65). An overview prepared by the Secretariat of reference points and their use in other international fisheries management bodies, mostly NAFO and FAO, indicated that: (i) few examples were available as to the methodologies used to identify critical reference points; and (ii) none were available for helping identify critical biological reference points on the status of populations, as required under Article II (Annex 5, paragraph 3.66). The Scientific Committee noted that the biological reference points used by CCAMLR are as advanced as any currently in use in fisheries management. Nonetheless, the Scientific Committee also recognised that further work needs to be undertaken to examine the properties of these reference points in relation to fish stocks with different life history characteristics.

5.23 The Scientific Committee noted the difficulties in applying the current decision rules to some stocks (Annex 5, paragraphs 3.68 and 3.70) and agreed that WG-FSA continue to examine the implications of the following elements of the decision rules at its next meeting:

(i) the decision rule pertaining to the 10% probability of falling below 20% of the median unexploited stock biomass may not be suitable for species such as *C. gunnari*, which, for example in Division 58.5.2, has a probability of falling below this level of approximately 0.5 without fishing. In this case, a possible change would be to modify the decision rule so that the probability of falling below the 20% reference level is not substantially increased by the effects of fishing (see Annex 5, paragraph 3.68 for details);

(ii) the decision rule concerning escapement of species which are important prey species may need to be modified if the rate of natural mortality explicitly includes predation (e.g. *C. gunnari* in Subarea 48.3) (see Annex 5, paragraphs 3.70 and 4.172 to 4.174);

(iii) decision rules may need to cater for variation in predator–prey interactions between different age classes of fish (such as *D. eleginoides* in Division 58.5.2) as well as spatial and temporal variation in such interactions (see Annex 5, paragraphs 3.71); and

(iv) appropriate biological reference points need to be developed for stocks in which pre-exploitation levels of standing stock may be unable to be estimated (see Annex 5, paragraphs 3.72).

5.24 The Scientific Committee recognised that the current decision rules have biological reference points phrased in terms relative to estimates of the median unexploited spawning stock biomass. However, as the uncertainties in the status of the stocks and the relationships between stock size, recruitment and environmental variability are reduced, the biological reference points concerned with protecting stocks from declining recruitment may be able to be phrased in absolute terms of a minimum absolute biomass.

5.25 The Scientific Committee agreed that further development of the long-term management strategy for *C. gunnari* will help clarify these issues and that the biological reference points should remain under review.

5.26 In addition, the Scientific Committee endorsed the view that target levels of F, including $F_{0.1}$, are inappropriate as biological reference points for implementing Article II (see also paragraph 5.62).

Developments in Assessment Methods

5.27 The Scientific Committee noted the improvements in the implementation of the generalised yield model (GYM) since last meeting, including the addition of: (i) a parametric bootstrap procedure to enable the use of a table of estimates of recruitments rather than the use of a lognormal recruitment function; and (ii) functions to enable interannual variability in M (Annex 5, paragraphs 3.78 and 3.79).

5.28 The Scientific Committee endorsed the view that validation of the GYM should be given a high priority by the Secretariat in the intersessional period and that an improved user interface be developed by the authors of the model for use at the next meeting of WG-FSA (Annex 4, paragraph 7.3; Annex 5, paragraphs 3.78 to 3.80).

Consideration of Management Areas and Stock Boundaries

5.29 A change, proposed by South Africa, to the boundary between Subareas 58.6 and 58.7 (see Annex 5, Figure 2), to separate the fishing grounds around the Prince Edward Islands from those around Crozet Island was considered by WG-FSA (Annex 5, paragraphs 3.81 to 3.83). The Scientific Committee recognised that the original statistical boundaries were derived by FAO from the review by Everson (1977) based on the best available knowledge on the likely distribution of stocks in the Antarctic, although this was incomplete for some areas.

5.30 The Scientific Committee reiterated that management units should have a biological justification and agreed that management advice should be based on stocks rather than statistical areas. To this end, management advice may need to be identified for individual stocks based on small-scale areas, such as is necessary for two stocks of *C. gunnari* in the Heard Island area (Annex 5, paragraphs 3.44 and 3.82).

Management Advice

5.31 The Scientific Committee recommended the proposed change of the boundary between Subareas 58.6 and 58.7 be considered by the Commission because the proposed boundary is likely to coincide with a natural boundary between stocks in the shelf area of Prince Edward Islands and stocks in the shelf area around Crozet Island.

5.32 The Scientific Committee noted that if this recommendation is adopted then adjustments, although likely to be minor, will need to be made to the existing database and reports for statistical subareas. This change will have an impact on the allocation of precautionary yield between the affected areas (see Table 5).

Assessments and Management Advice

Antarctic Peninsula (Subarea 48.1)

Notothenia rossii, Gobionotothen gibberifrons, Chaenocephalus aceratus, Chionodraco rastrospinosus, Lepidonotothen squamifrons and Champsocephalus gunnari (Subarea 48.1)

5.33 A summary of background information for the assessment is available in Annex 5, paragraphs 4.135 to 4.138. A survey carried out by Germany in the vicinity of Elephant Island, one of the most important fishing grounds, showed a lower stock biomass than the previous survey in 1987, prior to the closure of the fishery in this area in 1989. The causes for this decline are unclear but are discussed in Annex 5, paragraph 4.137.

5.34 No assessment was undertaken because of the low abundance of these species.

Management Advice

5.35 The Scientific Committee noted that, given the low biomass estimates for the 1996/97 season and some of the uncertainties associated with decline in biomass compared to 1987, there appears to be little prospect for a substantial trawl fishery for these species. The Scientific Committee therefore recommended that Conservation Measure 72/XII should remain in force for trawl fisheries for the species considered in this section until future surveys indicate an increase in fish biomass in the subarea.

5.36 The Scientific Committee recognised that Conservation Measure 72/XII applies to all fisheries in this subarea. If the Commission approves proposals for new longline fisheries in this subarea (Annex 5, paragraphs 4.120 to 4.134) then Conservation Measure 72/XII will need to be modified to exempt the approved new fisheries.

South Orkney Islands (Subarea 48.2) – Management Advice

5.37 In the absence of new information on stocks in this subarea, the Scientific Committee recommended that trawl fisheries in Subarea 48.2 should remain closed in accordance with Conservation Measure 73/XII.

5.38 The Scientific Committee recognised that Conservation Measure 73/XII applies to all finfish fisheries in this subarea. If the Commission approves proposals for new longline fisheries in this subarea (Annex 5, paragraphs 4.120 to 4.134) then Conservation Measure 73/XII will need to be modified to exempt the approved new fisheries (paragraphs 9.31 to 9.38).

South Georgia (Subarea 48.3)

Dissostichus eleginoides (Subarea 48.3)

Standardisation of CPUE Indices

5.39 The Scientific Committee noted the re-analysis by WG-FSA of the CPUE data from the *D. eleginoides* fishery in Subarea 48.3 using generalised linear models (GLMs) (Annex 5, paragraphs 4.143 to 4.155). The re-analysis was required because of an error in last year's calculations arising from incomplete information available on how to use a feature of the software package. As such, the results in Table 17 and Figures 5 and 6 of last year's report (SC-CAMLR-XV, Annex 5) are incorrect and should be disregarded.

5.40 The re-analysis of annual trends in CPUE have been updated to include revised information from previous fishing seasons, as well as new information from the 1996/97 fishing season. Also, the time series effects of fishing season on kilogram per hook and numbers per hook were adjusted for the presence of hauls with zero catches (Annex 5, paragraphs 4.150 and 4.151). The Scientific Committee endorsed the request for zero catches to be recorded on form C2 and reported to CCAMLR.

5.41 The Scientific Committee endorsed the view that unstandardised catch rates are not reliable indicators of trends in CPUE.

5.42 The Scientific Committee noted that the adjusted, standardised catch rates increased between the 1992 and 1993 fishing seasons, but declined after 1993. The decline was faster for kilogram/hook than it was for numbers/hook, indicating that the average size of fish in the catch has decreased over time. The Scientific Committee noted the trends with concern. The rapid decline in CPUE between 1993 and 1995 coincided with the period of substantial unreported catches. Since that time the level of unreported catches is believed to be low. The decline of both CPUE indices slowed between the 1995 and 1997 fishing seasons.

5.43 The Scientific Committee also noted that the results of the analysis of monthly trends in CPUE suggest that delaying the start of the *D. eleginoides* fishing season until 1 May of each year would not have a negative impact of catch rates (Annex 5, paragraph 4.155).

Assessment of Yield

5.44 The Working Group had not intended to undertake a reassessment of precautionary yield of *D. eleginoides* in Subarea 48.3 at this meeting. However, due to the discovery of an error in the procedure for estimating cohort densities from survey data using the swept-area method applied at meetings in 1995 and 1996, a revised analysis was undertaken. The revisions are detailed in Annex 5, paragraph 4.160.

5.45 Prof. J. Beddington (UK) noted that the estimates of recruitment in Table 18 of Annex 5 suggest that there may be a trend of increasing recruitment over the period covered by the surveys. Caution had been expressed by WG-FSA in 1996 that such trends could introduce bias into the log-normal recruitment function and, consequently, that care should be taken to examine the data for such trends (SC-CAMLR-XV, Annex 5, paragraph 4.73).

5.46 The Scientific Committee recommended that possible trends in estimates of recruitment be reviewed, as a matter of priority, at next year's meeting of WG-FSA, to determine whether these trends may be biological in origin or a function of the types of surveys and variability in results. The Scientific Committee requested the submission of any additional research survey data that would help in assessing the characteristics of recruitment in this area.

5.47 WG-FSA reviewed new information on maturity ogives for male and female *D. eleginoides* which confirmed earlier observations that males and females have different sizes at sexual maturity (Annex 5, paragraphs 4.156 to 4.159). These new results indicate that a high proportion of females in catches of *D. eleginoides* may be immature, which suggests this species may be vulnerable to recruitment overfishing. However, the Scientific Committee noted that the estimates of recruitment in Table 18 of Annex 5 provided no evidence for recruitment overfishing, although the most recent cohort in the analysis was from 1993.

5.48 The Scientific Committee endorsed the recommendation of the Working Group that more emphasis should be given to age and growth studies of this species and that a high priority be given to undertaking assessments using a two-sex model. Thus, modifications to the GYM for this task should be undertaken as a matter of urgency. Also, the Scientific Committee endorsed the recommendation that Members inform the Secretariat of the location and availability of scales and otoliths collected by scientific observers to facilitate analysis of this material.

5.49 After the close of WG-FSA, some small errors were detected in the analyses of precautionary yields. Corrected tables were presented to the Scientific Committee and these were inserted into the report of WG-FSA.

5.50 An assessment of the precautionary yield estimated using the GYM was undertaken by WG-FSA, incorporating the revised estimates of the parameters for recruitment as well as a revised maturity ogive and the catch for split-year 1996/97 (see Annex 5, paragraphs 4.161 to 4.162). The decision rule concerning the probability of depletion was binding (Annex 5, paragraph 4.161). The yield at which there is a probability of 0.1 of the spawning biomass falling below 20% of the median pre-exploitation spawning biomass level over 35 years was 3 540 tonnes. The median escapement for this catch level was 0.51.

Trends in Stock Status

5.51 The Working Group presented trends in median biomasses from the GYM, which predicts that the current median spawning biomass is 62% of the pre-exploitation median level and the fishable biomass potentially at 60% of the pre-exploitation median level. The Scientific Committee noted that this stock is therefore above, but approaching, one of the reference points used in

CCAMLR decision rules which holds that the median spawning stock should not be allowed to fall below 50% of its unexploited median level (Annex 5, paragraphs 4.162 and 4.165).

5.52 The Scientific Committee noted the concern of WG-FSA that standardised CPUEs have fallen more rapidly than the median fishable biomasses predicted by the GYM (see Annex 5, paragraphs 4.164 to 4.167 for discussion). The Scientific Committee considered that this discrepancy could be the result of greater total removals than currently estimated, although it was acknowledged that there were difficulties in comparing these two kinds of data. The Scientific Committee endorsed the need to examine this further at future meetings, with a modification to the GYM that enables the use of estimates of recruitment and catches specified for particular years. Nonetheless, the Scientific Committee considered that it would still be appropriate (and more risk averse) to view the trend of declining CPUE as an indication that stock size had declined rapidly over the period 1993 to 1995.

Management Advice

5.53 The revised estimate of precautionary yield from the GYM was 3 540 tonnes.

5.54 The Scientific Committee recommended that the catch limit for 1997/98 should be less than the 3 540 tonnes in order to maintain a degree of caution appropriate to the uncertainty indicated by the results of the CPUE analysis.

5.55 The Scientific Committee had difficulty, however, in advising on how much lower the catch limit should be in the forthcoming season. This was because there are no elements in the decision rules to reconcile conflicting indicators such as in this case, where the GYM suggests the stock is approaching a decision rule reference point, while the CPUE trend suggests it may already have exceeded it. A high priority task is to develop advice to deal with such situations.

5.56 Nevertheless, the Scientific Committee agreed that the following points can be taken into consideration in setting a catch limit for the 1997/98 season:

(i) recruitment overfishing is unlikely to be a problem at this time; and
(ii) a modest reduction of the catch limit below the estimate of precautionary yield would be appropriate.

5.57 The Scientific Committee noted that delaying the start of the *D. eleginoides* fishing season from 1 March until 1 May in line with the recommendation arising from the analysis of incidental mortality of seabirds in longline fisheries in this subarea (Annex 5, paragraph 4.155) was unlikely to have a negative impact on catch rates. The Scientific Committee also noted that problems associated with reducing the overall length of the fishing season could be mitigated by extending the end of the season to the end of September.

Champsocephalus gunnari (Subarea 48.3)

Development of a Long-term Management Strategy

5.58 The Scientific Committee welcomed progress on the consideration of long-term management strategies for *C. gunnari* arising from work in Subarea 48.3 and Division 58.5.2 (see Annex 5, paragraphs 4.171 to 4.178).

5.59 The Scientific Committee endorsed the view of WG-FSA that the following components should be evaluated for their inclusion in an integrated long-term management procedure:

(i) appropriate biological reference points for *C. gunnari* in Subarea 48.3 and Division 58.5.2 (see Annex 5, paragraphs 3.65 to 3.73);

(ii) the level of catch appropriate as a long-term precautionary yield when no recent surveys are available;

(iii) methods for adjusting catch levels based on recent survey results to take advantage of strong year classes recruiting to the fishery;

(iv) use of CEMP data and other knowledge of predator/prey interactions to predict adjustments in natural mortality, recruitment and growth parameters for use in assessments; and

(v) methods for achieving target levels of fishing mortality.

5.60 The Scientific Committee endorsed the future work proposed by the Working Group for the development of the assessment and management strategy for *C. gunnari* in Subarea 48.3, in particular:

(i) to analyse all available survey data to investigate the possible magnitude and frequency of periodic increases in M at South Georgia;

(ii) to examine the potential for deriving recruitment estimates directly from trawl survey results, rather than using the VPA results; and

(iii) to examine the sensitivity of assessments of yield to variations in growth parameters.

5.61 The Scientific Committee agreed that there is an urgent need to develop further the progress made at this year's meeting on long-term management strategies for *C. gunnari* fisheries and endorsed the holding of a three-and-a-half day workshop in association with the next meeting of WG-FSA. The Scientific Committee recommended that the workshop should go ahead, pending the submission of data and appropriate papers by 1 August 1998. The decision to hold the workshop will be taken by the Convener of WG-FSA, in consultation with the Chairman of the Scientific Committee and the Data Manager.

5.62 The Scientific Committee approved the following terms of reference for the workshop:

(i) to review the fisheries on *C. gunnari* in various subareas and divisions, including trends in catches and changes in stock composition in terms of length and age;

(ii) to review information on the biology and demography of the species, including age, growth, and reproduction and diet;

(iii) to review information on stock identity, structure and movements, including distribution, movements, segregation by age and stock separation;

(iv) to review estimates of absolute and relative abundance and year class strength (Annex 5, paragraph. 4.209);

(v) to review the historical assessment methods, including short- and long-term methods and highlight their shortcomings;

(vi) to evaluate interactions of *C. gunnari* with other components of the ecosystem, including krill and fur seals, to investigate past fluctuations in natural mortality and explore the potential to predict changes in M (Annex 5, paragraph. 4.178); and

(vii) to develop long-term management strategies for the fisheries on *C. gunnari*. These might include:

(a) taking account of any new development since the last meeting of WG-FSA;
(b) the evaluation of appropriate biological reference points;
(c) the level of catch appropriate as a long-term precautionary yield;
(d) methods for adjusting catch levels in the short term; and
(e) methods for achieving target levels of fishing mortality (Annex 5, paragraph 4.178).

5.63 The Scientific Committee recommended that participants at the workshop provide extensive reviews on items (i) to (v) in order to be able to keep discussions on these matters at the workshop as brief as possible.

5.64 The workshop would possibly require access to results from past bottom trawl surveys. Therefore, the Scientific Committee reiterated its recommendation (paragraph 10.6; Annex 5, paragraph 3.9) that high priority should be given to the development of a research trawl database in the Secretariat.

5.65 In light of the tasks listed in paragraphs 5.62(vi) and (vii), the Scientific Committee requested that WG-EMM considers at its next meeting in 1998 the following questions and provide the relevant information to the workshop:

(i) What is the importance of *C. gunnari* to predators?

(ii) What is the intensity and variability of predation on *C. gunnari* and the mechanisms that cause this variability?

(iii) From the time series of historical data, what is the nature, magnitude and frequency of ecologically important values which may be linked to effects on the production and mortality of *C. gunnari* stocks?

Assessment of Yield

5.66 There was no commercial catch of *C. gunnari* in Subarea 48.3 during the 1996/97 season, although there was a catch limit of 1 300 tonnes in accordance with Conservation Measure 107/XV. There has now been no substantial reported commercial catch since March 1990.

5.67 The Scientific Committee noted that precautionary catch limits for *C. gunnari* cannot be evaluated until further studies on the properties of possible reference points and decision criteria have been considered for this species (see Annex 5, paragraphs 3.68 and 3.69).

5.68 Background information considered in the assessment is described in Annex 5, paragraphs 4.186 to 4.198. The Scientific Committee endorsed the recommendation of the Working Group that a standardisation of the trawl survey time series using GLMs should be undertaken (Annex 5, paragraph 4.198), although it was noted that this might be problematic due to limited overlap in key factors in the dataset.

5.69 The Scientific Committee noted that recent surveys show that the population of *C. gunnari* in Subarea 48.3 has recovered from recent low levels and that the current stock comprises fish mostly in age classes 2 and 3 (Annex 5, paragraphs 4.199 to 4.201). Although recruitment in the current stock is greater than the mean recruitment arising from VPA run 5 in 1993 (Annex 5, Table 3), the Scientific Committee noted the uncertainty in VPA results and other indicators of stock status currently available (e.g. the estimate of current biomass from the recent UK survey is about 50% of the accumulated catch from the early 1980s), as well as the large variations in abundance known to occur naturally in this species. In light of this, the Scientific Committee noted that the status and potential of the stock in the long term needs to be reassessed and that this would be considered at a short workshop just prior to the next meeting of WG-FSA (see paragraph 5.61 above).

5.70 The Scientific Committee endorsed the short-term methodology used by WG-FSA to assess yield for the coming year (see Annex 5, paragraph 4.179 to 4.182 for details). This methodology used the lower 95% confidence bound from the UK survey in Subarea 48.3 in September 1997 as a basis for a short-term (two-year) projection of yield and stock size (Annex 5, paragraphs 4.199 to 4.202). The calculations are described in Annex 5, paragraphs 4.202 to 4.208.

5.71 The Scientific Committee noted the assessment of yield assumes one stock in Subarea 48.3. Marked differences in age structure between South Georgia and Shag Rocks warrants further examination with a view to resolving questions of stock structure in the region (Annex 5, paragraph 4.200).

Management Advice

5.72 The Scientific Committee noted that recent surveys show that the population of *C. gunnari* in Subarea 48.3 has recovered from recent low levels. However, given the continued uncertainty about the potential yield of *C. gunnari* in Subarea 48.3, the Scientific Committee considered that a conservative approach to management is appropriate in the immediate future.

5.73 The Scientific Committee noted that the yield estimated from the short-term projections undertaken at this year's meeting were based on the lower 95% confidence bound of the survey undertaken by the UK in September 1997 and that this constituted a conservative estimate of yield. Accordingly, the Scientific Committee recommended that fishing in the 1997/98 season should be limited to a total catch of 4 520 tonnes.

5.74 In order to protect the stock from directed fishing on juvenile fish, the Scientific Committee recommended that the approach recommended for Division 58.5.2 to limit the catch of small *C. gunnari* should be applied to Subarea 48.3 in the 1997/98 season (paragraph 5.118). Small *C. gunnari* should be defined as those of less than 240 mm total length.

5.75 No new information was available on the proportion of by-catch species in the commercial catch. The recommended catch limit is substantially below the implied ceilings on both a bottom trawl and pelagic trawl fishery (8 800 and 9 200 tonnes respectively) considered in SC-CAMLR-XI, Annex 5, paragraphs 6.67 to 6.74.

5.76 The Scientific Committee recalled that a pelagic trawl fishery would result in a lower proportion of by-catch and would avoid the possible adverse effects of bottom trawling on the benthic community (e.g. SC-CAMLR-XII, Annex 5, paragraph 6.61). Accordingly, it is recommended that the fishery in 1997/98 be undertaken by pelagic trawling only.

5.77 The fishing season set for 1996/97 by Conservation Measure 107/XV closed on 1 May 1997. The Scientific Committee noted that this represented a one-month extension of the season applied in previous seasons and was adopted by the Commission on the understanding that it would apply for the 1996/97 season only. In accordance with earlier seasons, the Scientific Committee recommended that the fishing season in the 1997/98 season be closed on 1 April to reduce fishing directed at spawning concentrations.

5.78 In order to provide the information required for assessment of the fishery, the Scientific Committee recommended that reporting requirements for the commercial fishery should include the submission of haul-by-haul data in accordance with standard CCAMLR formats and that an international scientific observer be on board every vessel participating in the fishery in the 1997/98 season.

5.79 The Scientific Committee emphasised that the assessment for the coming year is a short-term assessment based on a recent survey and should not be viewed as a long-term assessment. In this respect and as a result of the need for developing further the long-term management strategy, the Scientific Committee recommended that a survey be undertaken during the 1997/98 season.

5.80 The Scientific Committee noted the progress made towards developing a long-term management strategy for this species and recommended the holding of a workshop prior to the next meeting of WG-FSA to develop this further (paragraphs 5.61 to 5.64).

Chaenocephalus aceratus, Pseudochaenichthys georgianus, Gobionotothen gibberifrons, Notothenia rossii, Patagonotothen brevicauda guntheri and *Lepidonotothen squamifrons* (Subarea 48.3)

5.81 New biomass estimates of *Chaenocephalus aceratus, Pseudochaenichthys georgianus, Gobionotothen gibberifrons, Notothenia rossii, Patagonotothen brevicauda guntheri* and *Lepidonotothen squamifrons* were available to WG-FSA from Argentinian and UK biomass surveys conducted around Shag Rocks and South Georgia. The Scientific Committee noted the apparently low abundances of most of these stocks which were largely in line with previous results (see Annex 5, paragraphs 4.218 to 4.222 for details).

Management Advice

5.82 The Scientific Committee reiterated its advice from previous years concerning these species and therefore recommended that Conservation Measures 2/III, 3/IV and 95/XIV remain in force and that Conservation Measure 100/XV be extended to the 1997/98 season.

Electrona carlsbergi (Subarea 48.3) – Management Advice

5.83 In the absence of any new information (Annex 5, paragraph 4.224) the Scientific Committee recommended that Conservation Measure 103/XV be carried forward for the 1997/98 season.

South Sandwich Islands (Subarea 48.4)

5.84 Although a small fishery for *D. eleginoides* was open in this area with a catch limit of 28 tonnes (Conservation Measure 101/XV), no catches were reported (Annex 5, paragraph 4.231).

Management Advice

5.85 In the absence of any new information on this species, the Scientific Committee recommended that Conservation Measure 101/XV for this stock be carried forward for the 1997/98 season.

5.86 This subarea is subject to notification of new fisheries (Annex 5, paragraphs 4.120 to 4.134).

Bouvet Island (Subarea 48.6)

5.87 This area was subject to notification of new fisheries for *D. eleginoides* (Annex 5, paragraph 4.234). No fishing took place.

5.88 No information was available to make any assessment on other stocks occurring in this subarea (Annex 5, paragraph 4.235).

5.89 This subarea is subject to notification of new fisheries (Annex 5, paragraphs 4.120 to 4.134).

Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)

5.90 No new information was available to the Working Group to undertake any assessment on the stocks in these divisions (Annex 5, paragraph 4.237).

5.91 The Scientific Committee noted that fisheries for *Pleuragramma antarcticum*, *Chaenodraco wilsoni* and *Trematomus eulepidotus* had occurred in these divisions in the past and that these could now be considered to be lapsed fisheries. The Scientific Committee recommended that prior to the resumption of these fisheries, WG-FSA should be asked to examine all data available on these fisheries in order to make an assessment of future catch levels.

BANZARE and Elan Banks (Division 58.4.3)

Dissostichus spp. (Division 58.4.3)

5.92 This division is subject to notification of new and exploratory fisheries (Annex 5, paragraphs 4.120 to 4.134).

Ob and Lena Banks (Division 58.4.4)

Dissostichus eleginoides (Division 58.4.4)

5.93 This division is subject to notification of new fisheries (Annex 5, paragraphs 4.120 to 4.134).

Lepidonotothen squamifrons (Division 58.4.4)

5.94 A conservation measure to allow a commercial catch of 1 150 tonnes of *L. squamifrons* to be caught over a two-year period (Conservation Measure 87/XIII) was approved and extended over three consecutive seasons at the successive requests made by Ukraine, provided a biomass survey was undertaken. Apparently no biomass survey was carried out during the 1994/95, 1995/96 and

1996/97 seasons, and therefore no data were available to the Working Group to assess the state of this stock.

Management Advice

5.95 Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks provided an approved biomass survey is undertaken, was extended until the end of the 1996/97 season (Conservation Measure 105/XV). The Scientific Committee noted that the survey proposed by Ukraine did not take place and therefore recommended that the fishery should be closed until a biomass survey of the design approved by the Scientific Committee shows that the stock could support a sustainable fishery.

Kerguelen Islands (Division 58.5.1)

Dissostichus eleginoides (Division 58.5.1)

Standardisation of CPUE Indices

5.96 As for Subarea 48.3, the results from last year's meeting of WG-FSA were found to be in error, and Table 22 and Figure 7 of SC-CAMLR-XV, Annex 5 are not correct.

5.97 Details of the reanalysis of CPUE data are described in Annex 5, paragraphs 4.242 to 4.251. The year effect was the most significant component of variability in CPUE, and the month effect was the next most significant component of variability in catch rates. The effects of year and month on standardised catch rates from the trawl fishery were adjusted for the presence of hauls with zero catches. Adjusted, standardised catch per unit effort has decreased over the course of the time series, and CPUEs in the 1997 split-year were the lowest on record.

5.98 The Scientific Committee was concerned at the declining trend in adjusted, standardised catch rates and noted that the trend in unstandardised catch rates mirrored that of standardised catch rates. There was no clear pattern in standardised CPUE by month.

Management Advice

5.99 The Scientific Committee endorsed the advice of WG-FSA (Annex 5, paragraphs 4.252 to 4.257):

(i) the declining trend in CPUE in the trawl fishery demonstrated by the GLM analysis confirms previous studies of this stock. Annual reductions of the French catch limit (3 800 tonnes for the 1996 season, 3 500 tonnes for the 1997 season and 3 000 tonnes for the 1998 season) shows the concern in the management of the fishery in the French EEZ;

(ii) the French authorities have allocated a catch limit for trawling for the 1997/98 season. A maximum of 3 000 tonnes applies for the whole area, including a 1 000-tonne limit in the eastern sector;

(iii) the longlining catch limit in the western sector has already been established up to the end of 1997 (October–December). A catch limit of 500 tonnes applies for two vessels only. The total value for 1997/98 season in this sector will not exceed the value of the long-term sustainable yield estimated at the 1994 meeting (1 400 tonnes);

(iv) a catch limit of 600 tonnes will apply for 1997/98 season for one French longliner in the eastern sector outside the area used by trawlers; and

(v) the Working Group considered that the GLM analysis of factors affecting CPUE in the trawl fishery is a useful technique to improve its assessments and recommended the continued reporting of catch and effort data on a haul-by-haul basis. In addition, efforts should continue to acquire haul-by-haul data collected on board Ukrainian longline vessels from the Ukrainian authorities, and to ensure that such data are also collected from the longliner working in the eastern sector.

5.100 The Scientific Committee noted that illegal fishing could severely compromise the management of this stock. The estimated unreported catch of *D. eleginoides* by longliners in 1996/97 was 1.4 times the estimated sustainable level of fishing and four times greater than the legal limit for longliners in this division over that period. Thus, the Scientific Committee noted with concern that, when combined with the reported catches, this level of fishing was likely to be unsustainable.

Champsocephalus gunnari (Division 58.5.1)

5.101 As recommended by the Scientific Committee at last year's meeting (SC-CAMLR-XV, paragraph 4.96), there were no commercial catches on the shelf stock during the 1996/97 season (Annex 5, paragraph 4.258).

5.102 As requested by the Scientific Committee (SC-CAMLR-XV, paragraph 4.96), two pre-recruit biomass surveys were conducted during the summer/autumn of 1996/97 to evaluate the abundance of age 3 fish (Annex 5, paragraph 4.259 to 4.261). Three-year-old fish of the cohort born in 1994 were present in nearly all the catches. However, no aggregations of fish were detected despite indications from the previous year of a strong cohort entering the fishable stock. The abundance of other age classes was low.

5.103 The Scientific Committee noted that the Working Group was unable to explain the unexpectedly low biomass at this stage (Annex 5, paragraph 4.263). The French authorities have indicated that they plan to continue to monitor the stock with the help of the French trawlers on the basis of an allocation of very limited catches (not more than 1 to 5% of the present standing stock).

Management Advice

5.104 The Scientific Committee recalled its advice from the 1995 meeting (SC-CAMLR-XIV, paragraph 4.83) that the fishery for *C. gunnari* in Division 58.5.1 should be closed until at least the 1997/98 season when the cohort born in 1994 would have had an opportunity to spawn. The recommended pre-recruit biomass survey conducted this season has shown that the strength of this cohort (age 3) is lower than expected and no conclusive explanation for this situation is presently available.

5.105 The Scientific Committee supported the plan of action proposed by the French authorities as outlined in Annex 5, paragraph 4.263.

Notothenia rossii (Division 58.5.1) – Management Advice

5.106 No new data on the stocks of this species in the division were available. The Scientific Committee reiterated its advice that the fishery for *N. rossii* in Division 58.5.1 remain closed until new information demonstrating the recovery of the stock to a level that allows for its exploitation is submitted for analysis.

Lepidonotothen squamifrons (Division 58.5.1) – Management Advice

5.107 No new data were available to assess this stock. In the absence of a new assessment the Scientific Committee recommended that the Kerguelen fishery for *L. squamifrons* should remain closed.

Heard and McDonald Islands (Division 58.5.2)

Dissostichus eleginoides (Division 58.5.2)

Impact of Illegal Catches on Catch Limit

5.108 The Scientific Committee endorsed the re-evaluation of the precautionary yield (currently 3 800 tonnes) to examine the effect on the long-term annual yield of the estimates of unreported catches from this division in the last fishing season (Annex 5, paragraph 4.270). Two catch levels were used in these reassessments, being the reported catch (1 861 tonnes) plus the lower and higher estimates of unreported catches respectively (10 200 and 18 400). The future long-term annual yield at which median escapement is 0.5 was 3 720 tonnes for the lower estimate of catch and 3 700 tonnes for the upper estimate, provided that high levels of unreported catches do not continue. The respective probabilities of depletion below the 0.2 median pre-exploitation biomass over 35 years were 0.039 and 0.045.

Management Advice

5.109 In view of the large illegal catches estimated to have been taken from this division, the Scientific Committee recommended that the catch limit should be revised to 3 700 tonnes, the yield estimated given the higher estimate of illegal catches.

5.110 The Scientific Committee stressed that this catch limit should be used on the assumption that total catches are reduced to 3 700 tonnes or less in the near future. If total catches continue at levels similar to those estimated by WG-FSA for the 1996/97 season (i.e. at 5.5 times the revised long-term annual yield), there will be a much greater affect on the catch limit in future years than has been estimated at this meeting.

5.111 The Scientific Committee requested that WG-FSA examine how long the stock can sustain the current level of total catch and its long-term effect on standing stock and spawning biomass.

Champsocephalus gunnari (Division 58.5.2)

5.112 A commercial catch of 216 tonnes was taken by one vessel from Australia in Division 58.5.2 during the 1996/97 season, which was less than the precautionary catch limit of 311 tonnes set by Conservation Measure 110/XV.

Assessment of Yield

5.113 The short-term methodology used by WG-FSA to assess yield for the coming year (see Annex 5, paragraph 4.179 to 4.182 for details) was applied to the results from the Australian survey in August 1997 and used biological parameters derived from surveys around Heard Island (see Annex 5, paragraphs 4.274 and 4.275).

5.114 The Scientific Committee endorsed the assessments of *C. gunnari* in two regions – Heard Island plateau and Shell Bank (see Annex 5, paragraphs 4.276 and 4.277 for explanation). The bootstrap lower 95% confidence interval was used to estimate the initial age structure for the projection. This resulted in a combined catch over two years from the two abundant cohorts of 1 500 tonnes, comprising 900 tonnes in the first year and 600 tonnes in the second year.

Management Advice

5.115 The Scientific Committee recommended a catch limit of 900 tonnes for *C. gunnari* on the plateau at Heard Island for the 1997/98 season.

5.116 The Scientific Committee noted that the lower 95% confidence limit for the abundance estimate of *C. gunnari* on Shell Bank reported to WG-FSA was only 592 tonnes (Annex 5, paragraph 4.280). Accordingly, the Scientific Committee recommended that commercial fishing on this bank should be avoided in the 1997/98 season.

5.117 The Scientific Committee noted the value of having up-to-date surveys on which to base assessments of a species such as *C. gunnari* which has widely fluctuating abundance. Thus, it recommended that such surveys should be conducted regularly.

5.118 The Scientific Committee noted the conclusion of WG-FSA that there appears to be no compelling requirement to protect juvenile fish from the effects of fishing at levels that may be proposed for precautionary catch limits (see Annex 5, paragraph 4.282). However, this has not been established for the higher catch limits from the interim procedure for estimating catch limits for abundant cohorts. For this reason, the Scientific Committee agreed that it would be advisable to continue a procedure for limiting the proportion of small fish taken by the fishery. It recommended that a fishing vessel should move to another location when the proportion of small fish exceeds 10% of the total (provided the catch of small *C. gunnari* is above a minimum threshold such as 100 kg). Small *C. gunnari* should be defined as those of less than 240 mm total length. Further, the Scientific Committee requested that WG-FSA examine further the necessity of this requirement for when catch levels are raised above the precautionary limit.

Channichthys rhinoceratus, *Lepidonotothen squamifrons* and Skates (*Bathyraja* spp.) (Division 58.5.2)

5.119 The Scientific Committee endorsed the assessments of the long-term annual yield and potential by-catch of two species, and a group of species, caught as by-catch in the commercial trawl fishery in the Heard Island area: *C. rhinoceratus*, *L. squamifrons* and skates (*Bathyraja* spp.). These assessments are detailed in Annex 5, paragraphs 4.283 to 4.285 and paragraphs 4.313 to 4.315. Where possible, biological characteristics of the stocks used as inputs to the GYM were obtained from data of research surveys conducted in the division. However, when not available this data were extracted from information contained in the literature on related species occurring in other geographical areas (sometimes in very distant waters). Consequently, the yields derived from these results are uncertain, especially for skates for which very little information is available.

5.120 The long-term estimates of yield for C. rhinoceratus, L. squamifrons and skates were 69 to 97 tonnes (average 80 tonnes), 7 to 911 tonnes (average 325 tonnes) and 50 to 210 tonnes (average 120 tonnes) respectively. These ranges arise from the assessments of g for three different survey estimates. WG-FSA noted that the by-catch of these species in the Heard Island trawl fishery did not exceed the lowest estimates of yield for each species and therefore it does not seem to be negatively affecting their stocks. It also stated that while further work is needed to refine the estimates of long-term annual yields, especially for skates, these results could be used as a basis to set precautionary catch limits for these stocks in Division 58.5.2.

Management Advice

5.121 The Scientific Committee noted that, although the estimates of yield are based on biological parameters extrapolated from the literature, in many cases they provide a guide to long-term annual yield appropriate for these species. Thus, until more refined estimates are available, the Scientific Committee recommended the following precautionary catch limits for these species:

L. squamifrons	325 tonnes
C. rhinoceratus	80 tonnes
Bathyraja spp.	120 tonnes

5.122 The Scientific Committee also recommended that no directed fishing be allowed on these species. Consequently, the by-catch of these species in the trawl fishery for *C. gunnari* will be unlikely to exceed these limits.

Crozet Island (Subarea 58.6)

Dissostichus eleginoides (Subarea 58.6)

Standardisation of CPUE Indices

5.123 The Scientific Committee endorsed the analysis of CPUE data from the joint French–Japanese longline survey conducted around Crozet Island presented in Annex 5, paragraphs 4.288 to 4.296. It noted that this fishery takes significant by-catch of grenadiers, and that there may be an inverse relationship between catches of *D. eleginoides* and grenadiers. While depth was an important factor in explaining variation in CPUE, there was a significant relationship between CPUE and month. Standardised catch rates of *D. eleginoides* were highest in December 1996 and declined through April 1997.

5.124 The Scientific Committee noted that the declining trend in CPUE may have resulted from the substantial unreported catches taken from Subarea 58.6 since its last meeting in 1996. In this regard, the Scientific Committee noted that the median pre-exploitation spawning biomass estimated from the GYM for Subarea 58.6 (according to the proposed new boundaries which separate Crozet Island from the Prince Edward Islands) was 52 290 tonnes and the total estimated catch from this subarea with the proposed new boundary was 12 822 tonnes (Table 5). The Scientific Committee further noted that the total estimated catch from Subarea 58.6 was thus about 25% of the predicted median pre-exploitation spawning biomass. The Scientific Committee agreed that such a large proportion of the estimated spawning biomass being taken in a single year is a very serious situation. If this catch rate continues then the stock is likely to fall to 10% of pre-exploitation levels in the next four years. It is even more disturbing considering that last season was the first known occasion of a significant level of exploitation, and that very little is known of the fish stock in this region.

5.125 The Scientific Committee endorsed the view of the Working Group that since the declining trend in CPUE is likely to be a result of the substantial catches taken from Subarea 58.6, the information in this figure could not be used to assess how delaying the start of the fishing season until the beginning of May (as a means of reducing incidental mortality to seabirds) would affect the fishery.

5.126 The Scientific Committee noted that these assessments are difficult because of the absence of data on these species in this area. It therefore recommended that further work be undertaken as a matter of urgency to determine the biological parameters of *D. eleginoides* in this subarea.

5.127 The Scientific Committee noted the large by-catch of grenadier in this fishery and recommended that work be undertaken to assess the stock of grenadier in this area.

Management Advice

5.128 This subarea is subject to notification of new and exploratory fisheries (Annex 5, paragraphs 4.120 to 4.134).

5.129 The assessment of yield is considered for new fisheries in paragraphs 9.53 to 9.71.

5.130 The Scientific Committee agreed that the rapid decline in the CPUE and that the spawning stock may have been reduced by 25% from the median pre-exploitation level in the last year are cause for serious concern. It noted that the current catch rates are approximately nine times the precautionary level calculated for new fisheries for the existing subarea and 12.5 times the precautionary catch limits calculated for the subarea with the proposed new boundaries. The Scientific Committee agreed that the stock is severely threatened because of the illegal fishing activities.

Other Stocks (Subarea 58.6)

5.131 No information was available on other stocks occurring in this subarea.

Prince Edward Islands (Subarea 58.7)

Dissostichus eleginoides (Subarea 58.7)

Standardisation of CPUE Indices

5.132 The Scientific Committee endorsed the analysis of CPUE data from the longline fishery around Prince Edward Islands (see Annex 5, paragraphs 4.303 to 4.306). The Scientific Committee noted that there was not a clear pattern to the standardised series of CPUE by month.

5.133 The Scientific Committee requested that the Working Group undertake a more thorough analysis of the Prince Edward Islands data at its next meeting once all the haul-by-haul data are entered into the CCAMLR database.

5.134 The Scientific Committee noted that for this subarea, as in Subarea 58.6, the estimated total of reported and illegal catches is a high proportion of the median unexploited spawning biomass estimated from the GYM (according to proposed new boundaries). For this subarea the predicted median unexploited total biomass was 102 210 tonnes and the total estimated catch was 18 839 tonnes (Table 5), or approximately 18% of the median pre-exploitation total biomass. The Scientific Committee agreed that the situation in Subarea 58.7 was equally serious to that in Subarea 58.6 because such a considerable proportion of the estimated spawning stock biomass has been taken in a single year. Again, it is particularly disturbing that last season was the first known occasion of a significant level of exploitation, and that very little is known of the fish stock in this region.

5.135 The Scientific Committee noted that these assessments are difficult because of the absence of data on these species in this area. It therefore recommended that further work be undertaken as a matter of urgency to determine the biological parameters of *D. eleginoides* in this subarea.

Management Advice

5.136 This subarea is subject to notification of new and exploratory fisheries (Annex 5, paragraphs 4.120 to 4.134).

5.137 The assessment of yield is considered for new fisheries in paragraphs 9.53 to 9.71.

5.138 The Scientific Committee agreed that the rapid decline in the CPUE and that the spawning stock may have been reduced by 20% from the median pre-exploitation level in the last year are cause for serious concern. It noted that the current catch rates are approximately 30 times the precautionary level calculated under new fisheries for the existing subarea and 12.5 times the precautionary catch limits calculated for the subarea with the proposed new boundaries. The Scientific Committee agreed that the stock is severely threatened because of the illegal fishing activities.

5.139 The Scientific Committee recommended that a bottom trawl survey be carried out during the forthcoming season in order to obtain biological data on this species.

Other Stocks (Subarea 58.7)

5.140 No information was available on other stocks occurring in this subarea.

Pacific Ocean Sector (Area 88)

5.141 This subarea is subject to notification of new and exploratory fisheries (Annex 5, paragraphs 4.120 to 4.134).

5.142 No information was available on other stocks occurring in this sector.

General Management Advice on Assessments

5.143 The Scientific Committee noted with concern the escalation in illegal fishing in Area 58 (see paragraph 2.13). The uncertainty in the levels of total catches of *D. eleginoides* by longlining makes the assessments of yields of this species in this area very difficult. The Scientific Committee agreed that the levels of illegal catch used in these assessments are likely to be minimum estimates in most cases.

General By-catch Provisions

5.144 The Scientific Committee noted the deliberations of WG-FSA on issues associated with the by-catch of fish and endorsed the analysis of the implications of the current by-catch rules on fishing operations and the status of stocks (Annex 5, paragraphs 4.312 to 4.319).

5.145 The Scientific Committee agreed that in general it is preferable to evaluate levels of by-catch in relation to stock productivity rather than using arbitrary rules that restrict the level of by-catch. The Scientific Committee acknowledged, however, that there will often be instances where information is not available to estimate yield for by-catch species, which will require the use of different types of rules.

5.146 The Scientific Committee noted that there are practical problems with the by-catch provisions outlined in Conservation Measures 109/XV, 110/XV and 111/XV because the provisions of these three conservation measures make it difficult for fishermen to prospect for suitable trawling grounds. This is because the fishermen are frequently required to leave areas when catches of by-catch species were less than 100 kg.

5.147 The Scientific Committee endorsed the proposal by WG-FSA that the by-catch provisions in the three conservation measures be modified so that vessels are not forced to move if catches of any single by-catch species are less than 100 kg in any single haul. The Scientific Committee agreed that the 100-kg threshold for by-catch in a single haul would probably not cause stocks of by-catch species to become overexploited but agreed that there should also be an upper limit to the number of 100-kg by-catches that could occur in a single year. Ideally, this upper limit should be determined by the potential yield of each by-catch species.

Management Advice on Measures involving By-catch

5.148 The Scientific Committee recommended that the following mixed strategy (consisting of two components) be applied to by-catch species:

(i) total removals of each by-catch species are limited by estimates of potential yield; and
(ii) haul-specific by-catch limits are set at levels that permit prospecting but are not likely to cause the potential yield from Component (i) to be exceeded.

5.149 The Scientific Committee recommended that haul-specific by-catch limits in Component (ii) of the mixed strategy should be set on a case-by-case basis and noted that such a strategy has already been implemented in the *C. gunnari* fishery in Subarea 48.3 (Conservation Measure 107/XV).

Resumption of Closed or Lapsed Fisheries

5.150 The Scientific Committee welcomed the review by the Secretariat of the types of fisheries operating in the CCAMLR area (SC-CAMLR-XIV/BG/16 Rev. 2) in response to a recommendation last year that the Commission maintain a register of lapsed fisheries (SC-CAMLR-XV, Annex 5, paragraph 4.251). The paper identified five types of fisheries: new, exploratory, established, closed and lapsed. Currently, formal definitions only exist for new, exploratory and closed fisheries.

5.151 The Scientific Committee noted the discussion by WG-FSA on this topic (Annex 5, paragraphs 4.320 to 4.323). WG-FSA noted that the lack of consistent quality between the various notifications of new and exploratory fisheries received at this year's meeting indicated that Members applied different interpretations to the various requirements in the current conservation measures on new and exploratory fisheries (Conservation Measures 31/X and 65/XII). The Scientific Committee agreed that a standard framework for dealing with various types of fisheries would make it easier for Members to provide the information necessary to evaluate new and exploratory fishery notifications.

5.152 The Scientific Committee endorsed the recommendation of WG-FSA that information and procedures similar to those required for the initiation of a new fishery and/or for the execution of an exploratory fishery should be required during the resumption of a closed fishery. In this regard, the Scientific Committee agreed that before the resumption of a lapsed fishery (e.g. those recommended by the Scientific Committee for Divisions 58.4.1 and 58.4.2 – paragraph 5.91), WG-FSA should be asked to examine all data available on these fisheries in order to make an assessment of future catch levels. In order for this to be achieved the Scientific Committee recommended that a system be established for notifying the Commission that such an assessment is required and for the submission of appropriate data.

Ecosystem Interactions

5.153 The Scientific Committee noted the continued work investigating the by-catch of fish in the krill fishery (Annex 5, paragraphs 5.2 to 5.6) and that this will come to a close with the establishment of the final database by 1 March 1998 followed by subsequent data analyses and review of methodology during the next intersessional period by Members of WG-FSA (Annex 5, paragraph 5.6).

5.154 The Scientific Committee noted the development of a new method for monitoring the interaction between Antarctic blue-eyed shags (*Phalacrocorax bransfieldensis*) and inshore fish species (paragraph 4.12; Annex 5, paragraphs 5.7 to 5.9).

Research Surveys

5.155 The Scientific Committee noted the developments in research surveys discussed by WG-FSA in Annex 5, paragraphs 6.1 to 6.12, including proposed surveys in Subarea 48.1 (USA), Subareas 48.2 and 48.3 (Argentina), Subarea 48.6 and Division 58.4.4 (Spain), Division 58.5.1 (France) and Division 58.5.2 (Australia).

5.156 The Scientific Committee noted that the acoustic survey database being developed by the Secretariat for the synoptic survey of krill in Area 48 should be developed in such a way to accommodate data from acoustic surveys of fish, such as the Russian survey (Annex 5, paragraph 4.190).

Future Work of WG-FSA

5.157 The Scientific Committee endorsed the future work of WG-FSA on fish as set out in Annex 5, paragraphs 9.1 to 9.7. The Scientific Committee gave the following tasks a high priority:

(i) develop a data format and procedure for handling research survey data submitted to CCAMLR;

(ii) develop electronic forms and formats for the submission of data, reports and meeting documents;

(iii) consolidate and validate methodology and datasets used by WG-FSA;

(iv) arrange for data for WG-FSA analyses from the previous split-year to be prepared as a matter of priority;

(v) validate GYM and prepare documentation for the next meeting of WG-FSA;

(vi) develop routines to extract length frequencies for *D. eleginoides* corrected for size of catch and sample size;

(vii) extend current technical coordination by Members in the provision of scientific observers' data to encompass catch and effort data and CEMP data; and

(viii) consider conducting bottom trawl surveys in Subareas 58.6 and 58.7 for assessing stock abundance and biological parameters of *D. eleginoides*.

5.158 In addition, the Scientific Committee noted that future work should include, for *D. eleginoides*, collections of age/length data and a register of scales and otoliths should be obtained for research cruises as well as from observers on commercial vessels.

5.159 The Scientific Committee agreed that the work of the Secretariat detailed in Annex 5, paragraph 9.4 should be modified to:

(i) contact the Secretariat of the CMS and inform it of CCAMLR's work on albatross conservation and that Dr Kock will follow this up if required; and

(ii) encourage the adoption of provisions of Conservation Measure 29/XV for minimising by-catch of seabirds in fisheries in areas adjacent to the CCAMLR Convention Area.

Crab Resources

5.160 No vessels have fished for crabs in Subarea 48.3 since January 1996, and no vessels have expressed an interest in participating in this fishery during the 1997/98 crab fishing season (Annex 5, paragraphs 4.226 and 4.227).

5.161 The Scientific Committee endorsed WG-FSA's view that it was not necessary to conduct an assessment of the crab stock in Subarea 48.3 (Annex 5, paragraph 4.227) and noted that Conservation Measures 90/XV and 104/XV were in force for the 1996/97 crab fishing season.

5.162 The Scientific Committee noted that, currently, the crab fishery is not considered commercially viable (Annex 5, paragraph 4.227). At present, the viability of the fishery is related to various economic factors rather than to stock abundance, and the Scientific Committee agreed that the fishery could become commercially viable in the future. In this regard, the Scientific Committee endorsed WG-FSA's view that a conservative management scheme as contained in Conservation Measure 104/XV is still appropriate for this fishery (Annex 5, paragraph 4.229).

5.163 The Scientific Committee further noted that Conservation Measure 90/XV expires after the 1997/98 crab fishing season so there is currently a need to re-evaluate the experimental crab harvest regime. Although the fishery is not currently commercially viable, such a re-evaluation seems especially pertinent since the conservation measure is very complex. The Scientific Committee commented that Conservation Measure 90/XV should not prohibit the development of a commercially viable fishery.

5.164 The Scientific Committee advised that Conservation Measure 90/XV should remain in force for the 1997/98 crab fishing season, but agreed that WG-FSA should re-evaluate Conservation Measure 90/XV at its next meeting. In respect of such a re-examination, the Scientific Committee reiterated the view that if new vessels enter the Antarctic crab fishery it would not be useful for these vessels to conduct depletion experiments during Phase 2 of the experimental harvest regime. Rather, it might be useful to redraft Phase 2 of the regime and require each vessel to repeat Phase 1 or to conduct a tagging study during its second season of participation in the crab fishery (SC-CAMLR-XV, Annex 5, paragraph 4.183).

Squid Resources

5.165 The Scientific Committee noted that WG-EMM had responded to its request to evaluate aspects of paper WG-FSA-96/20. This paper examined the potential impact of a fishery for *M. hyadesi* on predators. While WG-EMM did not feel that there was sufficient information available to conclude how the development of such a fishery was likely to influence predators (Annex 4, paragraph 6.83), WG-EMM did support the precautionary approach set out in the paper (Annex 4, paragraph 6.87). This approach includes the currently adopted practice of setting a squid catch limit at 1% of estimated predator demand (such a catch limit was implemented in Conservation Measure 99/XV).

5.166 The Scientific Committee further noted that the fishery for *M. hyadesi* was a new fishery, and additional, detailed discussions on this fishery can be found in the Agenda Item 9 (paragraphs 9.15 to 9.18).

ECOSYSTEM MONITORING AND MANAGEMENT

Report of WG-EMM

6.1 In its discussions leading to an ecosystem assessment, WG-EMM considered trends in harvested species, dependent species and the environment and interactions between them. Trends in harvested species were discussed under Agenda Item 2 and trends in dependent species under Agenda Item 4.

General Items

6.2 As directed by the Scientific Committee during its last meeting (SC-CAMLR-XV, paragraph 5.8), the Subgroup on Statistics met just prior to the WG-EMM meeting.

6.3 The Scientific Committee noted that the subgroup and WG-EMM had difficulty with the use of the term 'anomaly' to describe noteworthy values in the CEMP indices because the term anomaly is commonly used to describe events that occur with low probability. However, events of interest may be fairly common, for example occurring once every four or five years. The important consideration may be whether the frequency of these events is changing over time. The Scientific Committee noted that the term 'Ecologically Important Value' (EIV) (referred to by the Subgroup on Statistics as 'Value Outside the Generally Observed Norm') had been agreed to describe a value of an index which is extreme relative to the distribution of values which are deemed to be unlikely to lead to substantial changes in the status of dependent, related and harvested species (Annex 4, paragraph 6.6).

6.4 The Scientific Committee noted that WG-EMM had completed preliminary studies using multivariate analysis, including principal component analysis, which led to the development of combined indices that summarise a large number of indices into a smaller set which can be more easily examined (Annex 4, paragraph 6.7).

6.5 The Scientific Committee also noted the desirability of having access to this methodology prior to the planned workshop to investigate Area 48, which will be held in June, 1998. Dr de la Mare indicated he would endeavour to work with the Secretariat to ensure its availability by March, in time for use by workshop participants.

6.6 WG-EMM noted the importance of being able to detect not only extreme values in the indices, but also changes in variability, trends and shifts in the values, and changes in the frequency of extreme events. In addition, as with any such analysis, the quality of the output depends critically on the input data. Contributors to CEMP indices were requested to check the validity of their data and to inform the Secretariat of any changes which might be required (Annex 4, paragraphs 6.8 and 6.9).

6.7 The Scientific Committee was pleased to note that subsequent to the WG-EMM meeting, the UK had completed and validated all of their CEMP data and submitted to the Secretariat appropriate changes.

6.8 The Scientific Committee agreed with WG-EMM's Subgroup on Statistics that the causes of values being missing in the database of CEMP indices need to be documented as part of the database. These might arise for several reasons such as: no observation made; or the observer was unable to make an observation due to some constraint; or an unrecorded zero value; or an error in data entry. These might have different interpretations in analysis. The Data Manager agreed to prepare a circular seeking relevant information (Annex 4, paragraph 6.11).

Environment

6.9 The Scientific Committee noted that information on water circulation, water mass distribution, position of fronts and sea-ice cover was discussed at WG-EMM and that a significant contribution to this section came from the results of the Workshop on International Coordination, which had taken place just prior to the meeting of WG-EMM (Annex 4, paragraphs 5.1 to 5.5).

6.10 WG-EMM also reported on additional studies which investigated the location and variability in the position of frontal zones and the water movement over the deep ocean and residence times over the shelf. In addition, topics which are relevant to understanding krill flux were discussed (Annex 4, paragraphs 5.6 to 5.13).

Environmental Parameters

6.11 The Scientific Committee noted that as part of CEMP, the Secretariat currently produces four environmental indices (Annex 4, paragraph 8.92). These are:

F2a – sea-ice percentage cover in a subarea in September;
F2b – sea-ice retreat past a CEMP site: number of ice free days;
F2c – sea-ice distance to a CEMP site: weeks sea-ice is within 100 km of site; and
F5 – summer sea-surface temperature adjacent to a CEMP site.

6.12 Further standard methods have been prepared by the Secretariat, however these are currently in draft form:

F1 – sea-ice cover viewed from a CEMP site;
F3 – local weather at a CEMP site; and
F4 – snow cover at a CEMP site.

6.13 The Scientific Committee agreed that further review of the draft environmental indices was necessary before formal data submissions could proceed (Annex 4, paragraphs 8.93 to 8.103).

Interactions between Ecosystem Components

Harvested Species and the Environment

6.14 The Scientific Committee agreed that the krill haul-by-haul fishery data are providing valuable information on the location of krill concentrations relative to local bathymetric features (Annex 4, paragraph 6.21).

6.15 It also noted that the krill fishery in Area 48 does not target the whole Scotia Sea area but is almost certainly able to target the regular high concentration regions. As these traditional fishing grounds are in the vicinity of some of the largest predator colonies in the area, this highlights the usefulness of the fishery data in considering interactions between predators, prey and fisheries. As with all of the prey and predator datasets, the need for careful interpretation of such data was emphasised. The Working Group noted the value of analyses of individual trawl-based fishery data and encouraged further development of analyses of the fishing operation (Annex 4, paragraph 6.22).

6.16 The Scientific Committee noted WG-EMM discussions on the strategic modelling exercise for the management of the ecosystem derived at WG-EMM in 1995 (SC-CAMLR-XIV, Annex 4, paragraphs 7.46 to 7.60 and Figures 3 and 4) and was encouraged by progress made by this year's WG-EMM meeting (Annex 4, paragraphs 6.30 to 6.34). It agreed with the suggestion that the various hypotheses being proposed should be developed so that they could be tested using the indices being compiled by WG-EMM. In addition, WG-EMM was encouraged to investigate whether the hypothesised relationship between winter sea-ice conditions and krill recruitment in the Elephant Island area was valid for other Southern Ocean localities.

Interactions between Krill and Dependent Species

Fur Seals

6.17 The Scientific Committee noted WG-EMM's report that biochemical analysis of samples of milk from lactating fur seals has demonstrated that the fatty acid composition can be used to provide an index of the major food components, fish and krill, in the diet. Further progress was reported in developing an energy budget for fur seals (Annex 4, paragraphs 6.39 to 6.42).

Seabirds

6.18 The Scientific Committee noted several reports to WG-EMM which investigated the interactions between krill and seabirds (Annex 4, paragraphs 6.43 to 6.48). It also noted that the insights into diet variation provided by these studies, and particularly the varying ability of species that are generally dependent upon krill to switch to other prey in the absence of krill. There is a continuum of species in terms of the extent to which fecundity, fledging/weaning mass and reduced survival of adults and young are affected by variations in krill abundance.

Minke Whales

6.19 WG-EMM reviewed results of several studies of minke whales which had been carried out in Division 58.4.1 and Subarea 88.1. Specifically these considered the girth of minke whale as an index of condition. Also raised was the relationship between minke whale condition, krill availability and the extent of ice cover (Annex 4, paragraphs 6.49 to 6.55).

6.20 The Scientific Committee endorsed the principle of developing standard methods for minke whales, but agreed with WG-EMM that there remained sufficient uncertainty about the spatial and temporal scales represented by such a monitoring parameter that their reintroduction as a CEMP monitoring species could not be justified at this stage.

6.21 The Scientific Committee also noted that to re-establish minke whales as a CEMP monitoring species would require methods capable of generating long-term data which involved non-invasive techniques such as photogrammetry (paragraph 4.9).

Dependent–Harvested Species Interactions

6.22 The Scientific Committee endorsed WG-EMM's view that it was advantageous to examine krill–predator interactions using both empirical and mechanistic models (Annex 4, paragraphs 6.58 to 6.72). At a broad scale, the empirical model being developed by Prof. D. Butterworth's group provides a useful foundation for the provision of management advice. Mechanistic modelling, still largely under development, will provide the necessary link between prey abundance and distribution and predator behaviour, which is measured in the form of CEMP parameters. This can be used to characterise better the functional relationship between krill abundance and predator demographic parameters.

6.23 The Scientific Committee agreed that the empirical model be developed further to ensure that in future there is a basis upon which management advice can be taken forward to the Scientific Committee. It also endorsed the mechanistic approach by inviting the submission of papers addressing this subject at future meetings.

Interactions between Dependent Species

6.24 The Scientific Committee noted that potential interactions between dependent species was relevant to WG-EMM's ability to discriminate between the effects of krill fishing and the effects of competition between predators (Annex 4, paragraphs 6.74 to 6.76), and agreed that it is an issue that should be incorporated within assessments of the reasons underlying changes in predator abundance.

Fisheries–Dependent Species Overlap

6.25 The model of dependent species and fisheries overlap, the Agnew–Phegan Model, was discussed by the Subgroup on Statistics and by WG-EMM (Annex 4, paragraph 6.10). The subgroup found that the model was not a direct measure of overlap, but rather was related to the total amount of krill removed from the foraging area during the critical period. WG-EMM agreed that the use of a new standardised index, the Schroeder index, which gives a measure of the spatial overlap between the dependent species and the fishery in a given time, was more appropriate. The Scientific Committee requested the Secretariat to report results obtained using the new index to the next meeting of WG-EMM.

6.26 The Scientific Committee also noted that an additional index is required to give some measure related to the possible impact on dependent species of the quantities of harvested species taken by the fishery (Annex 4, paragraph 6.10).

Predator Interactions with Fish and Squid

6.27 As demonstrated in papers submitted to previous meeting, Antarctic blue-eyed shags rely heavily on a range of inshore fish species. Many of these have historically been subject to heavy exploitation. (For further information, refer to paragraph 4.12.)

6.28 The Scientific Committee noted that WG-EMM had considered the potential impact of a fishery for *M. hyadesi* on predators and concluded that there was generally insufficient information to conclude how the development of such a fishery was likely to influence predators. It appeared that most predators were taking small squid and there was little indication that they were feeding on spent squid. Moreover the most accurate information about squid consumption came from the predator species which accounted for the smallest proportion of the estimated predation of squid in Area 48 (Annex 4, paragraph 6.83).

6.29 Last year, the Commission set a precautionary catch limit at 1% of the estimated predator demand. The Scientific Committee concurred that determining a more accurate estimate for the precautionary yield would require more information on estimates of the natural mortality rate of squid from one to two years of age, on variability in recruitment and on the appropriate level of squid escapement after fishing to meet predator requirements (Annex 4, paragraph 6.85).

6.30 The Scientific Committee recognised that only limited information was available on seasonal distribution and migration of *M. hyadesi* and that more information could be obtained by spreading the fishing season over the entire year. However, it also recognised that the fishing season should take into account the lack of sufficient data to assess how the development of a fishery would affect predators dependent on *M. hyadesi* (Annex 4, paragraphs 6.86 and 6.87).

6.31 The Scientific Committee agreed with the results of a workshop to consider the management of exploitation in the Heard Island area (Annex 4, paragraph 6.88). Detailed interactions had been considered and distilled into more simple views of the system. As a general rule such simplification attempts to account for the interactions which involve about 80% of the prey consumed by the predators.

Ecosystem Assessment

Estimates of Potential Yield

6.32 The Scientific Committee noted that refinements in the krill yield model to correct for bias would not greatly change the current value of γ used to calculate precautionary catch limits. The Working Group agreed that revised calculations of precautionary catch limits should be deferred until additional information becomes available (Annex 4, paragraphs 7.1 and 7.2).

6.33 The Scientific Committee noted that the GYM used by WG-FSA can duplicate results provided by the krill yield model and agreed that once validated it should replace the existing krill yield model (Annex 4, paragraph 7.3).

Precautionary Catch Limits

6.34 At present the precautionary catch limit for Area 48 has not been subdivided among subareas. An estimate of the biomass of krill for the vicinity of South Georgia based on an estimate of predator demand in that region was provided at the meeting (Annex 4, paragraph 7.4).

6.35 The Scientific Committee accepted WG-EMM's view that there was no need to make a subarea subdivision of the precautionary catch limit for Area 48 and that consideration of subdivision should be deferred until the results from the planned synoptic survey in Area 48 became available (Annex 4, paragraph 7.7).

Assessment of the Status of the Ecosystem

6.36 The Scientific Committee noted the following assessments of the status of the ecosystem provided by WG-EMM.

Subarea 48.1

6.37 Overall, in the Antarctic Peninsula region in 1996/97, absolute krill recruitment was close to historical averages. Around Elephant Island in 1996/97 there was a prolonged krill spawning season, a delayed spawning peak and a massive salp bloom. This followed below average sea-ice conditions in winter 1996. Excellent recruitment success was observed for the 1994/95 year, but lower recruitment success was observed for the 1995/96 year class. These observations confirm predictions made at last year's meeting (Annex 4, paragraph 6.38) and support the hypothesised relationships between recruitment success and winter sea-ice conditions (Annex 4, paragraphs 7.12 and 7.13).

6.38 In addition, the Scientific Committee noted WG-EMM's observation that low larval krill densities and high salp concentrations observed during this year suggest poor krill reproductive success. Poor recruitment of the 1996/97 krill year class is predicted (Annex 4, paragraph 7.14).

6.39 The Scientific Committee noted WG-EMM's view that there appeared to be an encouraging degree of coherence in CEMP indices across sites within Subarea 48.1 (Annex 4, paragraph 7.19). Specifically, Adélie penguin fledging success and fur seal pup production were higher than in recent years.

Subarea 48.2

6.40 At Signy Island, breeding success of Adélie, chinstrap and gentoo penguins were all at above average levels in 1996/97. This suggests a degree of coherence in predator indices with those in Subarea 48.1 (Annex 4, paragraph 7.20).

Subarea 48.3

6.41 Bird Island was the one CEMP site for which a combined index for dependent species had been developed (Annex 4, Appendix D, Figure 1). This indicated that there had been a steady improvement in predator reproductive success since the last poor year in 1993/94.

6.42 Krill biomass densities off South Georgia in December 1996 were comparable with those in the previous year and were relatively high for this region (Annex 4, paragraph 7.22).

Subarea 48.6

6.43 The population of chinstrap penguins at Bouvet Island has fallen sharply since 1989/90 whilst that of macaroni penguins has shown a more moderate decline. The population of Antarctic fur seals has grown dramatically over the same period (Annex 4, paragraph 7.23).

6.44 There is considerable interannual variation in the number of Antarctic petrels breeding successfully at Svarthamaren, but 1997 appears to have been quite a good year (Annex 4, paragraph 7.25).

Division 58.4.2

6.45 After two poor seasons, the breeding success of Adélie penguins at Béchervaise Island was high in 1996/97. The breeding population size has remained almost constant (Annex 4, paragraph 7.26).

Subarea 58.7

6.46 At Marion Island, macaroni and gentoo penguins have been monitored for the past three seasons. The CEMP indices measured in 1996/97 were all within the ranges of previous values and there were no obvious EIVs (Annex 4, paragraph 7.27).

Subarea 88.1

6.47 Although Adélie penguin breeding success was the highest of the three years for which data have been collected at Edmonson Point, no exceptional values of monitored CEMP indices were obtained in 1996/97 (Annex 4, paragraph 7.28).

Format for Presentation of Ecosystem Assessments

6.48 The Scientific Committee noted that it would be helpful if ecosystem assessments could be presented in a more standardised form. An illustrative example of a possible format, based on that used for fish stocks by WG-FSA, for an ecosystem assessment summary for Subareas 48.1, 48.2 and 48.3 was proposed. The Scientific Committee agreed that this approach should be considered further at the next meeting of WG-EMM (Annex 4, paragraph 7.30).

Possible Management Measures

6.49 No new management measures were proposed.

Plans for the Area 48 Workshop

6.50 The Scientific Committee agreed that the need for the Area 48 workshop remains and that the terms of reference for the workshop have not changed since last year (Annex 4, paragraph 8.110). The terms of reference are:

(i) identify the extent of between-season and within-season variation in key indices of the environment, harvested species, and dependent species over past decades;

(ii) identify coherence in the indices between sites and clarify understanding of the linkages between Subareas 48.1, 48.2 and 48.3;

(iii) develop working hypotheses; and

(iv) provide a summary report for consideration of the 1998 meeting of WG-EMM.

6.51 The Scientific Committee agreed that it would be useful to organise the workshop around the following hypothesis and its alternative:

(i) H_0: Subareas 48.1, 48.2 and 48.3 are discrete ecosystems and events observed in any one subarea do not reflect what is happening in other subareas; and

(ii) H_1: area is a homogenous ecosystem and events observed in any one subarea reflect the entire area.

6.52 It was recognised that neither of these hypotheses was likely to be correct. However, they represent the end points of the spectrum of possibilities and may thus serve a useful purpose for organising the workshop (Annex 4, paragraphs 8.112 and 8.113).

6.53 The Scientific Committee agreed to the following plans for the organisation of the workshop (Annex 4, paragraphs 8.114 to 8.117):

(i) the workshop should be held at Southwest Fisheries Center, La Jolla, Ca., USA, in June 1998. It was noted that the meeting venue was small and could accommodate relatively few participants. Dr Hewitt had agreed to convene the workshop;

(ii) workshop participants were requested to submit their full sets of data on indices (i.e. without combining similar indices). Participants were, however, encouraged to undertake analyses of their own data in advance of the workshop and to report their results to it; and

(iii) the CCAMLR Data Manager should attend the workshop and that secretarial support from the CCAMLR Secretariat should also be requested. This recommendation is motivated by the nature and scope of the workshop, particularly since diverse sources of data will be used and data in the CCAMLR database are likely to be considered.

Future Work

6.54 The Scientific Committee noted the considerable amount of work identified by WG-EMM which will be required in the future (Annex 4, paragraphs 10.1 to 10.52). This work covers many aspects of WG-EMM's work including: fisheries information, harvested species, methods, biomass survey, dependent species standard methods, environment, ecosystem analysis, and collaboration with IWC.

Advice to the Commission

6.55 Advice to the Commission in relation to precautionary catch limits for krill is given in paragraphs 6.33 and 6.34.

6.56 The Scientific Committee recommended that a workshop to consider the coherence of process relating to environment, krill and dependent species between Subareas 48.1, 48.2 and 48.3 be held during the intersessional period.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY ABOUT STOCK SIZE AND SUSTAINABLE YIELD

Lapsed Fisheries

7.1 The Scientific Committee has been requested to develop a formal procedure for dealing with lapsed fisheries (CCAMLR-XV, paragraph 9.6), especially concerning the conditions for reopening such fisheries.

7.2 A registry of fisheries in the CCAMLR Convention Area is contained in SC-CAMLR-XVI/BG/16 Rev. 2. There are no specific guidelines for which fisheries should be regarded as lapsed, but a number of fisheries were considered in this document to fall within this category. Some additions were made during the Scientific Committee meeting, and a consolidated list is in Table 6.

7.3 The Scientific Committee stressed that lapsed fisheries should be reopened according to precautionary principles. Resumption of such fisheries should involve prior notification and a data collection plan similar to those required for exploratory fisheries as developed at WG-FSA-97 and detailed in Appendix E of Annex 5.

7.4 The Scientific Committee considered that one potential approach to defining a fishery as lapsed is to consider the time period since the last commercial fishing activity, and the level of information about the current status of the resource. For some fisheries, this information level is proportional to the time since commercial fishing last took place. For others, there are non-commercial sources of information, such as research surveys. In all cases, the rate at which information becomes less relevant depends partly on the biology of the species in question, and in particular on the rate of turnover of the stock. Such stock-specific characteristics emphasise the merit of deciding on a case-by-case basis whether a fishery has lapsed.

7.5 The Scientific Committee considered examples of fisheries in the Convention Area which could be considered as lapsed.

(i) The fisheries for *P. antarcticum*, *C. wilsoni* and *T. eulepidotus* in Division 58.4.2 have never been assessed by WG-FSA. Given the time period since commercial catches were last taken (1990) the Scientific Committee considered that these fisheries should be classified as lapsed. In general, it would be appropriate to define such fisheries as lapsed after a simple time period since catches were last reported (say three or five years).

(ii) The fishery for *E. carlsbergi* in Subarea 48.3 has previously been formally assessed and management advice has been provided to the Commission. There has been no commercial catch in this fishery since 1992. At the time of the last assessment, a precautionary catch limit was adopted, which takes uncertainty into account and remains applicable until such time as the fishery is reassessed. If the fishery is resumed the collection of data required to update the assessment, including the undertaking of a survey (Conservation Measure 103/XV), is a high priority.

Long-term Management Strategy for *C. gunnari*

7.6 In 1997 WG-FSA began to develop methods for a long-term management strategy for *C. gunnari*, as requested by the Commission. The Commission's current decision rules on determining long-term yield cannot be applied because of the large natural variations in spawning stock biomass. This problem is dealt with fully in paragraphs 5.58 to 5.65 of this report.

Feedback Management for *D. eleginoides*

7.7 The Commission at its last meeting (CCAMLR-XV, paragraph 9.8) expressed concern that the abundance of the total *D. eleginoides* stock cannot be directly assessed from estimates of abundance of young fish by trawl surveys, as is current practice. WG-FSA and the Scientific Committee are aware of the need to be able to monitor the status of the total stock over the longer term, but as yet little progress has been made.

7.8 This problem is highlighted in the *D. eleginoides* fishery in Subarea 48.3. Here the predicted trend over a number of years in the spawning stock biomass from the GYM, and the trend in standardised CPUE derived with the GLM appears to be in conflict (paragraph 5.55). Further work is necessary to develop methods to take into account more than one indicator of the status of the stock, particularly when they are different.

7.9 Another major problem of managing under uncertainty is in the new and exploratory fisheries for *D. eleginoides*, where a lack of local data requires that information has to be extrapolated from other areas (paragraphs 9.53 to 9.71). A major problem is the lack of fisheries-independent data. For example, trawl surveys to assess stock biomass are required in each area to provide direct estimates of recruitment for use in assessments using current methodology. Other problems arise from having a high level of unreported catches compared to reported catches in some areas, which introduces a high degree of uncertainty about the status of the fish stocks.

7.10 Dr Øritsland informed the Scientific Committee about a symposium on 'Objectives and uncertainties in fisheries management with emphasis on three North Atlantic ecosystems' held in Bergen, Norway, from 2 to 5 June 1997 (SC-CAMLR-XVI/BG/8). The Scientific Committee welcomed this development and looked forward to the results being published in a special issue of *Fisheries Research*. They will be a useful addition to the Scientific Committee's deliberations on managing under uncertainty.

SCIENTIFIC RESEARCH EXEMPTION

8.1 The Scientific Committee noted the notifications by Members of scientific research surveys planned for the 1997/98 intersessional period (SC-CAMLR-XVI/BG/17, Table 5).

8.2 Dr Gubanov outlined the proposal by Ukraine to conduct a survey in Subareas 48.1 and 48.2 (SC-CAMLR-XVI/BG/9). This multidisciplinary oceanographic survey is scheduled to begin in December 1997 and extend into 1998. The survey will focus on oceanographic and hydrologic work, and will follow a sampling design similar to that used in a survey conducted earlier in 1997. The research vessel did not have the capacity to deploy trawls. The Scientific Committee noted this submission, and agreed that this survey would be administered under Conservation Measure 64/XII (paragraph 2, total catch < 50 tonnes).

8.3 Dr Balguerías outlined the proposal by Spain to conduct a longline survey in Subarea 48.6, outside territorial waters, and Division 58.4.4, and in waters in FAO Area 47 (SC-CAMLR-XVI/5). The survey, as notified by COMM CIRC 97/42, was to take place from 20 September to 20 October 1997. However, the survey had been postponed, and would now take place during October/November 1997. The survey would last about 45 days, and commercial longlines shortened to about 1 500 commercial-sized hooks, would be used to sample *D. eleginoides*. Conservation Measure 29/XV would be applied to minimise the incidental capture of seabirds and mammals, and the total catch is expected to be less than 50 tonnes.

8.4 Dr Balguerías also advised that the same configuration of longlines would be used throughout the survey. There were no specific plans to report unregulated fishing activities which may be encountered in the survey area, however these could be noted. The charter vessel, *Ibsa Quinto*, would not be carrying a CCAMLR inspector during the survey.

8.5 The Scientific Committee noted that, in accordance with Conservation Measure 64/XII (paragraph 1a), catches of *D. eleginoides* taken during the survey would be held against any catch limit in force. Further, because the fishing season was closed, catches would be held against catch limits for the 1997/98 season.

8.6 Dr Holt advised that the USA intended to conduct a stratified random bottom trawl survey for finfish during March/April 1998 in Subarea 48.1 (CCAMLR-XVI/MA/14). The total catch was expected to be less than 50 tonnes.

8.7 Prof. Moreno sought clarification as to whether the 50-tonne catch limit applied to each subarea surveyed during one cruise, or to the total catch taken during a cruise. The Scientific Committee agreed that the generic condition in the interpretation of Conservation Measure 64/XII was that the 50-tonne catch limit applied to each research cruise.

8.8 The Scientific Committee recalled the Commission's request to review the applicability of the 50-tonne limit in Conservation Measure 64/XII (CCAMLR-XIV, paragraph 8.7). The Scientific Committee noted that, in the absence of any new information from Members, WG-EMM had not be able to give this matter further consideration. In view of this, Scientific Committee was unable to comment further on the applicability of the 50-tonne limit.

NEW AND EXPLORATORY FISHERIES

New Fisheries in the 1996/97 Season

9.1 There were seven new fisheries operating in 1996/97 fishing season. Summary information on these is given in Table 7. Data received by the Secretariat in relation to these fisheries were summarised in Annex 5, Table 2.

9.2 Throughout this section, a split-year is the statistical reporting period which runs from 1 July in one year through to 30 June in the following year. Thus, for example, the 1997 split-year refers to the period from 1 July 1996 to 30 June 1997. Fishing seasons do not necessarily align with split-years, although catch data are frequently summarised by split-year. For new and exploratory fisheries, the fishing seasons are explicitly set out in individual conservation measures. Thus, the 1996/97 fishing season for *M. hyadesi* in Subarea 48.3 covers the period 2 November 1996 to 7 November 1997 (Conservation Measure 99/XV). In Table 7 below the reported catches correspond to those taken within the appropriate fishing seasons.

New Fishery for *M. hyadesi* in Subarea 48.3

9.3 A total catch of 81 tonnes was reported for the Republic of Korea/UK new fishery for *M. hyadesi* in Subarea 48.3. This was taken by a single vessel in 14 days during June/July 1997; fishing operations by this vessel for six days in January 1997 had failed to locate squid. The low effort expended in this fishery resulted largely from an unusually good and extended season for *Illex argentinus* in the southwest Atlantic (CCAMLR-XVI/21).

New Fisheries for *Dissostichus* spp. in Subarea 48.6 and Division 58.4.4

9.4 For administrative reasons, the new fisheries for *D. eleginoides* and *D. mawsoni* notified by South Africa for Subarea 48.6 and Division 58.4.4 did not take place.

New Fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7

9.5 A total of 2 521 tonnes of *D. eleginoides* were taken between October 1996 and 31 August 1997 in the new fisheries notified by South Africa for Subareas 58.6 and 58.7. This comprised 1 200 tonnes taken in the South African EEZ around Prince Edward Islands up to late January 1997 (CCAMLR-XVI/8 Rev. 1), a further 1 320 tonnes taken in the South African EEZ around Prince Edward Islands between 1 March and 31 August 1997, and around 400 kg taken outside the EEZ in Subareas 58.6. and 58.7. Approximately half the catches in the South African EEZ were taken in Subarea 58.6.

9.6 It was noted that, at least in respect of the fishery within the Prince Edward Islands EEZ, the results of the reported fishing operations had established that the fishery was commercially viable.

New Fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2

9.7 For a number of reasons, fishing operations in the new fisheries for *D. eleginoides* and *D. mawsoni* notified by New Zealand for Subareas 88.1 and 88.2 did not commence until May 1997

(CCAMLR-XVI/17). Given the later start to fishing, extensive sea-ice coverage greatly restricted fishing operations. Only two sets were made, resulting in a total catch of 128 kg of *D. eleginoides*.

9.8 Dr D. Robertson (New Zealand) explained that, in relation to the information recorded in Annex 5, the total catch had actually been taken from Subarea 88.1, with no fishing having occurred in Subarea 88.2.

New Fisheries for *Dissostichus* spp. in Division 58.4.3

9.9 New fisheries had been notified in 1996 for *Dissostichus* spp. in Division 58.4.3 by Australia and South Africa. In the Australian fishery, bottom trawls were to be used; in the South African fishery, longlines were to be used.

9.10 For administrative reasons, no fishing was undertaken in Division 58.4.3 by South African vessels. Limited fishing by an Australian vessel on BANZARE and Elan Banks resulted in a catch of 7 kg of *D. eleginoides* on Elan Bank. A VMS trial was successfully carried out.

New Fishery for Deepwater Species in Division 58.5.2

9.11 No catches of the intended species were made in the new fishery for deepwater species not covered by Conservation Measure 109/XV and 110/XV, which was notified by Australia in Division 58.5.2. Australia currently has no interest in progressing further with this fishery.

New Fisheries Notified for 1997/98

9.12 A number of the notifications for new or exploratory fisheries in 1997/98 were for fisheries that had been new fisheries in 1996/97. In some cases, no fishing had taken place and new fisheries had been re-notified. In other cases, however, very small catches had been taken during 1996/97 and Members had taken different approaches to notifications for these fisheries in 1997/98; Australia submitted a notification for an exploratory fishery, while the New Zealand and UK/Republic of Korea notifications were for new fisheries. In these cases, the Scientific Committee agreed to provide advice in relation to both Conservation Measures 31/X (for new fisheries) and 65/XII (for exploratory fisheries).

9.13 In several notifications for new and exploratory fisheries, it had not been specifically indicated that all the data collection and submission requirements of Conservation Measures 112/XV and 117/XV would be met. The Scientific Committee recommended that the data collection and submission requirements of these measures should be continued for both these conservation measures.

9.14 Experience gained in the South African new fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 suggested that compliance with those aspects of Conservation Measure 112/XV relating to fine-scale rectangles was feasible, but only if very good positional information was available, such as from VMS.

New Fishery for *M. hyadesi* in Subarea 48.3

9.15 The UK and the Republic of Korea submitted a notification (CCAMLR-XVI/21) for a new fishery for *M. hyadesi* in Subarea 48.3. This fishery had been notified as a new fishery for 1996/97, however a very small catch (81 tonnes) was taken.

9.16 The proposal was for two vessels to operate, taking between 800 and 1 200 tonnes per vessel, with a maximum catch of 2 500 tonnes. An analysis of future prospects for the fishery is given in SC-CAMLR-XVI/BG/10. Biological information and potential effects on dependent species were discussed in detail by WG-FSA last year and these issues were further considered by WG-EMM (Annex 4, paragraphs 6.83 to 6.87).

9.17 An outline data collection plan for this fishery is given in Appendix E to Annex 5. Development of this plan is the only additional requirement should the fishery be classified by the Commission as an exploratory fishery, rather than a new fishery. The Scientific Committee agreed that the scientific observer required for the squid fishery in this plan should be appointed under the CCAMLR Scheme of International Scientific Observation.

9.18 The Scientific Committee recommended that the existing conservation measure for this fishery (Conservation Measure 99/XV) should be carried over for the coming 1997/98 season with a modification to include the appointment of CCAMLR observers (see paragraph 9.17). It would also be necessary for the Commission to decide whether this fishing should be classified as a new or exploratory fishery. If classified as an exploratory fishery, the appropriate data collection plan is specified in Appendix E to Annex 5.

New Fishery for *D. eleginoides* in Division 58.4.4

9.19 Ukraine submitted a notification (CCAMLR-XVI/6) for a new fishery for *D. eleginoides* in Division 58.4.4.

9.20 Very little information is available to CCAMLR about the abundance and status of fish stocks in this division. However, CCAMLR-XVI/6 reveals the existence of data from a long series of trawl surveys conducted by Ukraine since 1971. None of these data have yet been submitted to CCAMLR, and the Scientific Committee recommended that Ukraine be requested to submit these data as soon as possible. Had these data been available in the CCAMLR database, the Scientific Committee believed that a thorough assessment of stock status similar to those undertaken in Subarea 48.3 and Division 58.4.2 could have been conducted and sound advice provided.

9.21 Dr Gubanov explained that the biomass estimates were based on by-catches of *D. eleginoides* (up to 2% of catches) in a trawl survey targeting primarily *L. squamifrons*. He noted that as the new fishery starts, more information on *D. eleginoides* will be forthcoming.

9.22 By-catches of *Bathyraja* spp., *M. whitsoni* and *M. marmoratus* are likely in this new fishery. Also, at shallower depths in the range proposed to be fished it is possible that *L. squamifrons* and *N. rossii* will be taken.

New Fisheries for *Dissostichus* spp. in Subarea 48.6
and Divisions 58.4.3 and 58.4.4

9.23 South Africa submitted a notification (CCAMLR-XVI/6) for new fisheries for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.3 and 58.4.4. In 1996/97, there were new fisheries notified by South Africa for Subarea 48.6 and Division 58.4.4, but these were not fished. The South African notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

9.24 The Scientific Committee observed that the notification for Division 58.4.4 is for a fishery in the same area as the Ukrainian notification discussed above. Australia has notified an exploratory trawl fishery for Division 58.4.3 in 1997/98.

9.25 Dr E. Marschoff (Argentina) noted that there was a potential overlap between the new fisheries in Divisions 58.4.3 and 58.4.4 and CEMP ISRs. It was noted that these ISRs were set up to study potential long-term impacts of krill fisheries on related and dependent species. At least in the short term, there appeared to be no problem with any overlap of these new fisheries with the ISRs.

New Fisheries for *Dissostichus* spp.
in Subareas 88.1 and 88.2

9.26 New Zealand submitted a notification (CCAMLR-XVI/17) for new fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2. A very small catch (128 kg) was taken in Subarea 88.1 in a new fishery undertaken by New Zealand in 1996/97. No fishing was carried out in Subarea 88.2. The New Zealand notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

9.27 It would be necessary for the Commission to decide whether this fishery should be classified as a new or exploratory fishery. If classified as an exploratory fishery, the appropriate data collection plan is given in Appendix E to Annex 5.

New Fishery for *D. eleginoides* in Subarea 48.6

9.28 Norway submitted a notification (CCAMLR-XVI/10) for a new fishery for *D. eleginoides* in Subarea 48.6. A new fishery had been notified by Norway for this subarea for 1996/97, but it was not fished.

9.29 As was the case with the notification submitted by Norway last year, WG-FSA had been unable to comment on the current notification, because of the lack of information provided. WG-FSA did query, however, the restriction of the notification to *D. eleginoides* only, since if fishing operations took place towards the southern part of Subarea 48.6, it is likely that *D. mawsoni* may also be taken.

9.30 Dr Øritsland apologised for the lack of detail provided in the notification. He provided the following supplementary information. The new fishery would be targeted at both *D. eleginoides* and *D. mawsoni*. There is no existing knowledge of the distribution, abundance or demography of either species in this subarea. One Norwegian flagged vessel (*Skarheim*) will participate in the fishery during the 1997/98 season. Fishing will be by Mustad longlines only. The planned fishing season is from 1 March to 31 August. The vessel will be fitted with VMS. Data will be collected and reported in full accordance with Conservation Measures 112/XV, 51/XII, 117/XV and 40/X. A CCAMLR scientific observer will be carried, if available, and all requirements of Conservation Measure 29/XV for mitigation of seabird mortality will be met. Plastic packaging bands will not be carried.

New Fisheries for *Dissostichus* spp.
in Subareas 48.1, 48.2 and 88.3

9.31 Chile submitted a notification (CCAMLR-XVI/9) for new fisheries for *Dissostichus* spp. in Subareas 48.1, 48.2 and 88.3. This notification and comprehensive supplementary information was discussed at length by WG-FSA.

9.32 For Subareas 48.1 and 48.2, there are conservation measures in force that prohibit directed fishing for finfish, at least until such time as a survey of stock biomass has been carried out, its results have been analysed, and a decision to reopen the fishery has been made by the Commission based on the advice of the Scientific Committee (Conservation Measure 72/XII and 73/XII). These had been imposed because of concerns about the status of finfish species vulnerable to capture in trawl fisheries in relatively shallow waters. The new fishery proposal was for longlining in deeper waters using the Spanish system. Examination of by-catches by longliners fishing for *D. eleginoides* in Subarea 48.3 suggested that if the Spanish system is used and longlining is restricted to depths greater than 600 m, it is unlikely that there would be any threat to the species of concern in these conservation measures.

9.33 Although the limited information available to the Scientific Committee suggests that the by-catch rates of the most likely by-catch species (skates and *Macrourus* spp.) are likely to be low, the Scientific Committee urged that an additional by-catch provision similar to that in Conservation Measures 109/XV, 110/XV and 111/XV be adopted, under which vessels move to another fishing location if the by-catch of species other than *D. eleginoides* or *D. mawsoni* in any one longline set exceeds 5%, subject to the modification suggested in CCAMLR-XVI/12 (see Annex 5, paragraphs 4.43 to 4.46).

9.34 The principal concern raised by Members regarding Subareas 48.1 and 48.2 was that the little information that existed from past scientific surveys suggested that the abundance of *D. eleginoides* and *D. mawsoni* in these areas may be very low. In this context, attention was drawn to the very low abundances of juvenile *D. mawsoni* in research surveys in these areas, in comparison with juvenile abundance estimates for *D. eleginoides* from surveys in Subarea 48.3, although it was noted that *D. mawsoni* may be more pelagic in its habits (WG-FSA-97/19 and 20), thus making it less vulnerable to capture in a bottom trawl survey.

9.35 Dr Holt observed that the approach planned by Chile, which involved first conducting a longline survey using one vessel and using the results of this to decide whether to proceed with further fishing was a very useful one. In view of the existing conservation measures and the likely low abundance of *Dissostichus* in the region, he would prefer that the results of the longline survey be reported to and discussed by the Scientific Committee before commercial fishing activities were undertaken.

9.36 Prof. Moreno noted that Conservation Measure 31/X (new fisheries) does not specify a requirement for an initial survey, followed by an analysis of the data during the next WG-FSA meeting, as a condition for the continuance of a new fishery proposal.

9.37 Prof. P. Arana (Chile) stated that the first stage of the proposed new fishery by Chile, which involves conduct of an initial survey, will guarantee that no fishing will take place in those areas where low abundances of *Dissostichus* spp. are found.

New Fisheries for *D. eleginoides* in Subareas 48.1, 48.2 and 48.4

9.38 Uruguay had submitted a preliminary notification by letter for new fisheries for *D. eleginoides* in Subareas 48.1, 48.2 and 48.4. This was discussed briefly by WG-FSA (Annex 5, paragraphs 4.53 to 4.58). During the Scientific Committee meeting, it was clarified by Uruguay that this had been a notice of intent only, and that no fishing will be carried out during the coming season.

New Fisheries for *Dissostichus* spp. in Divisions 58.4.4, 58.5.1, 58.5.2 and Subareas 58.6 and 58.7

9.39 The Scientific Committee noted that the proposal by France for exploratory fisheries in Divisions 58.4.4, 58.5.1 and 58.5.2 and Subareas 58.6 and 58.7 (outside EEZs) had arrived too late to be considered by WG-FSA. The Scientific Committee therefore agreed that these proposals could not be considered this year; they should be resubmitted (with full documentation) for evaluation at next year's meeting of WG-FSA.

Exploratory Fisheries Notified for 1997/98

9.40 One of the requirements of Conservation Measure 65/XII is that the Scientific Committee shall develop a data collection plan for each exploratory fishery. Outline data collection plans suitable for longline fisheries and for trawl fisheries for *Dissostichus* spp. and for jig fisheries for squid were developed by WG-FSA and they are given in Appendix E of Annex 5. These were accepted by the Scientific Committee (see also paragraph 9.17).

9.41 The Scientific Committee noted that in the preamble to Conservation Measure 65/XII, the Commission had agreed that exploratory fishing should not be allowed to expand faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles set forth in Article II. A vital element in ensuring this is the ability of the Scientific Committee to conduct stock assessments. For *Dissostichus* spp., the assessment methods available to the Scientific Committee all require research survey estimates of biomasses.

The Scientific Committee agreed that the conducting of research surveys would be an essential element of the development of exploratory fisheries. In this context, the Scientific Committee welcomed the inclusion of plans for the early conduct of research surveys in the notifications by South Africa and Australia.

Exploratory Fishery for *Dissostichus* spp. in Division 58.4.3

9.42 Australia submitted a notification by letter (received 19 September 1997) for an exploratory fishery for *Dissostichus* spp. in Division 58.4.3. A new fishery had been notified for this division by Australia for 1996/97; only 7 kg of *D. eleginoides* had been taken.

9.43 The Scientific Committee noted the detailed research and data collection plan for this fishery given in WG-FSA-97/31. Random stratified trawl surveys are planned for both BANZARE and Elan Banks, though surveys of both banks will not necessarily be completed in the first year. When these surveys have been completed, it should be possible for the Working Group to conduct stock assessments using the methods employed currently for Subarea 48.3 and Division 58.5.2.

Exploratory Fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 outside EEZs

9.44 Notifications have been submitted for exploratory fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 outside EEZs by South Africa (CCAMLR-XVI/8), Ukraine (CCAMLR-XVI/6) and Russia (by letter, received 20 August 1997).

9.45 A new fishery had been notified for these subareas by South Africa for 1996/97. A total of 2 521 tonnes of *D. eleginoides* had been taken by 31 August 1997, almost all within the EEZ around Prince Edward Islands. In addition, very large unreported catches were estimated to have been taken in these subareas. The notification by South Africa is intended to cover longline fishing only outside the Prince Edward Islands EEZ.

9.46 The Scientific Committee noted the detailed research, data collection and fishing plans tabled in CCAMLR-XVI/8 Rev. 1. It welcomed the fact that the research plan also envisages that a research survey will be completed in the two subareas within the first two years. This should enable the Working Group to conduct stock assessments using the methods employed currently for Subarea 48.3 and Division 58.5.2.

9.47 Practical experience gained with application of the 100-tonne fine-scale rectangle catch limit indicated there were some problems in its application. Consideration should be given to some relaxation of this limit in appropriate areas.

9.48 The original Ukrainian notification (CCAMLR-XVI/6) was for a new fishery, but on the advice of the Secretariat it has been treated here as for an exploratory fishery. There was insufficient information provided to allow the Scientific Committee to evaluate what was intended.

9.49 Dr Gubanov commented that the additional information needed could be supplied. He expressed concern, however, that if insufficient information is supplied, the conduct of a legal fishery in an area where there is very substantial unregulated fishing may be jeopardised.

9.50 The information provided in the Russian letter of notification was also insufficient for the Working Group to comment. Dr Shust apologised for the lack of information and provided the following. One longline vessel would participate, with a planned catch of around 700 tonnes. A CCAMLR scientific observer will be carried, and all conservation measures governing data collection and submission will be strictly adhered to, as will the measures relating to mitigation of incidental mortality. The data collection plan (Appendix E, Annex 5) will be followed as far as possible. The vessel is new, and he was unsure whether it was equipped with a VMS.

9.51 In Subareas 58.6 and 58.7, the Scientific Committee was concerned that there have been three new or exploratory fishing operations notified outside EEZs (South Africa, Ukraine and Russia). It is vital that there be very careful planning to ensure that all the appropriate data are collected and reported in a timely manner. It is also vital that fishing plans be coordinated in order to ensure that fishing effort is widely distributed, both spatially and throughout the year. In this respect it is essential that all participating vessels have accurate position fixing equipment fitted (such as VMS) and that the data reporting protocols are adequate.

9.52 The view was also expressed that it may be appropriate to impose restrictions on the total fishing effort to be expended in these subareas. In this context, Prof. G. Duhamel (France) advised that in the Crozet EEZ, only one vessel will be authorised to fish, and that very limited fishing effort is foreseen spatially and throughout the year.

Precautionary Catch Levels for New and Exploratory Fishing

9.53 Last year, WG-FSA had agreed that a conservative approach to advising on precautionary catch limits for new fisheries would be to extrapolate from estimated yields for *D. eleginoides* in Subarea 48.3 and Division 58.5.2 in a manner that is discounted to take implicit account of incomplete knowledge of previously unexploited areas and/or adjusted for the relative areas of fishable seabed (SC-CAMLR-XV, Annex 5, paragraph 4.28). However, in the absence of available data on seabed areas, it had been unable to complete these calculations.

9.54 During this year's meeting, the Secretariat calculated, for each subarea and division, the seabed areas in three depth ranges: 0 to 600 m (possibly representative of juvenile habitat), 600 to 1 800 m (longline fishing depths) and 500 to 1 500 m (trawl fishing depths). These calculations used Sandwell-Smith global sea floor topography data and computer programs (SC-CAMLR-XVI/BG/17).

9.55 Because this dataset is sparse in high latitude areas, estimates were only calculated for seabed areas in the nominated depth ranges north of 70°S. WG-FSA had agreed that this may result in a considerable underestimation of seabed area if there are substantial areas of shallow water in high latitudes. For instance, the degree of underestimation may be quite large in Subareas 88.1 and 88.2 (Ross Sea) and in a lesser measure in Subarea 88.3. Also, it is likely that seabed areas in regions with large numbers of isolated seamounts are underestimated.

9.56 During the Scientific Committee review of the seabed area calculations performed by WG-FSA, New Zealand tabled a document that contained alternative calculations of seabed areas for Subareas 88.1 and 88.2, including the areas south of 70°S, which used the GEBCO standard International Hydrographic Organisation (IHO) bathymetry data. A summary prepared at the Scientific Committee's request by the rapporteur is given in paragraph 9.57 below.

9.57 The New Zealand document reported calculations which resulted in estimated seabed areas between 600 and 1 800 m of 238 011 km^2 for Subarea 88.1 and 191 470 km^2 for Subarea 88.2. The seabed areas calculated by WG-FSA for the two subareas were 82 322 and 3 288 km^2 respectively. If these revised seabed areas were used, very much higher catch limits would have resulted than those calculated by WG-FSA (see Table 5). The New Zealand document concluded that it did not propose that tonnages as high as those derived from the corrected seabed calculations should necessarily apply, and suggested that precautionary catch limits for *Dissostichus* spp. should be combined within each of these two subareas, perhaps after use of an appropriate discount factor.

9.58 The Scientific Committee agreed that this submission had been received too late for it to be considered properly. It therefore agreed that it should pass on the information contained in paragraph 9.57 to the Commission without further comment. It recommended, however, that in the intersessional period, the Secretariat should undertake a comparative analysis of seabed areas calculated using the Sandwell-Smith and GEBCO data (including areas north of 70°S), and that WG-FSA should consider this at its next meeting. It also recommended that, should other Members know of other useful bathymetric data, these should be submitted to CCAMLR well in advance of the next WG-FSA meeting.

9.59 In relation to Subareas 58.6 and 58.7, Mr L. Jordaan (South Africa) observed that areas to the immediate north of the CCAMLR boundary had also been left out of the calculations (Annex 5, paragraph 4.97). He noted that economically viable catches had been taken to the north of the CCAMLR boundary, both inside and outside of the Prince Edward Islands EEZ. Adult fish had also been taken in depths less than 600 m in these subareas. Mr Jordaan further commented on the possible impact of this on stock assessments.

9.60 The method used by WG-FSA to calculate possible precautionary catch limits for *D. eleginoides* and *D. mawsoni* is detailed in paragraphs 4.99 to 4.105 of Annex 5. In brief, the method involved the following elements:

(i) proportional adjustments for areas of fishable seabed (between 600 and 1 800 m for longline fisheries, between 500 and 1 500 m for trawl fisheries) and for the latitudinal zones in which the two species were believed to be found;

(ii) calculations using the GYM with biological and fishery parameters set at the values most appropriate for the area under consideration;

(iii) allowances were made for the recent catch history, including estimated unreported catches; and

(iv) yield levels calculated in this way were then multiplied by 0.45 for *D. eleginoides* and 0.3 for *D. mawsoni*.

9.61 The resulting estimates are given in Table 5. WG-FSA had then recommended that, with the exception of *D. eleginoides* in Subarea 48.4, for which a catch limit of 28 tonnes should apply (see Annex 5, paragraph 4.123), the precautionary catch limits in Table 5 should be applied for new and exploratory fisheries. Comments relating to existing conservation measures for Subareas 48.1 and 48.2 are given in paragraphs 9.32 and 9.33. Additional comments are given in relation to new fisheries in Subareas 48.1 and 48.2 (paragraphs 9.34 and 9.36).

9.62 In a number of cases, the calculated precautionary catch limits in a subarea for either *D. eleginoides* or *D. mawsoni* shown in Table 5 were zero or very low. The Scientific Committee agreed with the conclusion of WG-FSA that it would be quite inappropriate to insist, for example, that a new fishery should cease if a zero or low precautionary catch limit on one species was inadvertently exceeded. Rather, it recommended that some flexibility be applied, perhaps by allowing a limited proportion of the catch limit for each *Dissostichus* spp. to be transferred between *D. eleginoides* and *D. mawsoni* if necessary.

9.63 At the time of adoption of the report, Dr Gubanov believed that the catch limit of 580 tonnes for *D. eleginoides* in Division 58.4.4 (Table 5) was not sufficiently justified as compared with the limit of 1 980 tonnes in the 1996/97 season.

9.64 Other Members responded that at last year's meeting WG-FSA and the Scientific Committee had been unable to take account of the area of seabed of the appropriate depths when calculating the limit of 1 980 tonnes. This year's calculations take this into account as well as the estimates of unreported catches (see paragraph 9.60).

9.65 The Scientific Committee agreed with the view of WG-FSA that the calculation method used was, scientifically, the best available given the existing information, and that it was essentially the method it had wanted to use last year, but had been unable to because of the lack of estimates of areas of fishable seabed.

9.66 However, it wished to emphasise that there were a number of important intrinsic uncertainties in the procedure that meant the results must be interpreted with considerable caution.

(i) First, as was noted last year (SC-CAMLR-XV, Annex 5, paragraph 4.30), the values calculated for precautionary limits should not be taken to imply that such quantities of fish would actually be available for capture.

(ii) The calculation procedure relies explicitly on extrapolation from assessments of existing fisheries for *D. eleginoides*. In particular, it makes the assumption that the recruitment rate per unit area of fishable seabed is the same across all areas. In some areas (e.g. Crozet) the approach has produced precautionary catch limits that were consistent with independent information on yield levels, but in most areas there are no data with which to test the accuracy of this assumption.

(iii) There is much greater uncertainty associated with the calculations for *D. mawsoni*, a species about which very little at all is known. This is reflected in part in the greater discount factor used for uncertainty (0.3), but it must be emphasised that this factor and the 0.45 factor for *D. eleginoides* (CCAMLR-XV, paragraph 8.17) used in the calculations are arbitrary. The appropriate degree of precaution to apply is seen as a matter on which the Commission must decide.

9.67 There were differences of opinion amongst Scientific Committee Members as to the extent to which these uncertainties cast doubt on the usefulness of the calculations for setting precautionary catch limits for new and exploratory fisheries.

9.68 Some Members believed that the lack of knowledge about some areas, and especially about *D. mawsoni*, was such that the Commission may wish to consider use of alternative methods for regulating new and exploratory fisheries. One such alternative method was first to require a survey or very limited fishing to be carried out in areas notified for new or exploratory fisheries and for the results to be reported and considered by CCAMLR before any commercial fishery commenced. Such a method has been used previously, for example, for *D. eleginoides* in the South Sandwich Islands (Subarea 48.4).

9.69 Other Members, while acknowledging the great value of fishery independent survey data, and their key role in the early stages of development of exploratory fisheries as already noted, believed there was a great danger in application of an alternative uniform approach that ignored the different amounts of information available for different areas. For some areas there is indeed no past history of fishing (regulated or unregulated) and little knowledge, but in others there has been well documented extensive unregulated fishing and other information available which should not be ignored. The calculation method used, while imperfect and to some extent arbitrary, did take account of existing information, including estimates of unregulated catches. The Commission could, of course, set different discount factors to those used in the calculations if it desired.

9.70 A further advantage cited for setting precautionary catch limits compatible with a regulated commercial catch for those areas with currently large unregulated catches is that the presence of legal new fishery operations will mean at least some fishery information is forthcoming to CCAMLR.

9.71 It was not possible to consider these issues at greater depth during this meeting. The Scientific Committee agreed that the range of views should be passed on to the Commission.

General Comments

9.72 The large number of notifications for new and exploratory fisheries for 1997/98, along with the need to review the results of new fisheries notified for 1996/97, meant that a large part of the time available to WG-FSA and to the Scientific Committee was devoted to discussing this topic.

9.73 The Scientific Committee was disappointed by the large variation in the amount of information contained in the notifications. In many cases, there was insufficient information to develop useful advice and in some cases the notifications referred to data and analyses not available to the Scientific Committee.

9.74 The Scientific Committee noted the experience in several fisheries that compliance with Conservation Measure 112/XV requires each vessel to have very accurate positioning information, which in each case, would require the installation of a VMS on each vessel.

Avoiding Incidental Mortality in New and Exploratory Fisheries

9.75 The Scientific Committee then examined the proposals for new and exploratory longline fisheries in relation to the management advice provided in respect of avoiding incidental mortality of seabirds (Annex 5, paragraphs 7.118 to 7.131, 7.148(xv); see also paragraph 4.62).

9.76 Table 8 summarises the main information of relevance. This indicates that:

(i) there is no difference between the advice in respect of avoiding seabird by-catch and the proposals for longline fishing seasons and operations for Subareas 48.4, 48.6, 88.1, 88.2 and 88.3; and

(ii) for Subareas 48.1 and 48.2, there is a one-month overlap (October) between the suggested restriction to the longline fishing season to protect seabirds from risk of by-catch and the duration of longline fishing indicated in the proposals for the new fisheries.

9.77 Some concern was raised in respect of Subareas 48.6, 88.1, 88.2 and 88.3, that although no restriction of fishing season had been proposed in relation to avoiding the main breeding season of albatrosses and petrels, the recommendation to retain Conservation Measure 29/XV effectively imposed some restriction due to the limited hours of darkness available for fishing in the southern part of these areas at certain times of year.

9.78 The original assessments for these areas had noted that they are poorly known and that the potential for seabird–fishery interactions was probably underestimated in the assessments. The application of Conservation Measure 29/XV was recommended principally as a precautionary measure until better data are available. In fact, the fishing seasons proposed by Chile, New Zealand, Norway and South Africa largely took account of this; it was confirmed that they would all be complying with all aspects of Conservation Measure 29/XV.

9.79 South Africa and Norway proposed that the season south of 60°S in Subarea 48.6 should be extended to run from 15 February to 31 October, approximately in line with the season in other areas in high latitudes (i.e. Subareas 48.1, 88.1, 88.2 and 88.3).

9.80 It was noted that the use of new devices to avoid incidental mortality of seabirds, such as setting longlines underwater, may in future enable vessels to avoid restrictions to fishing seasons and also restrictions imposed by Conservation Measure 29/XV (see also paragraph 4.67).

9.81 The main difficulties in reconciling advice on seabird by-catch with the new and exploratory fishing proposals relate to the subareas and divisions of Area 58.

9.82 In Division 58.4.3 and for South Africa in Division 58.4.4, the only discrepancies were the planned commencement of fishing on 1 March, as opposed to the recommendation of 1 May in respect of avoiding seabird by-catch (see paragraph 4.61).

9.83 The proposals for summer longline fishing by Ukraine in Division 58.4.4 and Subareas 58.6 and 58.7, for year-round longline fishing by South Africa in Subareas 58.6 and 58.7 and for December–June longline fishing by Russia in Subareas 58.6 and 58.7 are not in accordance with the recommendation of WG-FSA that, from the perspective of achieving a significant reduction in seabird by-catch in these subareas by vessels operating within the CCAMLR regulations, longline fishing should not be undertaken between 1 September and 1 May (Annex 5, paragraphs 7.126(vi), (viii) and (ix) and 7.148(xxi)).

9.84 These differences and potential difficulties were drawn to the attention of the Commission, together with reference to paragraph 9.80 above and to comments relating to discouraging unregulated fisheries (Annex 5, paragraphs 4.84 and 7.128).

9.85 Concern was raised that several fisheries (Chile in Subareas 48.1, 48.2 and 88.3; South Africa and Norway in Subarea 48.6, south of 60°S) were continuing to the end of October. This meant that data for the last month or two of these fisheries would be unavailable for assessment and evaluation by WG-FSA.

9.86 It was agreed that in order to facilitate the work of WG-FSA all Members undertaking these fisheries would ensure that all data acquired to the end of the split-year (end of June) would be submitted to the Secretariat as soon as possible.

Management Advice

9.87 In several notifications for new and exploratory fisheries, it had not been specifically indicated that all the data collection and submission requirements of Conservation Measures 112/XV and 117/XV would be met. The Scientific Committee recommended that the data collection and submission requirements of these measures should be continued for both these conservation measures.

9.88 The Scientific Committee recommended that the existing conservation measure for the *M. hyadesi* fishery in Subarea 48.3 (Conservation Measure 99/XV) should be carried over for the coming 1997/98 season, however with a modification to include the appointment of CCAMLR scientific observers (see paragraph 9.17). It would also be necessary for the Commission to decide whether this fishery should be classified as a new or exploratory fishery. If classified as an exploratory fishery, the appropriate data collection plan is specified in Appendix E to Annex 5.

9.89 The Scientific Committee recommended that Ukraine be requested to submit historical trawl survey data for Division 58.4.4 as soon as possible.

9.90 For *Dissostichus* spp., the assessment methods available to the Scientific Committee all require research survey estimates of biomasses. The Scientific Committee agreed that the conducting of research surveys would be an essential element of the development of exploratory fisheries.

9.91 Practical experience gained with application of the 100-tonne fine-scale rectangle catch limit indicated there were some problems in its application. Consideration should be given to some relaxation of this limit in appropriate areas.

9.92 Fishable seabed area calculations for areas north of 70°S have been carried out this year as part of the process of developing advice on precautionary catch limits (paragraphs 9.54 and 9.55). The possible biasing effects of ignoring higher latitude waters were recognised, but the Commission's attention is drawn to further comments in relation to Subareas 88.1 and 88.2 by New Zealand (paragraphs 9.56 to 9.58). Other comments on seabed area calculations for Subareas 58.6 and 58.7 are in paragraph 9.59.

9.93 Precautionary catch limits calculated using the scientifically best available method are shown in Table 5. However, there are a number of important intrinsic uncertainties in the procedure that meant the results must be interpreted with considerable caution.

(i) First, as was noted last year (SC-CAMLR-XV, Annex 5, paragraph 4.30), the values calculated for precautionary limits should not be taken to imply that such quantities of fish would actually be available for capture.

(ii) The calculation procedure relies explicitly on extrapolation from existing assessments of currently operating fisheries for *D. eleginoides*. In particular, it makes the assumption that the recruitment rate per unit area of fishable seabed is the same across all areas. In some areas (e.g. Crozet) the approach has produced precautionary catch limits that were consistent with independent information of yield levels, but in most areas there are no data with which to test the accuracy of this assumption.

(iii) There is much greater uncertainty associated with the calculations for *D. mawsoni*, a species about which very little at all is known. This is reflected in part in the greater discount factor used for uncertainty (0.3), but it must be emphasised that this factor and the 0.45 factor for *D. eleginoides* used by the Commission in 1996 are arbitrary. The appropriate degree of precaution to apply is seen as a matter on which the Commission must decide.

9.94 Some Members believed that the lack of knowledge about some areas, and especially about *D. mawsoni,* was such that the Commission may wish to consider use of alternative methods for regulating new and exploratory fisheries. One such alternative method was first to require a research survey or very limited fishing to be carried out in areas notified for new or exploratory fisheries and for the results to be reported and considered by CCAMLR before any commercial fishery commenced. Such a method has been used previously, for example, for *D. eleginoides* in the South Sandwich Islands (Subarea 48.4).

9.95 Other Members, while acknowledging the great value of fishery independent survey data, and their key role in the early stages of development of exploratory fisheries as already noted, believed there was a great danger in application of an alternative uniform approach that ignored the different amounts of information available for different areas. For some areas there is indeed no past history of fishing (regulated or unregulated) and little knowledge, but in others there has been well documented extensive unregulated fishing and other information available which should not be ignored. The calculation method used, while imperfect and to some extent arbitrary, did take account of existing information, including estimates of unregulated catches. The Commission could, of course, set different discount factors to those used in the calculations if it desired.

9.96 A further advantage cited for setting precautionary catch limits compatible with a regulated commercial catch for those areas with currently large unregulated catches is that the presence of legal new fishery operations will mean at least some fishery information is forthcoming to CCAMLR.

9.97 In a number of cases, the calculated precautionary catch limits in a subarea for either *D. eleginoides* or *D. mawsoni* shown in Table 5 were zero or very low. The Scientific Committee agreed with the conclusion of WG-FSA that it would be quite inappropriate to insist, for example, that a new fishery should cease if a zero or low precautionary catch limit on one species was inadvertently exceeded. Rather, it recommended that some flexibility be applied, perhaps by allowing a limited proportion of the catch limit to be transferred between *D. eleginoides* and *D. mawsoni* if necessary.

9.98 In relation to reconciling potential management measures for seabird by-catch with fishing operation in relation to new and exploratory longline fisheries, Table 8 summarises the main information of relevance. This indicates that:

(i) there is no difference between the advice in respect of avoiding seabird by-catch and the proposals for longline fishing seasons and operations for Subareas 48.4, 48.6, 88.1, 88.2 and 88.3;

(ii) for Subareas 48.1 and 48.2, there is a one-month overlap (October) between the suggested restriction to the longline fishing season to protect seabirds from risk of by-catch and the duration of longline fishing indicated in the proposals for the new fisheries;

(iii) in Division 58.4.3 and for South Africa in Division 58.4.4, the only discrepancies are the planned commencement of fishing on 1 March, as opposed to the recommendation of 1 May in respect of avoiding seabird by-catch (see paragraph 4.61); and

(iv) the proposals for summer longline fishing by Ukraine in Division 58.4.4 and Subareas 58.6 and 58.7, for year-round longline fishing by South Africa in Subareas 58.6 and 58.7 and for December to June longline fishing by Russia in Subareas 58.6 and 58.7 are not in accordance with the recommendation of WG-FSA that, from the perspective of achieving a significant reduction in seabird by-catch in these subareas by vessels operating within the CCAMLR regulations, longline fishing should not be undertaken between 1 September and 1 May (Annex 5, paragraphs 7.126(vi), (viii) and (ix) and 7.148(xxi)).

9.99 It was re-emphasised that the advice in paragraph 9.98 above, also endorsed by the Scientific Committee in paragraph 4.61, does not take into account other potential considerations, such as fishery operational considerations and measures to combat unregulated fishing (Annex 5, paragraph 7.128).

9.100 It was noted that the use of new devices to avoid incidental mortality of seabirds, such as setting longlines underwater, may in future enable vessels to avoid restrictions to fishing seasons and also restrictions imposed by Conservation Measure 29/XV (see also paragraph 4.67).

9.101 It was agreed that in order to facilitate the work of WG-FSA all Members undertaking longline fisheries continuing until October would ensure that all data acquired to the end of the split-year (end of June) would be submitted to the Secretariat as soon as possible (paragraph 9.86).

9.102 Concern was raised that several fisheries (Chile in Subareas 48.1, 48.2 and 88.3; South Africa in Subarea 48.6, south of 60°S) were continuing to the end of October. This meant that data for the last month or two of these fisheries would be unavailable for assessment and evaluation by WG-FSA (paragraph 9.85).

CCAMLR DATA MANAGEMENT

10.1 The Scientific Committee noted that most of the tasks it requested in 1996 have been completed. However, some tasks require further follow up and input.

10.2 Structural problems with the databases are significant and will require a staged approach to their solution, and collaboration with Members. Most of these problems relate to the way in which the CCAMLR databases have evolved, the absence of a formal underlying documented data model, the rapid expansion in the use of the databases and amount of data which they contain. Immediate issues were addressed and resolved during 1997 (SC-CAMLR-XVI/BG/11, 17, 18, 21 and 22).

10.3 Some problems are expected to require continued attention as the databases, and data submissions, evolve further and according to the needs of CCAMLR. Addressing these issues is part of the database development and maintenance workload identified by the Secretariat (SC-CAMLR-XVI/BG/14).

10.4 The Secretariat had processed more data this year than in 1996 or previous years, and this was made possible by employing a part-time contract data entry person from June to October 1997 to assist with this task. A part-time contract programmer was employed from June to October 1997 to relieve Secretariat staff to work on correcting these problems, and preparing the databases for the new fisheries. A greater quantity of data is expected during 1998 because of new and exploratory fisheries.

10.5 The Scientific Committee agreed that use of contract labour for data entry and programming was essential in view of the increasing data management workload of the Secretariat resulting from increases in the number of fisheries managed by CCAMLR.

10.6 The Scientific Committee noted that WG-FSA and WG-EMM had identified a large number of tasks for data management, and that these would be prioritised by the Chairman of the Scientific Committee and the conveners of the Working Groups before handing over to the Secretariat. WG-FSA had set up a small data steering group, and identified a number of key scientists to assist the Secretariat in performing its tasks. This approach was seen as constructive, and the Scientific Committee encouraged further such developments.

10.7 The Scientific Committee considered some strategic aspects of the proposed web site (SC-CAMLR-XVI/BG/20). The resources required to develop the data elements of such a web site, such as electronic data entry and validation, were estimated in SC-CAMLR-XVI/BG/14.

10.8 The Scientific Committee agreed that the development and implementation of the web site should follow the outline presented in SC-CAMLR-XVI/BG/20, including:

(i) objective of the web site – provide a framework for organising, presenting and delivering CCAMLR information in the four languages of the Commission; and

(ii) levels of access – at least two levels: (a) public access for all to see, and (b) secure and restricted access using password protection.

10.9 The Scientific Committee recommended that the *Basic Documents*, information on IMALF issues and standard software packages, such as those requested by WG-FSA (Annex 5, paragraph 10.17), be added to the information available via the web site (SC-CAMLR-XVI/BG/20, Table 1).

10.10 The Scientific Committee considered aspects of the web site security and recommended that:

(i) the primary databases should not be accessible via the web site; and
(ii) with the exception of STATLANT data, methods for data retrieval require careful consideration.

10.11 The Scientific Committee recommended that the implementation of sections containing meeting reports and published documents, conservation measures in force, and meeting documents be given the highest priority, and be developed during 1998. Other items should be referred to specialist groups for allocation of priorities.

10.12 The Scientific Committee advised, however, that development of the CCAMLR web site should not proceed at the expense of the higher priority database management activities essential to the assessment work of the Scientific Committee and its working groups.

10.13 The Scientific Committee considered the memorandum from the Chairman of SCAF seeking comments from the Scientific Committee on three recommendations contained in a management review of the Secretariat conducted by a Group of Experts in April 1997 (COMM CIRC 97/33). The Scientific Committee agreed with the three recommendations made by the management audit:

(i) the measures suggested by the Data Manager to keep the integrity of the database be endorsed;

(ii) the Data Manager's suggestions for reducing the workload associated with data entry and validation be endorsed; and

(iii) activities underway by the Secretariat to develop software for data entry and validation on board fishing vessels and/or in Member countries be endorsed.

10.14 The Scientific Committee agreed that the Data Manager should submit a regular status report to Scientific Committee on progress under recommendation 10.13(i). The Scientific Committee noted that developments in electronic data submission (recommendation 10.13(ii)) were also identified by WG-FSA (Annex 5, paragraph 10.11). Similarly, the development of standard software (recommendation 10.13(iii)) was also identified by WG-FSA (Annex 5, paragraph 10.11).

10.15 The Scientific Committee agreed that the task of forecasting resources for data entry (recommendation 10.13(iii)) could be done by Committee Members, rather than passing this task on to technical coordinators.

COOPERATION WITH OTHER ORGANISATIONS

11.1 The Scientific Committee noted that the observers from IUCN and ASOC would present their reports to the Commission.

SCAR

11.2 The Scientific Committee regretted the absence, for the second consecutive year, of an observer from SCAR. The presence of such an observer, able to provide information on the status of SCAR's programs of marine research and to facilitate collaboration between SCAR and CCAMLR, would be very useful.

11.3 The CCAMLR liaison officer (Dr Fanta) presented a report on the Ninth Meeting of SCAR's Group of Specialists on Environmental Affairs and Conservation (GOSEAC), held in Bremerhaven, Germany, in July 1997 (SC-CAMLR-XVI/BG/34). The main points of interest to CCAMLR are listed below.

(i) The standardisation and quality control of environmental monitoring of chemical and physical pollutants was discussed and will be developed during the intersessional period. The majority of the pollutants under consideration affect seabirds and seals on land, and/or krill, fish and elements of their food chain in coastal waters. Information on these methods, and the monitoring itself, may be of interest to WG-EMM.

(ii) Biological monitoring methods about the effect of human activities on some Antarctic organisms was a difficult task because of the natural fluctuations in the size of populations. This matter may be developed in conjunction with CEMP.

(iii) Attention was given to the issue of fishery-derived marine debris in the Southern Ocean, and its effect on seabirds and marine mammals within regions covered under the regulations of the Protocol on Environmental Protection of the Antarctic Treaty.

(iv) A matrix on environmental impact assessments continued to be developed. This matrix should contain a list a organisms that are sensitive to specific human actions. Collaboration with WG-EMM is important to ensure thorough coverage of this issue.

(v) In the future, marine areas will be considered for protection, and advice would be required from CCAMLR to evaluate the scientific and conservation priorities for these areas, as well as defining their boundaries and for definitions on marine areas.

(vi) As Antarctic Specially Protected Areas (ASPAs), and Antarctic Specially Managed Areas (ASMAs), are considered useful tools to avoid, or minimise, environmental impacts, developments should include closer links with CEMP.

(vii) Environmental education and training is considered important for improving compliance with environmental conservation measures. GOSEAC welcomed the publication of the booklet *Fish the Sea Not the Sky.*

(viii) A workshop on Environmental Education and Training in Antarctica is scheduled in Concepción, Chile, from 17 to 18 July 1998, and has been organised jointly by Chile and New Zealand. Topics will include consideration of marine ecosystems, and CCAMLR should be represented at that workshop.

(ix) Closer links between GOSEAC and WG-EMM should be developed to consider issues of common interest in environmental protection and monitoring in Antarctica.

11.4 The Scientific Committee noted the areas of common interest of both GOSEAC and WG-EMM, and encouraged close collaboration between these two working groups.

11.5 The CCAMLR liaison officer also presented a report on the meeting of the SCAR Subgroup on Evolutionary Biology of Antarctic Organisms, held in Padua, Italy, in October 1997 (SC-CAMLR-XVI/BG/36). The main points of interest to CCAMLR are listed below.

(i) The state of the art and present knowledge about evolutionary biology of Antarctic organisms were reported by specialists, and future trends of research were discussed.

(ii) CCAMLR's interests in fish stock identification and the determination of the provenance of seabirds killed during fishing activities were discussed (SC-CAMLR-XV, paragraph 11.1(v)); the SCAR subgroup requested information on the latter topic.

(iii) A workshop on adaptation, gene flow, evolution, biodiversity and new techniques will be held in Curitiba, Brazil, in 1999, to develop future programs of collaborative, interdisciplinary and coordinated research. An official announcement of this event will be sent to the CCAMLR Secretariat and the participation of CCAMLR experts in the fields of interest is welcomed.

(iv) The subgroup will meet in Concepción, Chile, in July, in connection with the SCAR meeting.

11.6 In respect of genetic research to determine the provenance of seabirds killed during fishing activities (paragraph 11.5(ii)), the Scientific Committee noted that further information was available in Alexander et al. (1997), and additional advice could be made available to the subgroup from experts such as Dr P. Ryan (South Africa).

11.7 Last year the Scientific Committee commented on the proposal by ATCM for a State of the Antarctic Environment Report. Further developments (CCAMLR-XVI/5, paragraph 12) indicate that an open-ended contact group of ATCM, facilitated by New Zealand would consider the development of this project during the intersessional period. No assistance from CCAMLR was required at present.

11.8 In respect of paragraph 11.3(v), the Scientific Committee noted that the Commission would be receiving from the ATCM a proposed definition of marine areas for consideration and possible endorsement (CCAMLR-XVI/5, paragraph 11).

SCOR

11.9 The Scientific Committee noted the report of the SCOR Working Group 105 on the impact of world fisheries harvests on the stability and diversity of marine ecosystems (SC-CAMLR-XVI/BG/24). Dr Everson informed the Scientific Committee that, contrary to earlier indications (letter from Dr Miller to Working Group 105 dated 22 May 1997), he had no intention of preparing an overview paper, or involving WG-EMM. However, Dr Miller's suggestion that a copy of the book *Understanding CCAMLR's Approach to Management* would make a significant contribution by CCAMLR was noted.

11.10 The Scientific Committee agreed that a copy of the final draft of this book should be sent to the SCOR Working Group prior to its meeting in Hobart, Australia, in January 1998.

IWC

11.11 The IWC Observer (Mr Ichii) reported on the Forty-ninth Meeting of the Scientific Committee of the IWC held in Bournemouth, UK, during September/October 1997 (SC-CAMLR-XVI/BG/32). The main points of interest to CCAMLR are listed below.

(i) The meeting considered cetaceans and climate changes, platforms of opportunity for cetacean sighting surveys, southern hemisphere humpback whales, and IWC-CCAMLR collaboration.

(ii) In relation to cetaceans and climate change, SC-IWC agreed that the research activities planned by CCAMLR and SO-GLOBEC present a unique opportunity for IWC to conduct research on whale distribution over a range of spatial and temporal scales. SC-IWC endorsed the proposal to conduct collaborative work with CCAMLR and SO-GLOBEC in the Southern Ocean, and recommended that this proposal be approved by the IWC.

11.12 The Scientific Committee noted that no specific recommendation for collaboration had been formulated. Rather, general discussions were held with Dr S. Reilly (IWC Observer) during WG-EMM (Annex 4, paragraphs 8.130 to 8.136). These discussions had established areas of mutual interest, and would facilitate future collaboration.

11.13 The Scientific Committee endorsed the terms of reference proposed by WG-EMM for a small liaison group with SC-IWC to further collaboration between IWC and CCAMLR (Annex 4, paragraph 8.137).

CCSBT

11.14 The Scientific Committee noted the following statement of the CCSBT Observer (Dr G. Tuck) at the ad hoc WG-IMALF. CCSBT is pleased to note the continuing cooperation between CCSBT and CCAMLR. The exchange of information and mutual participation in these meetings is very beneficial and will enhance the process required to mitigate the seabird by-catch problem. The CCSBT is encouraged by the efforts to monitor and mitigate seabird by-catch from longline fisheries within CCAMLR waters and welcomes further cooperation between the two organisations.

11.15 The Scientific Committee noted the report of the CCAMLR observer (Dr Sabourenkov) on the second meeting of the Ecologically Related Species Working Group (ERSWG) of CCSBT (SC-CAMLR-XVI/BG/13). This report was considered by WG-FSA, and used in its deliberations (Annex 5, paragraphs 7.13 to 7.15). The Scientific Committee welcomed the development of collaboration between CCSBT-ERSWG and CCAMLR and recommended that this continue and be built on in the future.

11.16 The Scientific Committee agreed to supply CCSBT with data on longline fishing effort in the CCAMLR Convention Area (Annex 5, paragraph 7.14).

ICES

11.17 The Scientific Committee noted the information provided by the CCAMLR observer (Dr Croxall) at the ICES meeting: Seabirds in the Marine Environment (SC-CAMLR-XVI/BG/3). Dr Croxall was unable to attend the meeting, but advised that the proceedings of that meeting are now published and contain two articles dealing with the Southern Ocean and others of potential interest to WG-EMM.

11.18 The Scientific Committee noted the report of the CCAMLR observer (Dr I. Lutchman) at the 1997 ICES Annual Science Conference – Eighty-fifth Statutory Meeting (SC-CAMLR-XVI/BG/26). The main points of interest to CCAMLR are listed below.

(i) A major session of the meeting concerned the precautionary approach and ICES. A new study group on the Precautionary Approach to Fisheries Management was formed in response to the growing demand for advice based on this concept. In addition, ICES will be hosting a symposium in Cape Town, South Africa, in November 1998 on the topic 'Confronting Uncertainty in the Evaluation and Implementation of Fisheries Management Systems'.

(ii) Other theme sessions of the Annual Science Conference included: trophic relationships, environmental factors, and synthesis and critical evaluation of research surveys.

(iii) One of the other highlights of the conference was the formalisation of four new committees of ICES: Oceanography Committee; Marine Habitat Committee; Living Resources Committee; and, Resource Management Committee.

(iv) The Living Resources Committee will be responsible for the biology and ecology of living resources, including those that are subject to harvest or have the potential to be harvested in the foreseeable future. The Resource Management Committee will provide a bridge between fisheries and environmental issues, and between science and management. Both these committees may be of interest to CCAMLR.

IOC

11.19 Dr Kock reported that he had been unable to meet with Prof. M. Tilzer regarding future collaboration between CCAMLR and IOC. The Scientific Committee recalled that a number of recommendations of IOCSOC relate to fundamental aspects of CCAMLR's work. However, it appears that few invitations were issued by IOC to scientists responsible for coordinating CCAMLR's work in these fields (SC-CAMLR-XV, paragraph 11.19).

CWP

11.20 The Scientific Committee noted the report of the Seventeenth Session of CWP, held in Hobart, Australia, during March 1997 (SC-CAMLR-XVI/BG/12). The matters discussed by CWP were referred to the Commission. CWP took note of the work of WG-IMALF. However, the Scientific Committee agreed that these and other specific issues regarding incidental mortality of seabirds would need to be followed up with ICCAT and IOTC.

SPC

11.21 The Scientific Committee noted the report of the SPC on the Twenty-sixth Regional Technical Meeting of Fisheries, held in Noumea, New Caledonia, in August 1996 (SC-CAMLR-XVI/BG/37). The main points of interest to CCAMLR are listed below.

(i) Incidental catches of seabirds (*Diomedea* spp. and *Procellaria* spp.) are frequent in tuna longline fisheries operating in the southern Pacific Ocean (zone WteP).

(ii) Incidental capture of seabirds was reduced by 88% following the introduction of streamer lines in a tuna longline fishery in the Tasman Sea.

Other

11.22 The Scientific Committee noted the report by Dr Øritsland on a symposium on 'Fisheries Management Under Uncertainty', held in Bergen, Norway, in June 1997 (SC-CAMLR-VI/BG/8). This paper was considered in paragraph 7.10.

11.23 The Scientific Committee noted the report of the CCAMLR observer (Dr M. Fukuchi) at the international Symposium on Environmental Research in the Antarctic held in Tokyo, Japan, in December 1996 (SC-CAMLR-XVI/BG/23). The main points of interest to CCAMLR are listed below.

(i) Activities under CEMP were considered an outstanding contribution since BIOMASS.

(ii) The possible direct and indirect effects of increasing CO_2 concentration, temperature, and UV-B irradiation on microorganisms in the Antarctic marine ecosystem were reviewed.

(iii) The international oceanographic surveys in the Antarctic Peninsula area, directly linked to the CCAMLR program, were introduced by Dr Kim.

(iv) The Japanese Sea Ice and Penguin Study program was investigating how Adélie penguins react to changes of environmental conditions.

(v) The long-term continuous measurements of partial pressure of CO_2 in the surface sea water and air in the eastern Indian Ocean Sector of the Antarctic Ocean revealed a dip of partial pressure of CO_2 in surface waters related to the upwelling around the Antarctic divergence.

11.24 The Scientific Committee noted the report of the CCAMLR observer (Dr P. Quilty) at the Symposium on Antarctica and Global Change: Interactions and Impacts held in Hobart, Australia, in July 1997 (SC-CAMLR-XVI/BG/31). The meeting was mainly concerned with physical aspects. However, future equivalent meetings planned more direct involvement with biologists, more integration of biological parameters, and would therefore have more direct relevance to the interests and needs of CCAMLR.

11.25 The Scientific Committee noted the report of Dr Miller at the First Meeting of Experts on Coastal and Marine Biodiversity held in Jakarta, Indonesia, in March 1997 (SC-CAMLR-XVI/BG/25). The main points of interest to CCAMLR are listed below.

(i) The meeting had looked to CCAMLR as a forward-thinking organisation.

(ii) The meeting developed an interim definition of a term 'ecosystem health'. Such a definition is fundamental to assessing the extent to which the effects on biodiversity are 'harmful'. The definition may need to be considered in the context of EIVs discussed by WG-EMM (Annex 4, paragraph 6.6).

(iii) Initiatives exist, or are being planned, to eco-label fishery products, with the idea that market forces will motivate sustainable resource use. Such initiatives may be of assistance in combating unregulated fisheries within the CCAMLR Convention Area.

(iv) WG-FSA may wish to consider UNEP as an avenue for spreading awareness of IMALF issues.

11.26 The Scientific Committee also noted that CCAMLR, through the Scientific Committee, should maintain a watching brief on developments within the CBD as these may affect the participation of CCAMLR and its Members in associated biodiversity activities.

Future Cooperation

11.27 The following observers were nominated to represent CCAMLR at intersessional meetings:

(i) meeting of SCOR Working Group, January 1998, Hobart, Australia – Dr Quilty;

(ii) general meeting of SCOR, including meetings of the GLOBEC Open Science Committee and SO-GLOBEC Steering Committee, March 1998, Paris, France – Dr Kim;

(iii) meeting of CCSBT-ERSWG, April 1998, Japan – Drs Tuck or B. Baker;

(iv) meeting of the SC-IWC, April–May 1998, Muscat, Oman – Dr Kock;

(v) Second international Symposium on Fish Otolith Research and Application, June 1998, Bergen, Norway – Dr J. Ashford;

(vi) XXV SCAR, July, Concepción, Chile – Dr Croxall (bird meeting), Prof. Torres (seal meeting), Dr Fanta (Subgroup on Evolutionary Biology of Antarctic Organisms, and Workshop on Environmental Education and Training in Antarctica), Prof. B. Fernholm (Working Group on Biology);

(vii) SCAR VII Biology Symposium, August–September 1998, Christchurch, New Zealand – Dr P. Penhale;

(viii) 1998 ICES Annual Science Conference, September 1998, Lisbon, Portugal – Dr Lutchman;

(ix) ICES Symposium on Confronting Uncertainty in the Evaluation and Implementation of Fisheries Management Systems, November 1998, Cape Town – Dr Miller;

(x) FAO meeting on by-catch in fisheries, Japan – Drs Croxall and Miller to consult and approach Dr J. Cooper;

(xi) GOSEAC, July 1998, Basel, Switzerland – Dr Fanta;

(xii) SC-CMS, April-May 1998, Bohn, Germany – Secretariat to correspond with CMS and obtain information on timing, possibly Dr Kock.

11.28 Australia will host a workshop proposed at the ATCM on the introduction of disease into Antarctic birds and seals to be held in Hobart from 25 to 28 August 1998.

11.29 The Scientific Committee agreed that all observers invited to meetings of the Scientific Committee and Working Groups in 1997 should be invited to attend the meetings in 1998.

PUBLICATIONS

12.1 The fourth volume of *CCAMLR Science* was published just prior to CCAMLR-XVI. The Scientific Committee expressed its thanks to Dr Sabourenkov (Editor), Ms G. Tanner (Production Editor), Mrs R. Marazas, Ms G. von Bertouch and Mr B. Denholm for their efforts in producing this volume (208 pages).

12.2 The following documents were also published during 1997:

(i) annual reports;
(ii) *CCAMLR Scientific Abstracts* covering papers presented in 1996;
(iii) extensively revised edition of *CEMP Standard Methods*;
(iv) *Scientific Observers Manual*; and
(v) *Statistical Bulletin*, Volume 9.

12.3 The following documents are being prepared for publication:

(i) flyer and stickers for *Fish the Sea Not the Sky*;
(ii) *Understanding CCAMLR's Approach to Management*;
(iii) educational brochure on marine debris in the Antarctic; and
(iv) seabird identification guide.

12.4 The Scientific Committee agreed that the booklet *Understanding CCAMLR's Approach to Management* will be prepared in the four languages during 1998, and published during 1999 as a high-quality booklet with colour plates. The budget for publishing this booklet was approved by SCAF.

12.5 The Scientific Committee noted that the seabird identification guide, which has been reviewed by the Oversight Committee, is now well advanced; New Zealand will present more detailed information to the Commission.

12.6 The Scientific Committee endorsed the recommendation of WG-FSA not to publish a revised edition of *Statistical Bulletin*, Volume 1 (SC-CAMLR-XVI/BG/19; Annex 5, paragraph 3.16).

12.7 Drs Everson and de la Mare confirmed the need to review the *CCAMLR Science* editorial policy regarding the selection of papers to be sent to peer review. The current policy is difficult to implement during working group meetings and should be refined. The Scientific Committee agreed that the Editorial Board meet during the next week's Commission meeting to review this policy, and streamline the process.

SCIENTIFIC COMMITTEE ACTIVITIES DURING THE 1997/98 INTERSESSIONAL PERIOD

13.1 The following Scientific Committee activities are planned for the 1997/98 intersessional period:

(i) workshop on processes within the South Atlantic Sector of Southern Ocean (Area 48);
(ii) Second International Symposium on Fish Otolith Research and Application;
(iii) meeting of WG-EMM;
(iv) workshop on *C. gunnari* immediately prior to WG-FSA;
(v) meeting of WG-FSA; and
(vi) Workshop on International Coordination.

13.2 The Workshop on Area 48 is scheduled for the last two weeks of June 1998 at the Southwest Fisheries Science Center in La Jolla, California, USA.

13.3 The Second International Symposium on Fish Otolith Research and Application is sponsored by CCAMLR, and will be held in Bergen, Norway, from 20 to 25 June 1998.

13.4 Dr V. Ravindranathan (India) extended a formal invitation from the Government of India to hold the meeting of WG-EMM in India, at a time and date suitable to CCAMLR, and a venue to be selected. The Scientific Committee gratefully accepted the invitation.

13.5 The Scientific Committee noted the extreme workload of WG-FSA this year, and examined ways of alleviating this problem at future meetings. It discussed the possibility of holding concurrent meetings with provision for appropriate interaction on agreed agenda items.

13.6 The Scientific Committee agreed that concurrent meetings would be appropriate, subject to:

(i) sufficient attendance of members of WG-IMALF; and
(ii) adequate resources and facilities available from the Secretariat.

13.7 Delegations from Argentina, Brazil, Chile, Germany, Japan, Republic of Korea, UK, Ukraine and USA discussed the possibility of joint research in the near future. Members reviewed the activities which had been conducted twice in the Antarctic Peninsula area during the 1994/5 and 1996/97 seasons, and emphasised that the major purpose of the Workshop on International Coordination is to aid the activity of WG-EMM as well as other organisations which have interconnection with CCAMLR.

13.8 The Workshop on International Coordination encouraged Members to:

(i) participate in the CCAMLR synoptic krill biomass survey in Area 48 in 1999/2000;

(ii) support the survey and research activities of SO-GLOBEC, especially in relation to life history and demography studies of krill, between 1998 and 2001; and

(iii) assist in developing a survey of oceanic ecosystems in Area 48 incorporating research on phytoplankton, zooplankton and oceanography, by participating in either or both of the synoptic survey and SO-GLOBEC activities.

13.9 Therefore, members of the Workshop on International Coordination agreed to continue communication during the intersessional period to finalise appropriate sampling protocols.

BUDGET FOR 1998 AND FORECAST BUDGET FOR 1999

14.1 The budget of the Scientific Committee only includes costs directly related to meetings of the Scientific Committee or to meetings which are of immediate relevance to the work of the Scientific Committee. Further, these budget estimates do not include costs for data management. It is the understanding of the Scientific Committee that costs for data management relate directly to the management of fisheries in the Convention Area.

14.2 The Scientific Committee discussed the overrun cost of producing the report of WG-FSA-97. The total overrun cost was estimated at A$11 100 for covering the additional costs of translation and document production. The Scientific Committee noted the overrun and referred the matter to SCAF. The estimated cost of the WG-FSA meeting in 1998 was augmented by A$7 000.

14.3 In addition, the Scientific Committee agreed that a further A$3 000 be added to the budget of WG-FSA-98 to cover the cost of producing the report from a proposed workshop on *C. gunnari* (paragraph 5.61), scheduled in Hobart immediately prior to the WG-FSA meeting.

14.4 The costing for the Secretariat's participation at, and support to, the workshop on processes within the South Atlantic Sector of the Southern Ocean (Area 48) was reviewed. The Scientific Committee agreed that the budget item for secretarial support (A$4 400) should be given a low priority because alternative support may be available (e.g. UK may be able to provide secretarial support).

14.5 Funding for the Data Manager to participate in the intersessional meeting of CWP (SC-CAMLR-XVI/BG/12) was discussed. The Scientific Committee agreed that CWP activities should be referred to the Commission, and should not be funded by the Scientific Committee.

14.6 The budget of the Scientific Committee for 1998, as agreed by the Scientific Committee, is summarised in Table 9.

14.7 The Scientific Committee discussed the budget requirements for the publication *Understanding CCAMLR's Approach to Management*. The Scientific Committee acknowledged the great effort of Dr Kock (Editor) and colleagues in drafting the manuscript, and agreed that it should be published as a high-quality booklet. The suggested costing of A$69 700 will be allocated within the Commission's publication budgets for 1998 and 1999.

ADVICE TO SCOI AND SCAF

15.1 Advice to SCOI and SCAF is given under Agenda Items 3 and 14.

ELECTION OF THE VICE-CHAIRMEN OF THE SCIENTIFIC COMMITTEE

16.1 In accordance with Rule 8 of the Rules of Procedure of the Scientific Committee there was an election of two Vice Chairmen. Prof. Fernholm nominated Dr V. Siegel (European Community), and Dr Kim nominated Dr K. Shust (Russia). In making the nominations, Prof. Fernholm and Dr Kim referred to the considerable experience of both Drs Siegel and Shust.

16.2 Drs Siegel and Shust were unanimously elected as Vice-Chairmen of the Scientific Committee for the period from the end of the Sixteen Meeting until the end of the Scientific Committee meeting in 1999.

16.3 Dr Miller thanked Prof. Fernholm and Dr Kim for their work as Vice-Chairmen, and welcomed Drs Siegel and Shust to their new posts.

NEXT MEETING

17.1 The next meeting of the Scientific Committee will take place in Hobart, Australia from 26 to 30 October 1998.

OTHER BUSINESS

Submission of Papers

18.1 The Scientific Committee endorsed the recommendations of WG-EMM and WG-FSA regarding the circulation of meeting documents and CCAMLR reports. The Working Groups had agreed that the rules pertaining to the submission and circulation of meeting documents should be strictly enforced (Annex 4, paragraph 11.1; Annex 5, paragraph 10.2). These rules were necessary so as to allow participants adequate time to consider papers and issues for discussion, and alleviate the workload of the Secretariat in the lead up to meetings.

18.2 The Scientific Committee endorsed the recommendations of WG-EMM and WG-FSA that Members and the Secretariat should be encouraged to move towards electronic submission and circulation of papers (Annex 4, paragraph 11.3; Annex 5, paragraph 10.3), and other steps to streamline the publication of these documents. This was seen as a logical step, and one which would eventually reduce the amount of paper used in producing the documents, and the volume of papers carried by Members to and from the meetings. Eventually, papers could be submitted electronically via email, or through the proposed CCAMLR web site.

18.3 The Scientific Committee noted that the current CCAMLR document distribution publication policy had resulted in a restricted circulation of CCAMLR reports and publications, with many participants at working groups no longer receiving bound copies of the Scientific Committee reports, and other relevant documents prior to the working group meetings (Annex 5, paragraph 10.4). The Scientific Committee recommended that the Commission review the current distribution policy to ensure that all participants at working group meetings receive, as a minimum, copies of the working group and Scientific Committee reports.

Secretariat Support

18.4 The Scientific Committee noted the great job that the Secretariat performed each year, under considerable pressure, in support of the Scientific Committee and its working groups. The number and complexity of the tasks had increased considerably over time, and the Scientific Committee examined ways of alleviating some aspects of this workload. In doing so, the Scientific Committee was sensitive to the need to provide constructive advice and guidance to the Secretariat.

18.5 The Scientific Committee identified three areas for review:

(i) advice to potential hosts of working group meetings;
(ii) preparation by the Secretariat prior to meetings; and
(iii) conduct and organisation during meetings.

18.6 The Scientific Committee noted that the Secretariat has a set of guidelines for working group meetings. These guidelines include a check list of equipment and facilities required by the Secretariat. In addition, Dr Everson was developing a set of guidelines for conveners, the Secretariat and potential hosts to facilitate planning and organisation of working group meetings. The Scientific Committee agreed that these should be combined.

18.7 The Scientific Committee agreed that the Chairman of the Scientific Committee and conveners of WG-EMM and WG-FSA should meet during the Commission meeting to collate the Secretariat's tasks, and allocate priorities and deadlines. The Scientific Committee agreed that this was an essential task which had lapsed during recent years. Such a list would provide a clear understanding of the intersessional requirements of the Scientific Committee and working groups, and enable conveners to consider alternative options if tasks can not be completed within the resources available. This would also facilitate review, identification of problems and resource limitations. Finally, this would provide feedback to both the Scientific Committee and Commission, as recommended by the management review of the Secretariat (Report of the Group of Experts, paragraph 98).

18.8 The Scientific Committee agreed that the Chairman and conveners of the working groups would prepare a schedule for the implementation of high priority tasks identified by the Scientific Committee and its working groups. It also agreed that this schedule would be appended to its report[1].

18.9 The Scientific Committee also considered processes during the meeting, and identified several areas where efficiencies could be reviewed. For example, the following points, which also apply to all meeting participants, should be reviewed:

(i) dispersal of meeting documents; and
(ii) organisation of rapporteurs.

18.10 The Scientific Committee noted that a substantial part of its report consisted of words drawn directly from the reports of the working groups. In this respect, the Scientific Committee agreed that, during the intersessional period, the Chairman and the conveners of the working groups would investigate ways of restructuring the suite of reports so as to minimise repetition.

18.11 Finally, the Scientific Committee noted that the library resources in the Secretariat provided inadequate support to Members during the analyses of WG-FSA, and staff during the intersessional periods. The Scientific Committee recommended that adequate resources be provided to improve the scientific contents of the library, particularly in the fields of stock assessment, ecosystem management and taxonomy.

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[1] The schedule was circulated to Members in November 1997.

International Krill Symposium

18.12 Dr Nicol reported on preparations for the Second International Symposium on Krill (SC-CAMLR-XVI/BG/35). The symposium will be held during August/September 1999 at the University of Santa Cruz, California, USA. The main sessions will cover:

(i) krill demography, life history and genetic diversity;
(ii) krill development, growth, reproduction and ageing;
(iii) krill physiology and biochemistry;
(iv) krill nutrition, metabolism and energetics; and
(v) krill behaviour, swarming, vertical migration, foraging and antipredator mechanisms.

18.13 CCAMLR was contributing A$7 000 in 1998 towards the cost of running the symposium.

18.14 Some Members questioned the allocation of half the time of the symposium to invited speakers and of US$41 000 (73% of the total symposium costs) to the expenses of these speakers. Dr Nicol agreed to bring this concern to the notice of the organisers.

Data and Data Access Rules

18.15 It was noted that the Secretariat maintains two datasets (on sea-ice and sea-surface temperature), whose raw data have been acquired from public domain NOAA datasets. It was agreed that these data should not be subject to the existing rules of data access which apply to data submitted by Members to the CCAMLR databases. The Secretariat should, therefore, entertain direct requests for access to these data from individual researchers. In due course these data could be included in the open access part of the proposed CCAMLR web site. Any costs of processing requests should, however, be charged to the user, who should also be required to make appropriate acknowledgment to CCAMLR.

ADOPTION OF THE REPORT

19.1 The report of the Sixteenth Meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

20.1 In closing the meeting, the Chairman thanked Members of the Scientific Committee for a very productive meeting, the rapporteurs for their efforts and long hours, and working group conveners, Drs Everson (WG-EMM) and de la Mare (WG-FSA), for being instrumental in guiding discussions and rapporteurs. The Chairman also thanked all those involved in supporting the Scientific Committee behind the scenes, and in particular Mrs L. Bleathman, Mrs R. Marazas, Mrs P. McCulloch and Ms G. Tanner, Mr E. Appleyard and Mr N. Williams, the large team of CCAMLR translators and interpreters, and the sound technicians. He also thanked Dr Ramm for his assistance.

20.2 On behalf of the Scientific Committee, Dr Beddington thanked the Chairman for the absolutely splendid job he did chairing his first Scientific Committee meeting; Dr Kock concurred.

20.3 The Scientific Committee noted with regret the passing of Dr Antonio Mazzei (Chile), a long-standing and respected member of the Scientific Committee, who died on 19 July 1997.

20.4 The Chairman then closed the meeting.

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Everson, I. 1977. The living resources of the Southern Ocean. FAO Southern Ocean Fisheries Survey Programme. GLO/SO/77/1: 155 pp.

Alexander, K., G. Robertson and R. Gales. 1997. *The Incidental Mortality of Albatrosses in Longline Fisheries*. A report on the Workshop from the First International Conference on the Biology and Conservation of Albatrosses, Hobart, Australia – September 1995. Australian Antarctic Division, Hobart: 44 pp.

Table 1: National krill catches (in tonnes) since the 1989 split-year based on STATLANT returns.

Country	Split-year*								
	1989	1990	1991	1992	1993	1994	1995	1996	1997
Chile	5 329	4 500	3 679	6 065	3 261	3 834			
Germany		396							
Japan	78 928	62 187	67 582	74 325	59 272	62 322	60 303	60 546	58 798
Latvia						71			
Republic of Korea	1 779	4 039	1 210	519					
Panama							141	495	
Poland	7 798	1 275	9 571	8 607	15 909	7 915	9 384	20 610	19 156
USSR**	301 498	302 376	275 495						
Russia				151 725	4 249	965			
South Africa						2			
Ukraine				61 719	6 083	8 852	48 884	20 056	4 246
UK									308
Total	395 332	374 773	357 537	302 960	88 774	83 961	118 712	101 707	82 508

* The Antarctic split-year begins on 1 July and ends on 30 June. The column 'split-year' refers to the calendar year in which the split-year ends (e.g., 1989 refers to the 1988/89 split-year).

** Although the formal date for the dissolution of the USSR was 1 January 1992, for comparative purposes statistics are compiled here for Russia and Ukraine separately for the complete split-year, i.e. 1 July 1991 to 30 June 1992.

Table 2: Total krill catch (in tonnes) in the 1997 split-year by area and country. The catch for the 1996 split-year is indicated in brackets.

Subarea/Division	Japan		Panama		Poland		Ukraine	
48.1	37 480	(45 719)			13 498	(14 927)		(1 738)
48.2	98	(4)				(24)		(2 706)
48.3	21 220	(14 823)		(495)	5 658	(5 659)	4 246	(15 612)
Total	58 798	(60 546)		(495)	19 156	(20 610)	4 246	(20 056)

Subarea/Division	UK		Total	
48.1	308		51 286	(62 384)
48.2			98	(2 734)
48.3			31 124	(36 589)
Total	308		82 508	(101 707)

Table 3: National finfish catches (in tonnes) since the 1989 split-year based on STATLANT returns.

Country	Split-year*								
	1989	1990	1991	1992	1993	1994	1995	1996	1997
Argentina						9	867	107	
Australia				4		2			1 057
Bulgaria				114	220	70	177		
Chile				2 917	2 125	150	1 894	3 092	1 275
France	587	579	1 576	1 589	826	4 211	4 173	3 673	3 674
Japan								263	334
Republic of Korea						143	420	381	425
Poland	12	523	41						
Russia		1 453[1]		48 589	281	265	11	102	
Spain			35						291
South Africa									2 096
Ukraine	440[1]	3 530[1]		11 265	2 346	942	5 473	1 003	1 007
UK	4	61	9	10		6			403
USA								184	
USSR**	103 813	46 092	97 240						
Total	104 856	52 238	98 901	64 488	5 798	5 798	13 015	8 805	10 562

* and ** Refer to footnotes in Table 1.

1 Recently submitted historical catch data has assigned a proportion of the former-USSR catches to Ukraine and Russia.

Table 4: Total finfish catch (in tonnes) in the 1997 split-year by area and country. The catch for the 1996 split-year is indicated in brackets.

Subarea/ Division	Argentina	Australia	Chile	France	Japan	Republic of Korea
48.3	(107)		1275 (3092)			425 (381)
58.4.3		<1				
58.5.1				3674 (3670)	(263)	
58.5.2		1057				
58.6				3	334	
58.7						
Total	(107)	1057	1275 (3092)	3674 (3673)	334 (263)	425 (381)

Subarea/ Division	South Africa	Russia	Spain	Ukraine	UK	USA	Total
48.3		(102)	291		403	(184)	2394 (3866)
58.4.3							
58.5.1				1007 (1003)			4681 (4936)
58.5.2							1057
58.6	122						456 (3)
58.7	1974						1974
Total	2096	(102)	291	1007 (1003)	403	(184)	10562 (8805)

Table 5: Precautionary catch limits for new and exploratory fisheries for *Dissostichus* spp. during 1997/98.

Target Species	Area	Reported Catch (tonnes) to 31 August 1997	Estimated Total Catch (tonnes) including Unreported	1996/97 Catch Limit (tonnes)	Seabed Area (km²)		GY Unadjusted Catch Limit (tonnes) for Total Area	GY Unadjusted Catch Limit (tonnes) for Species	Precautionary Catch Limit (tonnes)	
					<600 m <500[d] m	600–1800 m 500–1500[d] m			0.45*GY	0.30*GY
Longline:										
D. eleginoides	48.3 (600–1800 m)	3 924	3 924	5 000	45 110	67 506				
D. eleginoides	48.1 north of 65°S				156 505	73 107	4 456	4 141	1 863	
D. mawsoni	48.1 south of 65°S				130 206	5 569		315		94
D. eleginoides	48.2 north of 60°S				198	16 847	4 195	953	429	
D. mawsoni	48.2 south of 60°S				35 465	57 308		3 242		972
D. eleginoides	48.4 north of 57°S	0	0	28	816	7 356	1 352	415	186	
D. mawsoni	48.4 south of 57°S				2 940	16 587		937		281
D. eleginoides	48.6 north of 65°S	0	0	1 980[b]	1 288	34 879	4 133	1 973	888	
D. mawsoni	48.6 65–70°S				32 963	38 205		2 160		648
D. eleginoides	58.4.3 north of 60°S				352	107 795	6 199	6 100	2 745	
D. mawsoni	58.4.3 south of 60°S				0	1 753		99		29
D. eleginoides	58.4.4 north of 60°S	0	?[c]	1 980[b]	8 783	22 848	1 290	1 290	580	
D. mawsoni	58.4.4 south of 60°S				0	0		0		0
D. eleginoides	58.6 current	2 521[a]	19 233	2 200[b]	19 933	69 158	4 860	4 860	2 187	
D. eleginoides	58.7 current		14 129	2 200[b]	1 988	15 618	1 041	1 041	468	
D. eleginoides	58.6 proposed		12 822		17 677	28 691	1 971	1 971	887	
D. eleginoides	58.7 proposed		18 839		4 244	56 085	3 916	3 916	1 762	
D. eleginoides	88.1 north of 65°S	0.128	0.128	1 980[b]	21	13 277	4 658	751	338	
D. mawsoni	88.1 65–70°S				57 087	69 045		3 907		1 172
D. eleginoides	88.2 north of 65°S	0	0	1 980[b]	17	1 012	185	57	25	
D. mawsoni	88.2 65–70°S				3	2 276		128		38
D. eleginoides	88.3 north of 65°S				0	20	1 520	1	0	
D. mawsoni	88.3 65–70°S				76 729	26 867		1 519		455
Trawl:										
D. eleginoides	58.5.2 (500–1500 m)	1 861	10 437	3 800	48 186	91 771				
D. eleginoides	58.4.3 north of 60°S	0.007	0.007	1 980[b]	107	49 550	2 140	2 140	963	
D. mawsoni	58.4.3 south of 60°S				0	0		0		0

[a] Subareas 58.6 and 58.7 combined   [b] *Dissostichus* spp.   [c] Evidence of substantial fishing (see Annex 5, Appendix D, Table D.3)   [d] Trawl fisheries

Table 6: Details of lapsed fisheries.

Subarea/Division	Species	Method	Last Reported Catch
48.4	*Dissostichus eleginoides*	Longline	1993
48.3	*Electrona carlsbergi*	Trawl	1992
58.4.1	*Euphausia superba*	Trawl	1995
58.4.2	*Euphausia superba*	Trawl	1989
58.4.4	*Lepidonotothen squamifrons*	Trawl	1991
58.4.2	*Chaenodraco wilsoni*	Trawl	1990
58.4.2	*Pleuragramma antarcticum*	Trawl	1989
48.1	*Chaenodraco wilsoni*	Trawl	1985
58.4.2	*Trematomus eulepidotus*	Trawl	1990

Table 7: Summary of new fisheries operated in the 1996/97 season.

Conservation Measure	Target Species	Subarea/ Division	Catch Limit (tonnes)	Season	Reported Catch (tonnes)	Closure Date 1997
99/XV	*M. hyadesi*	48.3	2 500	2 Nov 1996 – 7 Nov 1997	81	7 November
114/XV	*D. eleginoides* *D. mawsoni*	48.6	1 980	1 March – 31 Aug 1997	0	31 August
116/XV	*D. eleginoides* *D. mawsoni*	58.4.4	1 980	1 March – 31 Aug 1997	0	31 August
116/XV	*D. eleginoides* *D. mawsoni*	58.6, 58.7	2 200 in each	30 Oct 1996 – 31 Aug 1997	2 521[d]	31 August
115/XV	*D. eleginoides* *D. mawsoni*	88.1, 88.2	1 980 in each	15 Feb – 31 Aug 1997	0.128[d]	31 August
113/XV	*D. eleginoides* *D. mawsoni*	58.4.3	1 980	2 Nov 1996[a] or 1 Mar 1997[b] – 31 Aug 1997	0.007[d]	31 August
111/XV	Deepwater species	58.5.2	50[c]	2 Nov 1996 – 31 Aug 1997	0	31 August

[a] For trawling
[b] For longlining
[c] For each species not covered by Conservation Measures 109/XV and 110/XV
[d] *Dissostichus eleginoides*

Table 8: Information relevant to reconciling potential management measures for seabird by-catch with fishing operations in relation to new and exploratory longline fisheries.

Subarea/ Division	Seabird By-catch Considerations				Fishing Proposal Information				
	Risk	Proposed Closure	CM 29/XV	Ref. to WG-FSA Report	Member	Season	Observer	CM 29/XV	Ref. to WG-FSA Report
48.1	3	Oct–Mar	✓	7.126(i)	Chile	1 Apr–31 Oct[1]	✓	✓	4.38–4.50
48.2	3	Oct–Mar	✓	7.126(ii)	Chile	1 Apr–31 Oct[1]	✓	✓	4.38–4.50
48.6	5	None	✓	7.126(iv)	South Africa	1 Mar–31 Aug	✓	✓	4.27–4.29
					South Africa (south of 60°S)	15 Feb–31 Oct[2]	✓	✓	
					Norway	15 Feb–31 Aug	✓	✓	4.35–4.37
58.4.3	?2–3	Sep–Apr	✓	7.126(v)	South Africa	1 Mar–31 Aug	✓	✓	4.27–4.29
58.4.4	?2–3	Sep–Apr	✓	7.126(vi)	Ukraine	Sep 97–May 98	✓	✓	4.21–4.26
					South Africa	1 Mar–31 Aug	✓	✓	4.27–4.29
58.6	1	Sep–Apr	✓	7.126(viii)	South Africa	Year round	✓	✓	4.75–4.86
					Ukraine	Sep 97–May 98	✓	✓	4.87–4.89
					Russia	Dec 97–Jun 98[3]	✓	✓	4.90–4.91
58.7	1	Sep–Apr	✓	7.126(ix)	South Africa	Year round	✓	✓	4.75–4.86
					Ukraine	Sep 97–May 98	✓	✓	4.87–4.89
					Russia	Dec 97–Jun 98[3]	✓	✓	4.90–4.91
88.1	3	None	✓	7.126(x)	New Zealand	15 Feb–31 Aug	✓	✓	4.30–4.34
88.2	5	None	✓	7.126(xi)	New Zealand	15 Feb–31 Aug	✓	✓	4.30–4.34
88.3	5	None	✓	7.126(xii)	Chile	1 Apr–31 Oct[1]	✓	✓	4.38–4.52

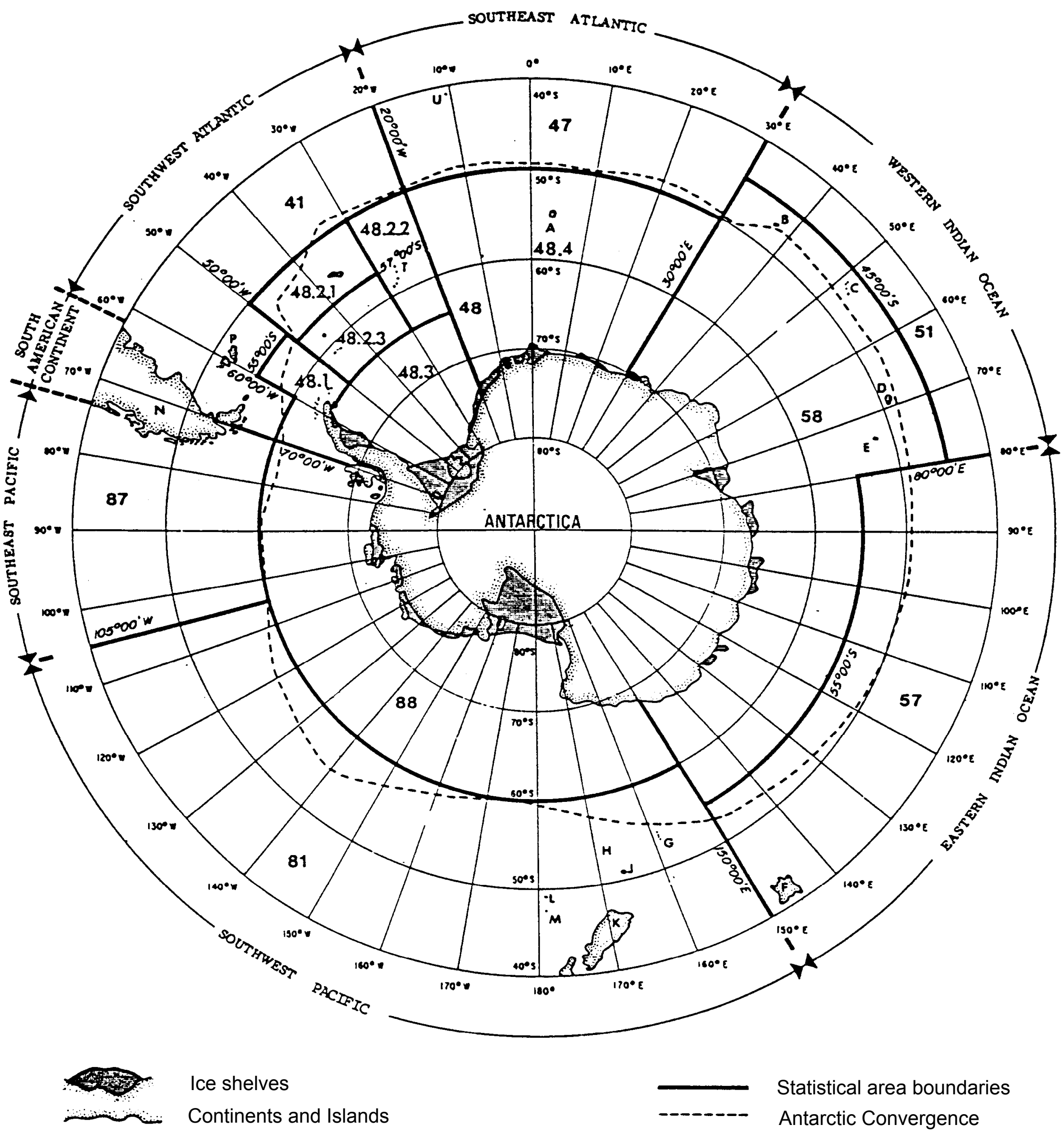
Risk: 1 = High, 3 = Average, 5 = Low (see Annex 5, paragraph 7.124)

Proposed closure: in respect of avoiding main breeding seasons of albatrosses and petrels.

[1] Modified from original proposal during the meeting; the fish survey will take place between mid-February and late March.
[2] Modified from original proposal during the meeting.
[3] Notified during the meeting.

Table 9: Scientific Committee budget for 1998 and forecast budget for 1999.

1997 Budget		1998	1999 (forecast only)
	Working Group on Fish Stock Assessment		
	Meeting		
13 000	Preparation and Secretariat support	13 200	13 700
21 000	Report completion and translation	21 400	22 800
0	Increased report costs	7 000	7 000
34 000		41 600	43 500
0	Workshop on *C. gunnari*	3 000	0
	Working Group on Ecosystem Monitoring and Management		
	Meeting		
19 000	Preparation and Secretariat support	19 300	19 900
24 000	Report completion and translation	24 300	24 900
43 000		43 600	44 800
1 000	Guide to Understanding CCAMLR's Approach to Management	0	0
0	Support of International Krill Symposium	7 000	4 500
0	Support of SCAR Bird Assessment	0	5 000
	Travel for Scientific Committee Program		
39 500	WG-EMM meeting (freight, flights and subsistence)	40 100	42 700
8 500	Subgroup on Statistics (including Secretariat support)	0	0
	Workshop on Area 48		
0	Data Manager travel	3 500	0
0	Secretarial support	4 400	0
0	Report costs	3 800	0
0		11 700	0
4 400	International Data Meetings	0	5 200
1 000	**Contingency**	1 100	1 100
A$131 400	Total	A$148 100	A$146 800



Code	Name of Islands and Continents	Lat.	Long.	Code	Name of Islands and Continents	Lat.	Long
A	Bouvet	54°S	5°E	L	Antipodes	49°S	179°E
B	Prince Edward and Marion	46°S	38°E	M	Bounty	47°S	179°E
C	Crozet	46°S	51°E	N	South America		
D	Kerguelen	49°S	70°E	P	Falklands (Malvinas)	51°S	59°W
E	McDonald and Heard	53°S	73°E	Q	South Shetland	62°S	58°W
F	Tasmania (Australia)			R	South Orkney	61°S	45°W
G	Macquarie	54°S	159°E	S	South Georgia	54°S	37°W
H	Campbell	52°S	169°E	T	South Sandwich	57°S	26°W
J	Auckland	50°S	166°E	U	Gough	39°S	11°W
K	South Island (New Zealand)						

Figure 1: Proposed statistical areas in the Southwest Atlantic sector of the Southern Ocean (Everson, 1977).

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DATA MANAGER	David Ramm
ADMINISTRATION/FINANCE OFFICER	Jim Rossiter
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AGENDA FOR THE SIXTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE SIXTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

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   (ii) Fish
   (iii) Crabs
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(ii) Fish Resources
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(iii) Crab Resources
  (a) Report of WG-FSA
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9. New and Exploratory Fisheries

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ANNEX 4

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(San Diego, USA, 21 to 31 July 1997)

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(San Diego, USA, 21 to 31 July 1997)

INTRODUCTION

Opening of the Meeting

1.1 The third meeting of WG-EMM was held at the Hubbs-Sea World Research Institute, San Diego, USA, from 21 to 31 July 1997.

1.2 Dr M. Tillman, Director of the Southwest Fisheries Science Center, welcomed the participants to San Diego on behalf of the National Marine Fisheries Service. In opening the meeting, Dr Tillman outlined the history of the US Antarctic research program and recent advances in monitoring changes in populations of krill* and dependent species. Investigations on the impact of climate change on Antarctic marine living resources have led to greater needs for integrated physical and biological oceanography. The meetings of WG-EMM have served to pull these fields together and further contribute to the collaborative effort.

1.3 Dr Tillman thanked Mr D. Kent, Executive Director of Hubbs–Sea World Research Institute, and his staff, for making available the institute facilities for the meeting. He also thanked Sea World for their support during the meeting. Dr R. Holt (USA), the local organiser, thanked the US State Department and the National Science Foundation for their financial contributions to the meeting.

1.4 On behalf of the Working Group, the Convener, Dr I. Everson (UK), thanked Dr Tillman and the US Government for the invitation to hold the meeting in San Diego. Dr Everson expressed the Working Group's appreciation to Dr Holt and his team from the Southwest Fisheries Science Center for their substantial work in organising the meeting. He also thanked the staff of Hubbs–Sea World Research Institute for their involvement in the meeting. Dr Everson noted that the first meeting of the former WG-Krill was held in La Jolla in 1989, and had provided a sound foundation for the work of WG-EMM. In outlining the work ahead, Dr Everson welcomed the participants, the observers from two international organisations, Mr J. Cooper (IUCN) and Dr S. Reilly (IWC), and the new Data Manager, Dr D. Ramm, to the meeting.

Adoption of the Agenda and Organisation of the Meeting

1.5 A revised Provisional Agenda was introduced and discussed. The order of agenda items had been rearranged so as to provide a better coverage of the issues to be considered. The Agenda, as amended, 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 is Appendix C.

* For the purpose of this document, krill is *Euphausia superba* unless stated otherwise.

1.7 The report was prepared by Dr I. Boyd (UK), Prof. D. Butterworth (South Africa), Drs J. Croxall (UK), W. de la Mare (Australia), R. Hewitt and E. Hofmann (USA), G. Kirkwood (UK), K.-H. Kock (Germany), D. Miller (Chairman, Scientific Committee), E. Murphy (UK), S. Nicol (Australia), P. Penhale (USA), P. Trathan and J. Watkins (UK), P. Wilson (New Zealand) and the Secretariat.

Intersessional Activities

1.8 The Subgroup on Statistics met in La Jolla, USA, from 14 to 18 July 1997 and its report is attached as Appendix D.

1.9 The Workshop on International Coordination was also held in La Jolla from 14 to 18 July 1997 and its report submitted as WG-EMM-97/44. The executive summary of the workshop is attached as Appendix E.

FISHERIES INFORMATION

Harvesting Strategies

2.1 A summary of fine-scale data from the krill fisheries conducted during the 1995/96 season was presented by the Secretariat (WG-EMM-97/23). Krill catches were reported by four Members: India (6 tonnes in Subarea 58.4), Japan (60 546 tonnes mostly in Subarea 48.1), Poland (20 610 tonnes mostly in Subarea 48.1) and Ukraine (20 056 tonnes mostly in Subarea 48.3). In addition, Panama reported a catch of 496 tonnes in Subarea 48.3. No catches were reported from Area 88. The total krill catch reported was 101 714 tonnes.

2.2 Dr Boyd noted that large catches had been reported from fine-scale rectangles bordering the northern limit of the CCAMLR Convention Area. He inquired about the availability of information on krill fisheries in waters adjacent to the Convention Area. Dr Everson identified reports of catches along the northern boundary of Subarea 48.1 (e.g. November 1995). The Working Group requested that the Secretariat identify the nationality of vessels fishing in those areas, and seek information from those Members on any krill catches which may have been taken in adjacent waters.

2.3 The krill catches reported to the Secretariat by July 1997 indicated that four Members fished during the 1996/97 season: Japan (58 771 tonnes in Subareas 48.1 and 48.3), Poland (16 159 tonnes in Subareas 48.1 and 48.3), UK (308 tonnes in Subarea 48.1) and Ukraine (5 657 tonnes in Subareas 48.2 and 48.3). No catches were reported from Areas 58 or 88. The total catch of krill reported at the time of the meeting was 80 895 tonnes.

2.4 Members were asked about their plans to fish for krill during the 1997/98 season. Japan planned to continue fishing for krill at levels of catch and effort similar to those reported in 1996/97 (i.e. about 60 000 tonnes and four vessels). The Republic of Korea planned to deploy one trawler and take about 4 400 tonnes of krill. The UK indicated that detailed information was not yet available, but it anticipated that one vessel would fish for krill at catch levels similar to those in 1996/97 (i.e. about 500 tonnes). Chile and Russia reported that they did not plan to fish for krill. No information was available from Poland and Ukraine; these Members were not represented at the meeting.

2.5 Prof. Butterworth identified the potential for a rapid expansion of the krill fishery in response to major changes in the commercial viability of the fishery. He proposed that the economic history of the fishery be documented so that market trends and product developments can be identified. Dr Nicol informed the Working Group that a FAO report on worldwide trends in krill fisheries was due for release (FAO, in press).

2.6 Krill markets in 1996/97 were generally in decline. Mr M. Kigami (Japan) reported that the Japanese krill fleet supplied three types of markets: (i) aquaculture food, (ii) bait for recreational fisheries, and (iii) human consumption. The demand for aquaculture food has decreased in recent years, and the market for human consumption was small. Further, the Japanese market for bait was oversupplied, and Japan exported bait within Asia (e.g. Taiwan, Republic of Korea).

2.7 Mr Kigami said that the krill fishery was an important fishery to Japan, and he expected that this situation would be maintained in the future. In addition, the Working Group noted that other nations were gearing up for krill fishing within the Convention Area. Dr Miller reported that recent popular fishery articles indicated that China was preparing to enter the krill fishery. Dr E. Sabourenkov (Secretariat) reported on a proposal for a joint krill fishing venture between Ukraine and Canada using a supertrawler.

2.8 Dr B. Bergström (Sweden) questioned the ability for krill catches to rapidly increase and approach the precautionary catch limits set within the Convention Area. Dr Nicol suggested that this was unlikely to occur within the next one to two years. However, recent significant developments in krill-based pharmacology and biotechnology, which are closely guarded while pending patent, could change the nature of the fishery and lead to an increase in krill catches over the next five years. Consequently, the potential impact of these advances on the commercial viability of the krill fishery was difficult to evaluate.

2.9 Dr S. Kawaguchi (Japan) reported on the krill harvesting strategies used by Japanese vessels to avoid large catches of salps and 'green' krill (WG-EMM-97/37). Dr V. Sushin (Russia) reported on krill harvesting strategies used by Russian trawlers (WG-EMM-97/50). Drs Hewitt and Trathan outlined the importance of distinguishing between the behaviour of fishermen and environmental variability when interpreting variations in CPUE. Further, different fleets used different harvesting strategies: Japanese trawlers usually conduct short directed tows, while Russian and Polish vessels generally have longer tow durations.

2.10 Dr Everson stressed the importance of acquiring haul-by-haul data for the krill fishery. He urged Members to continue submitting this type of data to the Secretariat.

International Scheme of Scientific Observation

2.11 Dr Everson outlined the usefulness of the time budget data for krill fishery operations submitted by Ukraine in 1995. No further data have been submitted to date, and Members were reminded of the need to acquire and submit these data to the Secretariat (SC-CAMLR-XV, paragraph 4.11).

2.12 The method for collecting time budget data, and methods for collecting other observer data were revised during 1996/97. Early in 1997 the Secretariat produced an updated version of the *Scientific Observers Manual*. This manual has now been published and sent to all Members.

Other Information

2.13 No further information was presented.

HARVESTED SPECIES

Distribution and Standing Stock

3.1 A number of features of the distributional behaviour of krill were described which might affect the interpretation of the results from surveys.

Information from Scientific Surveys

3.2 The aggregation patterns of krill, detected acoustically, in the Elephant Island area (Subarea 48.1) differed from inshore where krill were in tight swarms, to offshore where they were found in layers (WG-EMM-97/28). The overall density inshore was about four times as high as that in the slope/offshore region. The swarms inshore exhibited diurnal vertical migrations whereas the layers offshore did not.

3.3 Acoustic records from this survey suggested that myctophid fish were absent from the inshore region but were common in the slope/offshore region. They formed large scattering layers which undertook diurnal vertical migrations from a daytime depth of greater than 150 m to the surface at night. The distributional and behavioural interactions of krill and myctophids were thought to affect their predation by fur seals and chinstrap penguins (see section 6).

3.4 In the Elephant Island area, scattering from krill during 1996/97 was generally in the upper 50 m, frequently near the thermocline and above water c. 0°C, and coincident with both the shelf break and a persistent but variable frontal zone (WG-EMM-97/44). Myctophids are thought to be associated with circumpolar deep water.

3.5 Revised results (WG-EMM-97/49) of the acoustic survey in Subarea 48.2 which was conducted by RV *Atlantida* in February/March 1996 (WG-EMM-96/36) were submitted. The total krill biomass in the surveyed area (19 200 n miles^2) was assessed as 2 million tonnes.

3.6 Vertical migration was seen as a source of bias in the conduct of this survey where a night-time drop in krill density was consistently observed and consequently the results had been corrected for this (WG-EMM-97/49). There was also a suggestion that because the survey was conducted late in the season it may have underestimated the maximum summer biomass.

3.7 Inshore–offshore and longitudinal differences in the distribution of krill from a 1996 survey of Division 58.4.1 were also reported (WG-EMM-97/59). Gravid females were only found in deep water north of the shelf break, with the remainder of the population found both north and south of the shelf break. The results of the survey and an analysis of historical data suggested that the 120–150°E region is an area where krill are perennially scarce and restricted to coastal region whereas krill in the 80–120°E region are more abundant and extend further offshore.

Information from the Fishery

3.8 Evidence from the krill fishery tends to support the scientific evidence of different patterns of distribution and behaviour of krill in inshore and offshore areas.

3.9 Krill fishing northeast of Livingston Island concentrated on the shelf and continental slope area (WG-EMM-97/36). Data from this fishery indicate that in summer larger krill are found in oceanic to continental slope area with small krill on the shelf, but that in late autumn only large krill occurred in slope and shelf areas.

3.10 CPUE data also show inshore–offshore differences in Area 48, with values for catch per towing time generally being higher in the shelf area and lower offshore (WG-EMM-97/22). The population size is generally larger on the shelf because of the presence of both adults and juveniles compared to offshore, where only adults are found, but there may be years when this is not observed. This may occur when krill are abundant and tend to spread out from the shelf area into the oceanic waters, or when the krill population lacks some of the juvenile size groups and the offshore adults contribute more to the overall biomass. The first possibility was not evident from the data presented, the second seems more likely.

Areal Distributions

3.11 Two surveys of Ross Sea – in ice cover (November/December 1994) and immediately following ice retreat (December 1989–January 1990) indicated higher biomass of krill in this area than had been previously envisaged (WG-EMM-97/53).

3.12 Seasonal differences in relative abundances of the two species of krill – *Euphausia superba* and *E. crystallorophias* – were determined by using two acoustic frequencies and by using net samples to verify the acoustic targets. *E. crystallorophias* was abundant in the south and near Ross Island in summer, whereas *E. superba* was found in a superswarm in an ice-free area in the pack-ice in front of Terra Nova Bay in spring but mainly further north later.

3.13 Analysis of haul-by-haul data from the Soviet fishing fleet in Subarea 48.2 provided information on the concentration of krill aggregations and their movement near Coronation Island (WG-EMM-97/50). One offshore krill aggregation persisted for 25 days and drifted to the northwest at a rate of 7.4 km/day and was fished throughout November 1989 until it dispersed. From December 1989 to April 1990, however, the fishing fleet remained to the northwest of Coronation Island and fished temporally and spatially sustained krill concentrations.

Trends in Krill Distribution and Standing Stock

Within-season Trends

3.14 In the South Shetland Islands, surveys were conducted during the spring and summer of 1996/97 (WG-EMM-97/16, 97/30, 97/33 and 97/44). Trends observed within the 1996/97 season included a prolonged spawning period with spawning peak late in the season and poor survival. The highest densities of krill were observed in the frontal zone parallel to the shelf break, which is consistent with previous years.

3.15 A survey conducted by the US in the Elephant Island area (Subarea 48.1) in February 1997 indicated an average year for krill abundance (WG-EMM-97/30), rather than the abundant year suggested by the *Polarstern* cruise conducted in December 1996 (WG-EMM-97/16). The seasonal maximum in krill abundance usually occurs in January, but this year it appears to have occurred earlier.

Between-season Trends

3.16 Acoustic biomass surveys of two areas in the South Georgia region in 1996/97 indicated that lower krill densities and larger krill were found northwest of South Georgia compared to those in the survey area to the northeast. These results were comparable to those from spring 1996 but differed from those obtained in 1994 when krill densities were substantially lower (WG-EMM-97/48).

3.17 Longer-term data from 11 cruises between 1980 and 1987 to the South Georgia region indicate that there were consistent differences in the sizes of krill caught in different areas around the island and that these differences may arise because the krill there originate in different water masses (WG-EMM-97/47). Larger krill encountered at the western end of South Georgia were associated with Bellingshausen Sea water, whereas smaller krill at the eastern end of the island were associated with Weddell Sea water.

3.18 Trends over the last 20 years detected from the results of net surveys conducted in Subarea 48.1 indicated that krill abundance and biomass are now at their highest levels since the mid-1980s, with standing stock in 1996/97 primarily composed of age 2+ krill recruited from spawning in 1994/95 (WG-EMM-97/29 and 97/33).

Indices of Abundance, Distribution and Recruitment

Indices of Local Distribution and Abundance

3.19 The Working Group recalled its request last year for information on indices of local krill availability (SC-CAMLR-XV, Annex 4, paragraphs 3.60 to 3.71), and noted that no progress had been reported in this area.

3.20 The Working Group reiterated the importance that it placed on the development of such indices and accordingly repeated the request that it had made last year (see paragraph 10.5).

Indices of Recruitment

Subarea 48.1

3.21 All available proportional recruitment data from Elephant Island since 1977 were analysed and a new ‘absolute’ recruitment index, in numbers per 1 000 m^3, was presented (WG-EMM-97/29). Compared to preceding years the absolute recruitment index had increased considerably over the past two years and it was suggested that krill stock size in this area should increase as a result. The ‘absolute’ krill recruitment index has increased over the last two years suggesting that the low levels of the last decade may be a result of variability rather than a downward shift in overall krill abundance.

3.22 Proportional recruitment estimates from the Elephant Island area indicate above-average reproductive success for krill spawning in 1994/95 and below-average reproductive success for krill spawning in 1995/96.

3.23 Spawning in the Elephant Island area in 1996/97 was delayed. Although spawning began in December 1996 it only peaked in March when there was a low level of abundance. This occurrence suggests that poor recruitment in this area next year is expected (WG-EMM-97/44).

3.24 Proportional recruitment indices calculated from commercial catches are broadly similar to those from scientific surveys (WG-EMM-97/22 and 97/35). The fishery, however, is selective – the nets select for the larger sizes of krill and the fishery concentrates in specific areas so the commercial data are biased. Proportional recruitment indices calculated from commercial fishery data may provide some useful information on recruitment. For example, because the commercial fishery targets large krill, the presence of large amounts of small krill in the catches may indicate very good recruitment that year.

Subarea 48.3

3.25 Off South Georgia, the only years when strong year classes of year-one krill were found were 1980/81 and 1994/95; these correspond with strong year classes off the Peninsula (WG-EMM-97/47 and 97/48). For example, the 34 mm size class found at South Georgia in 1996/97 can be linked to similar year classes in Subareas 48.1 and 48.2. However, because South Georgia experiences a mixture of waters it may be difficult to see year classes clearly and it is not possible to separate the water masses reliably on a simple east–west division (WG-EMM-97/47).

3.26 In length-frequency data from the commercial catch, only in one out of four years were the size frequencies from the commercial catch in Subarea 48.3 similar to those from Subarea 48.1 (WG-EMM-96/51).

Future Work on Recruitment

3.27 The Working Group recognised the recent progress in assessing krill recruitment from scientific surveys but noted that there was still much work to be done. A priority task was to develop a reliable predictor of krill recruitment and to determine its statistical properties so that it can be used in assessments.

3.28 There is continuing interest in knowing whether the recruitment and density data obtained for restricted areas reflect more global trends. Variability in krill recruitment and abundance will have to be apportioned between large-scale environmental processes and smaller-scale processes operating within the krill population.

3.29 Further analyses are required to determine how well the measures of abundance and proportional recruitment are matched by the output of the krill yield model (see also SC-CAMLR-XV, Annex 4, paragraph 6.23).

CPUE

3.30 Data from the commercial fishery in Area 48 provided an historical background to changes in CPUE (WG-EMM-97/22 and 97/35) and to the current levels of CPUE from the fishery operating in Subarea 48.1 (WG-EMM-97/36).

3.31 CPUE data for Area 48 for the period from 1975/76 to 1987/88 indicated that the highest CPUE occurred in 1980/81 and the lowest in 1977/78 which corresponds to scientific survey estimates of abundance for these years (WG-EMM-97/22). There was little apparent trend between years in the length-frequency distributions from the commercial catch.

3.32 The data from Subarea 48.1 indicated that there was a steady decrease in CPUE in the Livingston Island area and that this was most likely driven by the fishery concentrating more on higher-quality 'less-green' krill over time, although decreases in krill density could not be ruled out as a possible cause (WG-EMM-97/35). There were no apparent trends in the Elephant Island area, but this may have been because of the high variability in krill abundance and distribution noted there.

3.33 Annually-analysed CPUE data typically have very high variances. Surprisingly, given the greater degree of sampling, these are often greater than the variance estimates for scientific surveys in the same region. However, these estimates are not strictly comparable because the scientific survey results reflect only sampling variability and fail to take account of variations in catchability over time.

3.34 The CPUE variance may, in fact, swamp real differences in abundance that should correlate with other events. For example, at South Georgia, mass predator starvation was observed in 1977/78 which was associated with changes in measures of CPUE from the fishery in Subarea 48.3; however, because of the high variances, these observed correlations were not statistically significant.

3.35 The interpretation of CPUE data has some further problems. Observed decreases in CPUE in the Livingston Island area (WG-EMM-97/35) could be a result of krill abundance decreases or of changes in fishing operations – for example, the fleet avoiding 'green' krill. There are also differences in operational strategies of ships from different Members – Japan (and Chile) pursue a much more targeted fishery than Russia and Poland. Japanese CPUE probably reflects within-swarm density whereas Russian CPUE is probably more reflective of general density in the area. Differences in the tonnage of ships may also play a part.

3.36 CPUE provides a greater degree of sampling than scientific surveys and is relatively easily obtained from the commercial fleet but it has inherent biases. Catch/tow time gives some measure of within-swarm krill density but some measure of swarm distribution is also required to interpret these data (Mangel, 1988; Butterworth, 1988).

3.37 Search time has been suggested as a measure of interswarm distribution which could be obtained from the fishing fleet but it has proved difficult to obtain this regularly despite the advances reported at the last Working Group meeting using randomised time sheets by scientific observers (WG-EMM-96/26).

3.38 CPUE data are difficult to interpret because there are uncertainties, not only with regard to the operational strategies, but also because of lack of knowledge of the detailed distributional behaviour of krill and how this varies with abundance. Scientific surveys are essential to provide this type of information.

3.39 CPUE will only ultimately be of use if it can be factored into management advice. There have been major advances in understanding the behaviour of the krill fishery, and also in the data availability from the fishery over the last 10 years, for example, the availability of fine-scale data from the fishery. There is still, however, the problem that the fishery concentrates in a tiny fraction of the range of krill and any measure from the fishery is unlikely to provide an assessment of large-scale krill abundance in the near future.

3.40 The Working Group encouraged further attempts to incorporate CPUE with other operational information from the fishing fleets to work towards providing an index which could be used for assessment purposes.

Krill–Salp Interaction

3.41 New information was presented on the seasonal presence of salps (WG-EMM-97/30 and 97/73), the within-season appearance of salps (WG-EMM-97/33) and the geographic distribution of salps and their relationship to krill and ice (WG-EMM-97/59).

3.42 In the Elephant Island area, following below-average sea-ice coverage over winter, salps reached the second-highest recorded level of abundance despite being only moderately abundant early in the season (WG-EMM-97/30 and 97/33). Increasing salp abundance over the summer season was considered to be unusual and may be linked to the unusually high (4°C) surface water found in the area later in the season.

3.43 The late season salp abundance observed in the Elephant Island area was predicted to cause poor krill recruitment in 1997/98. Few krill larvae were seen late in the season which could have been caused by poor spawning success, by the larvae being eaten by salps, or by advection of the larvae out of the area.

3.44 A negative correlation was reported between the by-catch of salps in the commercial krill catch and the presence of ‘green’ krill, suggesting that when salps were abundant, krill were not feeding actively (WG-EMM-97/37). Salp blooms were generally detected later in the season (February/March) by the commercial fishery.

3.45 In Division 58.4.1 the presence of salps on transects of a scientific survey was negatively correlated with the average annual sea-ice cover (WG-EMM-97/59) whereas krill abundance was positively correlated with annual ice cover. This suggests that there may be a relationship between krill salps, and ice on a geographic as well as on a seasonal scale.

3.46 When dealing with the relationships between krill, salps and the environment and it is necessary to distinguish between hypothesis generating and hypotheses testing processes. A multivariate analysis of salp–krill recruitment/abundance/ice-cover data was suggested as an intersessional task that should be completed before definitive conclusions on these relationships could be reached.

DEPENDENT SPECIES

4.1 The Working Group reviewed papers concerned with the population sizes and demography of dependent species.

4.2 In response to a request from the Working Group, WG-EMM-97/39 described the population sizes of CEMP monitoring species at Marion Island in 1996. Overall, there had been a 22% decline in the breeding population size of gentoo penguins since the previous estimate made in 1994, but this was still an overall increase in numbers since a survey carried out in 1984. Estimates of the breeding population size of macaroni penguins gave the lowest level since surveys began in 1976. Since 1994, the size of the breeding population has declined by about 4% each year.

4.3 The Convener welcomed data resulting from the first year of occupation of the new CEMP site at Bouvet Island (WG-EMM-97/20). From a time series including seven counts of the study site dating back to 1958, the number of breeding chinstrap penguins increased by a factor of 10-times between 1958 and 1979 and has subsequently declined by a similar factor up to 1997. Macaroni penguins increased by a similar order of magnitude through to 1979 and have apparently decreased slowly in number since then. Cape petrels feed mainly on krill at Bouvet Island and showed highly variable breeding success due partly to predation in some parts of the population by sub-Antarctic skuas (WG-EMM-97/56). The population of Antarctic fur seals has increased substantially since 1990. The magnitude of the current rate of increase is such that it must be driven partly by immigration.

4.4 Up-to-date estimates of the breeding population sizes of fur seals and penguins at Cape Shirreff, Livingston Island (WG-EMM-97/62 and 97/63) showed that the long-term increase in fur seal numbers has continued at this site with an estimated average increase of 13% per annum. Although the total number of pups born at Cape Shirreff is still small compared with the numbers at South Georgia, the rate of increase is similar to that observed there in recent years.

4.5 At Cape Shirreff, the size of the breeding population of chinstrap penguins appears to have increased since surveys made over 40 years ago, while the numbers of breeding gentoo penguins have not changed (WG-EMM-97/62). However, Prof. D. Torres (Chile) and Dr W. Trivelpiece (USA) informed the Working Group that qualitative observations indicate that colonies of chinstrap penguins have declined in recent years. Analysis of population counts since 1990 are under review.

4.6 The Working Group noted the potential for changes in predator population sizes due to interactions between different groups of predators. Disturbance of penguins by some fur seals and the presence of penguins in the diets of fur seals has been described from Livingston Island (WG-EMM-97/62). The rapid increase in fur seal numbers generally has the potential to make some shore-breeding sites less attractive for penguins. Although it was acknowledged that this was a possibility, evidence from South Georgia did not support this view since gentoo penguins and fur seals appeared to co-exist at several sites. Furthermore, the declines in macaroni penguins at South Georgia and Marion Island had occurred mainly in areas and/or colonies which were inaccessible to fur seals.

ENVIRONMENT

5.1 The Convener noted that the report of the Workshop on International Coordination (WG-EMM-97/44) contained information relevant to environmental interests and asked Dr S. Kim (Republic of Korea), Convener of the workshop, to summarise the report.

5.2 Dr Kim introduced WG-EMM-97/44 by noting that a workshop was convened at the Southwest Fisheries Center in La Jolla, USA, during the week prior to the meeting of WG-EMM. Scientists from Japan, Republic of Korea, Germany, and the US participated in the workshop. Dr Kim asked Mr A. Amos (USA), who was the leader of the subgroup on the environment, to summarise this portion of the report.

5.3 Mr Amos said that three Members, Republic of Korea, Germany and the US, participated in the sequential occupation of a transect along 55°W during the 1996/97 field season to obtain information on seasonal environmental variability. All Members used the same instrumentation (e.g. CTD) and methodology, which minimised variability between datasets.

5.4 Mr Amos noted that the general water-mass structure seen in 1996/97 was the same as that seen in previous years. However, the surface temperatures in December 1996 were higher than those observed in previous years. Temperatures above 4°C were observed for the first time. The reason for the higher temperatures and the biological implications of this are unknown.

5.5 The Convener thanked Mr Amos for his summary and noted that the seasonal datasets from 55°W provide an example of what can be accomplished through cooperative, coordinated research.

5.6 WG-EMM-97/6, which provided further discussion of the German hydrographic dataset collected during December 1996 in the Elephant Island region, was introduced. Time series data presented in this paper show movement of the boundary between the Weddell Sea and southeast Pacific surface waters. This paper recommends a cooperative analysis of historical hydrographic data from the Elephant Island region.

5.7 WG-EMM-97/40 presented an analysis of hydrographic and sea-surface temperature data obtained during January and February 1994 around South Georgia. The primary focus of this analysis was on defining the position and character of the Polar Front and associated mesoscale features. The data and analysis indicate that the Polar Front is quite variable and it is suggested that this variability is likely of crucial importance to many of the predator species breeding at the northern end of South Georgia. Dr Trathan noted that this paper provides the first documentation of changes in the position of the Polar Front in this region.

5.8 Following from work begun at the Workshop on Evaluating Krill Flux Factors (WS-Flux) in Cape Town, South Africa in 1994, WG-EMM-97/65 provided revised calculations of krill flux in the South Georgia region. The fluxes were calculated using the circulation fields from the Fine Resolution Antarctic Model (FRAM) and hydroacoustic data. The computed krill fluxes were then compared to the estimated needs of predator populations in the South Georgia region. Dr Murphy said that further discussion of this paper would take place in the context of ecosystem interactions.

5.9 WG-EMM-97/67 used flow fields derived from historical wind, hydrographic, and circulation data to calculate transport patterns and transport times for particles released west of the Antarctic Peninsula and throughout the Scotia Sea. The simulated trajectories show that wind transport alone results in small displacements of particles from their initial location. Displacement due to the large-scale geostrophic flow transports particles from the Antarctic Peninsula to South Georgia in 120–160 days. A combination of wind and large-scale flow is needed to move particles from the northern Weddell Sea to South Georgia.

5.10 The hydrographic and circulation characteristics of the Antarctic continental shelf between 150°E and the Greenwich Meridian were described in WG-EMM-97/68. This analysis shows similarity in many of the water masses and water-mass structure over this region.

5.11 WG-EMM-97/66 gave examples of four marine fisheries that are affected by environmental variability. This paper was presented as an information item. The case histories indicate that management strategies for exploited fisheries must include the effects of environmental variability.

5.12 WG-EMM-97/69 presented an analysis of sea-ice data from the Antarctic Peninsula region obtained between 1978 and 1995. These data show a region of persistent open water off the tip of the Antarctic Peninsula. This feature was pronounced during 1987 and 1991, which were characterised by extensive sea-ice cover. Years of reduced sea-ice cover did not show the region of open water at the tip of the Antarctic Peninsula. A persistent region of open water may have considerable implications for biological production in this region.

5.13 Dr M. Naganobu (Japan) suggested that the region of open water may be a polynya produced by the westerly winds. Dr Kock said that the open water region observed at the tip of the Peninsula may not fit the accepted definition of a polynya. Dr Hewitt said that the important point made in WG-EMM-97/69 was that the region at the tip of the Antarctic Peninsula may be ice free in August and September when the ice extent is greatest. He also noted that the open water feature is more extensive in space and time than a simple lead in the ice.

ECOSYSTEM ANALYSIS

By-catch of Fish in the Krill Fishery

6.1 WG-EMM-97/72 provided information on the species composition and the amount of fish by-catch in krill catches of the trawler *Niitaka Maru* over the continental slope and in oceanic waters to the north of the South Shetland Islands from 1 to 23 February 1997. Sampling onboard followed the standardised manner as set out in the *Scientific Observers Manual*. Fish were encountered in 16 out of 80 hauls. With the exception of one specimen of the coastal icefish *Neopagetopsis ionah*, all fish belonged to oceanic mesopelagic species with the myctophid *Electrona antarctica* as the predominant species among them. Fish by-catches were primarily observed in hauls conducted in the late evening and at night when mesopelagic fish migrate to the upper part of the water column to feed.

6.2 The Working Group welcomed the continuous effort of Japanese scientists to provide information on the by-catch of juvenile fish in the krill fishery. The Working Group noted, however, that this study, as most previous studies, had been conducted in austral summer. It reiterated requests from previous years (e.g. SC-CAMLR-XV, Annex 4, paragraph 6.3) to extend these studies to other seasons to take into account spatial and seasonal differences in the occurrence of fish in krill catches in order to better assess when fish are most vulnerable to the krill fishery.

6.3 Following a recommendation of the Working Group from last year (SC-CAMLR-XV, Annex 4, paragraph 6.3), stomach contents of fish specimens incidentally taken by a Japanese krill fishing vessel in January–February 1995 are currently being studied in order to obtain a better understanding on the association of fish with krill aggregations. Results of this analysis will be submitted to the 1997 meeting of WG-FSA.

6.4 Following a request by WG-FSA in 1995, the Science Officer, Dr Sabourenkov, provided an interim report on the status of the comprehensive review on the by-catch of fish in the krill fishery which is currently being conducted under his coordination by a group of specialists in this field. The Working Group has agreed on a protocol for how the data should be analysed. The Secretariat has established a database which currently contains records from 1 018 commercial hauls taken in Subareas 48.1 and 48.2 and Divisions 58.4.1, 58.4.2 and 58.4.4. More information, primarily from the krill fishery in Subarea 48.1, is likely to be submitted by Japan and Chile in the near future. Information from other areas, for example Subarea 48.3, is also available. However, these data are often of limited value due to the lack of information on zero catches. The database is currently being extended to incorporate information from research vessels on the fish by-catch from macrozooplankton/nekton surveys which may assist in identifying areas where and when pelagic stages of Antarctic fish are abundant and likely to be taken during krill fishing. Pending the submission of outstanding datasets, it is envisaged that results from this review will become available at the 1997 meeting of WG-FSA.

Report of the Subgroup on Statistics

6.5 The Working Group considered the Report of the Subgroup on Statistics (Appendix D) which met in La Jolla, USA, immediately prior to the Working Group meeting. Aspects of the subgroup's report on indices of at-sea behaviour and survey design are discussed under other agenda items (paragraphs 8.69, 8.70 and 8.121).

Identification of 'Anomalies' in CEMP Indices

6.6 The subgroup recommended that an alternative term be found for 'anomaly' to describe noteworthy values in the CEMP indices. The term anomaly is commonly used to describe events that occur with low probability. However, events of interest may be fairly common, for example occurring once every four or five years. The important consideration may be whether the frequency of these events is changing over time. WG-EMM agreed that it would use the term 'Ecologically Important Value' (EIV), referred to by the Subgroup on Statistics as 'Value Outside the Generally Observed Norm' to describe a value in an index that is extreme relative to the distribution of values which are deemed to be unlikely to lead to substantial changes in the status of dependent, related and harvested species. The Working Group noted that the application of this definition requires not only further development of the statistical methods applied to the indices, but also further consideration on determining the range of values which would be deemed as unlikely to lead to substantial changes in the status of dependent, related and harvested species.

6.7 The Working Group noted the promising results obtained from illustrative examples of multivariate analyses of the CEMP indices including principal component analysis and a simple additive index. In particular, the Working Group endorsed the further development of multivariate analyses, including studies of combined indices that summarise a large number of indices into a smaller set which can be more easily examined. The Working Group also noted that comparing indices to distributions estimated from a set of baseline data provided for more reliable detection of extreme values.

6.8 The Working Group noted the importance of being able to detect not only extreme values in the indices, but also changes in variability, trends and shifts in the values, and changes in the frequency of extreme events.

6.9 Contributors to CEMP indices were requested to check the validity of data in WG-EMM-97/25 Rev. 1 and to inform the Secretariat of any changes which might be required.

Agnew–Phegan Model

6.10 The Subgroup on Statistics suggested modifications to the Agnew–Phegan model of overlap both in terms of adjustments to temporal aspects of the underlying model and changes in the form of the index calculated from it. The Working Group agreed that the Schroeder index proposed by the subgroup should be applied to Subarea 48.1 and requested the Secretariat to report the results to the next meeting. The Data Manager undertook, with assistance from Dr de la Mare, to examine revisions of the underlying model to improve its temporal aspects. The Working Group also noted that the Schroeder index gives a measure of the spatial overlap between the dependent species and the fishery in a given time period. It was agreed that an additional index is required to give some measure related to the possible impact on dependent species of the quantities of harvested species taken by a fishery.

Missing Values

6.11 The Working Group endorsed the advice of the Subgroup on Statistics that the causes of missing values in the database of CEMP indices need to be documented as part of the database. This is required so that if missing values need to be imputed for a particular type of analysis, the method of imputation can take into account those cases where the fact that data are missing is not independent of the expected values of the missing data. The Data Manager is preparing a circular seeking the information specified in paragraphs 5.3 to 5.6 of the subgroup's report (Appendix D). The Working Group also endorsed the advice of the subgroup given in paragraph 5.7 of Appendix D, and in particular that imputed values where all data for a particular year are missing should not be incorporated into the CCAMLR database.

Interactions between Ecosystem Components

Krill-centred Interactions

Harvested Species and the Environment

6.12 The Working Group discussed the ecological and fishery-based studies of the environment and harvested species interactions together. Initially mesoscale studies were considered with emphasis on the results from the last season, and aspects of importance for ecosystem analysis were noted. A number of the papers were discussed elsewhere in the agenda, so in this section only the main interaction effects relating to harvested species have been emphasised.

6.13 WG-EMM-97/6, 97/16, 97/30, 97/33 and 97/44 dealt with results from multidisciplinary surveys in the Elephant Island area during the 1996/97 field season. In particular WG-EMM-97/30 described the acoustically detected distribution of krill relative to hydrographic features measured during February 1997, and WG-EMM-97/33 provided a detailed description of salp population growth in February and March 1997. WG-EMM-97/44 presented results from the Workshop on International Coordination which provided an assessment of seasonal and between-year differences in (i) hydrographic conditions, (ii) phytoplankton biomass, composition and distribution and chlorophyll *a* concentrations, and (iii) krill and salp abundance and reproductive success in the Elephant Island area, from December 1996 to March 1997. Following conceptual ideas presented at earlier meetings the studies related krill and salp reproductive success to winter sea-ice conditions.

6.14 These data build on the long time series being generated for the Elephant Island region. The season 1996/97 showed a different pattern of development with the occurrence in the area of very warm surface water and the apparent rapid development of the salp population. The Working Group noted that this was not a direct effect of ice extent on krill recruitment but appeared to be a mid-season disruption of the krill population development. This emphasises that it is not only the potential sea-ice driven recruitment fluctuations which generate variability in this region. There may also be environmental events occurring at a range of scales which impact on the local krill population. Other details were also given with a detailed summary presented in WG-EMM-97/44 which is attached in Appendix E. The Working Group noted the paper also gave a series of recommendations relating to future integration of Elephant Island area studies. Some of these are of direct relevance to WG-EMM studies and attention was drawn to the list.

6.15 A number of papers gave information on the interactions occurring in other areas of the Southern Ocean. These highlighted the large-scale water mass effects, interactions with the seabed, contrasts between the shelf and off-shelf regions and considered the remote sources of krill in particular regions.

6.16 WG-EMM-97/28 described the different horizontal and vertical distributions of krill of different size and maturity stage and of myctophids occurring between inshore and slope/offshore areas adjacent to Seal Island. These regions provide different feeding environments for their predators. The distributional patterns of prey species were related to the strength and depth of the thermocline, which differs between inshore and offshore areas and the location of the shelf break front, which varies both seasonally and interannually.

6.17 Krill length-frequency distributions from the South Georgia region between 1980 and 1997 were analysed in WG-EMM-97/47 to consider regional variation. Distributions of krill representing different length categories were related to possible source areas and the transport from the Weddell Sea and Bellingshausen Sea. The larger krill occurred in the length-frequency distributions from the west of the island.

6.18 Data from the South Orkney Island area on water circulation and krill distribution were reported in WG-EMM-97/49. The aggregation of krill in relation to water circulation was related to the eddy activity in the shelf-break area north of Coronation Island in the South Orkney Island group.

6.19 WG-EMM-97/59 reported on the structure of krill populations in the 80–150°E area of the Southern Ocean during January and March 1996. The study emphasised the geographical variation of the krill populations, with lower krill densities in areas where salp abundance was high. The geographical relationship of krill and salps was discussed in relation to the sea-ice conditions, extending the temporal concept framed for the Antarctic Peninsula area to a larger scale. It was suggested that the southeast Indian Ocean area may be a particularly good area for examining these geographical aspects of the sea-ice, krill and salp relationships.

6.20 WG-EMM-97/53 presented data on the distribution of krill in sea-ice areas in the Ross Sea. The work indicated that densities of krill in the Ross Sea area can be similar to other high krill abundance regions of the Southern Ocean. Aspects of the krill aggregation characteristics in relation to sea-ice conditions were also presented. Krill aggregations were less frequent below the ice, with individual krill encountered in the surface ice floe areas. These interactions have important implications for the availability of prey to predators. The Working Group also discussed the potential effects of predators in modifying the prey distribution.

6.21 Although the relationship between krill and shelf break has been known for a long time, the haul-by-haul fishery data (WG-EMM-97/36, 97/41, 97/50 and 97/51) are providing larger-scale, longer-term indications of the position of exploitable concentrations of krill. The data are revealing aspects of the highly focused nature of the fishery and the importance of local bathymetric features in determining fishing grounds. The importance of the water circulation and seabed interactions in generating conditions for the concentration of krill was particularly emphasised in WG-EMM-97/50 and 97/51.

6.22 It was noted that the krill fishery does not target the whole Scotia Sea area and it was pointed out that the fishery, although focused, is almost certainly able to target the regular high concentration regions. As these traditional fishing grounds are in the vicinity of some of the largest predator colonies in the area, this highlights the usefulness of the fishery data in considering interactions between predators, prey and fisheries. As with all of the prey and predator datasets, the need for careful interpretation of such data was emphasised. The Working Group noted the value of analyses of individual trawl-based fishery data and encouraged further development of analyses of the fishing operation.

6.23 The Working Group discussed the integration of the information on krill–environment interactions and the factors determining the population dynamics. A number of papers addressed this topic bringing together a range of research and fishery-based information. In particular, WG-EMM-97/73 reported on the sea-ice, krill and salp interactions in the Elephant Island area.

6.24 Factors affecting krill population dynamics were further discussed in WG-EMM-97/29, in which the updated recruitment index series for the Elephant Island area was presented. In particular, the importance of the timing of spawning as well as the following winter sea-ice conditions in determining the recruitment success for a year class was noted.

6.25 Aspects of the integration of long-term information were addressed in WG-EMM-97/22 and 97/35, which developed analyses of krill fishery data to examine interannual variability. Both indicated the value of such analyses but also emphasised the problems in interpretation of the data. Links between recruitment indices and environmental changes were discussed in WG-EMM-97/35, but aspects of operational changes in the fishery were also noted.

6.26 The value of fishery-derived information in considering ecosystem interactions was again emphasised by WG-EMM-97/37 which presented data on the salp by-catch and condition of krill based on logbook data from fishing vessels. It was noted that the salp by-catch showed an inverse relationship with the occurrence of 'green' krill. The Working Group discussed ancillary data collected in association with the fishing operation and encouraged further analyses and reporting of such data.

6.27 Two papers (WG-EMM-97/67 and 97/65) addressed the concept of transport of krill with the ocean currents. WG-EMM-97/67 builds on work presented at WS-Flux in 1994 and emphasised the importance of the Southern Antarctic Circumpolar Current Front (SACCF) in the transport of krill across the Scotia Sea to the South Georgia area. The effect of Ekman drift is to entrain further particles in the SACCF and generates transport times from the Antarctic Peninsula to South Georgia of 140–160 days.

6.28 WG-EMM-97/65 also develops ideas presented at WS-Flux and combines physical model data and krill survey data to estimate krill flux and turnover times and related this to predator demand in the South Georgia area. Many of the concepts on which the approach is based are shown in the data and descriptions given in WG-EMM-97/49 and 97/50. WG-EMM-97/65 emphasised that there will be differential flux and turnover rates in such areas and that these will be important in determining the local availability of krill to predators. Further data are required to quantify krill flux and explore the development of krill aggregations in areas of complex hydrodynamics. The Working Group encouraged further analyses of the transport of krill and the factors determining the aggregation patterns.

6.29 There were detailed discussions of all the papers and the new information provided. It was noted that there was a range of hypotheses on the environmental and biological interactions determining the local krill population. These hypotheses included the factors of large-scale krill transport, water mass variations, biotic interactions within the area such as competition between salps and krill for the available primary production and the hypothesis of winter sea-ice conditions affecting the recruitment of krill and development of salp populations. It was noted that some of these factors were probably more important in some areas of the Southern Ocean than others.

6.30 The Working Group was reminded of the strategic modelling exercise for the management of the ecosystem derived at WG-EMM in 1995 and this was discussed using the conceptual framework shown in Figures 3 and 4 of the WG-EMM-95 report (SC-CAMLR-XV, Annex 4). It was suggested that the various hypotheses being proposed should be developed so that they could be tested using the indices being compiled by WG-EMM. This synthesis of ideas could then be used in guiding further refinements of the approach.

6.31 The discussions led to the generation of Figure 1 which characterises the main interactions occurring in a region based on the concepts derived from the Elephant Island area. The figure illustrates the environmental factors determining local krill abundance and distribution.

6.32 The concepts underlying the generation of Figure 1 are given in Table 1 with a brief comment on the potential form of the environmental interaction with the biological processes in the area. The final column of the table considers the requirements for the application of the ideas to a larger area.

6.33 The distinction between the krill population processes and the environmental factors influencing these was emphasised. For example, one of the population processes was immigration/emigration while the physical factor involved is characterised as advection. The Working Group agreed that the table and figure give a useful summary of the various hypotheses being discussed in relation to environment and harvested species interactions in the Elephant Island area.

6.34 There was some discussion about the possibility of generating a table which captured more generally ideas about the operation of the Southern Ocean ecosystem. However, it was noted that the hypothesised relationship between winter sea-ice conditions and krill recruitment may not have a circumpolar generality. It was suggested that the approach could be applied to other areas and Members were encouraged to develop such a view of the environmental factors and processes determining the local krill population in other Southern Ocean areas.

6.35 Various statistical and modelling approaches to examine the important interactions were discussed. The Working Group encouraged further multivariate analyses of the form recommended by the Subgroup on Statistics (Appendix D).

6.36 A paper which presented a more general view of the environmental variability effects on marine fisheries was discussed (WG-EMM-97/66). The review paper emphasised the environmental control of fisheries and highlighted the need for flexible management strategies.

6.37 The Working Group agreed that development should continue on methods which can allow for the incorporation of environmental information into management strategies.

6.38 As a final point the Working Group was reminded that at last year's meeting there was a prediction of a strong krill recruitment for the 1995/96 season in the Elephant Island area. WG-EMM-97/29 indicated that the proportional recruitment was low but the absolute recruitment was high as a result of a higher biomass of krill in the area. WG-EMM-97/44 predicted that, on the basis of a late krill spawning, below-average ice conditions and the high observed salp density, there will be a poor recruitment from the 1996/97 season.

Interactions between Krill and Dependent Species

Fur Seals

6.39 The Working Group reviewed papers concerning the interactions between krill and dependent species. Those that included information concerning the diet of predators, total consumption based on energy requirements, and the effects of changes in krill abundance on predator behaviour and production were considered by taxonomic group, i.e. seals, seabirds and minke whales. A further group of papers concerning the mechanisms of the interactions between dependent species and krill was considered separately.

6.40 WG-EMM-97/60 considered the diet of adult and subadult male Antarctic fur seals at Nelson Island, South Shetland Islands. Based on the analysis of scats, this study demonstrated that both krill and fish were important components of the diet and that myctophids were the dominant species group in the fish component of the diet. It was not known whether these seals were foraging in the Bransfield Strait region or elsewhere. Dr V. Siegel (Germany) suggested that such information might be useful because the composition of fish populations differs between Bransfield Strait and areas to the west of the South Shetland Islands.

6.41 In another study (WG-EMM-97/14) the diet of female Antarctic fur seals was examined using a new method involving the analysis of fatty acids in milk. This demonstrated that during 1991, a year of known low krill abundance, the krill component of the diet of female fur seals was reduced during the perinatal period compared with the remainder of lactation. It also showed that diet changed from mainly krill in the early and middle parts of lactation to one that contained a greater proportion of fish during the later stages of lactation, consistent with data from scat analysis. However, at this stage, it is not possible to distinguish between the different fish taxa involved.

6.42 Predator consumption rates have recently become a critical component of a proposed method for estimating the minimum krill standing stock biomass (WG-EMM-97/65) in Subarea 48.3. In WG-EMM-97/11 and 97/13, estimates were provided of the variation in the energy demand of Antarctic fur seal pups during the period of dependency on maternal resources. This will contribute to refining estimates of the consumption of krill by fur seals. These papers also demonstrated the magnitude of reduction in the total energy delivery to pups that resulted from the low level of krill abundance in 1991.

Seabirds

6.43 An important aspect of diet studies involving predators is the different degrees of specialisation on krill as a food source. A gradation of specialisation on krill among six species of predators at South Georgia was illustrated in WG-EMM-97/15. The paper also provided the length-frequency distributions of krill taken by each predator which showed differences between surface-feeding and diving species and small, but significant, biases towards larger individuals compared with net hauls. There was additional bias (in favour of mature females) in the maturity stage and sex of krill taken by predators in comparison with net hauls.

6.44 The two species of diving petrels at South Georgia have diets which are dominated by crustaceans. However, the South Georgia diving petrel has a greater dependency on krill than the common diving petrel in which copepods are the largest component of the diet (WG-EMM-97/10). This pattern of dependency on both krill and copepods was also demonstrated in a five-year study of the diet of Antarctic prions at South Georgia (WG-EMM-97/12). During years of low krill abundance, prions switched to feeding on copepods without reduction in reproductive success.

6.45 Cape petrels at Bouvet Island (Subarea 48.6) also have a diet that is dominated by krill (WG-EMM-97/56), consistent with data from Subareas 48.2 and 48.3 but different from the only study in Subarea 48.1, which indicated fish as the most important component of the diet. Diet samples from chinstrap and macaroni penguins from Bouvet Island also showed that these species are highly dependent on krill, although macaroni penguin diets also included myctophid fish (WG-EMM-97/20). Mr Cooper also informed the Working Group that southern fulmars at Bouvet Island appeared to take mainly krill.

6.46 Similarly, Antarctic petrels at Svarthamaren, Dronning Maud Land, feed krill to their chicks but birds sampled at sea in adjacent areas to the breeding colony were shown mainly to have a diet of fish (WG-EMM-97/58). It is therefore possible that the diet taken by adults foraging to provision their own needs differs from that supplied to the chicks. The Working Group also welcomed the calculations made of the total food consumption by Antarctic petrels at this site as a valuable addition to knowledge of the potential impact of these predators on krill.

6.47 WG-EMM-97/64 represented a comprehensive collaborative study between Australian and French scientists to compare the foraging ranges and diets of Adélie penguins in Division 58.4.1. This combined shore-based studies of foraging and diet with ship-based studies of prey in the regions. The trawl and penguin samples differed at the two sites. At Casey Station, where net samples contained both *E. crystallorophias* and *E. superba*, penguins took mainly *E. crystallorophias* and little *E. superba.* In contrast, at Dumont d'Urville, net samples contained only *E. crystallorophias* whereas penguins fed on both *E. crystallorophias* and *E. superba*.

6.48 The Working Group noted the insights into diet variation provided by these studies of seabirds and particularly the varying ability of species that are generally dependent upon krill to switch to other prey in the absence of krill. There is a continuum of species in terms of the extent to which fecundity, fledging/weaning mass and reduced survival of adults and young are affected by variations in krill abundance.

Minke Whales

6.49 Mr T. Ichii (Japan) reviewed the results of studies of minke whales which had been carried out by the Japanese Whale Research Program (WG-EMM-97/17 and 97/18) in Division 58.4.1 and Subarea 88.1. He concluded that minke whales are large consumers of krill in the Indian Ocean and the Ross Sea and that they may be an appropriate species for monitoring the status of krill stocks. This was based upon estimates of daily food consumption by minke whales which had been derived from a study of the diel variation in the mass of stomach contents. He estimated that the consumption of krill by minke whales in the Ross Sea region, around 3 million tonnes, was equivalent to the total standing stock biomass estimated for the region in late spring 1994 (WG-EMM-97/53).

6.50 The seasonal increase in the girth of minke whales was lowest in years of low krill abundance and, based on the analysis of the response of the girth of minke whales to changes in krill abundance, Mr Ichii proposed that girth could be used as a parameter to monitor the changing status of krill stocks.

6.51 Mr Ichii suggested that reduced body condition in minke whales is related to increased ice extent. This was because sea-ice covered the zone of the shelf slope which, therefore, made this rich region inaccessible to minke whales. Although this negative relationship between sea-ice and predator performance is similar to that observed in Subarea 48.2, it may differ from the current understanding of interactions between sea-ice, krill and predators in Subarea 48.1. However, further research is required to examine the differences and similarities between observations from each of these subareas. Mr Ichii also commented that the Ross Sea region had previously been considered an area of low food availability, which appeared paradoxical because this was an area of high minke whale density.

6.52 WG-EMM-97/17 provided information concerning the energetics and krill consumption by minke whales that had been requested previously. The Working Group agreed that it would be useful to have similar estimates for Area 48. Prof. M. Mangel (USA) suggested that past simulations used to model the krill fishery (Mangel, 1988) could be extended to predators such as the minke whale if the fishery was viewed to operate in a similar manner to a pelagic predator.

6.53 Unlike all the other CEMP monitoring species, with the exception of the crabeater seal, the minke whale is also the only species which is not a central-place forager which may mean that it could provide valuable insights into ecosystem variability which may not be available from the other monitoring species. Mr Ichii had proposed that changes in girth could be used as a monitoring parameter for minke whales. Although the Working Group supported the principle of developing standard methods for minke whales and acknowledged the importance of minke whales as predators of krill, it was felt that there remained sufficient uncertainty about the spatial and temporal scales represented by such a monitoring parameter that their reintroduction as a CEMP monitoring species could not be justified at this stage.

6.54 The Working Group also noted that to re-establish minke whales as a CEMP monitoring species would require methods capable of generating long-term data; non-invasive techniques, including photogrammetric measurements, should be investigated.

6.55 The Working Group noted that it would be useful to apply the estimates of minke whale food consumption given in WG-EMM-97/17 over a wide geographical range to quantify better the impact of minke whale predation on krill.

International Whaling Commission

6.56 Dr Reilly, the observer from IWC, explained that, having now completed its main task of developing a management procedure for whales, the focus of the interest of the IWC had shifted towards other topics, including the effects of the environment on whales. This was aimed at trying to incorporate predictions about climate variability, and about how this was likely to affect whales, into management advice. Dr Reilly drew the attention of the meeting to the report of its Workshop on Cetaceans and Climate Change held in Hawaii, USA, during April 1996. Several members of WG-EMM had been present at this meeting and Dr V. Marín (Chile) had represented SC-CAMLR on the steering group for the Hawaii Workshop.

6.57 The Working Group agreed to examine further the issue of areas of common interest to the IWC and WG-EMM. It was also recognised that the activities of WG-EMM had to a large degree ignored whales, despite their undoubted importance as krill predators, partly because whales were viewed as the preserve of the IWC. The research activities established by different national programs to address issues of importance to WG-EMM had begun to address fields of common interest to the IWC and there was perhaps potential to expand the scope of these activities by coordinating activities with the IWC. Further discussions are contained in paragraph 8.133.

Dependent–Harvested Species Interactions

6.58 The Working Group considered the mechanisms of predator–krill interactions separately from the empirical consequences of these interactions as they affect predator population dynamics in relation to a fishery.

6.59 WG-EMM-97/28 examined the mechanisms underlying the behaviour of chinstrap penguins and fur seals foraging from Seal Island. This paper had been revised in response to comments provided last year by the Working Group. It suggested that there were two distinct penguin foraging strategies involving daytime and overnight foraging trips and that these corresponded to trips made over the shelf and beyond the shelf break respectively. In contrast, fur seals always foraged beyond the shelf break.

6.60 Several different factors are likely to affect foraging behaviour including the distance to the prey, depth/dispersion of the prey, energy content of the prey, demand of the young and the necessity for parents to forage for themselves in addition to their dependent young. WG-EMM-97/28 demonstrated the possible effects of different depths/dispersions of prey, prey profitability and the distance which had to be travelled to find prey. Considering all of these variables, it should be possible to model the underlying mechanisms and trade-offs associated with this behaviour to begin to predict how behaviour might change in relation to changes in the underlying prey distribution. Prof. Mangel had provided an early version of such a model to the previous meeting of WG-EMM (Switzer and Mangel, 1996).

6.61 The Working Group noted the suggestion that the behaviour of penguins foraging to provision themselves may differ from that used when provisioning chicks. This could result in different diets as also suggested by the observations from Antarctic petrels (WG-EMM-97/58; paragraph 6.46). Chinstrap penguins at Admiralty Bay show no clear distinction in day and night foraging activities. This difference across sites further emphasises the need to understand how foraging behaviour is likely to vary as a result of different prey distributions. Differences between the foraging of penguins and fur seals might also be explained by taking life history variables into account within a mechanistic model.

6.62 WG-EMM-97/8 is a step towards an empirical assessment of how predators are likely to be influenced by variations in prey availability. This study examined the effects of an experimental reduction in the foraging capabilities of fur seals on the provisioning of pups. It showed that even though a significant reduction in swimming performance was achieved by the experimental manipulation, this did not affect the ability of these fur seals to provision their young. This illustrates that parameters of foraging and reproductive performance in these seals, some of which are used as CEMP indices, tend to be buffered against reduction in krill abundance.

6.63 This mechanistic approach to examining predator responses to variations in krill dispersion contrasts with the empirical approach outlined by WG-EMM-97/70. The Working Group welcomed further development of the predator–prey model presented at previous meetings of WG-EMM. In particular, it was noted that further simulations had been carried out taking into consideration comments from Drs Croxall and Boyd on the empirical estimates of survival rates in black-browed albatrosses and Antarctic fur seals. Their main conclusions were that the effect of a fishery on the depletion of a predator population was particularly sensitive to R^{max}, the maximum potential rate of increase. In the case of black-browed albatrosses, the sensitivity was such that a fishery of almost any level would cause the population to decline. Fur seals were less sensitive but Prof. Butterworth emphasised the importance of R^{max} even for this species. Therefore, in both cases, uncertainty about the value of R^{max} was likely to reduce the precision of the predicted effect of γ (krill fishing intensity) on the predator population size.

6.64 Dr Boyd considered that, in practice, the form of the functional relationship used in the model was probably more of a problem than the value of R^{max}. Whereas R^{max} can be estimated with reasonable precision, there are many factors that could affect the functional response. As illustrated in Figure 6 of WG-EMM-97/70, the functional relationship is between predator survival rate and krill availability. Krill availability, as seen by the predator, may not correspond well with krill availability defined by a synoptic survey mainly because predators may forage on different optimal densities/distributions of krill. It would be possible, for example, that the relationship between B (krill availability as defined in WG-EMM-97/70) and predator survival rate is not monotonic.

6.65 Prof. Butterworth pointed out that the form of the functional relationship had been recommended by the previous meeting and that uncertainty in the functional relationship is taken into account to some extent by *n* in Table 4 of WG-EMM-97/70. However, the functional relationship for the black-browed albatross, which is known to switch to alternative prey in years of low food availability, had taken this into account. The ability of species to prey-switch was seen by the Working Group as an important issue and this had been addressed by papers tabled at this meeting (see paragraphs 6.43 to 6.48). It was suggested that such an approach adopted to take prey switching into account for the albatross should also be extended to the fur seal.

6.66 It was also reported that little progress had been made with applying the model to Adélie penguins mainly because there were specific problems with the field data which had still to be resolved.

6.67 Dr Croxall raised the issue of the scales which were addressed by the model. Whereas the form of the functional relationship in the model may apply over a wide spatial and temporal scale, it is the effects of fishing at small scales that would seem to be of most importance.

6.68 Prof. Mangel questioned what was the effect of introducing variability into the relationship between krill fishing intensity and predator population depletion which is currently only represented as a deterministic relationship in WG-EMM-97/70. In response, Prof. Butterworth indicated that work was in progress to address this question.

6.69 Dr K. Shust (Russia) questioned the realism of the model because, on inspection, there appeared to be no relationship between predator survival rates and known periods of low krill abundance and that the variability in predator survival rates appeared to be small.

6.70 In response, Dr Boyd pointed out that, at least for fur seals, we might not expect to see a large response in survival rate if krill availability is such that most of the survival rates lie on the top plateau of the functional relationship.

6.71 Overall, the Working Group considered that there was much to be gained from a parallel approach to examining krill-predator interactions involving empirical and mechanistic models. At a broad scale, the empirical model described in WG-EMM-97/70, provides a useful foundation for the provision of management advice. The mechanistic modelling will provide the necessary link between prey abundance and distribution and predator behaviour, which is measured in the form of CEMP parameters. This can be used to better characterise the functional relationship between krill abundance and predator demographic parameters.

6.72 The Working Group encouraged the further development of the empirical model to ensure that in future there is a basis upon which management advice can be taken forward to the Scientific Committee. It also endorsed the mechanistic approach by inviting the submission of papers addressing this subject at future meetings.

Status and Trends of Dependent Species

6.73 The SCAR Bird Biology Subcommittee and the SCAR Group of Specialists on Seals had been requested by CCAMLR to provide guidance about the present status and trends of Antarctic seabird and seal populations. The report from the Bird Biology Subcommittee was tabled at the Scientific Committee last year. The report from the Group of Specialists on Seals arrived too late to be circulated at the present meeting. It was decided to defer consideration of both documents until the 1998 meeting of WG-EMM.

Interactions between Dependent Species

6.74 The issue of potential interactions between dependent species was raised because this was seen to be relevant to the Working Group's ability to discriminate between the effects of krill fishing and the effects of competition between predators.

6.75 This subject had been discussed previously (see also paragraph 4.6) and the Working Group considered that it is an issue that should be incorporated within assessments of the reasons underlying changes in predator abundance.

6.76 Dr Bergström noted that within WG-EMM consideration could be given to the possibility that one dependent species affects other dependent species to the extent that local species diversity may decline.

Fisheries–Dependent Species Overlap

6.77 New information on the potential overlap between the commercial fleet and predators in part of Subarea 48.2 was provided in WG-EMM-97/51. Dr Sushin noted that calculations of the proportion of local krill biomass on the entire fishing ground in Subarea 48.2 was less than 10% during the December–March critical period for krill predators. The paper also concluded that, for the area where the fleet worked most intensively, it took less than 14% per month of the local biomass. Given the regular recruitment of krill to this area from other areas, the authors of WG-EMM-97/51 believed that competition between the fishing fleet and the local predators was negligible.

6.78 The Working Group did not have time to evaluate the model used in WG-EMM-97/51 to estimate local krill biomass. Nevertheless even if the estimates of the proportion of local krill biomass removed by the fishery are correct, it does not follow that the impact on the large local breeding populations of krill predators is negligible. Dr Croxall noted that the situation described in WG-EMM-97/51 was one where the modelling approach described last year by Prof. Mangel (Switzer and Mangel, 1996; SC-CAMLR-XV, Annex 4, paragraphs 6.47 to 6.55) would give a much more realistic assessment of the nature, magnitude and potential consequences of the interactions between this fishery and local krill predators.

6.79 The Working Group noted that the distribution of the fishery at South Georgia was concentrated on the shelf break to the north of the island (WG-EMM-97/41). This is also a region targeted by krill predators. However, the fishery at South Georgia takes place in winter whereas the current understanding of predator dispersion is mainly from the summer. Therefore, the actual degree of overlap between predators and the fishery at South Georgia remains to be determined.

Predator Interactions with Fish and Squid

6.80 Predator interactions with fish or squid may have significance for decisions made concerning the management of developing squid and finfish fisheries in the Southern Ocean.

6.81 Accordingly, the UK tabled a list of published papers relevant to this subject (WG-EMM-97/7). In another paper, king penguins from the Crozet Islands were shown to feed mainly on myctophids but also took small quantities of squid (WG-EMM-97/9). The main species was *Moroteuthis*, an ammoniacal species which is currently of no commercial value. As indicated in WG-EMM-97/11 and 97/28, myctophids and other fish species can also form a small but important element in the diets of Antarctic fur seals.

6.82 As demonstrated in papers submitted to previous meetings of WG-EMM and in WG-EMM-97/61, Antarctic shags rely heavily on a range of inshore fish species. Many of these have been subject to historical heavy exploitation. The Working Group considered that, if a reliable method could be developed, it may be appropriate to adopt the Antarctic shag as a monitoring species. The Working Group then passed this question to the Subgroup on Monitoring Methods.

6.83 The Working Group also considered WG-FSA-96/20 (Rodhouse, in press) which had been referred to WG-EMM by the Scientific Committee. This paper examined the potential impact of a fishery for *Martialia hyadesi* on predators. The Working Group considered that there was generally insufficient information to conclude how the development of such a fishery was likely to influence predators. It appeared that most predators were taking small squid and there was little indication that they were feeding on spent squid. Moreover, the most accurate information about squid consumption came from the predator species which accounted for the smallest proportion of the estimated predation of squid in Area 48.

6.84 The Secretariat reported that a Korean fishing vessel had caught 28 tonnes of squid during four days of fishing in the last 10 days of June this year. A further 53 tonnes had been caught since then making a total of 81 tonnes so far this year in Subarea 48.3.

6.85 The Working Group noted that the Commission has set a precautionary catch limit at 1% of the estimated predator demand. The Working Group agreed that determining a more accurate rate for the precautionary yield would require more information on estimates of the natural mortality rate of squids from one to two years of age, on variability in recruitment and on the appropriate level of squid escapement after fishing to meet predator requirements.

6.86 Dr Kim pointed out that only limited information was available on the seasonal distribution and migratory movements of *M. hyadesi* and that more information could be obtained by spreading the fishing season over the entire year, thus allowing it to operate more flexibly in relation to changes in oceanographic conditions, especially around the Polar Frontal Zone.

6.87 Other members noted that the fishing season should be set to take into account the lack of sufficient data to assess how the development of a fishery for *M. hyadesi* would affect its dependent predators. At this stage, the Working Group supported the precautionary approach as set out in WG-FSA-96/20.

6.88 A report of a workshop to consider the management of exploitation in the Heard Island area was presented by the Australian delegation in WG-EMM-97/27. This multidisciplinary report considered a program of work and developed modelling approaches for the ecosystem. Detailed interactions had been considered and this had been distilled to more simple views of the ecosystem. As a general rule such a simplification attempts to account for the interactions which provide about 80% of the prey consumed by the predators.

6.89 WG-EMM-97/42 presented an analysis pertinent to the determination of the appropriate level for the median biomass after fishing (escapement) in the *Dissostichus eleginoides* fishery at Heard Island. The analysis took into account the age classes of *D. eleginoides* taken by elephant seals, based on seven otoliths from probably four *D. eleginoides* found in one of 65 sampled stomachs. The analysis indicated that the level of escapement in the age classes likely to be eaten by elephant seals was of the order of 87%, and the assessment developed by WG-FSA would not require adjustment to account for predator requirements of this species.

ECOSYSTEM ASSESSMENT

Estimates of Potential Yield

7.1 WG-EMM-97/45 detailed a method for correcting for a bias in the approach used in the krill yield model to compute the median krill spawning biomass in the absence of fishing on krill (i.e. the median pre-exploitation level). The bias was small for estimates of the median status of the spawning stock under fishing compared to this pre-exploitation level, but somewhat larger for estimates of the probability that the spawning stock be reduced below some critical level over a projection period.

7.2 It was noted that such improved computations would not greatly change the current value of γ used to calculate precautionary catch limits. Accordingly, the Working Group recommended that revised calculations of precautionary catch limits should be deferred until additional pertinent information (such as the results of the synoptic krill survey planned for Area 48) becomes available.

7.3 It was also noted that the GYM used by WG-FSA can duplicate results provided by the krill yield model, and is more readily extended to incorporate new features (such as the bias correction process referenced in paragraph 7.1 above). Noting also that the computer program implementing this GYM will shortly be validated by the Secretariat, the Working Group recommended that, once validated, it should replace the existing krill yield model for future krill-related computations, because a single rather than two standard programs would be easier for the Secretariat to maintain, though the existing krill program should be kept in its current form for cross-checking purposes.

Precautionary Catch Limits

7.4 At present, the precautionary catch limit for Area 48 has not been subdivided amongst subareas, in particular because the FIBEX survey estimate of krill biomass in Subarea 48.3 is considered to be unrepresentatively low as a result of incomplete areal coverage (SC-CAMLR-XIII, paragraph 5.35).

7.5 WG-EMM-97/65 presented a calculated biomass of krill for the vicinity of South Georgia based on an estimate of predator demand in that region, using the method of Everson and de la Mare (1996).

7.6 Drs Shust and Sushin expressed strong doubt about this calculated biomass (WG-EMM-97/65) and the possibility of using it as the basis for the calculation of a precautionary catch limit for Subarea 48.3.

7.7 The Working Group commented that should the Scientific Committee see an immediate need to recommend a subarea subdivision of the precautionary catch limit for Area 48, it might wish to take account of the information referenced in paragraph 7.5 for computations for Subarea 48.3. Nevertheless, as with other possible adjustments to such limits (see paragraph 7.2), it recommended that their consideration be deferred until the results from the planned synoptic survey in Area 48 become available (thus obviating any need to apply the approach of paragraph 7.5 in Subarea 48.3).

7.8 Two questions were raised in relation to utilisation of the Everson and de la Mare method referenced in paragraph 7.5 above:

(i) would this mean that the precautionary catch limit was decreased if the estimated predator demand in a subarea fell because of a reduction in predator numbers?

(ii) would the method be applied to subareas other than Subarea 48.3?

7.9 The Working Group noted that:

(i) these issues had not been discussed in detail but the method under consideration estimated demand averaged over a number of years; and

(ii) the method would be considered for application only in subareas where no adequate direct survey-based abundance estimate was available.

Assessment of the Status of the Ecosystem

7.10 In developing its assessment of the status of the ecosystem in 1996/97, the Working Group relied primarily on the summaries of CEMP indices prepared by the Secretariat (WG-EMM-97/25 Rev.1) and on tabled papers presenting analyses of these and related data. As these latter papers were discussed extensively under earlier agenda items, only summaries of relevant conclusions are presented here.

7.11 The method used to identify anomalies in WG-EMM-97/25 was that agreed at last year's meeting of WG-EMM. It was noted that when it becomes possible to use revised methods for identifying EIVs along the lines recommended by the Subgroup on Statistics (WG-EMM-97/34; see also paragraph 6.6), additional years may be highlighted to those identified as anomalies in WG-EMM-97/25 Rev. 1. WG-EMM's ability to interpret the many series of indices will also be considerably enhanced when widespread use can be made of the multivariate methods for combining indices considered by the Subgroup on Statistics.

Subarea 48.1

7.12 Overall, in the Antarctic Peninsula region in 1996/97 absolute krill recruitment was close to historical averages.

7.13 Around Elephant Island, in 1996/97 there was a prolonged krill spawning season, a delayed spawning peak and a massive salp bloom. This followed below-average sea-ice conditions in winter 1996. Excellent recruitment success was observed for the 1994/95 year class, but lower recruitment success was observed for the 1995/96 year class. These observations confirm predictions made at last year's meeting (see paragraph 6.38) and support the hypothesised relationships between recruitment success and winter sea-ice conditions.

7.14 Low larval krill densities and high salp concentrations observed during this year suggest poor krill reproductive success. Poor recruitment of the 1996/97 krill year class is predicted.

7.15 Surface water temperatures off Elephant Island were unusually high throughout the spring and summer of 1996/97.

7.16 Although data for Adélie penguins at Palmer Station in 1996/97 are yet to be submitted to the CCAMLR database, WG-EMM-97/30 reported that there was a decrease in population size and breeding success of Adélie penguins, matching the predicted effects of a year with below-average sea-ice cover on over-winter survival of penguins and consistent with the krill recruitment index at Elephant Island.

7.17 At Cape Shirreff and San Telmo Islets, both pup production and total counts of fur seals were higher in 1996/97 than in the preceding five years (WG-EMM-97/63 and 97/77).

7.18 At Esperanza Station, Adélie penguin fledging success was slightly higher in 1996/97 than in the preceding two years, while penguin arrival weight and fledging weight were about average in 1996/97.

7.19 The Working Group noted that there appeared to be an encouraging degree of coherence in CEMP indices across sites within Subarea 48.1. Dr Trivelpiece noted that, on the basis of unpublished data being submitted to CCAMLR, this coherence was also present in data from Admiralty Bay.

Subarea 48.2

7.20 At Signy Island, breeding success of Adélie, chinstrap and gentoo penguins was at average to above-average levels in 1996/97. This suggests a degree of coherence in predator indices with those in Subarea 48.1 Breeding population size of Adélie penguins has now returned to 1994 levels, after the 24% decrease in 1995. In contrast chinstrap penguin populations have still not recovered from a similar decrease in the same year. Gentoo penguin populations continue to increase. At Laurie Island, Adélie penguin breeding success was higher than in 1996.

Subarea 48.3

7.21 Bird Island was the one CEMP site for which the Subgroup on Statistics had developed, as an illustrative example, a combined index for dependent species. The single index combined separate indices for fur seals, and for macaroni and gentoo penguins

(WG-EMM-97/34). As shown in Appendix D, Figure 1 (taken from WG-EMM-97/34) this index indicated that there has been a steady improvement in predator reproductive success since the last poor year in 1993/94, with 1996/97 being the best of the last four to five years. Note that the methods used to produce this figure are still under development.

7.22 Krill biomass densities off South Georgia in December 1996 were comparable with those in the previous year and were relatively high for this region. The summer sea-surface temperature in 1997 was within the range of previous values.

Subarea 48.6

7.23 The population of chinstrap penguins at the CEMP site at Bouvet Island has fallen sharply since the last visit to the site in 1989/90, while that of macaroni penguins has shown a more moderate decline (WG-EMM-97/20). The population of Antarctic fur seals has grown dramatically since the last visit.

7.24 It was noted that the fur seal foraging durations measured at Bouvet Island in 1996/97 were comparable to those observed at South Georgia during a normal krill year.

7.25 The Antarctic petrel colony at Svarthamaren, Dronning Maud Land has been monitored since 1991/92. Considerable variation has been observed in the numbers of petrel nests with egg or chick in the hatching period, but 1997 appears to have been quite a good year. Breeding frequencies and survival rates estimated at this colony are similar to values estimated at other Antarctic petrel colonies (WG-EMM-97/78).

Division 58.4.2

7.26 After two poor seasons, the breeding success of Adélie penguins at Béchervaise Island was high in 1996/97. The breeding population size has remained almost constant.

Subarea 58.7

7.27 At Marion Island, macaroni and gentoo penguins have been monitored for the past three seasons. The CEMP indices measured in 1996/97 were all within the ranges of previous values and there were no obvious EIVs.

Subarea 88.1

7.28 Though Adélie penguin breeding success was the highest of the three years for which data have been collected at Edmonson Point, no exceptional values of monitored CEMP indices were obtained in 1996/97. Data are not available as yet for Ross Island in 1996/97.

Format for the Presentation of Ecosystem Assessments

7.29 The Working Group agreed that it would be helpful if ecosystem assessments could be presented in a more standardised form. An illustrative example of a possible format for an ecosystem assessment summary for Subareas 48.1, 48.2 and 48.3 was proposed. This is given in Appendix F. The format was based on that used to present assessment summaries by WG-FSA.

7.30 The Working Group considered this to be a useful approach and agreed that this matter should be considered further at next year's meeting, with a view to presenting ecosystem assessment summaries in a standardised form in its 1998 report.

Consideration of Possible Management Measures

7.31 No new management measures are proposed.

METHODS AND PROGRAMS INVOLVING STUDIES OF HARVESTED AND DEPENDENT SPECIES AND THE ENVIRONMENT

Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species

Recruitment

8.1 WG-EMM-97/29 used the method outlined in de la Mare (1994a) to calculate an absolute recruitment index R_1 (number of one-year-old krill recruits per 1 000 m^3). The Working Group welcomed the use of this index. The relative merits of the different methods used to calculate confidence intervals for density estimates from net sampling surveys (de la Mare, 1994a, 1994b, 1994c) were also discussed. While the bootstrap method produced unbiased confidence intervals, these may not be as 'precise' as those produced by the assumption-dependent maximum likelihood technique. The Working Group agreed that at present it was advantageous to use both techniques. It was agreed that a draft standard method for this index should be developed.

Net Sampling

8.2 WG-EMM-97/21 examined net avoidance when sampling krill at night. The numerical density of krill in the net was similar to that estimated acoustically from a transducer mounted on the net, but significantly less than that estimated using a hull-mounted transducer, this effect decreasing with increasing depth. While such results could be influenced by depth-dependent transducer sensitivity, method of noise removal and most importantly instrument threshold settings, the suggestion that acoustic krill biomass might be underestimated due to vessel avoidance had implications for the design of future acoustic surveys. For instance night-time estimates of krill biomass would be more biased than daytime estimates if krill moved towards the surface at night.

8.3 WG-EMM-97/21 and 97/43 both considered the problem of net avoidance causing a bias in length-frequency distributions due to large krill avoiding the net better than small krill. Results from the first paper suggested that differential net avoidance was not a problem at night. A series of citations in the second paper concluded that there was no evidence of differential net avoidance for several euphausiid species both during the day and night.

8.4 WG-EMM-97/32 examined the problem of how many net samples were required to adequately assess and describe the krill and zooplankton assemblages in the Elephant Island area. The results indicated that considerable sampling effort was required to precisely estimate zooplankton and krill abundance, and krill population structure. The Working Group emphasised the importance of assessing the trade-off between sampling effort and sampling precision when designing and carrying out all net sampling programs.

8.5 WG-EMM-97/32 compared acoustic and net estimates of krill density during a survey in Division 58.4.1. Acoustic density estimates were up to several orders of magnitude larger than net density estimates. Excluding net estimates where the catch contained less than 90% krill reduced the variation by an order of magnitude but there was still no correlation between acoustic and net estimates. The Working Group agreed that the spatial scale over which such comparisons were made was very important and encouraged further analysis to improve the sample coincidence of the two methods.

Acoustic Target Identification and Echo Classification

8.6 WG-EMM-96 requested further work on multifrequency acoustic identification of krill. The Working Group was therefore pleased to receive a number of papers on multifrequency techniques (WG-EMM-97/24, 97/26, 97/28, 97/31, 97/44, 97/46, 97/53 and 97/54).

8.7 Net samples were used to validate acoustic delineation of krill echoes in paper WG-EMM-97/46. About 80% of acoustic targets thought to be krill on the basis of their appearance on echo charts were also identified as krill based upon a difference in mean volume backscattering strength (MVBS) at 120 and 38 kHz (ΔMVBS = $MVBS_{120}$ - $MVBS_{38}$) of between 2 and 12 dB. Biomass values estimated from krill identified using ΔMVBS were 94% of those estimated using echo-chart appearance. A simplified bent cylinder model was shown to be a better predictor of krill length than a fluid-filled sphere model.

8.8 The Working Group noted that similar findings were presented in paper WG-EMM-97/53 which also utilised ΔMVBS to delineate krill in the acoustic record. A mean ΔMVBS of 10.15 dB (sd = 1.6 dB) for krill of mean length 34.1 mm (average TS -74 dB) was obtained for aggregations of krill. The range of differences (6–14 dB) was attributable to both biological and behavioural factors.

8.9 WG-EMM-97/28 used backscatter at 120 and 50 kHz to differentiate between krill (assumed to backscatter at 120 kHz) and myctophid fish (assumed to backscatter at 50 kHz). In addition the different depth of occurrence and the different echo-chart appearance of krill and myctophids provided extra information to differentiate the targets. Volume backscattering strengths were reported to be lower for myctophids than for krill especially at 120 kHz. This was attributed to a lack of a swim bladder in the myctophids. However, an alternative explanation for the lower MVBS values may be lower densities of myctophids than krill. It was recognised that identification of echo traces attributed to myctophids still needs validation.

8.10 WG-EMM-97/44 also used the association of krill and myctophids with different water masses as an additional tool to distinguish between echo signals attributable to the two taxonomic groups.

8.11 WG-EMM-97/26 described acoustic signals thought to be characteristic of ommastrephid squid caught near to the Antarctic Polar Frontal Zone. The squid (average mantle length = 228.6 ± 21.8 mm) were linked with a strongly speckled layer on the echo chart with a ΔMVBS from -3 to 1 dB.

8.12 WG-EMM-97/24 demonstrated that exploiting frequency-dependent scattering and beam geometries improves single target discrimination and hence TS estimates. Differences in these TS values provided information about the constituents of mixed-species assemblages. The effectiveness of the method is sensitive to the combined uncertainties of the single-frequency measurements and variations in animal size, shape, orientation and acoustic impedance.

8.13 The Working Group noted that the power of multifrequency taxa delineation methods is increased by including biological and behavioural information (see for instance WG-Krill-94/12 which coupled TS measurements with length-frequency information and physics-based expectations).

8.14 WG-EMM-97/54 used multifrequency echo intensity data to discriminate a mixture of zooplankton taxa. Discriminate function analysis of differences between MVBS at 38, 120, and 200 kHz separated krill from four other species of zooplankton with an overall correct classification of 77%. The Working Group noted that differences in two- and three-frequency MVBS are linear and bi-linear approximations to non-linear scattering phenomenon (WG-Krill-94/13). Consequently, the efficiency of such methods is dependent upon distributions of animal length and orientation, the acoustic frequencies and pulse lengths, and the integration volume. Thus, echo-intensity data alone may be useful to separate even quite similar zooplankton species, but the techniques are much improved by including information on target distributions (horizontal and vertical) and length frequency.

8.15 The Working Group noted that another approach to the discrimination of acoustic targets was described in WG-EMM-97/31. Here, image analysis techniques were used to produce descriptional parameters of fish shoals which enabled species discrimination. Again, depth-dependent descriptors increased the discrimination success rate.

8.16 The Working Group reiterated the need for objective and repeatable techniques for delineating scattering taxa. It was recognised that multifrequency identification methods, in particular simple techniques which exploit the differences in scattering at two or more frequencies, are useful tools for delineating scattering taxa, especially when coupled with ancillary information such as animal length distributions.

8.17 The Working Group also recognised that image-recognition techniques, such as those being developed within the ICES community, are also potentially very useful as objective means for taxa delineation.

8.18 Most importantly, techniques such as those described in paragraphs 8.16 and 8.17 could be employed with equal precision by all investigators. Thus, Members were encouraged to continue studies on species discrimination techniques and to report their results in conjunction with theoretical expectations.

8.19 The Working Group recognised, however, that multifrequency acoustic techniques were not yet available to all nations undertaking biomass surveys, nor was there yet a recognised standard for such measurements. Therefore, the Working Group agreed that the recommendations from WG-EMM-96 were still valid. In particular, Members should always report biomass attributable to all biological scatterers prior to any allocation of biomass to krill and other taxa.

Acoustic Calibration

8.20 WG-EMM-97/52 described the effect of changes in transducer temperature on calibration. The authors concluded that 120 kHz S_v transducer gain was on average 1.4 dB less at South Georgia (sea temperature 2°C) than when calibration took place in waters with a temperature of 7.3°C. Such a difference would lead to a 50% underestimate of biomass. A similar trend was observed for 38 kHz. The Working Group recognised that such changes were significant and recommended most strongly that calibration should be conducted at water temperatures comparable to those found in the survey region.

8.21 WG-EMM-97/31 included a table summarising uncertainties in vertical echo sounding. The Working Group noticed in particular that some users of the Simrad EK500 had detected considerable variation in calibration values over several seasons.

8.22 WG-EMM-97/74 described the highly variable nature of acoustic background noise over a wide range of time scales. Three methods (of varying degrees of complexity) for the removal of background noise were described and compared. The method of noise removal has important implications for biomass estimation. In particular underestimation of noise can lead to substantial overestimation of biomass.

8.23 The Working Group recommended strongly that Members collecting data should not use any noise removal or thresholding techniques during the process of data collection and logging. Ideally raw ping-by-ping data should be stored and noise removal or thresholding should be undertaken as a separate stage during data processing.

8.24 The Working Group recognised that in the proposed synoptic survey it was most desirable to be able to use exactly the same noise estimation and removal techniques on all the datasets.

Target Strength (TS)

8.25 WG-EMM-97/24 demonstrated that the single target discrimination algorithm employed by the EK500 failed in 35 and 40% of cases for 38 and 120kHz, respectively. The effectiveness of combining the synchronised signals from two or more adjacent split-beam transducers of different frequencies improved the *in situ* single target discrimination giving correct results in 98.2 to 99.4% of cases. As noted in paragraph 8.12, such techniques also have considerable utility in describing the constituents in mixed-species assemblages.

8.26 WG-EMM-97/75 described a comprehensive series of TS estimations based on krill swimming free within a large volume tank. The Working Group was pleased to receive the final analysis of this work, noting that median TS values within the range -76.7 to -71.8 dB for krill with mean lengths between 29.6 and 36.2 mm complemented other TS data included in the interim TS relationship derived at WG-Krill-91.

8.27 The Working Group noted that characterisation of krill TS has advanced greatly since 1991. In particular, it has been repeatedly demonstrated through theory and experiment that krill TS is a highly non-linear function, depending primarily on animal length, orientation, shape, density and sound speed. Thus, the Working Group recommended that summaries and comparisons of TS data and models should account for the TS distributions, rather than focusing exclusively on values of central tendencies.

Biomass Estimates

8.28 The Working Group reviewed the extent and detail of methodological description within papers using acoustic techniques to estimate biomass. In particular the Working Group complimented the authors of WG-EMM-97/49 on the quality of the presentation and description of methodology.

8.29 While there was generally much more detail provided the Working Group reiterated the need to take account of the recommendations in Appendix G in the report of WG-EMM-96 (SC-CAMLR-XV, Annex 4).

8.30 The Working Group agreed that, given that much advice on net and acoustic sampling methods had been published in recent reports of WG-EMM and WG-Krill, the Secretariat should extract all relevant method advice from all the relevant reports and present them together (see also paragraph 8.122).

8.31 The Working Group agreed that standard methods for net and acoustic sampling, data storage and analysis for the planned synoptic survey of Area 48 should be specified and developed (see paragraph 8.122).

Survey Design

8.32 Various papers submitted to WG-EMM contained information relevant to the design, timing and placement of krill acoustic surveys.

8.33 WG-EMM-97/22, 97/28 and 97/36 highlighted differences in krill distribution/abundance between inshore and offshore areas within Area 48. The Working Group recognised that such differences were important for the allocation of survey effort inshore as opposed to offshore.

8.34 WG-EMM-97/49 emphasised that seasonal timing may impact on survey results and also indicated diel differences in krill density between day and night (see discussion in paragraph 8.2). The latter has some bearing on whether acoustic surveys are undertaken during both day and night; a topic previously discussed by WG-EMM (SC-CAMLR-XV, Annex 4, paragraph 3.75).

8.35 Acoustic target identification (see also paragraphs 8.15 and 8.16) and night-time estimation of krill biomass around South Georgia were reported in WG-EMM-97/48.

8.36 WG-EMM-97/53 followed a similar presentation to the Working Group's last meeting and outlined the results of an Italian survey in the Ross Sea during 1989/90 and 1994/95. The Working Group noted that due to the prevailing ice conditions, the survey had been based on a design and post stratification procedure which was somewhat different to that customarily used for the estimation of krill biomass and its associated variance. As such, survey effort was apportioned to pre-determined and geographically-defined boxes which were then treated as individual sampling units.

8.37 It was agreed that, given the ice conditions prevailing in the Ross Sea, the Italian approach offered a sensible and interesting way to implement krill surveys under such circumstances. Further consideration of the statistical assumptions underlying, and associated ramifications of, the approach is essential to its evaluation and to assessing its comparability with more routinely applied procedures. In particular, the Working Group noted that consideration still needs to be given to the efficacy of subdividing surveys into subsidiary sampling units which are considered as independent, and to which bootstrap variance estimation procedures can then be applied. Similarly, comparisons need to be made between survey variances estimated from data in ice-free areas using customarily applied analyses with those where the Italian approach is applied to the data as well as with the results from the survey described in paragraph 8.36 above.

Consideration of CEMP Sites

Management Plans

8.38 In accordance with Conservation Measure 18/XIII, which requires a review of CEMP management plans every five years in order determine whether revisions are required and whether continued protection is necessary, the Seal Islands CEMP site (Conservation Measure 62/XI) was discussed.

8.39 Dr Holt reminded Members that the US has reduced its research program at Seal Island, due to concerns raised during a safety review of the island (SC-CAMLR-XIV, Annex 4, paragraph 5.10). He stated that the US has begun a multi-year plan to remove all structures from the island. During this period, data on chinstrap penguin fledging weights and on penguin and seal tag sightings will be collected.

8.40 Dr Holt stated that the US intended to revise the Seal Islands Management Plan for consideration by the Scientific Committee and noted that continued site protection was required for at least the next five years. At the end of five years, the US will have made a decision whether or not to continue limited data collection at Seal Island.

8.41 The Working Group encouraged the US to revise the Seal Islands CEMP site management plan in time for consideration by the Scientific Committee. The Working Group recommended to the Scientific Committee that site protection be extended for five years, subject to approval of a revised management plan.

New CEMP Sites

8.42 Dr Penhale presented a summary of the discussion of the Ad Hoc Subgroup on the Protection of Sites (Dr K. Kerry (Australia), Dr Penhale and Prof. Torres) regarding Norway's request to the Commission for the designation of a CEMP site at Bouvet Island. The subgroup viewed very positively the extension of the CEMP research program to Subarea 48.6 (WG-EMM-97/19), due, in particular, to the increased interest in fishing in the area. The Working Group recommended to the Scientific Committee that this site be accepted as a CEMP site.

8.43 The Working Group complimented Norway on its thorough and well-documented Management Plan for the CEMP site at Bouvet Island (WG-EMM-97/19) and noted that site protection has been provided through national legislation in Norway; thus, site protection under Conservation Measure 18/XIII is not required.

Review of Existing CEMP Sites

8.44 The Working Group reviewed the status of work at existing CEMP sites to assess whether research programs at several sites were short-term efforts or long-term commitments.

8.45 As far as the Working Group could determine, sites where data on dependent species are being collected annually according to CEMP standard methods are as follows:

Subarea 48.1	Anvers Island, Esperanza Station, Cape Shirreff, Stranger Point, Admiralty Bay and Seal Island
Subarea 48.2	Signy Island and Laurie Island
Subarea 48.3	Bird Island
Subarea 48.6	Bouvet Island and Svarthamaren
Division 58.4.2	Béchervaise Island and Syowa Station
Subarea 58.6	Marion Island
Subarea 88.1	Edmonson Point and Ross Island.

Methods for Monitoring the Performance of Dependent Species

8.46 Last year the Subgroup on Monitoring Methods (SC-CAMLR-XV, Annex 4, Appendix I) proposed a variety of new standard methods, reviewed each of the existing standard methods and suggested areas where changes were required. Although these revisions and additions to *CEMP Standard Methods* are now complete, copies have not yet been circulated and were therefore unavailable to the members of the subgroup at the meeting.

8.47 The Working Group considered each method for which comments had been received in tabled papers or in the Report of the Subgroup on Statistics (Appendix D).

Existing Methods

A1 – Adult Weight on Arrival at Colony

8.48 The Subgroup on Statistics (Appendix D, paragraph 2.4(ii)) noted that for several standard methods adequate new data exist to evaluate whether the recommended sampling regimes and sample sizes are appropriate. Members with such data were encouraged to undertake evaluations and report the results to WG-EMM.

8.49 The Subgroup on Monitoring Methods noted this with particular reference to the five-day sampling period, which applies also to Methods A5, A7 and A9. Originally the five-day blocks were designed as an interim measure to extend sampling over the whole period of interest. However they are very demanding to execute in the field. Researchers are encouraged to analyse their data to see if the five-day period is still an appropriate basis for data collection.

A2 – Duration of First Incubation Shift

8.50 The Working Group expressed interest in the proposed Principal Component Analysis (PCA) of Béchervaise Island data by Australia, as it will greatly assist the review of the utility of this method.

A5 – Duration of Foraging Trips

8.51 The Working Group noted the concern raised in WG-EMM-97/71 about the effect of externally mounted instruments on penguins. They recommended the addition of Culik et al., 1994 and Croll et al., 1991 to the references for Method A5 and to the observation protocol (section 4) on the use of TDRs for collection of data on at-sea behaviour. The Working Group was, however, confident that recent advances in knowledge of attachment site to minimise hydrodynamic problems and reductions in size of instruments have significantly reduced this problem.

8.52 Other problems associated with Method A5 were discussed, for example, the need to standardise data reporting between years and to relate data to a standard biological reference point, such as mean creche date. The Data Manager should review the existing data, and revise the standard method appropriately, in consultation with the originators of the data. Once this had been done sample size appropriateness should be reviewed.

8.53 Dr F. Mehlum (Norway) outlined the problem Norway experienced on Bouvet Island with Method A5 and macaroni penguins. The method of only using males in the study reduces the chances of acquiring data because males stay at the nest for 10 days or more after chicks hatch before they commence foraging trips to sea. In order to get enough samples, transmitters were fitted to males and females. The Working Group encouraged Norwegian scientists to submit data for both sexes separately and to evaluate any differences.

A8 – Chick Diet

8.54 WG-EMM-97/71 discusses a potential bias in diet studies, whereby the fish component may be underestimated. The Working Group recommended that a paragraph on this topic be incorporated the next time standard methods are reviewed.

8.55 Mr Cooper reported that collection of diet samples from gentoo penguins at Marion Island has been stopped due to concerns that the disturbance results in reduced breeding success. He noted that gentoo penguins breeding at islands in the southern Indian Ocean are highly susceptible to disturbance. No obvious effects of this kind are known from studies of gentoos at South Georgia, South Orkney or South Shetland Islands.

A9 – Chronology

8.56 The Working Group welcomed the suggestions in WG-EMM-97/71 for reducing disturbance associated with the Method A9 protocol. It recommended that this topic should be addressed the next time that this standard method is reviewed.

B3 – Black-browed Albatross Demography

8.57 Dr Croxall advised the Working Group that the demographic data have been supplied to Prof. Butterworth for the modelling exercise, and can now be submitted to the CCAMLR database.

B4 – Petrel Diet

8.58 Diet data for Cape petrels at Bouvet Island (WG-EMM-97/56) and Antarctic petrels at Svarthamaren (WG-EMM-97/58) collected under this new standard method are now available. They should be submitted to the CCAMLR database as soon as possible.

B5 – Antarctic Petrel Population Size, Breeding Success

8.59 Dr S.-H. Lorentsen (Norway) indicated the intention to submit data from Svarthamaren (WG-EMM-97/78) to the CEMP database. Similar data for this species are held by Dutch and US scientists (e.g. Drs J. van Franeker and P. Hodum) working with Australia. The Data Manager should contact them to see whether some of their data would meet the criteria for submission to the CEMP database under this standard method.

C1 – Antarctic Fur Seal Foraging Trip Duration

8.60 The current standard method stipulates that individuals must have completed six foraging trips to be included in the calculation of the parameter in each year. Individuals which lose their pups during the first six trips are excluded from the analysis. This may lead to the creation of bias in the estimate of foraging trip duration.

8.61 The Working Group agreed that it is important for the biases created by inclusion/exclusion of individuals from the data to be investigated. Detailed datasets exist which would allow this to be done. Depending on the results, it may be necessary to reconsider how the index of foraging trip duration is both collected and calculated. Simulation of different sampling regimes could provide a guide to the most appropriate method for measuring foraging trip duration. However, considering the long time series that has already been collected for this parameter, it would be necessary to conduct monitoring of the parameter for an appropriate period using both the old and new methods simultaneously to ensure compatibility of all sections of the time series.

C2 – Antarctic Fur Seal Pup Growth

8.62 Biases exist in the measurement of pup growth in Antarctic fur seals (WG-EMM-97/34). This occurs because pups which die are lost from the sample so that, as pups age, there will be a tendency only to sample survivors which are also likely to be individuals with the greatest growth rates. A possible solution to this is to assess the growth of total population biomass. However, this modification would require the collection of data about population size and pup mortality rate in parallel with data about growth.

Observation Protocols and Techniques

Toxicology and Disease Studies

8.63 WG-EMM-97/39 summarises recent preliminary serological evidence for the presence of infectious bursal disease virus in Antarctic penguins. Undetected outbreaks of such diseases might have implications for interpreting CEMP data.

New Methods

A3B – Breeding Population Size

8.64 Dr Wilson introduced WG-EMM-97/57, a draft standard method for using aerial photography as an alternative method to ground counts of nests in entire colonies. The Working Group suggested changes to detail regarding camera format, film type and, via Dr Boyd, a formula for estimating the area of the photo footprint for each exposure. The method should apply initially only to Adélie penguins but may well be applicable to, and could be tested on, other species. Dr Wilson will submit a revised version next year.

C3 – Antarctic Fur Seal Adult Female Survival Rate and Pregnancy Rate

8.65 Preliminary draft methods for estimating survival and pregnancy rates in Antarctic fur seals (WG-EMM-97/4) were considered by the Working Group. A major problem with such methods is that they may require to be adapted to the specific circumstances concerning the study site. The two methods proposed for estimating survival rate involved the use of age structures and mark-recapture.

8.66 There are difficulties associated with using age structures to estimate survival rates, mainly because of the necessity to make assumptions about the rate of change in the population and because it would only ever be possible to sample relatively small numbers of individuals from each age class. The Working Group considered that it was not practical to use this as a standard method and recommended that the mark-recapture method should be developed. Specifically, attention should be given to developing a generalised method of randomly sampling individuals across the population of breeding females.

C4 – Antarctic Fur Seal Diet

8.67 Draft methods for the determination of diet in Antarctic fur seals using scats (WG-EMM-97/5) were considered by the Working Group. The methods as presented had been written specifically to address the question of the diet of adult females during lactation. The Working Group endorsed the proposal but suggested the inclusion of certain modifications. These were:

(i) the methods should be broadened to include diet sampling of adults and juveniles at breeding and non-breeding sites and other times of year;

(ii) the methods should include assessment of the section of the population which has been sampled by including a measure of the percent occurrence of different age/sex classes of individuals in the site from which samples are obtained;

(iii) attention needs to be given to the relative visibility of scats containing different types of prey; and

(iv) an assessment of the statistical power associated with different sample sizes of scats is required.

Potential Methods for Krill-dependent Species

Antarctic Fur Seal Breeding Success

8.68 A method for monitoring breeding success should be developed for Antarctic fur seals. However, this is closely associated with development of a method for measuring pregnancy rate using mark-recapture (paragraphs 8.65 and 8.66) and it would be appropriate to defer the development of this method until the method for measuring pregnancy rate has been resolved.

At-sea Behaviour

8.69 The Report of the Subgroup on Statistics (Appendix D) made specific recommendations about how to proceed with the development of analytical methods for measuring at-sea behaviour. A significant problem with setting up a standard method of analysis is that the understanding of at-sea behaviour is likely to develop with time and that summary parameters derived from these datasets may become outdated. To avoid this, the subgroup suggested that data should be submitted in both raw and analysed formats. Software to derive monitoring parameters from these data should be developed for use by the Secretariat and by the suppliers of the data. This will ensure that all data are analysed in the same way and will eliminate biases resulting from using slightly different analytical methods on each dataset. Although the datasets involved were potentially very large, the technology was now available to enable this approach to be taken.

8.70 This approach will also enable the inclusion of raw data on at-sea behaviour within the CEMP database in advance of firm decisions being made about how to analyse these datasets and about the monitoring parameters to be derived from them.

Minke Whales

8.71 The Working Group briefly reviewed the elements of WG-EMM-97/18 concerning body fat condition and stomach content mass of minke whales. While these indices are appropriate in concept, the spatial and temporal scales over which they integrate information are uncertain and hard to relate to those of land-based predators, and therefore the indices need further study. The Working Group lacked the expertise to review these methods further.

Crabeater Seals

8.72 The Working Group noted that the APIS Workshop on Survey Design held in Cambridge, UK, during July 1996 had made recommendations about the methods used to carry out surveys of seals in pack-ice. These methods could, with small modifications, form the basis for monitoring crabeater seal abundance within CEMP.

8.73 These methods had already been applied successfully by Australia for aerial and ship-based surveys and they were being tested by the UK for application to regular surveys using fixed-wing aircraft.

8.74 The SCAR Group of Specialists on Seals was requested to provide CCAMLR with a copy of the workshop report as soon as possible.

Potential Method for Non Krill-dependent Species

8.75 WG-EMM-97/61 describes the development of a project designed to provide data on the relative abundance of coastal fish populations (including those of several species formerly the targets of commercial fisheries in Subareas 48.1 and 48.2) through monitoring diet (from pellets) and reproductive performance of Antarctic shags. The paper also provides new data validating improvements to the draft standard methods proposed in a paper tabled in 1995. The Working Group welcomed this latest study. It felt that enough new information was now available to justify preparing a revised version of the draft standard method for consideration by WG-EMM and WG-FSA.

Use of CEMP-related Methods in ASI Project

8.76 WG-EMM-97/38 provides information on the Antarctic Site Inventory Project (ASIP), which includes making estimates of breeding population size at penguin colonies using counting methods similar to those of CEMP, but with the timing of counts not standardised within and between years. The results of this study might be of interest to CCAMLR but the consequences of the different method being used will need investigating. ASIP should be requested to provide WG-EMM with a list of its sites and, in due course, to submit a paper to CCAMLR when about five years of consecutive data are available from most sites.

Missing Values in Datasets

8.77 The Subgroup on Statistics had reviewed this problem, which is of particular relevance to CEMP data on dependent species, in detail (Appendix D, paragraphs 5.1 to 5.8). It defined various potential categories of missing data and made recommendations concerning the circumstances when techniques to impute missing values might reasonably be used.

8.78 Reasons why values are missing in the CEMP database could include:

(i) data collected but not submitted;

(ii) data not collected:

(a) because of no intention to do so or because of logistic problems – i.e. values are missing completely at random;

(b) because of adverse environmental conditions – i.e. values cannot be assumed to be missing completely at random;

(c) because of biological circumstances (e.g. all chicks died before fledging weight values could be obtained) – i.e. value would clearly have been non-random and its absence potentially relevant to ecosystem status; and

(d) data censored (see Appendix D, paragraph 5.3(iv)), non-random and requiring special treatment.

8.79 Data holders were requested to review (against WG-EMM-97/25 Rev. 1) all missing values in their data in terms of these criteria and to inform the Data Manager of the reasons why values are missing.

8.80 To assist in this process the Working Group undertook a brief review of the more obvious missing values.

Laurie Island (Argentina)	A3, A6a:	1995 – value missing because of logistics problem.
		1996 – value missing because data assigned to wrong colony denominator – i.e. present, but in wrong place in database.
Stranger Pt (Argentina)	A1:	1989 – reason uncertain.
	A3:	1995 – data missing as above.
		1996– present but wrong designations (as above).
Elephant Island (Brazil)	A7, A8:	1991 – no expedition took place.
Seal Island (USA)	A8:	1992, 1993 – chinstrap data missing. Dr Holt to investigate.
	C1:	1989 – missing year. Dr Holt to investigate.

8.81 In the case of Standard Methods A3 and A6 the data submitted appear to contain numerous examples of missing values for particular sub-colonies within a single year. There may also be circumstances where values within the submitted data have been imputed prior to submission. In the first case data holders should inform the Data Manager of the reason the values are missing. In the second case they should inform the Data Manager of the identity of the imputed missing values and how they were calculated. The Subgroup on Statistics has recommended further development of appropriate methods for imputing missing values in such datasets. The Working Group noted the advice of the Subgroup on Statistics that where all data for a particular year are missing no imputations should be carried out.

Other Business

8.82 Prof. Torres suggested that there was a need to coordinate the system of tagging Antarctic fur seals to ensure that replication of tag types and numbers deployed at different sites did not lead to confusion. The Working Group agreed that it was important to standardise tagging procedures for fur seals both to benefit from the experience in tagging methods and tag type of current researchers and to ensure compatibility across sites to avoid confusion of tags applied in different locations.

8.83 Dr Boyd described methods currently used for tagging Antarctic fur seals at Bird Island. This involved the use of Dalton Jumbo tags which have the advantages that they have an embossed number, their colours remained patent for the effective lifetime of the tag, they had been shown to last for more than 10 years and they were relatively inexpensive. They have the disadvantage that, in recent years, some batches of tags had split when applied.

8.84 Dr Boyd emphasised the importance of positioning the tag correctly both because of its relevance to the welfare of the animal and to help ensure that tags are not ripped out of the flipper.

8.85 The Working Group recommended that a standard method for tagging fur seals should be prepared and Dr Boyd agreed to undertake this task in time for the next meeting of the Working Group.

8.86 There was extensive discussion about how to coordinate tag number and colour sequences. This was complicated by the problem that many different tag colours and number combinations had already been applied over the years especially at Bird Island. Norway also planned to continue using the number sequences from their work on Arctic seals within their program at Bouvet Island. It was also considered to be important that tag numbers do not exceed four digits in order to ensure readability of the number at a distance. This meant there were fewer options available for tag colour/number combinations.

8.87 The Working Group agreed that the following colour combinations would be allocated for tagging of Antarctic fur seals under CEMP.

Location	Colour(s) of each Portion of the Tag Male/Female
Cape Shirreff	white / orange
Bouvet Island	white / yellow
Bird Island	white / light blue, yellow / light blue, green / orange
South Georgia	white / green
Elsewhere	white / black

8.88 These combinations will come into effect from 1999 at Bird Island and South Georgia and from 1998 elsewhere. They will permit researchers at each site to use whatever number sequences they desire while maintaining distinction between sites.

8.89 It was agreed that information on tagging would be submitted to the SCAR Antarctic Seals Tagging Database which is located at the National Marine Mammal Laboratory, Seattle, USA.

8.90 In relation to the Norwegian CEMP-related program at Bouvet Island (WG-EMM-97/20) it was recognised that due to the timing of arrival and departure of field workers, not all data could be collected exactly according to CEMP standard methods. Nevertheless continued standardised collection of such data from this site would be most valuable. Simulation studies, using CEMP data from other sites, to estimate the magnitude of biases in any of the Bouvet Island data, should be undertaken as soon as possible.

Methods for Monitoring Environmental Variables of Direct Importance in Ecosystem Assessment

8.91 No papers were submitted which directly considered CEMP environmental indices. However, the Working Group considered that it should focus upon the existing environmental indices as well as looking at ways of developing new indices which may be useful to CCAMLR.

CEMP Indices

8.92 As part of the CCAMLR Ecosystem Monitoring Program, the Secretariat currently produces four environmental indices (F2a–c and F5) which are considered to be relevant to the assessment of the dependent species indices (A1–8, B1a–b, C1–2). The dependent species indices are mainly site related and the current environmental indices reflect this situation. The existing indices are:

F2a Sea-ice percentage cover in a subarea in September;
F2b Sea-ice retreat past a CEMP site: number of ice free days;
F2c Sea-ice distance to a CEMP site: weeks sea-ice is within 100 km of site; and
F5 Summer sea-surface temperature adjacent to a CEMP site.

8.93 Further standard methodologies have been prepared by the Secretariat, however these are currently in draft format. These methodologies are also site related. The draft indices are:

F1 Sea-ice cover viewed from a CEMP site;
F3 Local weather at a CEMP site; and
F4 Snow cover at a CEMP site.

8.94 The Working Group reviewed each of the environmental indices in turn, including those which are currently active (F2a–c and F5) and those which are in draft format (F1, F3 and F4).

8.95 Using visual observations, index F1 aims to describe the amount of sea-ice cover in the vicinity of predator colonies. It was considered that such data are likely to reflect important ecological information and that they may be of importance in the analysis of predator indices. The Working Group felt that it would be useful to determine whether sea-ice data were already collected at CEMP sites and asked the Secretariat to request details of such information from Members. Standard methodologies are available for describing sea-ice cover, however it was not known whether these had been adopted. Therefore, before an appropriate index can be developed, or the draft method description updated, the Working Group felt it would be useful for the Data Manager to review the methodologies used by Members.

8.96 Using remotely-sensed data, index F2 aims to describe the percentage cover of sea-ice within a subarea (F2a), the number of ice-free days at a CEMP site (F2b), and the number of weeks when the ice-edge is within 100 km (F2c). The production of index F2 is carried out by the Secretariat using data obtained from the Joint Snow and Ice Data Center. The Data Manager agreed to document the methodology and to update the method descriptions. Methods for the analysis of remotely-sensed sea-ice data are continually improving and the Working Group emphasised the importance of Members developing collaborative links with experts in the subject. Areas of particular interest for the analysis of predator indices include sea-ice concentration, position and duration of polynyas, and sea-ice thickness. The Working Group noted that some Members already prepare their own indices from remotely-sensed sea-ice data, and felt that it would be useful if details of these methodologies were accessible to the Secretariat so that comparison may be made with index F2.

8.97 Index F3 aims to describe the local weather at a CEMP site, which the Working Group considered was likely to be of ecological importance. The Working Group felt that it would be useful to determine if weather records were collected at CEMP sites and asked that the Secretariat request details of such information from Members. The Working Group noted that weather records may not be available for individual field sites, however, records are likely to be available for most research stations and substituting data from such a nearby location may be appropriate in some situations. Weather data from Research Stations are collected using agreed protocols and are archived in meteorological data centres from where they are readily available. The Data Manager agreed to review the availability of meteorological data from CEMP sites and from research stations so that consideration of appropriate weather indices may proceed.

8.98 Using visual observations, index F4 aims to describe the local snow cover at a CEMP site. The Working Group felt that it would be useful to determine if snow cover records were collected at CEMP sites and asked that the Secretariat request details of such information from Members. Before an appropriate index can be developed, or the draft method description updated, the Working Group felt it would be useful for the Data Manager to review the methodologies used by Members.

8.99 Using remotely-sensed Advanced Very High Resolution Radiometry (AVHRR) data, index F5 aims to describe the sea-surface temperature adjacent to a CEMP site. The production of index F5 is currently carried out by the Secretariat using data obtained from the National Center for Atmospheric Research (NCAR). The Data Manager agreed to investigate and document the methodology used to prepare the index and to produce a method description. The Working Group considered that the NCAR sea-surface temperature dataset should also be further investigated in order to provide other indices which may be relevant to an integrated ecological analysis. Dr Trathan agreed to carry out further investigation of the dataset and to prepare a paper for a future meeting.

8.100 The Working Group noted that two environmental indices (F2c and F5) describe summer averages using the mean value over December, January and February; it was accepted that this period was originally chosen in order to cover the breeding period of many dependent species. However, it was considered that the use of a summer average should be reviewed, particularly as the remotely-sensed data for index F2c and index F5 are available throughout the year.

8.101 The Working Group recognised that short-lived events in the physical environment may lead to catastrophic breeding failure in some predator species, although such events may not be apparent in an annual environmental index. The Working Group therefore welcomed the recent changes to data forms which were designed to record comments on unusual events (SC-CAMLR-XV, Annex 4, paragraph 4.65). Matching the scale of physical and biological records was considered necessary and such physical data should be obtained at the resolution of the biological data, even if this required that an annual index integrated a number of physical records. The meeting also considered that year-round data were preferable to data which covered just the period around the breeding season of dependent species.

8.102 The Working Group noted that time series of physical data often showed serial correlation. This should be taken into account during further development of methods for highlighting EIVs. The Working Group noted that standard methodologies for time series analysis may be more appropriate for physical data.

8.103 The Working Group recognised that a review of the draft environmental indices (F1, F3 and F4) was necessary before formal data submission could proceed. In order to ensure that these indices were applicable to the analysis of predator data, this review should be made by individuals with knowledge of the biological indices, as well as individuals with knowledge of the environment. In preparation for such a review, the meeting asked that the Secretariat request information from Members regarding the draft indices (paragraphs 8.95, 8.97 and 8.98), and that this information should include methodological details for sea-ice cover (F1), meteorology (F3) and snow cover (F4) for those CEMP sites where such data were currently collected. The Working Group also considered that the two existing environmental indices (F2c and F5) which are based on a summer average should also be reviewed (paragraph 8.100).

Future Directions

8.104 Further environmental parameters are desirable in order to fully characterise the physical environment adjacent to CEMP sites. A similar range of indices may also be appropriate to characterise fisheries locations. The Working Group accepted, however, that such indices would not be immediately available and that considerable effort would be required by Members in order to prepare new methods. The Working Group considered that characterising variability in the position of the southern Antarctic Circumpolar Current Front was of particular relevance, but that present techniques required the use of ships with hydrographic facilities. An examination of the sea-surface temperature at frontal positions may therefore prove to be useful.

8.105 Remotely-sensed ocean colour data may shortly become available with the proposed launch of the SeaSTAR satellite which carries a Sea-viewing Wide Field-of-view Sensor (SeaWiFS). The Working Group considered that such data should be examined as soon as available with the view to generating an environmental index.

8.106 The Working Group also considered that use of tidal models and mixed-layer models would be particularly profitable and that Members should be encouraged to develop applications. Oceanographic models require specific data to run or for ground truthing, and the Working Group noted that such data could be gained from a number of sources; these may include ships of opportunity and research cruises.

8.107 The feasibility of analysing data from predators tagged with oceanographic recording devices and relating such data to the environment was discussed. The Working Group felt that such methods may provide the possibility of generating oceanographic indices and that they should be encouraged.

8.108 The Working Group recognised that a number of new directions (paragraphs 8.104 to 8.107) were under development by Members and that these approaches may lead to the generation of novel ways of describing the environment. The Working Group therefore encouraged Members to develop these approaches and to present future results to WG-EMM.

Synoptic B_0 Survey

8.109 The meeting noted that the synoptic survey which was proposed for the determination of a new krill B_0 estimate also offered the opportunity to collect other valuable ecological data. It was agreed that the planning process for the survey should therefore include consideration of environmental and physical processes from the earliest stages.

Plans for the Area 48 Workshop

8.110 The Working Group's discussions of further plans for the Area 48 workshop included deliberations on the following issues:

(i) purpose, objectives and expected products of the workshop;
(ii) structure of the workshop; and
(iii) date, duration and venue of the workshop.

8.111 The Working Group re-confirmed the terms of reference for this workshop as listed in SC-CAMLR-XV, paragraph 5.25. These are:

(i) identify the extent of between-season and within-season variation in key indices of the environment, harvested species, and dependent species over past decades;

(ii) identify coherence in the indices between sites and clarify understanding of the linkages between Subareas 48.1, 48.2 and 48.3;

(iii) develop working hypotheses; and

(iv) provide a summary report for consideration of the 1998 meeting of WG-EMM.

8.112 The Working Group agreed that it would be useful to organise the workshop around the following hypothesis and its alternative:

(i) H_0: Subareas 48.1, 48.2 and 48.3 are discrete ecosystems and events observed in any one subarea do not reflect what is happening in other subareas; and

(ii) H_1: Area 48 is a homogenous ecosystem and events observed in any one subarea reflect the entire area.

8.113 It was recognised that neither of these hypotheses was likely to be correct. However, they represent the end points of the spectrum of possibilities and may thus serve a useful purpose for organising the workshop.

8.114 With regard to the structure of the workshop, it was agreed that:

(i) indices derived from datasets (not necessarily using standard methods) should be submitted prior to the meeting;

(ii) these indices would be loaded on a central server that could be accessed by a network of computers available to workshop participants;

(iii) working papers could be submitted that elucidated the details of sampling and data processing leading to the formulation of an index; and

(iv) additional working papers could be submitted which drew attention to apparent relationships between indices.

8.115 It was agreed that the primary purpose of the workshop was to explore coherence among processes occurring throughout Area 48. Workshop participants were requested to submit their full sets of data on indices (i.e. without combining similar indices). Participants were, however, encouraged to undertake analyses of their own data (e.g. investigating properties of indices, multivariate analysis, etc.) in advance of the workshop and to report their results to it.

8.116 Relevant ecosystem processes were divided into four categories and coordinators were assigned to facilitate submission of indices describing seasonal variation in these processes. Processes to be indexed and their coordinators are:

(i) Physical Environment (Mr Amos, Drs Trathan and Naganobu):
- (a) sea-ice;
- (b) circulation;
- (c) hydrography;
- (d) meteorology; and
- (e) sea-surface temperature.

(ii) Biotic Environment (Dr Loeb):
- (a) phytoplankton; and
- (b) zooplankton.

(iii) Dependent Species (Drs Croxall and Trivelpiece):
- (a) CEMP indices;
- (b) other indices; and
- (c) cetacean catches and sightings.

(iv) Krill (Drs Watkins and Siegel):
- (a) demographics;
- (b) recruitment;
- (c) abundance and distribution of post larval forms (as determined from net samples and acoustic surveys);
- (d) abundance and distribution of larvae; and
- (e) fishery-dependent data.

8.117 The Working Group invited the submission of any indices as long as they could be used to address the hypotheses outlined in paragraph 8.112. Contributors are encouraged to contact the appropriate coordinator.

8.118 The Working Group recommended that the workshop should be held at the Southwest Fisheries Science Center in La Jolla, USA, during the last two weeks of June 1998. It was noted that the venue could accommodate no more than 20 participants. Dr Hewitt agreed to convene the workshop and to organise communications between the coordinators listed above.

8.119 The Working Group recommended that the CCAMLR Data Manager should attend the workshop and that secretarial support from the CCAMLR Secretariat should also be requested. This recommendation is motivated by the nature and scope of the workshop, particularly since diverse sources of data will be used and data in the CCAMLR database are likely to be considered.

8.120 The Working Group recommended that the Convener formulate a request to the IWC for cetacean catch and sighting records for Area 48. The request should be forwarded by the Secretariat to the IWC.

Synoptic Survey in Area 48

8.121 WG-EMM noted the Subgroup on Statistics deliberations concerning the proposed synoptic survey of Area 48 (Appendix D, paragraphs 6.1 to 6.6). It agreed with the subgroup's view that the primary objective of such a survey would be to provide an updated estimate of krill biomass (B_0) and its variance for use in the krill yield model to estimate precautionary catch limits for the area.

8.122 Considering a timetable for the survey, the Working Group reviewed information presented at previous meetings (WG-EMM-95/71; SC-CAMLR-XI, Annex 5, Appendix H; Trathan and Everson, 1994; SC-CAMLR-XV, Annex 5, paragraphs 3.72 to 3.75) and made the following recommendations:

(i) the synoptic survey of Area 48 should be scheduled for the austral summer of 1999/2000. This timing is considered to offer the most suitable compromise which addresses the urgent need for the survey and allows sufficient time for logistical planning;

(ii) survey effort should be concentrated in Subareas 48.1, 48.2 and 48.3. However, consideration needs to be given to the allocation of survey effort north of Subarea 48.1 (FAO Area 41.0) and to the zone covered by the southwest Atlantic circulation within the western part of Subarea 48.4;

(iii) a series of task groups should be constituted to develop a survey work plan for consideration at WG-EMM's 1998 meeting. The following tasks and nominated scientists are proposed so as to provide a coordinated approach to the task at hand:

(a) <u>delineation of survey boundaries and strata</u> (Dr Everson). Particular note to be taken of allocating survey cover to the north of Subarea 48.1, to the east of Subarea 48.2 and around oceanic islands or other physical features in Subareas 48.1, 48.2, 48.3 and 48.4;

(b) <u>identification of information impacting on survey implementation and analyses</u> (Dr Murphy). An important consideration in this context would be to consider the implications of water circulation as this may affect the transport of krill (e.g. as outlined in WG-EMM-97/67);

(c) <u>acoustic sampling protocols</u> (Drs Demer, Hewitt, Pauly, Watkins and Madureira);

(d) <u>net sampling protocols</u> (Drs Siegel, Loeb and Watkins);

(e) <u>survey design and simulation</u> (Drs B. Manly (New Zealand), A. Murray (UK), Everson and de la Mare). The results of this study (see paragraphs 8.125 to 8.129 below) are considered crucial for the setting of limits (particularly in respect of time allocations) to the survey activities outlined in subparagraphs (c) and (d) above;

(f) oceanographics/environmental sampling protocols (Mr Amos, Drs Trathan and Naganobu). It was emphasised that focus should be given to the underway sampling of key environmental parameters and that the sampling of such parameters should not compromise the surveys synopticity or its primary objective of estimating B_0;

(g) ancillary information. To maximise ship survey time, it was acknowledged that some vessels may undertake activities (e.g. whale sighting) ancillary to the surveys main objectives. As with (f) above, it was emphasised that these activities should not detract from the survey's primary aim to estimate B_0; and

(iv) to facilitate the approach outlined in (iii) above, WG-EMM requested the Secretariat to compile a list of previous agreements (e.g. on acoustic survey standardisation) by CCAMLR and its subsidiary bodies relevant to synoptic survey design in general and the synoptic survey of Area 48 in particular (see also paragraphs 8.32 to 8.37).

8.123 The Working Group also recommended that the tasks outlined in the previous paragraph should be collated as a draft survey plan in time for consideration by a survey steering committee convened by Dr Holt and comprising Mr Amos, Drs Demer, Everson, Manly, Murphy, Naganobu, Phan van Ngan and Siegel. This committee could meet in conjunction with the planned Area 48 workshop in mid-1998 and prepare an outline survey plan to be considered at WG-EMM's 1998 meeting.

8.124 WG-EMM agreed with the Subgroup on Statistics' conclusion that the two key outstanding issues regarding the synoptic survey design for Area 48 are questions surrounding stratification and random versus systematic placement of survey transect lines.

8.125 The Working Group recommended that a simulation study be implemented so as to provide a quantitative comparison of the relative efficiencies of random as opposed to systematic transect placement in a synoptic survey for krill in Area 48. This study should be afforded high priority.

8.126 The Working Group therefore proposed that a small panel, comprising Drs Manly, de la Mare, Murray, Everson and other interested parties, should be tasked with defining realistic goals and boundaries for the simulation study (paragraph 8.122(iii)(e)). At a minimum this study should consider:

(i) the cost (in ship-hours) of alternative survey designs and transect placements (including the cost-benefit of various levels of randomisation in design);

(ii) the effects of and potential for survey biases introduced by diel vertical migration of krill (particularly with respect to the allocation of survey effort by day alone, as opposed to day and night together);

(iii) the effects of spatial coherence in krill distribution being different in different directions (including possible biases likely to arise from up- and downstream placements of survey transects and the relative costs of surveying a population which varies in time and space); and

(iv) whether there is a point at which the marginal utility of reducing the survey variance becomes small. This could be studied by considering when the results of the krill yield model become more sensitive to variability in krill recruitment than to uncertainty in krill biomass.

8.127 WG-EMM agreed that a number of other considerations should be taken into account in the setting up of the simulation. These would include:

(i) the optimal allocation of survey effort and transect placement, given the likely levels of ship commitment (i.e. available ship time) and the consequent expectation of optimal benefit in terms of minimising survey variance and maximising survey precision;

(ii) the trade off between allocation of survey effort and reduction in survey variance, especially when additional allocation of effort results in only marginal reduction in variance;

(iii) the range of krill spatial distributions likely to be encountered and how these may reflect transect placement. This will require examination of historic data, the simulation and sampling of various theoretical spatial distributions to take into account temporal variability arising from horizontal patchiness or diel vertical migration and to assess the likely range of impacts on estimates of survey variance; and

(iv) the use of historic datasets (e.g. FIBEX, data from the Discovery Investigations, commercial fisheries information) as well as regional scale (e.g. the Australian survey of Division 58.4.1) and local scale (e.g. the AMLR surveys around Elephant Island) data as an empirical basis for setting up the simulation as well as for tuning its results.

The Working Group noted that complete consideration of the items identified in subparagraphs (iii) and (iv) above constitute a substantial task within the planned time scale (one year) of the simulation.

8.128 WG-EMM agreed that the panel should formalise the simulation study terms of reference and develop an achievable (in the time available, i.e. one year) and realistic action plan prior to the Scientific Committee's 1997 meeting.

8.129 In the absence of a simulation study, WG-EMM noted the Working Group's conclusion that randomly-spaced parallel transects offer a conservative survey design since both design and model-based variance estimators can be used to analyse survey data. In this regard the Working Group acknowledged that randomly-spaced parallel transects offer a fall-back position which in no way reduces the urgency attached to the simulation study and that the former should not be seen as a desirable alternative. In this context, the Working Group recognised that consideration remains to be given to the apportionment of random as opposed to fixed transect allocation in a synoptic survey of krill in Area 48.

Other Activities in Support of Ecosystem Monitoring And Management

CCAMLR–IWC Collaboration

8.130 At its annual meeting in 1996, the IWC recommended that joint CCAMLR–IWC working groups be established to consider collaborative work in the Southern Ocean. As a consequence, SC-CAMLR invited IWC to send a representative to attend the 1997 Meeting of WG-EMM (SC-CAMLR-XV, paragraph 11.14). Dr Reilly, convener of the IWC Standing Working Group on the Effects of Environmental Change on Cetaceans, took part in the deliberations on behalf of the IWC (see paragraph 1.4).

8.131 The Working Group identified the study of the distribution of whales in relation to krill, oceanography and bathymetry as an area of common interest to CCAMLR and IWC. Therefore, it suggested the following ways in which closer collaboration could be developed:

(i) participation in existing and planned surveys which focus on either krill (or other prey) and environmental conditions or cetacean sightings;

(ii) joint analysis of recent and historical datasets containing information on whale distribution, whale catches and prey distribution and abundance; and

(iii) annual exchange of information which is of relevance to the other organisation.

Participation in Existing and Planned Surveys

8.132 The participation in existing and planned surveys of the other organisation would encompass various levels of involvement. The provision of advice by the IWC on CCAMLR-dedicated national and international surveys could range from the compilation of cetacean sighting protocols, information on minimum datasets required, skills of observers required to obtain reliable datasets, or the recruitment of suitable observers to the actual participation in those surveys. Examples where IWC protocols have been incorporated into krill surveys recently are the Australian krill survey in Division 58.4.1 in 1995/96, the German krill survey around Elephant Island in 1996/97 and various AMLR surveys over the last 10 years. Pending further investigation, cetacean sighting surveys might also become part of other CCAMLR-dedicated surveys, such as the UK predator/krill survey around South Georgia, and the CCAMLR international synoptic krill survey in Area 48 which is planned for 1999/2000. CCAMLR could provide advice to the IWC or IWC Members on surveys with the primary focus on cetaceans which include studies on the behaviour of whales in relation to prey distribution and abundance and/or the environment. As an example, CCAMLR has provided advice to the IWC on the planning of the Southern Ocean Whale and Ecosystem Research Cruises (SOWER) in 1995.

Coordination of CCAMLR and IWC Research Activities

8.133 Pending the experience from the collaborative work outlined in the previous paragraph, it could be envisaged that CCAMLR and the IWC would work together in some parts of the Southern Ocean to study the distribution and behaviour of whales in relation to prey distribution and the environment. The planned CCAMLR survey to estimate krill biomass in the western part of Area 48 (Subareas 48.1 to 48.4) in the 1999/2000 season (see paragraph 8.122) would offer the opportunity for such a joint effort if the IWC would be able to conduct one of its SOWER surveys in parallel with the CCAMLR survey.

Analysis of Historical and Recent Datasets

8.134 As more information on krill biology and population dynamics become available, it could be useful to revisit historical datasets, for example from the Discovery Investigations, which may now provide new insight into the behaviour of whales in relation to their prey and the environment, and the distribution and abundance of krill. Prerequisites for such investigations are:

(i) an inventory of existing historical datasets containing information on whale distribution, krill distribution and abundance and environmental parameters. This could be compiled in collaboration between the CCAMLR and IWC Secretariats;

(ii) the IWC database on catch records and biological information of whales taken in the Southern Ocean, as soon as it is completed; and

(iii) the specification of the objectives for which these datasets should be re-analysed. These need to be developed by CCAMLR in the intersessional period.

Prey surveys in the CCAMLR Convention Area have incorporated cetacean sightings without, however, following standard protocols such as those developed for line transect surveys. Advice about how such data might best be analysed, might be sought through the IWC.

Annual Exchange of Information

8.135 The exchange of information between the two organisations should be improved and could include lists of working papers a well as their abstracts. Working papers which are of relevance to both organisations should be submitted to meetings of both organisations either as working papers or as background documents, as has been the case for papers WG-EMM 97/17 and 97/18. Such papers need not be restricted to problems in the Southern Ocean, but might contain information on new methods which could be applied to studies in the Southern Ocean.

8.136 A closer collaboration between CCAMLR and the IWC could best be achieved by forming a small liaison group with IWC-SC which could work (mostly by correspondence) on matters outlined above. Members of this group should cover a wide range of expertise and should not be confined to those who attend meetings of both CCAMLR and the IWC.

8.137 Draft terms of reference for such a group will need to be developed by the Scientific Committee. WG-EMM suggested the following terms of reference:

(i) to facilitate communication between CCAMLR and the IWC on all scientific matters of mutual interest;

(ii) to advise the Scientific Committee on matters relevant to potential collaborative work, for example:

(a) exchange of information;
(b) the analysis of historical datasets;
(c) survey methods
(d) studies of interactions between whales, prey and the environment; and
(e) estimate prey consumption by whales.

GLOBEC Workshop

8.138 Following the meeting of WG-EMM there will be a workshop to plan the Southern Ocean Global Ocean Ecosystem Dynamics (SO-GLOBEC) effort. The SO-GLOBEC program will provide an opportunity to test hypotheses about environmental and biological interactions in the Antarctic marine ecosystem. Given the mutual scientific interests, it is hoped that collaborative research effects between CCAMLR and SO-GLOBEC will be developed.

ADVICE TO THE SCIENTIFIC COMMITTEE

9.1 The Secretariat should acquire data on krill catches in areas adjacent to Subarea 48.1 (paragraph 10.1).

9.2 Members should be encouraged to continue to submit the following data from their krill fisheries (paragraphs 10.2 to 10.4):

(i) haul-by-haul data;
(ii) time budget data; and
(iii) fish by-catch data.

9.3 Members should note the Working Group's advice on data collection and processing for zooplankton surveys using acoustic techniques (paragraph 10.11).

9.4 The Secretariat should compile into a single reference document all papers submitted to meetings of WG-EMM and WG-Krill relevant to surveys of krill distribution and abundance (paragraph 10.12).

9.5 The Working Group recommended that a synoptic survey of krill biomass in Area 48 be undertaken in the austral summer of 1999/2000 (paragraph 10.14).

9.6 The Working Group recommended that site protection at Seal Island under Conservation Measure 92/XI be extended for five years subject to approval of a revised management plan (paragraph 8.41).

9.7 The Working Group recommended that Bouvet Island be accepted as a CEMP monitoring site (paragraph 8.42).

9.8 The Secretariat should revise Tables 1 to 4 of the introduction of the standard methods and circulate the revised standard methods to all Members as soon as possible (paragraph 10.16).

9.9 The Data Manager should investigate the availability of data on Antarctic petrels potentially appropriate for the CEMP database (paragraph 10.18).

9.10 The Secretariat should request, from appropriate SCAR groups, the reports of workshops on survey design (APIS) and estimation of seabird distribution and abundance at sea (Bird Biology Subcommittee) (paragraphs 10.23 and 10.25).

9.11 The Secretariat should request ASIP to supply a list of its sites and to supply further information in due course (paragraph 10.26).

9.12 The Data Manager should request from Members specified information on environmental data (paragraph 10.27(i), (ii) and (iv)).

9.13 The Secretariat should request Members to check that their data in the CEMP database are correctly summarised in WG-EMM-97/25 Rev. 1 to ensure prompt submission to the Data Manager of CEMP data from current and recent seasons and outstanding historical data where available (paragraph 10.32) and to provide information on missing values (paragraph 10.33).

9.14 The Scientific Committee should note the advice from the Subgroup on Statistics concerning imputation of missing values (paragraph 6.11 and Appendix D, paragraph 5.7) and the request for development of imputation techniques when missing values have been identified.

9.15 The Scientific Committee should note the conclusions of the Subgroup on Statistics concerning evaluation of the Agnew–Phegan model for calculating potential overlap between fisheries and dependent species (Appendix D, paragraphs 3.1 to 3.15; paragraph 10.34).

9.16 The Scientific Committee should note the prediction of poor recruitment from krill spawning during 1996/97 in Subarea 48.1 (paragraph 6.38; also paragraph 3.43).

9.17 The Scientific Committee should note the recommendations contained in the executive summary of the report of the Workshop on International Coordination (Appendix E) as these apply to Members whose work is relevant to the topics considered by the workshop (paragraph 10.35).

9.18 The Scientific Committee should note comments on the possible re-establishment of minke whales as a CEMP monitoring species (paragraphs 6.53 and 6.54).

9.19 In response to the request of the Scientific Committee to evaluate aspects of WG-FSA-96/20, the Working Group noted the lack of sufficient data to assess how the development of a fishery in Subarea 48.3 for the squid *M. hyadesi* would affect its dependent predators. It supported the precautionary approach recommended in WG-FSA-96/20 (paragraphs 6.83 to 6.87).

9.20 The Working Group recommended that a workshop to consider the coherence of processes relating to environment, krill and dependent species between Subareas 48.1, 48.2 and 48.3 be held during the intersessional period with the terms of reference, arrangements and responsibilities as set out in paragraphs 8.111 to 8.119. This includes a request for the attendance of the Data Manager and for secretarial support (paragraph 8.119).

9.21 The Working Group recommended that revised calculations of precautionary limits be deferred until the results of the synoptic krill survey for Area 48 are available (paragraph 7.2).

9.22 The Working Group recommended that when the computer program implementing the GYM has been validated by the Secretariat it should replace the existing krill yield model for future krill-related computations (paragraph 7.3).

9.23 The Working Group recommended that subarea subdivision of the precautionary catch limit for krill in Area 48 be deferred until the results of the planned synoptic survey for Area 48 are available (paragraph 7.7).

9.24 The Scientific Committee should note the ecosystem assessment undertaken by the Working Group (paragraphs 7.12 to 7.28), in particular the preliminary use of new developments in methods to identify EIVs in data submitted to the CEMP database.

9.25 The Secretariat should request from the IWC:

(i) an inventory of the historical datasets on whale distribution and associated prey and environmental data and circulate the response to Members with the request for suggestions on analyses of such data which are relevant to CCAMLR (paragraphs 10.49 and 10.50);

(ii) cetacean catch and sightings records relevant to Area 48, in advance of the Area 48 workshop (paragraph 8.120).

9.26 The Working Group recommended that the Scientific Committee approve the establishment of a liaison group to facilitate collaboration between the Scientific Committees of the IWC and CCAMLR (paragraphs 8.136 and 8.137).

9.27 The Working Group recommended that the Scientific Committee review arrangements for meetings of WG-EMM, with particular attention to improving the availability and content of working group papers and the provision of the most appropriate Secretariat support at meetings (paragraphs 11.1 to 11.7).

FUTURE WORK

Fisheries Information

10.1 The Secretariat will seek information on krill catches which may have been taken in waters adjacent to those for which catches were reported along the northern boundary of Subarea 48.1 in recent years (paragraph 2.2).

10.2 Submission of haul-by-haul data from the krill fishery should continue to be encouraged (paragraph 2.10; SC-CAMLR-XV, Annex 4, paragraph 10.8(vii)).

10.3 Time budget data from krill fishing operations need to be acquired and submitted (paragraph 2.11).

10.4 Data on by-catch of fish in krill catches from seasons other than the austral summer are required (paragraph 6.2).

Harvested Species

General

10.5 Information and data on indices of local krill availability should be submitted to the next meeting of the Working Group (paragraphs 3.20, 6.77 and 6.78).

10.6 A reliable predictor of krill recruitment needs to be developed and its statistical properties assessed (paragraph 3.27).

10.7 The relationship between measures of abundance and proportional recruitment and the output of the krill yield model needs investigating (paragraph 3.29).

10.8 Further development of CPUE indices, incorporating additional operational information from the krill fishery, is encouraged (paragraph 3.40).

Methods

10.9 It was agreed to develop a draft standard method for the calculation of an absolute recruitment index for krill (paragraph 8.1).

10.10 Information and results relating to techniques for species-discrimination of zooplankton and nekton, in particular using image-recognition and multifrequency acoustic methods, should be submitted to the next meeting (paragraph 8.18).

10.11 Members collecting data from surveys of zooplankton distribution and abundance using acoustic techniques should note the Working Group's advice on data collection, logging and processing (paragraph 8.23).

10.12 Advice and information on methods and techniques relevant to the conduct of surveys of krill distribution and abundance which had been provided to current and previous meetings of WG-EMM and WG-Krill would be compiled into a single-reference source by the Secretariat (paragraphs 8.30 and 8.122(iv)).

10.13 Standard methods for net and acoustic sampling, data storage and analysis need to be developed prior to the synoptic survey of Area 48 (paragraph 8.31) by the task groups identified in paragraph 8.122(iii).

Biomass Survey

10.14 The Working Group recommended that work to prepare for a synoptic survey of krill biomass in Area 48 be undertaken with the arrangements and responsibilities described in paragraphs 8.121 to 8.129.

Dependent Species

Existing Standard Methods

10.15 The Working Group had not identified a need for any revision of the *CEMP Standard Methods* at this stage (except as in paragraph 10.13). When the *CEMP Standard Methods* is next revised, topics requiring further consideration, in addition to those listed in paragraphs 8.48 to 8.75, should include:

(i) potential biases in diet studies (paragraph 8.54);
(ii) reducing disturbance associated with Method A9 (paragraph 8.56).

10.16 The Working Group recommended that before circulating to Members the *CEMP Standard Methods* as revised last year, Tables 1 to 4 of the introduction should be updated by the Secretariat, to take account of changes to sites and to Members' work as reported in SC-CAMLR-XV/BG/2. If possible, reference to two additional publications should be inserted in Method A5 and Section 4 of Observation Protocols and Techniques (see paragraph 8.51).

10.17 Members holding appropriate datasets were requested to evaluate sampling regimes and sample sizes for standard methods (paragraph 8.48), especially:

(i) in relation to five-day sampling periods for Methods A5, A7 and A9 (paragraph 8.49);

(ii) in conjunction with definition of a biological reference point for Method A5 (paragraph 8.52);

(iii) in relation to differences in foraging trip duration of macaroni penguins for Method A5 (paragraph 8.53);

(iv) investigating different approaches to analysis of data on Antarctic fur seal foraging trip duration (paragraphs 8.60 and 8.61); and

(v) reducing bias in methods estimating offspring growth rates (paragraph 8.62).

10.18 The Data Manager should investigate the availability of data potentially appropriate for CEMP on Antarctic petrel population size and breeding success (paragraph 8.59).

Potential Standard Methods

10.19 Revisions of the proposed new standard methods for penguin breeding population size (A3B), Antarctic fur seal adult female survival rate and pregnancy rate (C3), and Antarctic fur seal diet (C4) should be submitted to next year's meeting (paragraphs 8.64 to 8.67).

10.20 A draft standard method on tagging of Antarctic fur seals should be prepared by Dr Boyd (paragraph 8.85) and submitted to next year's meeting.

10.21 Members conducting research on fur seals should note the colour combinations for tags prescribed for the sites at Cape Shirreff, Bouvet Island, Bird Island, South Georgia and elsewhere (paragraph 8.87). Members tagging fur seals should ensure that data are submitted to the SCAR Antarctic Seals Tagging Database (paragraph 8.88).

10.22 The suggestion that data on at-sea behaviour, collected according to the standard method set out in Section 4 of Observation Protocols and Techniques should be submitted in both raw and analysed data format (paragraphs 8.69 and 8.70), requires the development of instructions for doing this which should be submitted to the Working Group as soon as possible, taking account of the methodological investigations recommended by the Subgroup on Statistics (Appendix D, paragraph 7.13).

10.23 The Secretariat should request from the SCAR Group of Specialists on Seals, the report of the APIS Workshop on Survey Design (paragraph 8.74), together with relevant details from Australian shipboard surveys and UK pilot studies with fixed-wing aircraft (see paragraph 8.73) in order to develop a standard method for monitoring crabeater seal abundance.

10.24 Dr R. Casaux (Argentina) and colleagues were encouraged to submit to the Working Group a new version of a draft standard method for collecting data on relative abundance of coastal fish species by monitoring the diet and reproductive success of Antarctic shags (paragraphs 6.82 and 8.75).

Other Matters

10.25 The Secretariat should request from the SCAR Subcommittee on Bird Biology, the report of the workshop dealing with standardising quantitative surveys of seabird abundance and distribution at sea (SC-CAMLR-XV, Annex 4, paragraph 4.92).

10.26 The Secretariat should request ASIP to provide a list of sites being monitored and, at a future time, a review of the data collected (paragraph 8.76).

Environment

10.27 The Working Group concluded that it was timely to review the nature of environmental data being collected to develop existing or potential CEMP standard methods. To assist in this:

(i) the Data Manager was requested to obtain information on data currently being collected under Methods F1, F3 and F4 (paragraphs 8.95, 8.97 and 8.98);

(ii) the Data Manager was requested to obtain indices of sea-ice cover and related measures currently being collected by Members in standard fashion (paragraph 8.95);

(iii) Dr Trathan was requested to investigate the dataset currently used to provide indices of sea-surface temperature under Method F5 to see if other indices could be developed (paragraph 8.99); and

(iv) the Data Manager would request Members to review the temporal scales at which data for Methods F2c and F5 should be collected (paragraph 8.100).

10.28 The Working Group agreed that it was desirable to obtain data on additional environmental parameters to characterise the physical environment adjacent to CEMP sites and within ISRs. Members were encouraged to investigate this intersessionally, particularly in relation to characterising frontal positions, investigating properties of oceanographic models and the potential use of instrumented predators to obtain relevant oceanographic information (paragraphs 8.104 to 8.108).

10.29 Cooperative analysis of historical hydrographic data from the Elephant Island region is encouraged (paragraph 5.6).

Ecosystem Analysis

10.30 Further work should be undertaken on multivariate analysis of CEMP indices, including studies of combined indices and the definition of baselines (paragraphs 6.7 and 6.35).

10.31 Members were requested to check the summary of the data held in the CEMP database as set out in WG-EMM-97/25, Rev. 1 and to inform the Data Manager of any errors or omissions (paragraph 6.9).

10.32 All Members were requested to ensure prompt submission to the CEMP database of (paragraph 9.13):

(i) outstanding data from the 1997 season;

(ii) outstanding historical data for all parameters currently covered by standard methods; and

(iii) data for the 1998 season, particularly for Area 48, to ensure that this is available in advance of the proposed workshop.

10.33 Information on missing values within data submitted to the CEMP database should be provided to the Data Manager as soon as possible (paragraph 6.11; see also paragraphs 8.79 and 8.81).

10.34 In respect of potential overlap between fisheries and dependent species, further work is required on (paragraph 6.10):

(i) revision of the Agnew–Phegan model, especially in respect of temporal aspects;

(ii) calculation of Schroeder indices; and

(iii) development of indices to assess possible impact of harvest on dependent species.

10.35 Members whose work is relevant to studies contributing to topics considered by the Workshop on International Coordination (WG-EMM-97/44) should take note of the recommendations in the executive summary of this report (Appendix E).

10.36 Analysis of trawl-based data from fishing operations to investigate the nature of potential interactions between predators, prey and fisheries is encouraged (paragraph 6.22).

10.37 Further analysis of ancillary data deriving from the krill fishery is encouraged (paragraph 6.26).

10.38 Further studies quantifying krill flux and exploring interactions between water transport and patterns of krill aggregation are required (paragraph 6.28).

10.39 Studies apportioning variability in krill recruitment and abundance between large-scale (environment) and small-scale (population) processes should be undertaken (paragraph 3.28).

10.40 Multivariate analyses of the relationships between salp abundance, krill recruitment, krill abundance and ice cover should be undertaken (paragraph 3.46).

10.41 Relationships between environmental factors and processes determining local krill population distribution and abundance should be developed for areas additional to Subarea 48.1 (paragraph 6.34).

10.42 Development of methods which assist incorporation of environmental information into management strategy are encouraged (paragraph 6.37).

10.43 Work to quantify the impact of minke whales on krill is encouraged (paragraphs 6.30 and 6.55).

10.44 Prof. Butterworth was encouraged to complete work on the existing model of functional relationships involving Antarctic fur seal and black-browed albatross (taking into account new information and advice provided in paragraphs 6.63 to 6.65, 6.68, 6.71 and 6.72) and to investigate the possibility of further progress with the sub-model involving Adélie penguin (paragraph 6.66).

10.45 The development of complementary approaches involving mechanistic modelling were encouraged (paragraphs 6.71 and 6.72).

10.46 The Working Group will consider the reviews by SCAR of the status and trends of dependent species at its next meeting (paragraph 6.73).

10.47 The Working Group will consider potential interactions between dependent species more explicitly at its next meeting (paragraph 6.74).

10.48 The Working Group recommended that a workshop to consider the coherence of processes relating to environment, krill and dependent species between Subareas 48.1, 48.2 and 48.3 be held during the intersessional period with the terms of reference, arrangements and responsibilities as set out in paragraphs 8.111 to 8.118.

Collaboration with the IWC

10.49 The Secretariat should request from IWC an inventory of the historical datasets on whale distribution and associated prey and environmental data (paragraph 8.134).

10.50 On the basis of this report the Secretariat will invite Members to suggest objectives, relevant to the work of the Working Group, for analysis of these datasets; these suggestions would be discussed at the next meeting (paragraph 8.134).

10.51 The Secretariat should request from IWC cetacean catch and sightings records relevant to Area 48, in advance of the Area 48 workshop (paragraph 8.120).

10.52 The Working Group identified responsibilities and priorities for all tasks listed in paragraphs 10.1 to 10.51 of the report and requested the Secretariat to summarise in a table format those needing to be carried out in the forthcoming year. This table would be distributed as a background paper at the forthcoming meeting of the Scientific Committee.

OTHER BUSINESS

Working Group Papers

11.1 The current rules require papers tabled at working group meetings to be lodged with the Secretariat by 0900 h on the first morning of the meeting. Participants bringing papers to meetings on the day of the meeting are asked to provide 40 copies. Papers received by the Secretariat in Hobart 30 days before the commencement of a working group meeting are circulated to participants prior to the meeting.

11.2 This year 20 out of 80 papers were received 30 days in advance of the WG-EMM meeting. The late arrival of the bulk of papers to be considered for discussion meant that important papers may not have received due attention. Indeed some papers were not available until the second day of the meeting. Participants therefore had great difficulty in reading all the papers and in adequately introducing them into the debate.

11.3 The Working Group agreed that the current situation as outlined above is unsatisfactory. It drew the Scientific Committee's attention to this important matter and made the following suggestions:

(i) the timely availability of working group papers should be improved. This could entail a mandatory closer submission deadline (e.g. two weeks before the beginning of a working group meeting), ensuring the availability of <u>all</u> papers to participants on registration. If the above cannot be met then participants must bring sufficient copies for all meeting participants (i.e. 75 copies) for distribution before 0900 h on the first day of the meeting.

(ii) the overall amount of material to be read by every participant should be reduced. This could be achieved by requesting the submission of informative abstracts of papers only and requiring the authors to indicate on the cover page that the papers are either for full consideration or contain background information only. Full papers could then be available on prior request;

(iii) photocopying and preparation of meeting papers at the beginning of the working group meeting should be minimised. Notwithstanding participants bringing their own papers to the meeting (see (i) above) participants should be requested to provide cover pages (including the CCAMLR approved disclaimer clause) to their papers. If at least the titles of papers were notified in advance of the meeting, that would enable the Secretariat to assign paper numbers which participants could include on their cover pages. Failing this, paper numbers would have to be inserted by hand; and

(iv) exploration of alternative methods to disseminate the information contained in papers should continue. This could entail the distribution of papers prior to the meeting by electronic means.

11.4 The Working Group agreed that there would be no point in implementing rules for the timely submission and distribution of papers if such rules were not strictly applied as this would defeat the purpose of the exercise.

Secretariat Support at WG-EMM Meetings

11.5 The Working Group expressed its thanks to the Secretariat for a difficult job well done in supporting its activities during meetings of the Working Group and its associated bodies. However, concern was expressed that certain aspects of this support could be improved in the interests of efficiency and in the deployment of adequate resources and skills to support WG-EMM's complicated function.

11.6 While acknowledging that the Commission had agreed to delay the publication of bound copies of the Commission and Scientific Committee's reports to spread the translation load, the Working Group requested that bound copies of the latter should be available in good time for WG-EMM meetings. This would allow Members easy access to past deliberations and associated material considered by the Scientific Committee.

11.7 To ensure the efficient deployment of limited Secretariat resources and given current budgetary constraints, WG-EMM requested the Scientific Committee to consider a process whereby the skill necessary for working group support should be more clearly defined. The purpose of such a review will be to ensure that the number and skills of Secretariat staff travelling to working group meetings is commensurate with the tasks likely to be required by the meeting concerned. As a general principle the Working Group agreed that the Scientific Committee is in the best position to define the Secretariat needs for meetings of its subsidiary working groups.

Krill Symposium

11.8 The Working Group examined a draft program for the second International Krill Symposium scheduled for 1999 and noted that the program will be presented to the Scientific Committee at its 1997 meeting (SC-CAMLR-XIV, paragraphs 4.23 and 4.24; SC-CAMLR-XV, paragraph 4.26).

ADOPTION OF THE REPORT

12.1 The report of the third meeting of WG-EMM was adopted.

CLOSE OF THE MEETING

13.1 In closing the meeting, the Convener, Dr Everson, expressed his sincere thanks to Dr Holt and his colleagues in San Diego for the substantial amount of work they had done to ensure that the meeting ran smoothly. He also thanked the participants for their contributions, and the rapporteurs for their work. Finally he thanked the Secretariat staff, and particularly Mrs G. Mackriell and Mrs R. Marazas for their support in preparing meeting papers and the report.

13.2 Dr Miller, on behalf of the Working Group, expressed his thanks to Dr Holt and his team for arranging the meeting, and his gratitude to Sea World and the Hubbs–Sea World Research Institute for providing excellent meeting facilities. He also thanked the Convener for conducting the meeting in an efficient and productive fashion.

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Table 1: Interactions between harvested species (krill) and the environment based on information derived from Elephant Island.

Environmental factors	Processes Determining Local Krill Population				Differential Effects on Local Versus Regional Populations
	Krill Production	Recruitment	Natural Mortality	Immigration and Emigration	
Primary production	Important Position, extent, timing and species composition of local blooms affects krill production – depends on physical environment.	Important	Important?	??	Important at all scales.
Biotic interactions (including salps and possibly other zooplankton).	Salps competing for primary production. Krill consumes zooplankton in winter.	Spring salp blooms inhibit early spawning. High summer salp populations consume eggs and larvae.	Salps eat eggs and larval krill.		Important at both local and regional scales.
Sea-ice	Winter and spring growth promoted by extensive sea-ice.	Extensive winter sea-ice promotes early spawning and improves survival of larvae. Poor sea-ice development promotes spring salp bloom.	Natural mortality over-winter reduced by extensive ice.	??	On local scales the relevant sea-ice effects occur upstream and in preceding years.
Changes in water temperature and circulation, including positions of fronts, depths of mixed layers, local advection	Direct effects on krill growth. Higher surface layer temperatures increase salp biomass. Local krill density affected by changes in local circulation – eddies.	Direct effects on krill spawning and survival. Higher surface layer temperatures increase salp biomass.	Higher surface layer temperatures increase incidence of parasites and disease. Influx of myctophids associated with circumpolar deepwater – increased predation.	Krill retention, distribution and transport affected?	Relative importance of effects depend on scale of interest i.e. regional or local.
Advection	Standing krill stock depends on transport. Salps advected with warm water masses.	Recruitment from advected krill may predominate at local scales. Recruitment exported to downstream localities.			Standing stock more dependent on transport at the local scale.

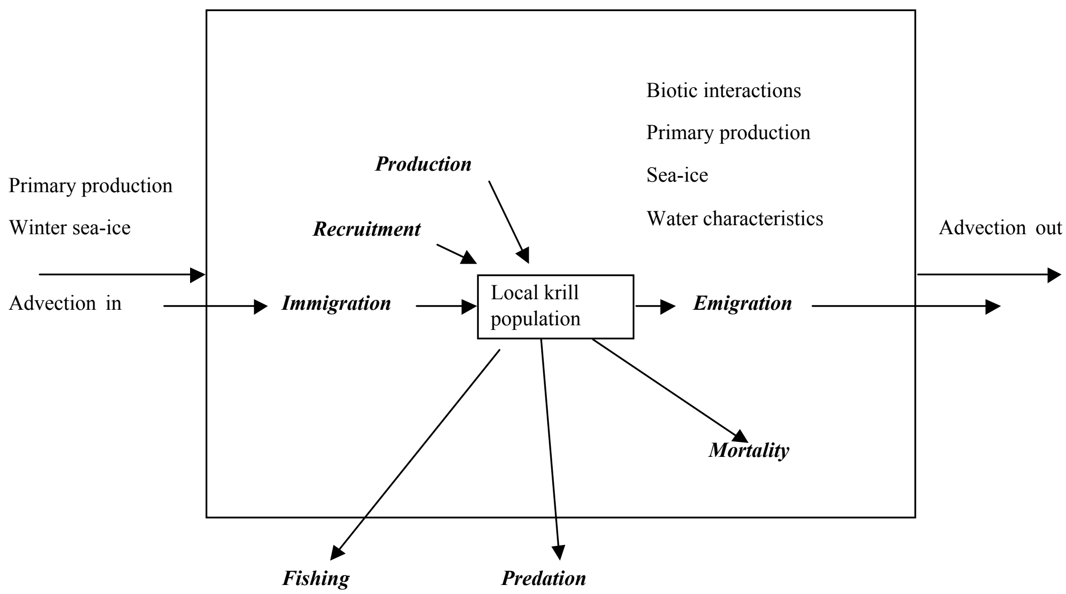

Figure 1: Environmental (biotic and abiotic) factors and processes determining local krill population distribution and abundance. The population processes are shown in bold italics. See Table 1 for further description of the possible effects of the environment on population processes.

APPENDIX A

AGENDA

Working Group on Ecosystem Monitoring and Management
(San Diego, USA, 21 to 31 July 1997)

1. Introduction

    (i) Opening of the Meeting
    (ii) Organisation of the Meeting and Adoption of the Agenda

2. Fisheries Information

    (i) Catches, Status and Trends
    (ii) Harvesting Strategies
    (iii) Observer Scheme
    (iv) Other Information

3. Harvested Species

    (i) Distribution and Standing Stock
    (ii) Recruitment and Production
    (iii) Indices of Abundance, Distribution and Recruitment
    (iv) Future Work

4. Dependent Species

    (i) Studies on Distribution and Population Dynamics
    (ii) Future Work

5. Environment

    (i) Consideration of Studies on Key Environmental Variables
    (ii) Indices of Key Environmental Variables
    (iii) Future Work

6. Ecosystem Analysis

    (i) By-catch of Fish in the Krill Fishery
    (ii) Report of the Subgroup on Statistics
    (iii) Interactions between Ecosystem Components
        (iii.i) Krill-centred Interactions
            (a) Harvested Species and the Environment
            (b) Harvested Species and Fisheries

(c) Dependent Species and the Environment
(d) Dependent Species and Harvested Species
(e) Fishery and Dependent Species Overlap
(iii.ii) Fish- and Squid-centred Interactions

7. Ecosystem Assessment

(i) Estimates of Potential Yield
(ii) Precautionary Catch Limits
(iii) Assessment of the Status of the Ecosystem
(iv) Consideration of Possible Management Measures
(v) Future Work

8. Methods and Programs Involving Studies on Harvested and Dependent Species and the Environment

(i) Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species

(ii) Consideration of CEMP Sites
(a) Review Management Plan for the Seal Islands Site
(b) Consideration of New Requests for Site Protection

(iii) Methods for Monitoring the Performance of Dependent Species
(a) Consideration of Comments on Existing Methods
(b) Consideration of New Draft Methods for Fur Seal Diet and Demography

(iv) Methods for Monitoring Environmental Variables of Direct Importance in Ecosystem Assessment

(v) Plans for a Workshop Meeting to Consider Harvested and Dependent Species in Area 48

(vi) Plans for a Synoptic Krill Survey in Area 48

(vii) Other Activities in Support of Ecosystem Monitoring and Management

9. Advice to the Scientific Committee
(i) General Advice
(ii) Management Advice

10. Future Work

11. Other Business

12. Adoption of the Report

13. Close of the Meeting.

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(San Diego, USA, 21 to 31 July 1997)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management (San Diego, USA, 21 to 31 July 1997)

WG-EMM-97/1 Rev. 1	PROVISIONAL AGENDA AND PROVISIONAL ANNOTATED AGENDA FOR THE 1997 MEETING OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT (WG-EMM)
WG-EMM-97/2	LIST OF PARTICIPANTS
WG-EMM-97/3 Rev. 1	LIST OF DOCUMENTS
WG-EMM-97/4	DRAFT STANDARD METHOD FOR THE MEASUREMENT OF ANNUAL SURVIVAL RATE AND PREGNANCY RATE IN ADULT FEMALE ANTARCTIC FUR SEALS I.L. Boyd (UK)
WG-EMM-97/5	DRAFT STANDARD METHODS FOR MONITORING DIET IN ANTARCTIC FUR SEALS I.J. Staniland and K. Reid (UK)
WG-EMM-97/6	HYDROGRAPHIC CONDITIONS IN THE ELEPHANT ISLAND PLATEAU REGION DURING DECEMBER 1996 M. Stein (Germany)
WG-EMM-97/7	PREDATOR-PREY INTERACTIONS BETWEEN HIGHER PREDATORS AND FISH AND CEPHALOPODS IN THE SOUTHERN OCEAN I.L. Boyd, J.P. Croxall and P.A. Prince (UK)
WG-EMM-97/8	VARIATION IN FORAGING EFFORT BY LACTATING ANTARCTIC FUR SEALS: RESPONSE TO SIMULATED INCREASED FORAGING COSTS (*Behav. Ecol. Sociobiol.* (1997), 40: 135–144) I.L. Boyd, D.J. McCafferty and T.R. Walker (UK)
WG-EMM-97/9	FISH AND SQUID IN THE DIET OF KING PENGUIN CHICKS, *APTENODYTES PATAGONICUS*, DURING WINTER AT SUB-ANTARCTIC CROZET ISLANDS (*Marine Biology* (1996), 126: 559–570) Y. Cherel and V. Ridoux (France), P.G. Rodhouse (UK)
WG-EMM-97/10	DIET AND FEEDING ECOLOGY OF THE DIVING PETRELS *PELECANOIDES GEORGICUS* AND *P. URINATRIX* AT SOUTH GEORGIA (*Polar Biol.* (1997), 17: 17–24) K. Reid, J.P. Croxall, T.M. Edwards, H.J. Hill and P.A. Prince (UK)

WG-EMM-97/11 MILK CONSUMPTION AND GROWTH EFFICIENCY IN ANTARCTIC FUR SEAL (*ARCTOCEPHALUS GAZELLA*) PUPS
(*Can. J. Zool*. (1996), 74: 254–266)
J.P.Y. Arnould, I.L. Boyd and D.G. Socha (UK)

WG-EMM-97/12 INTERANNUAL VARIATION IN THE DIET OF THE ANTARCTIC PRION *PACHYPTILA DESOLATA* AT SOUTH GEORGIA
(*EMU* (1997), 97: 00–00)
K. Reid, J.P. Croxall and T.M. Edwards (UK)

WG-EMM-97/13 LACTATION AND THE COST OF PUP-REARING IN ANTARCTIC FUR SEALS
(*Marine Mammal Science*, in press)
J.P.Y. Arnould (UK)

WG-EMM-97/14 MILK FATTY ACID SIGNATURES INDICATE BOTH MAJOR AND MINOR SHIFTS IN FORAGING ECOLOGY OF LACTATING ANTARCTIC FUR SEALS
(*Canadian Journal of Zoology*, in press)
S.J. Iverson (Canada), J.P.Y. Arnould and I.L. Boyd (UK)

WG-EMM-97/15 DIETARY SEGREGATION OF KRILL-EATING SOUTH GEORGIA SEABIRDS
(*J. Zool. Lond.* (1997), 242: 000–000)
J.P. Croxall, P.A. Prince and K. Reid (UK)

WG-EMM-97/16 DEVELOPMENT OF THE KRILL STOCK IN THE ELEPHANT ISLAND REGION DURING THE 1996/97 SEASON
V. Siegel (Germany)

WG-EMM-97/17 CONSUMPTION OF KRILL BY MINKE WHALES IN AREAS IV AND V OF THE ANTARCTIC
T. Tamura, T. Ichii and Y. Fujise (Japan)

WG-EMM-97/18 INTERANNUAL CHANGES IN BODY FAT CONDITION, STOMACH CONTENT MASS AND DISTRIBUTION OF MINKE WHALES IN ANTARCTIC AREAS IV AND V
T. Ichii, T. Tamura, Y. Fujise, S. Nishiwaki and K. Matsuoka (Japan)

WG-EMM-97/19 ESTABLISHMENT OF A CEMP MONITORING PROGRAM AT BOUVETØYA
K. Isaksen, V. Bakken, I. Gjertz and F. Mehlum (Norway)

WG-EMM-97/20 PRELIMINARY RESULTS FROM CEMP MONITORING OF ANTARCTIC FUR SEALS, CHINSTRAP PENGUINS AND MACARONI PENGUINS AT BOUVETØYA 1996/97
K. Isaksen, G.J.G. Hofmeyr (Norway), B.M. Dyer (South Africa), A. Næstvold, F. Mehlum, I. Gjertz, V. Bakken (Norway) and O. Huyser (South Africa)

WG-EMM-97/21	AVOIDANCE, A PROBLEM IN SAMPLING ANTARCTIC KRILL AT NIGHT I. Everson, D. Bone and C. Goss (UK)
WG-EMM-97/22	CATCH PER UNIT EFFORT DATA FROM THE EARLY YEARS OF COMMERCIAL KRILL FISHING OPERATIONS IN THE ATLANTIC SECTOR OF THE ANTARCTIC V. Siegel (Germany) and V. Sushin (Russia)
WG-EMM-97/23	REPORTING OF FINE-SCALE KRILL DATA IN THE 1995/96 SEASON Secretariat
WG-EMM-97/24	A MULTI-FREQUENCY METHOD FOR IMPROVED ACCURACY AND PRECISION OF *IN SITU* TARGET STRENGTH MEASUREMENTS D.A. Demer, M.A. Soule and R.P. Hewitt (USA)
WG-EMM-97/25 Rev. 1	CEMP INDICES 1997: SECTIONS 1 TO 3 Secretariat
WG-EMM-97/26	IDENTIFICATION OF SQUID ECHOES IN THE SOUTH ATLANTIC C. Goss, P. Rodhouse, J. Watkins and A. Brierley (UK)
WG-EMM-97/27	REPORT OF THE WORKSHOP ON PREDATOR-PREY-FISHERIES INTERACTIONS AT HEARD ISLAND AND MCDONALD ISLANDS AND AT MACQUARIE ISLAND (Delegation of Australia)
WG-EMM-97/28	IMPORTANT ASPECTS OF PREY DISTRIBUTION FOR THE FORMATION OF FORAGING AREAS OF CHINSTRAP PENGUINS AND ANTARCTIC FUR SEALS AT SEAL ISLAND T. Ichii (Japan), J.L. Bengtson (USA), T. Hayashi, A. Miura, T. Takao (Japan), P. Boveng, J.K. Jansen, M.F. Cameron, L.M. Hiruki, W.R. Meyer (USA), M. Naganobu and S. Kawaguchi (Japan)
WG-EMM-97/29	KRILL DENSITY, BIOMASS, PROPORTIONAL RECRUITMENT AND RECRUITMENT INDEX IN THE ELEPHANT ISLAND REGION DURING THE PERIOD 1977 TO 1997 V. Siegel (Germany), V. Loeb (USA) and J. Gröger (Germany)
WG-EMM-97/30	AMLR 1996/97 FIELD SEASON REPORT – OBJECTIVES, ACCOMPLISHMENTS AND TENTATIVE CONCLUSIONS (Delegation of USA)
WG-EMM-97/31	ICES WORKING GROUP ON FISHERIES ACOUSTICS SCIENCE AND TECHNOLOGY (FAST): SUMMARY REPORT OF THE MEETING IN HAMBURG 18–19 APRIL 1997 I. Everson (UK)

WG-EMM-97/32	HOW MUCH IS ENOUGH? ANALYSIS OF THE NET SAMPLING EFFORT IN THE ELEPHANT ISLAND AREA NECESSARY TO ADEQUATELY ASSESS AND DESCRIBE KRILL AND ZOOPLANKTON ASSEMBLAGES DURING SUMMER V. Loeb (USA)
WG-EMM-97/33	KRILL, SALPS AND OTHER DOMINANT ZOOPLANKTON TAXA IN THE ELEPHANT ISLAND AREA DURING THE 1997 AUSTRAL SUMMER V. Loeb, D. Outram and K. Puglise (USA)
WG-EMM-97/34	REPORT OF THE SUBGROUP ON STATISTICS (La Jolla, California, 14 to 18 July 1997) (Attached to this report as Appendix D)
WG-EMM-97/35	CPUE AND PROPORTIONAL RECRUIT INDICES FROM JAPANESE KRILL FISHERY DATA IN SUBAREA 48.1 S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
WG-EMM-97/36	CPUES AND BODY LENGTH OF ANTARCTIC KRILL DURING 1995/96 SEASON IN THE FISHING GROUNDS AROUND THE SOUTH SHETLAND ISLANDS S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
WG-EMM-97/37	INTERANNUAL AND SEASONAL VARIABILITY OF SALP BY-CATCH FROM JAPANESE KRILL FISHERY AROUND THE SOUTH SHETLAND ISLANDS S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
WG-EMM-97/38	THE APPLICATION OF CCAMLR ECOSYSTEM MONITORING PROGRAM (CEMP) STANDARD METHODS IN THE ANTARCTIC SITE INVENTORY PROJECT R. Naveen (USA)
WG-EMM-97/39	SEROLOGICAL EVIDENCE OF THE PRESENCE OF INFECTIOUS BURSAL DISEASE VIRUS IN ANTARCTIC PENGUINS – POSSIBLE IMPLICATIONS FOR CEMP Delegation of Australia
WG-EMM-97/40	CHARACTERISATION OF THE ANTARCTIC POLAR FRONTAL ZONE TO THE NORTH OF SOUTH GEORGIA IN SUMMER 1994 P.N. Trathan, M.A. Brandon and E.J. Murphy (UK)
WG-EMM-97/41	ANALYSIS OF TRAWL DATA FROM THE SOUTH GEORGIA KRILL FISHERY P.N. Trathan, E.J. Murphy, I. Everson and G. Parkes (UK)
WG-EMM-97/42	ESCAPEMENT OF ELEPHANT SEAL PREY IN THE HEARD ISLAND FISHERY FOR *DISSOSTICHUS ELEGINOIDES* A.J. Constable, R. Williams, W.K. de la Mare and D. Slip (Australia)

WG-EMM-97/43	A COMPARISON BETWEEN THE ESTIMATED DENSITY OF KRILL FROM AN ACOUSTIC SURVEY WITH THAT OBTAINED BY SCIENTIFIC NETS ON THE SAME SURVEY T. Pauly, S. Nicol, W.K. de la Mare, I. Higginbottom and G. Hosie (Australia)
WG-EMM-97/44	WORKSHOP ON INTERNATIONAL COORDINATION (14 to 18 July 1997)
WG-EMM-97/45	BIAS IN THE ESTIMATION OF KRILL YIELD FROM USING A DETERMINISTIC FORMULATION OF THE MEDIAN UNEXPLOITED SPAWNING BIOMASS A.J. Constable and W.K. de la Mare (Australia)
WG-EMM-97/46	NET SAMPLE VALIDATION OF ACOUSTIC TECHNIQUES USED TO IDENTIFY AND SIZE ANTARCTIC KRILL J.L. Watkins and A.S. Brierley (UK)
WG-EMM-97/47	VARIATION IN THE DISTRIBUTION OF ANTARCTIC KRILL *EUPHAUSIA SUPERBA* AROUND SOUTH GEORGIA J.L. Watkins, A.W.A. Murray and H.I. Daly (UK)
WG-EMM-97/48	KRILL BIOMASS ESTIMATES FOR SOUTH GEORGIA, DECEMBER AND JANUARY 1996/97 A.S. Brierley, J.L. Watkins and C. Goss (UK)
WG-EMM-97/49	KRILL BIOMASS AND DISTRIBUTION IN SUBAREA 48.2 DURING SUMMER 1996 S.M. Kasatkina, V.A. Sushin, M.I. Polishuk and A.M. Abramov (Russia)
WG-EMM-97/50	DISTRIBUTION OF SOVIET COMMERCIAL FLEET AT KRILL FISHERY IN THE SOUTH ORKNEYS SUBAREA (SUBAREA 48.2) DURING 1989/90 V.A. Sushin (Russia)
WG-EMM-97/51	ASSESSMENT OF FISHING INTENSITY OF KRILL IN SUBAREA 48.2 DURING THE SEASON OF 1989/90 B.F. Ivanova, S.M. Kasatkina and V.I. Sushin (Russia)
WG-EMM-97/52	VARIATION IN ECHOSOUNDER CALIBRATION WITH TEMPERATURE AND SOME POSSIBLE IMPLICATIONS FOR ACOUSTIC SURVEYS OF KRILL BIOMASS A.S. Brierley, C. Goss, J.L. Watkins and P. Woodroffe (UK)
WG-EMM-97/53	SPATIAL AND TEMPORAL DISTRIBUTION OF KRILL *EUPHAUSIA SUPERBA* BIOMASS IN THE ROSS SEA (1989/90, 1994/95) M. Azzali and J. Kalinowski (Italy)

WG-EMM-97/54 ACOUSTIC DISCRIMINATION OF SOUTHERN OCEAN ZOOPLANKTON
A.S. Brierley, P. Ward, J.L. Watkins and C. Goss (UK)

WG-EMM-97/55 BREEDING DISTRIBUTION AND POPULATION SIZES OF THREE SPECIES OF PENGUIN AT SUBANTARCTIC MARION ISLAND
R.J.M. Crawford, B.M. Dyer, M. Greyling, J. Hurford, D. Keith, M.A. Meyer, L. Upfold and A.C. Wolfaardt (South Africa)

WG-EMM-97/56 BREEDING BIOLOGY AND DIET OF PINTADO PETRELS *DAPTION CAPENSE* AT BOUVETØYA DURING THE SUMMER OF 1996/97
O. Huyser and B.M. Dyer (South Africa), K. Isaksen (Norway), P. Ryan and J. Cooper (South Africa)

WG-EMM-97/57 DRAFT STANDARD METHOD A3B
P. Wilson (New Zealand)

WG-EMM-97/58 DIET AND PREY CONSUMPTION OF ANTARCTIC PETRELS *THALASSOICA ANTARCTICA* AT SVARTHAMAREN, DRONNING MAUD LAND AND AT SEA OUTSIDE THE COLONY
S. Lorentsen (Norway), N. Klages (South Africa) and N. Røv (Norway)

WG-EMM-97/59 POPULATION STRUCTURE OF THE ANTARCTIC KRILL (*EUPHAUSIA SUPERBA*) POPULATIONS IN CCAMLR DIVISION 58.4.1 DURING JANUARY TO MARCH 1996
S. Nicol, J. Kitchener, R. King, G. Hosie and W.K. de la Mare (Australia)

WG-EMM-97/60 THE DIET OF THE ANTARCTIC FUR SEAL *ARCTOCEPHALUS GAZELLA* AT HARMONY POINT, NELSON ISLAND, SOUTH SHETLAND ISLANDS
R. Casaux, A. Baroni and A. Carlini (Argentina)

WG-EMM-97/61 ON THE ACCURACY OF THE PELLET ANALYSIS METHOD TO ESTIMATE THE FOOD INTAKE IN THE ANTARCTIC SHAG *PHALACROCORAX BRANSFIELDENSIS*
R. Casaux (Argentina)

WG-EMM-97/62 POPULATION SIZE AND DISTRIBUTION OF *PYGOSCELIS ANTARCTICA* AND *P. PAPUA* AT CAPE SHIRREFF, LIVINGSTON ISLAND, ANTARCTICA (1996/97 SEASON)
R. Hucke-Gaete, D. Torres and V. Vallejos (Chile)

WG-EMM-97/63 POPULATION SIZE AND DISTRIBUTION OF *ARCTOCEPHALUS GAZELLA* AT SSSI NO. 32, LIVINGSTON ISLAND, ANTARCTICA (1996/97 SEASON)
R. Hucke-Gaete, D. Torres, V. Vallejos and A. Aguayo (Chile)

WG-EMM-97/64 ADÉLIE PENGUINS FORAGING BEHAVIOUR AND KRILL ABUNDANCE ALONG THE WILKES AND ADÉLIE LAND COASTS, ANTARCTICA
B.C. Wienecke, R. Lawless (Australia) D. Rodary, C. Bost (France), R. Thomson, T. Pauly, G. Robertson, K. Kerry (Australia) and Y. Lemaho (France)

WG-EMM-97/65 HORIZONTAL FLUX OF SECONDARY PRODUCTION IN THE SOUTHERN OCEAN FOOD WEB: CURRENT VELOCITY DATA AND THE TRANSPORT OF KRILL IN THE SOUTH GEORGIA ECOSYSTEM
E.J. Murphy, I.E. Everson and P.N. Trathan (UK)

WG-EMM-97/66 ENVIRONMENTAL VARIABILITY EFFECTS ON MARINE FISHERIES: FOUR CASE HISTORIES
E.E. Hofmann and T.M. Powell (USA)

WG-EMM-97/67 STRUCTURE OF THE ANTARCTIC CIRCUMPOLAR CURRENT IN THE SOUTH ATLANTIC WITH IMPLICATIONS FOR BIOLOGICAL TRANSPORT
E.E. Hofmann, J.M. Klinck, R.A. Locarnini, B. Fach (USA) and E. Murphy (UK)

WG-EMM-97/68 HYDROGRAPHY AND CIRCULATION OF THE ANTARCTIC CONTINENTAL SHELF: 150°E EASTWARD TO THE GREENWICH MERIDIAN
E.E. Hofmann and J.M. Klinck (USA)

WG-EMM-97/69 PURSUIT OF POLYNYAS IN THE ANTARCTIC PENINSULA AREA
M. Naganobu, K. Shibazaki, N. Kimura, Y. Okada and S. Matsumura (Japan)

WG-EMM-97/70 FURTHER KRILL-PREDATOR MODEL CALCULATIONS
R.B. Thomson and D.S. Butterworth (South Africa)

WG-EMM-97/71 AUSTRALIA'S CONTRIBUTION TO CEMP 1996/97: SUMMARY AND NOTES
(Delegation of Australia)

WG-EMM-97/72 FISHES INCIDENTALLY CAUGHT BY JAPANESE ANTARCTIC KRILL COMMERCIAL FISHERY TO THE NORTH OF THE SOUTH SHETLAND ISLANDS IN FEBRUARY 1997
T. Iwami, M. Naganobu, T. Ichii and S. Kawaguchi (Japan)

WG-EMM-97/73 EFFECTS OF SEA-ICE EXTENT AND KRILL OR SALP DOMINANCE ON THE ANTARCTIC FOOD WEB
(*Nature* (1997), 387: 897–900)
V. Loeb (USA), V. Siegel (Germany), O. Holm-Hansen, R. Hewitt, W. Fraser, W. Trivelpiece and S. Trivelpiece (USA)

WG-EMM-97/74	ECHO INTEGRATION IN LOW SIGNAL TO NOISE REGIMES: METHODS OF NOISE ESTIMATION AND REMOVAL I. Higginbottom and T. Pauly (Australia)
WG-EMM-97/75	LABORATORY TARGET STRENGTH MEASUREMENTS OF FREE SWIMMING ANTARCTIC KRILL (*EUPHAUSIA SUPERBA*) T. Pauly and J.D. Penrose (Australia)
WG-EMM-97/76	WITHDRAWN
WG-EMM-97/77	SYNTHESIS OF THE ACTIVITIES CARRIED OUT AT SSSI NO. 32 AND CEMP SITE 'CAPE SHIRREFF AND SAN TELMO ISLETS' DURING THE ANTARCTIC SEASON 1996/97 D. Torres N. (Chile)
WG-EMM-97/78	SUMMARY OF MONITORING AND RESEARCH ACTIVITIES AT SVARTHAMAREN, DRONNING MAUD LAND N. Røv, S. Lorentsen and T. Tveraa (Norway)
WG-EMM-97/79	PROPOSAL FOR THE SECOND INTERNATIONAL SYMPOSIUM ON KRILL M. Mangel (USA), S. Nicol (Australia), J. Cuzin-Roudy (France), Y Endo (Japan), D. Miller (South Africa) and J. Watkins (UK)

OTHER DOCUMENTS

SC-CAMLR-XVI/BG/2	DRAFT CEMP TABLES 1 TO 3 Secretariat
WG-FSA-96/20	PRECAUTIONARY MEASURES FOR A NEW FISHERY ON *MARTIALIA HYADESI* (CEPHALOPODA, OMMASTREPHIDAE) IN THE SCOTIA SEA: AN ECOLOGICAL APPROACH (*CCAMLR Science* (1997), 4: 125–139) P.G. Rodhouse (UK)

APPENDIX D

REPORT OF THE SUBGROUP ON STATISTICS

(La Jolla, USA, 14 to 18 July 1997)

REPORT OF THE SUBGROUP ON STATISTICS
(La Jolla, USA, 14 to 18 July 1997)

INTRODUCTION

1.1 The 1997 meeting of the Subgroup on Statistics was held from 14 to 18 July 1997. The meeting was convened by Dr G. Watters (USA) and held at the Southwest Fisheries Science Center in La Jolla, USA.

1.2 A provisional agenda was introduced and discussed. It was agreed that an additional item, 'Synoptic Survey Design', be added to the agenda. The agenda (Attachment A) was adopted without further modification.

1.3 The list of participants is included as Attachment B, and the list of documents submitted to the meeting is included as Attachment C.

1.4 The report was prepared by Drs I. Boyd and J. Croxall (UK), B. Manly (New Zealand), W. de la Mare (Australia), A. Murray (UK), D. Ramm (Secretariat) and G. Watters (USA).

REVIEW OF UPDATED TIME SERIES OF CEMP INDICES

2.1 Dr Ramm introducted WG-EMM-97/25 which comprises the complete tabulation of all data submitted to CEMP (section 2), a selection of figures illustrating these data (section 3) and presentations relating to the identification of anomalies following the methods proposed by the subgroup last year (section 1).

2.2 Dr Ramm and the Secretariat were thanked for the considerable work involved in producing such a comprehensive set of documents.

2.3 In reviewing the compilation of incides the subgroup noted a small number of errors which were corrected in WG-EMM-97/25 Rev. 1.

2.4 The subgroup also made some specific comments:

(i) in the illustration of data collected under Method A1B (section 3, A1B, Figures 1 to 5) the different years should be more clearly demarcated; and,

(ii) for several of the standard methods adequate data were now available to evaluate whether the recommended sampling regimes and sample sizes are appropriate. Members with such data were encouraged to undertake evaluations and report the results to WG-EMM.

FURTHER REVIEW OF IDENTIFICATION
OF ANOMALIES IN CEMP INDICES

2.5 The subgroup recognised two particular issues with the identification of anomalies:

(i) identifying anomalies in data from non-normal distributions; and

(ii) some observations that are 'anomalies' from the biological point of view may not be statistically significant.

2.6 The paper by Drs Manly and MacKenzie (WG-EMM-Stats-97/6) was reviewed. The authors discussed the properties of a method for detecting anomalous years in CEMP indices, and extended the idea to situations where data contain a linear trend and autocorrelation, and where data are drawn from a constant distribution other than a normal distribution. In the case of non-normally distributed data, a Box-Cox transformation was applied prior to analysis. The method requires further investigation, but seems generally quite suitable for detecting single extreme values rather than, for example, a permanent change in the mean of a data series.

2.7 The paper by Dr de la Mare (WG-EMM-Stats-97/7) was also reviewed. This includes a proposal for combining CEMP variables to produce a smaller number of summary indices. It also notes that the currently used procedure for detecting anomalies lacks power when there are several extreme values, and that a permanent change in the mean and/or standard deviation in a series is better detected by calculating standardised residuals using the mean and standard deviation from a selected baseline derived from the series. From this point of view the detection of anomalies would include the following steps:

(i) define the classes of behaviour in a series to be detected (a change in the mean, a change in the variance, trend, etc.);

(ii) select a normalising transformation if necessary;

(iii) select a baseline derived from the series;

(iv) examine the statistical properties of the procedure taking into account possible serial correlation, missing values, etc.; and

(v) examine the power of the procedure to detect the phenomena of interest.

2.8 The need to take into account the uses for indices was discussed. It was noted that they are essentially meant to measure various aspects of the food available to predators, with integration over various spatial and temporal scales (Table 1). This emphasises the need to understand the relationship between indices through multivariate analyses, particularly if they are to be combined to produce summary indices of various kinds.

2.9 The use of the word 'anomalies' may be confusing because often what may need to be detected are extreme values that may be part of the natural variation in the system. To some extent these extreme values may just be the result of highly non-linear responses of the predators to environmental conditions. It is recommended that an alternative term be used such as VOGON (Value Outside the Generally Observed Norm). Here 'norm' is defined to be the conditions that are satisfactory for the predator populations.

2.10 Some illustrative calculations were carried out in order to demonstrate the potential value of multivariate analysis. For this purpose the data shown in Table 2 from Bird Island were used. A principal component analysis on the correlation matrix for the indices for the years 1990 to 1997 produced the output shown in Attachment D. It was found that the first component accounts for 53.0% of the variation in the data, while the second and third components account for 19.9% and 12.3%, respectively. Thus between them the first two components account for 72.9% of the variation, while the first three components account for 85.3% of the variation. Applying the analysis to transformed data gives very similar results.

2.11 The first component is essentially an average of the fur seal cow foraging duration (with a negative sign so that the least negative values represent good conditions), gentoo breeding success, macaroni fledging weight, the proportion of krill in the macaroni diet, the proportion of krill in the gentoo diet, the average of the last weighed fur seal pup mass for females, and the average of the last weighed fur seal mass for males. This component can be interpreted as the *overall biological state*. Component 2 mainly reflects the estimated fur seal pup growth rates for males and females, which may be biased because of high mortality in poor years. For this reason high values are not necessarily associated with good conditions. This can be named *fur seal pup growth*. Component 3 is mainly the *macaroni breeding success*. This may reflect the fact that these penguins are able to adapt their diet in poor years so that again it is not a good measure of overall biological conditions.

2.12 The subgroup considers that the results of this principal component analysis are helpful in clarifying the relationship between the various individual indices and the conditions in the different years and recommends that similar analyses are conducted for other sites and variables.

2.13 An initial exploration of the simple combination index suggested in WG-EMM-Stats-97/7 was prepared using CEMP dependent species data from fur seals and macaroni and gentoo penguins at South Georgia. The parameters selected for this illustration can be combined because they refer to similar temporal and spatial scales. The parameters included are listed in Table 2.

2.14 The simple index involves transforming and standardising the various parameters along the lines adopted by WG-EMM in 1996. Each parameter is transformed to have roughly a standard normal distribution. The parameter values are then added together and re-standardised using the estimated standard deviation for the sum using the covariance (correlation) matrix. The values are standardised also with respect to sign, for example, positive values indicating better than average conditions for the predator. For this reason, the sign of the transformed fur seal foraging trip duration was reversed. The simple index can be calculated for all years where some data exist.

2.15 The mean values and covariance matrix needed for the standardisation of the data series were calculated using the data for the period 1989 to 1997; the years when data were available for all the parameters. Prior to standardisation, the data were transformed using the currently accepted transforms for each parameter. This period has been used to provide the baseline mean and covariance matrix for the calculation of the index back to the beginning of the data series in 1977. The subgroup did not examine whether this particular period would form a suitable baseline; the results presented here are for illustrative purposes only. The resulting correlation matrix is shown in Table 3.

2.16 Figure 1 shows the simple index using all the available data. It clearly indicates the two known poor years in 1977 and 1984. The index also suggests poor years in 1987, 1988 and 1994, although the last does not appear as poor as the assessment arrived at by WG-CEMP in 1994. Because the fur seal pup growth parameters were not given a high loading in the first principal component from the principal components analysis (paragraph 2.11), the index was re-calculated without using these data. Excluding these data from the index (shown with a dashed line) results in a slight further depression of the point for 1994, but otherwise there are no changes of any substantial consequence. In light of the fact that 1994 was an extremely poor year for fur seals, the insensitivity of the index to the fur seal pup growth suggests that this parameter is not effectively indexing fur seal reproductive success. It was suggested that these parameters may require further refinement, e.g. by using growth rate of total pup biomass instead of individual pup growth rates.

2.17 Figure 2 shows the simple index calculated without fur seal pup growth rates (dashed line) compared with the simple index based on the breeding success of the two penguin species only (the only parameters represented in all years). The comparison shows that, at least in this instance, the index is not particularly sensitive to the absence of some of the parameters.

2.18 The subgroup considered that the results were encouraging and recommended that further studies should be undertaken to develop some form of combined simple indices at the appropriate regional and temporal scales. The subgroup also noted that the simple index may be more robust for identifying VOGONs than the separate parameter indices because the distribution of a sum of random variables approaches a normal distribution even when the random variables themselves are not normally distributed.

2.19 The subgroup noted previous concerns that the VOGON detection method does not always identify VOGONs when these events are known to be biologically significant (SC-CAMLR-XV, Annex 4, paragraph 4.72). The subgroup agreed that in instances where the distribution of an index (or its transformation) was not approximately normal, the 0.05 α-level might be too stringent to detect biologically significant VOGONs. It was also suggested that it may be useful to develop a procedure for identifying a VOGON in cases where a high proportion of the indices are close to, but not exceeding, their critical levels in the same year.

2.20 To provide two examples of where the 0.05 α-level could be too stringent, the subgroup estimated what α-level would be required to detect all of the biologically significant VOGONs in the Bird Island time series of gentoo penguin (Index A6a) and black-browed albatross (Index B1) breeding successes. Dr Croxall identified the biologically significant VOGONs in each time series.

2.21 For each example, the calculations were made in four steps:

- the index was transformed with the log-odds transformation;
- the least extreme, biologically significant VOGON was identified;
- a critical value (Z_C) for detecting the least extreme VOGON was calculated from

$$Z_c = \frac{\bar{x} - LEV}{s}$$

where $\bar{x}$ and s are the mean and standard deviation of the transformed index, and LEV is the value of the least extreme VOGON; and

- the α-level corresponding to Z_C was identified by simulating 1 000 20-year time series of standardised normal deviates, counting the number of instances where the absolute value of simulated deviate was $\geq Z_C$, and dividing this count by 20 000.

2.22 The results of the example calculations are provided in Table 4. An α = 0.22 would be required to detect all of the biologically significant VOGONs in the gentoo time series, and an α = 0.69 would be required for the albatross time series. An α = 0.05 would be too stringent in both cases.

2.23 Given the results of the example calculations, the subgroup agreed that the appropriate α-level for identifying VOGONs should be selected on an index-by-index basis after careful consideration of whether each index (or its transformation) is normally distributed. When the index (or its transformation) is not normal, α-levels between 0.2 and 0.3 may be appropriate.

CRITICAL EVALUATION OF THE ASSUMPTIONS AND PARAMETER VALUES OF THE AGNEW AND PHEGAN (1995) MODEL OF REALISED OVERLAP

3.1 Last year WG-EMM requested that the Subgroup on Statistics evaluate the assumptions and parameter values in the fine-scale model of the overlap between penguin foraging demands and the krill fishery in the South Shetland Islands and Antarctic Peninsula (Agnew and Phegan, 1995) (SC-CAMLR-XV, Annex 4, paragraph 6.80). This model calculates penguin foraging demand and is intended for the purposes of calculating an index of foraging–fishery overlap during the critical period December to March. Data from Subarea 48.1 on penguin foraging characteristics, energetic demands, and population numbers, and monthly krill catches by fine-scale grid are used as inputs to the model.

3.2 To assist in this process the Secretariat had requested (SC CIRC 97/2) data and analysis providing estimates of:

(i) monthly composition of diet (of penguins and fur seals);
(ii) maximum and mean/modal foraging distance;
(iii) mean foraging bearings; and
(iv) fine-scale data on foraging distributions.

3.3 Such data have been provided for gentoo and macaroni penguins and Antarctic fur seals for Bird Island South Georgia (Subarea 48.3) in WG-EMM-Stats-97/5. Data for chinstrap penguins at Seal Island had been submitted to the Secretariat for consideration by WG-EMM but were not available at the subgroup meeting. It was regretted that similar data have not yet been provided for other sites, particularly those in Subarea 48.1 where several extensive studies of diet and foraging have been carried out.

3.4 In reviewing the model the following main topics were considered:

(i) foraging distance;
(ii) foraging bearing;

(iii) predator consumption rates;
(iv) population counts; and
(v) model structure.

3.5 The model assumes that penguin foraging distances are normally distributed about a mean distance from the colonies. The values used in the model were: chinstrap penguin mean foraging distance of 20 km with a standard deviation of 8 km ~N(20,8); Adélie penguin ~N(38,15); gentoo penguin ~N(10,4); and macaroni penguin ~N(28,11). The maximum foraging distance was set to the mean + 2 standard deviations.

3.6 The model assumes that penguin foraging bearings are uniformly distributed about a line perpendicular to the coast on which the colony lies. Data on foraging bearings from colonies in Subarea 48.1 are limited to Seal Island. The values used in the model ranged generally 40° either side of a line perpendicular to the coast.

3.7 The foraging distance and bearing data used in the model were certainly appropriate for the Seal Island area. The group noted the paucity of available data to extend the model to include other regions within Subarea 48.1, and recommended that extrapolation to regions with no data should be made with caution.

3.8 The distribution of foraging distances is unlikely to be normal. *A priori* some kind of exponential distribution might be expected; available evidence from at-sea observations shows the pattern of distribution to be skewed. For foraging bearing there is no *a priori* reason, nor any observational evidence, to suggest that any assumption other than a uniform distribution is warranted. The distribution of both parameters should be re-examined in the light of new data, and literature on animal movements.

3.9 The model uses mean values for predator consumption rate which were the best estimates available from studies up to around 1984. There are quite extensive additional data on at-sea metabolic rate and energy requirements of penguins now available (see e.g. WG-EMM-96/19 and SC-CAMLR-XV, Annex 4, paragraph 6.41) which could improve the estimates used in the model.

3.10 The penguin population counts used in the model were derived from a long-term dataset on penguins counts, and were the best available in 1992. An updated dataset is now available (SC-CAMLR-XV/BG/29).

3.11 The subgroup examined the four steps involved in the model:

(i) estimating the total number of penguins from all colonies foraging within the area;
(ii) calculating the number of these expected to forage within each 10 x 10 n miles^2;
(iii) calculating the total consumption of krill by penguins; and
(iv) calculating the foraging–fishery overlap (FFO) index.

The subgroup agreed that the basic spatial modelling approach used was appropriate. However, it was not clear whether the temporal aspects of penguin foraging had been adequately captured in the model, and the subgroup agreed that this aspect should be developed further. The subgroup also found that the FFO index was not a direct measure of overlap, but rather was related to the total amount of krill removed from the foraging area during the critical period. The FFO index is the product [total krill consumption by penguins]∗[total krill catch in the fishery] with units of (mass)^2.

3.12 The subgroup proposed that a new standardised index be developed based on niche overlap theory (SC-CAMLR-XV, Annex 4, Appendix H), such as Schroeder's index

$$I_t = 1 - 0.5\sum\left|p_{i,t} - q_{i,t}\right|$$

where $p_{i,t}$ is the proportion of krill consumed by a predator(s) in grid square i during time period t and $q_{i,t}$ is the proportion of krill consumed by the fishery in grid square i during time period t. This type of index would range from I_t = 0, no spatial overlap between predator consumption and fishery consumption during period t to I_t = 1, complete overlap between predator consumption and fishery consumption during period t. At present, $p_{i,t}$ can be calculated along the lines of the structure in Agnew and Phegan (1995).

3.13 It was recommended that this new index should be applied first to Subarea 48.1, initially using the existing data from Seal Island. This should be undertaken by the Secretariat so that results can be presented to the meeting of the Scientific Committee in October.

3.14 The subgroup recommended that the next tasks relating to studies of realised overlap should include:

(i) examination of the sensitivity of the index I to the various assumptions made about penguin foraging effort and prey consumption;

(ii) incorporation of appropriate data on foraging effort and distribution from sites in Subarea 48.1 in addition to Seal Island. These data should be submitted as soon as possible using the forms prepared by the Secretariat (SC CIRC 97/2) as a guide but, where appropriate, providing data and analyses in ways analogous to those in WG-EMM-Stats-97/5; and

(iii) applying the model to Subarea 48.3. It was noted that the fishery currently operates there in winter providing little interaction with krill-dependent predators during the December to March critical period. Useful analyses, however, might still be made by using data from earlier years when the krill fishery operated in summer.

3.15 Future desirable developments would be to examine the overlap between penguin foraging demands and the krill fishery during other potentially critical periods. Of particular importance is the post-fledging period when large numbers of chicks begin foraging independently and adults are feeding intensively in preparation for their annual molt. Recent studies are also indicating that critical periods may exist during the winter. There are little or no empirical data for most of these periods. In terms of winter studies, the priority species for concurrent investigation of the distribution of predator foraging and the krill fishery are fur seal, macaroni penguin and chinstrap penguin.

DEVELOPMENT OF INDICES OF AT-SEA BEHAVIOUR AND METHODS OF DERIVING THEM VIA ANALYSIS OF SAMPLE DATASETS

4.1 Previous discussions of WG-EMM had identified a need for a coordinated approach to the analysis of data about the at-sea behaviour of diving predators such as penguins and fur seals. The main reason for this is to allow monitoring of the behaviour of diving predators at finer spatial and temporal scales than have been available using current CEMP indices. A further objective would be to provide input to the realised overlap index (paragraph 3.12). This will also utilise several existing datasets. Methods for measuring at-sea behaviour, and for the deployment of instruments used for measuring at-sea behaviour, have already been adopted (WG-EMM-96).

4.2 The subgroup was tasked with:

(i) reviewing appropriate temporal and spatial scales for developing indices of at-sea behaviour (SC-CAMLR-XV, Annex 4, paragraphs 3.61 to 3.65 and 7.58);

(ii) considering sample datasets and analyses (SC-CAMLR-XV, Annex 4, paragraphs 4.44 and 7.58);

(iii) developing indices and methods for the calculation via analysis of the sample datasets (SC-CAMLR-XV, paragraph 5.38(i)); and

(iv) providing advice on the most appropriate indices for inclusion in the CEMP database (SC-CAMLR-XV, Annex 4, paragraphs 4.44 and 7.58).

4.3 The subgroup examined several sample datasets from Antarctic fur seals. From a bivariate dataset involving time and depth (sampled at intervals from 5 to 15 seconds) it is possible to derive several subsidiary parameters such as dive depth, dive duration and the interval spent at the surface between dives. In turn, these can provide information about dive frequency, proportion of dives made at different times of day, and bouts of diving. Past studies have shown that these have the potential to provide information about variability in at-sea behaviour between years that reflects variation in food availability.

4.4 There is little consensus in the literature as to how comparisons of at-sea behaviour between individuals and across years should be made. As a general principle, the subgroup recommended that comparisons should be based on procedures that correctly take into account the variability in the data. In particular, attention was drawn to spectral analysis as a potentially useful approach. This would have the advantage of incorporating all of the data into a single analytical approach while minimising the need to make assumptions about how individual units of behaviour, such as dives or bouts of dives, should be defined.

4.5 A second approach, which also overcomes many of the assumptions with defining dives and bouts of dives, is to examine the cumulative time spent submerged during a foraging trip in relation to cumulative time spent at sea. The slope of this relationship could provide a single parameter that integrates most of the variability in at-sea behaviour within a single index.

4.6 Comparing at-sea behaviour across years is complicated by a potentially high degree of variability between individuals and because many of the parameters that are commonly used to measure at-sea behaviour often have highly-skewed distributions. Some may also show a degree of bimodality.

4.7 The subgroup recommended that the use of a randomisation test should be investigated to examine interannual variability in the indices. Dr Manly suggested that this could involve the following procedure:

(i) assume that the data consists of records for individual foraging trips and that these are from different animals;

(ii) for each pair of foraging trips measure the difference between them (e.g. a Kolmogorov-Smirnov measure of the difference between the index distribution). This gives a predator difference matrix for which $a(i, j)$, the element in row i and column j, is the difference for predators i and j;

(iii) generate a second matrix in which the elements are sample similarities as often recommended for the multi-response permutation procedure (Mielke et al., 1976). Thus the element $b(i, j)$ in row i and column j contains 0 from two cases in different years and $1/(n-1)$ for two cases in a year with a sample of size n;

(iv) test whether the correlation between $a(i, j)$ and $b(i, j)$ is significantly negative, by comparison with the distribution found by randomly permuting the sample labels for one of the matrices, i.e. do a Mantel (1967) matrix permutation test as described by Manly (1997); and

(v) the test can be done with any statistic measuring the difference between the behaviour of two predators.

4.8 The large size of the datasets and the need for detailed consideration of how these analytical techniques can be applied to measurements of at-sea behaviour meant that it was impractical for the subgroup to investigate these methods during the meeting. Drs Boyd and Murray agreed to undertake an example analysis to assess this method using multi-year data from Antarctic fur seals and to report the results to a future meeting of WG-EMM.

4.9 Scales of variability in at-sea behaviour may be defined most satisfactorily using spectral analysis. An example of such an analysis carried out by Dr Boyd showed several peaks in the spectrum that corresponded to the different scales of behaviour, namely, the dive, dive bouts and diel variability. Dr Murray suggested that alternatives to the assumptions of sine wave forms associated with Fourier transformations may provide an alternative spectrum with additional information. Drs Boyd and Murray also agreed to investigate this intersessionally.

4.10 The subgroup also considered the utility of including locational data from satellite tags as a variable describing at-sea behaviour. The precision of locational data is sufficient for input to the predator–fisheries realised overlap index (paragraph 3.12). However, at this stage, the precision of satellite locations is insufficient to allow assessments to be made of variability in foraging locations at the smallest spatial scales addressed by time–depth data.

4.11 The subgroup concluded that it was still too early to make firm recommendations about which indices of at-sea behaviour should be included within the CEMP database. Further consideration should be given to this subject once the various methods discussed by the subgroup had been tested.

METHODS FOR COPING WITH MISSING VALUES
IN MULTIPLE DATASETS

5.1 Dr Murray presented his paper WG-EMM-Stats-97/8. The paper outlines three stages in analysis of incomplete datasets:

(i) understanding the mechanisms generating the missing values (were they random or not?);

(ii) deciding on the appropriate analysis of the data in order to support the required inferences (e.g. trend estimation, identification of unusual values); and

(iii) choosing and implementing an appropriate method of missing data imputation and subsequent data analysis.

The classes of missing value mechanisms and the broad categories of imputation methods were reviewed. For a value to be considered as 'missing at random' the probability of it being missing should be independent of the observed and missing values. Analysis of an example dataset of Chinstrap penguin colony counts from Signy Island was presented to illustrate four methods of imputation.

5.2 A method of evaluating the effect of imputing missing values on the analysis would be to take a complete dataset and try various patterns (random and non-random) and extents of data deletion. Imputed values could then be compared with the original values and analyses of completed datasets compared with the analysis of the full dataset. This would give a measure of the success of the imputation procedures. Many studies of this kind have been reported in the literature and for at least some the finding has been that, although individual values may not match the original data closely, statistics such as means may be close to the original values. For illustrative purposes, an exercise of this kind may be useful for an example CEMP dataset.

5.3 WG-EMM-Stats-97/8 drew attention to the importance of understanding the mechanisms leading to missing data and called for a discussion of these in the context of CEMP series. A number of possible reasons for missing data in CEMP indices were identified.

(i) <u>Data were not collected either because there was no intention to collect or because logistic considerations</u> such as lack of means of access or equipment failure prevented collection. Such data could be considered to be missing completely at random.

(ii) <u>Data were not collected because of adverse environmental conditions</u>, such as sea-ice preventing access to a site or bad weather making completion of field work impossible. Depending on the nature of the variable in question, such reasons might not be regarded as random. For instance, for some biological parameters such as arrival time, the presence of sea ice might have an important influence so that the same reason leading to the data being missing might also affect the value. Such data could not be regarded as missing at random.

(iii) <u>Data were not collected due to biological circumstances</u>, for example the animals in question died during the course of the season (e.g. death of chicks before fledging as occurs in some years). This seems unlikely to occur at random and may, in itself, be an important biological indicator of the ecosystem status in that year.

(iv) Data were not recorded although they are known to exceed a given threshold (e.g. where data exceed storage capacity of the recording instrument). This is called censoring and is common in observations of time duration where the event, such as return from a foraging trip, is not observed before the end of the period available for observation. The reasons might be either biological in the case of extended or incomplete foraging trips in poor seasons or non-biological in the case of equipment failure or exceeding instrument data storage capacity. The former could certainly not be regarded as random although the latter might in some circumstances be so regarded. Standard statistical methods are available for estimating parameters of distributions (such as means) where observations for some units in the sample are censored. It was felt that it would be worth reviewing the standard method for foraging trip duration of fur seals (method C1) to see whether adoption of this analysis methodology would allow more complete datasets of this index to be produced.

(v) Data were not reported where in fact they were actually null values, for example certain prey items were absent from stomach contents. Such values should be identified and replaced with zeroes in the data base.

5.4 The subgroup agreed that it was important to assess the CEMP series to determine the reasons for the missing data before proceeding to formal analysis. Such an assessment should be done as soon as possible. The originators of the data should be encouraged to supply the necessary information and it was felt that such a request could be phrased in the form of a multiple choice along the lines in paragraph 5.3.

5.5 There are two levels at which missing data may arise in the CEMP series. The first is at the level of the samples which go to make up the calculated value which is submitted; the second at the level of the calculated CEMP indices.

5.6 It is important to discover if any missing value techniques have been applied to sample data in the calculation of values which have been already submitted to CCAMLR. In certain cases, for example a colony count is missing from a set of colony counts at a site, missing value imputation could be used to calculate a site value. The subgroup recommended that where such cases can be identified the raw data should be submitted so that appropriate statistical techniques can be examined and applied.

5.7 Missing values in time series incorporated into the CEMP database should only be imputed in the course of analyses for particular purposes. The methods used should take into account the reasons for the missing data supplied by the originators of the data and the intent of the analysis. Such imputed data should not be stored in the CCAMLR database. The imputed values should not be used as if they are real data. They serve solely to allow the analysis of values which do exist and, indeed, different values may be imputed in the context of different analyses. It is important to ensure that the imputation methods which are used serve to allow the use of all observed data without adding artificial effects to the data. That is, the imputed values should be as far as possible 'neutral' in their effect on estimates of means, correlations, trends, etc.

5.8 Imputation should be as realistic as possible with consideration being given to the appropriate biological, spatial and temporal factors in deciding which data to use in multivariate imputation techniques. For example, imputation might be 'cross-sectional' based on using values for the same variable or related variable(s) at different colonies or sites in the same year, or 'longitudinal' using values from adjacent years, or a combination of both.

SYNOPTIC SURVEY DESIGN

6.1 The subgroup reiterated the view that the primary objective of the synoptic survey is to provide an estimate of krill biomass and its variability for use in the krill yield model. Other objectives (e.g. to study the spatial structure of krill aggregations) are secondary. The subgroup noted that there are two key issues with regard to the design of the synoptic survey: stratification, and random versus systematic placement of transect lines.

6.2 The subgroup agreed with WG-EMM's previous opinion (SC-CAMLR-XV, Annex 4, paragraph 3.75(v)) that the survey should be stratified according to large-scale spatial differences in krill density. The subgroup noted that there are many historical datasets (e.g. FIBEX, AMLR, LTER) that can be used to estimate how sampling effort should be allocated between strata.

6.3 The subgroup initiated the discussion on transect placement by noting that random placement should facilitate both design-based (e.g. Jolly and Hampton estimators) and model-based (e.g. geostatistics) estimates of variance in krill biomass. Systematic transect placement requires model-based variance estimation. Model-based variance estimators can be more efficient than design-based estimators, but such estimators are conditional on the adequacy of the model. A simulation study is needed to compare the relative efficiencies of random and systematic transect placement in a synoptic survey for krill. Such a study is the only quantitative way of comparing the two survey designs.

6.4 The subgroup agreed that a simulation study should receive high priority; it would be best if the work could be completed within about one year. A small panel of interested parties should be convened as soon as possible to define some realistic goals and boundaries for the simulation study. The subgroup did note that the simulation should, at a minimum, consider the following points:

(i) the cost (e.g. in ship-hours) of alternative designs (including the cost of various degrees of randomisation);

(ii) the biases introduced by the diel vertical migrations of krill; and,

(iii) the effects of the spatial coherence of the krill distributions being different in different directions.

It might also be valuable to consider whether there is a point at which the marginal utility of reducing the variance becomes small. This could be studied by considering when the results of the krill yield model become more sensitive to variability in krill recruitment rather than to uncertainty in krill biomass.

6.5 Drs Manly and Murray stated that they would be willing to develop the simulation study in collaboration with a colleague from New Zealand who specialises in geostatistics. Drs Manly and Murray also noted that they would be grateful for input from other interested parties, especially those with historical krill survey datasets. Dr de la Mare undertook, in conjunction with the Secretariat, to examine the marginal utility of reducing the variance in biomass estimates.

6.6 In the absence of a simulation study, the subgroup agreed that randomly-spaced parallel transects would be a conservative design because both design- and model-based variance estimators could be used to analyse the data.

ADVICE TO WG-EMM

7.1 The subgroup summarised its recommendations.

Agenda Item 2

7.2 The term VOGON (Value Outside the Generally Observed Norm) should be used in place of anomaly (paragraph 2.9).

7.3 Principal components analysis should be carried out for appropriate sites and indices (paragraph 2.12).

7.4 The fur seal pup growth index (C2b) may not be an effective measure of reproductive success and should be examined for further refinement (paragraph 2.16).

7.5 Further studies should be undertaken to develop combinations of CEMP indices at appropriate regional and temporal scales that may be more robust for identifying VOGONs than individual indices (paragraph 2.18).

7.6 Consideration should be given to the development of a procedure for identifying situations where a high proportion of indices give near VOGONs (paragraph 2.19).

7.7 Appropriate α-levels for identifying VOGONs should be done on an index-by-index basis, with levels higher than 0.05 being considered for non-normal data (paragraph 2.23).

Agenda Item 3

7.8 Modify the Agnew and Phegan (1995) model to improve temporal aspects (paragraph 3.11).

7.9 A new index of niche overlap, such as Schroeder's Index, should be applied to Subarea 48.1 (paragraph 3.12).

7.10 Further work on the study of realised overlap, including sensitivity analyses, incorporation of new data from Subarea 48.1, and application to Subarea 48.3 should be undertaken (paragraph 3.14).

7.11 Future developments of a realised overlap index should examine penguin–fishery interactions during other potentially critical periods (paragraph 3.15).

7.12 Additional data should be submitted so that the work outlined above can progress (paragraph 3.3).

Agenda Item 4

7.13 Methods of comparing at-sea behaviour indices between sites and across years should be developed with randomisation tests (paragraphs 4.7 and 4.8).

7.14 Indices that summarise at-sea behaviour, including the use of satellite data (paragraph 4.10), should be developed and the properties of these indices should be investigated (paragraph 4.9).

7.15 Items in paragraphs 7.13 and 7.14 need to be dealt with before a decision can be made about which indices can be incorporated into the CEMP database.

Agenda Item 5

7.16 Various missing value scenarios should be explored with a complete CEMP dataset (paragraph 5.2).

7.17 Information on the reasons for missing values in CEMP data should be collected, as soon as possible, along the lines suggested in paragraph 5.3 (paragraph 5.4).

7.18 Work should be undertaken to identify series and methods whereby missing sample data can be imputed in order to provide a value for a parameter which would otherwise be missing from the CEMP series (paragraph 5.6).

7.19 Work should be undertaken to explore the methodology for analyses of multivariate series with missing values so that such analyses can be performed in the future (paragraphs 5.7 and 5.8).

Agenda Item 6

7.20 A simulation study should be conducted to compare random versus systematic transect spacing for the synoptic krill survey, and a panel should be convened to define realistic goals and boundaries for the study (paragraph 6.4).

7.21 Work should be undertaken to use the krill yield model to examine the marginal utility of reducing uncertainty in the krill biomass estimate (paragraph 6.5).

7.22 Random transect spacing should be used in the synoptic survey if a simulation study is not completed (paragraph 6.6).

CLOSE OF THE MEETING

8.1 The report was adopted. In closing the meeting the Convener thanked the Southwest Fisheries Science Center and Dr R. Holt for hosting the meeting. The Convener also thanked all the meeting participants.

REFERENCES

Agnew, D.J. and G. Phegan. 1995. Development of a fine-scale model of land-based predator foraging demands in the Antarctic. *CCAMLR Science*, 2: 99–110.

Manly, B.F.J. 1997. *Randomisation, Bootstrap and Monte Carlo Methods in Biology*, 2nd Edition. Chapman and Hall, London.

Mantel, N. 1967. The detection of disease clustering and a generalized regression approach. *Cancer Research*, 27: 209–220.

Mielkle, P.W., K. J. Berry and E.S. Johnson. 1976. Multi-response permutation procedures for *a priori* classifications. *Communications in Statistics*, A5: 1409–1424.

Table 1: Temporal scales of integration of variables monitored for predators.

2 – 10 years	1 Year	0.5 – 2 Years	About 6 Months (winter)	1 – 6 Months (summer)
Juvenile survival	Adult survival	Population size	Adult mass at arrival	Foraging trip duration Pup growth rate Weaning/fledging mass Breeding success Diet composition Meal mass

Table 2: Data from Bird Island used for illustrative purposes for multivariate analysis and the production of summary indices. The sign of the fur seal foraging duration is given a negative sign in order that the least negative values represent good conditions.

Year	C1 Fur Seal Cow Foraging Duration * (-1)	C2b Fur Seal Pup Growth Female	C2b Fur Seal Pup Growth Male	A6a Macaroni Breeding Success	A6a Gentoo Breeding Success	A7 Macaroni Fledging Weight	A7 Gentoo Fledging Weight	A8 Macaroni Proportion Krill in Diet	A8 Gentoo Proportion Krill in Diet	Fur Seal Last Weighed Mass Female	Fur Seal Last Weighed Mass Male
1977				0.476	0.598						
1978				0.250	0.006						
1979				0.473	0.294						
1980				0.602	0.577						
1981				0.527							
1982				0.509	0.048						
1983				0.491	0.506						
1984				0.092	0.285						
1985				0.477	0.428						
1986				0.504	0.418						
1987				0.361	0.427						
1988				0.364	0.468						
1989				0.608	0.457	3450	5464				
1990	-80	1.89	2.38	0.592	0.356	3237	5800	0.998	0.594	11.24	13.07
1991	-203	2.77	3.26	0.583	0.010	3112	5043	0.694	0.191	11.48	12.73
1992	-94	2.14	2.58	0.408	0.631	3507	5791	0.988	0.499	12.84	14.81
1993	-123	2.67	3.69	0.553	0.894	3318	5482	0.833	0.845	12.45	15.02
1994	-469	2.48	2.66	0.456	0.040	2913	5065	0.112	0.129	10.66	11.89
1995	-103	2.12	3.31	0.505	0.583	3025	5239	0.536	0.544	11.21	13.92
1996	-90	2.25	2.78	0.445	0.789	3179	5502	0.999	0.243	11.84	14.31
1997	-97	2.25	2.95	0.484	0.500	3300	5960	0.986	0.362	11.93	14.95

Table 3: Correlation matrix for CEMP parameters of dependent species during the breeding season at South Georgia for the years 1989 to 1997.

Variable	Fur Seal Foraging Trip Duration	Fur Seal Pup Growth Females	Fur Seal Pup Growth Males	Macaron i Breeding Success	Gentoo Breeding Success	Macaroni Fledging Weight	Gentoo Fledging Weight	Macaroni Krill Proportion in Diet	Gentoo Krill Proportion in Diet	Fur Seal Female Pup Mass at Weaning	Fur Seal Male Pup Mass at Weaning
Fur seal foraging trip duration	1.000	0.611	0.069	0.047	0.710	0.665	0.743	0.808	0.590	0.552	0.730
Fur seal pup growth females		1.000	0.672	-0.160	0.367	0.225	0.607	0.571	0.197	-0.051	0.132
Fur seal pup growth males			1.000	-0.307	-0.139	0.109	0.389	0.451	-0.347	-0.185	-0.311
Macaroni breeding success				1.000	-0.272	-0.168	-0.166	-0.073	0.310	-0.283	-0.270
Gentoo breeding success					1.000	0.549	0.590	0.506	0.717	0.607	0.835
Macaroni fledging weight						1.000	0.784	0.630	0.546	0.919	0.766
Gentoo fledging weight							1.000	0.769	0.432	0.560	0.663
Macaroni krill proportion in diet								1.000	0.213	0.454	0.491
Gentoo krill proportion in diet									1.000	0.528	0.624
Fur seal female pup mass at weaning										1.000	0.851
Fur seal male pup mass at weaning											1.000

Table 4: Determination of α-levels that are required for detecting biologically identified VOGONs.

	Gentoo	Albatross
Years with biologically significant VOGONs	1978, 1982, 1991, 1994	1980, 1984, 1987, 1991, 1994
Years excluded from analysis – reason for exclusion	1981 – no data	1988, 1995 – adverse environmental conditions identified as main cause of breeding failure
Adjusted time series length	20 years	20 years
Year with least extreme VOGON	1982	1987
Mean of transformed index	-0.7210	-1.4650
Standard deviation of transformed index	1.8508	2.1379
Level of least extreme VOGON	-2.9874	-2.3259
Critical value required to detect least extreme VOGON	1.2245	0.4027
α-level for critical value	0.22	0.69

Figure 1: Illustration of the simple index for dependent species at South Georgia which combines fur seal and penguin data relevant to the breeding season. The full line is the index using all the data values, the dashed line shows the effect of deleting the fur seal pup growth data.

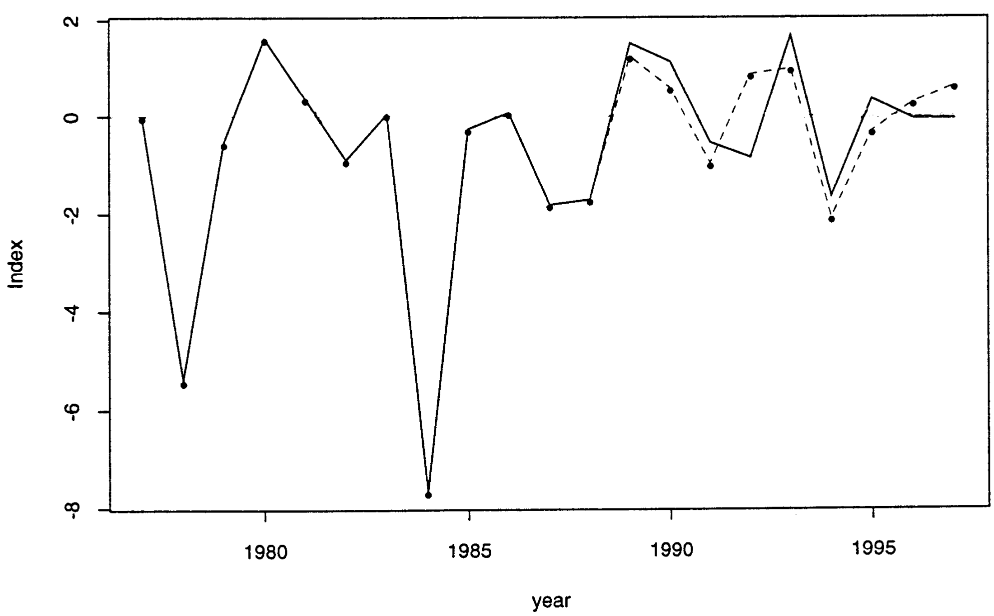

Figure 2: Illustration of the simple index for dependent species at South Georgia which combines fur seal and penguin data relevant to the breeding season. The full line is the index using only the penguin breeding success data, the dashed line shows the effect of including all the other data, apart from the fur seal pup growth data.

ATTACHMENT A

AGENDA

Subgroup on Statistics
(La Jolla, USA, 14 to 18 July 1997)

1. Introduction

   (i) Opening of the Meeting
   (ii) Organisation of the Meeting and Adoption of the Agenda

2. Further Review of Identification of Anomalies in CEMP Indices

   (i) Review updated time series of CEMP indices

   (ii) Summarise recent problems with/suggestions for identifying anomalies (various problems and suggestions can be found in SC-CAMLR-XV, Annex 4, paragraphs 4.58 to 4.61, 4.70, 4.72, 4.75 and 7.1)

   (iii) Discuss and develop methods to deal with problems/take up suggestions in identifying anomalies (SC-CAMLR-XV, paragraph 5.38(ii))

3. Critical Evaluation of the Assumptions and Parameter Values of the Agnew and Phegan (1995) Model of Realised Overlap

   (i) Review and summarise data and analyses submitted in response to SC CIRC 97/2 (‘WG-EMM Subgroup on Statistics – Request for Data and Analyses’)

   (ii) Evaluate assumptions and parameter values used in the Agnew and Phegan model (SC-CAMLR-XV, paragraph 5.38(iv))

   (iii) Determine whether the data submitted in response to SC CIRC 97/2 could be used to refine the Agnew and Phegan model or develop an alternative index of realised overlap

4. Development of Indices of At-sea Behaviour and Methods of Deriving them via Analysis of Sample Datasets

   (i) Review appropriate temporal and spatial scales for developing useful indices (background information on this topic is presented in SC-CAMLR-XV, Annex 4, paragraphs 3.61 to 3.65 and 7.58)

   (ii) Consider sample datasets and analyses (SC-CAMLR-XV, Annex 4, paragraphs 4.44 and 7.58)

   (iii) Develop indices and methods for their calculation via analysis of the sample datasets (SC-CAMLR-XV, paragraph 5.38(i))

(iv) Provide advice on the most appropriate indices for inclusion in the CEMP database (SC-CAMLR-XV, Annex 4, paragraphs 4.44 and 7.58)

5. Methods for Coping with Missing Values in Multiple Datasets

(i) Examine methods for interpolating missing data in matrices of time series of CEMP indices collected from a group of predator colonies (SC-CAMLR-XV, paragraph 5.38(iii) and Annex 4, paragraph 4.63)

6. Synoptic Survey Design

7. Advice to WG-EMM

8. Close of the Meeting.

ATTACHMENT B

LIST OF PARTICIPANTS

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(La Jolla, USA, 14 to 18 July 1997)

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LIST OF DOCUMENTS

Subgroup on Statistics
(La Jolla, USA, 14 to 18 July 1997)

WG-EMM-Stats-97/1	PROVISIONAL AND ANNOTATED PROVISIONAL AGENDA FOR THE 1997 MEETING OF THE WG-EMM SUBGOUP ON STATISTICS
WG-EMM-Stats-97/2	LIST OF PARTICIPANTS
WG-EMM-Stats-97/3	LIST OF DOCUMENTS
WG-EMM-Stats-97/4	DEVELOPMENT OF INDICES OF AT-SEA BEHAVIOUR I.L. Boyd (UK)
WG-EMM-Stats-97/5	DIET AND FORAGING RANGE OF PENGUINS AND FUR SEALS AT SOUTH GEORGIA J.P. Croxall, I.L. Boyd, K. Reid and P.N. Trathan (UK)
WG-EMM-Stats-97/6	TESTS FOR ANOMALOUS YEARS IN THE CCAMLR INDEX SERIES (DRAFT) B.F. Manly and D. MacKenzie (New Zealand)
WG-EMM-Stats-97/7	SOME CONSIDERATIONS FOR THE FURTHER DEVELOPMENT OF STATISTICAL SUMMARIES OF CEMP INDICES W.K. de la Mare (Australia)
WG-EMM-Stats-97/8	TREATMENT OF MISSING VALUES IN CEMP DATA SETS A. Murray (UK)

OTHER DOCUMENTS

WG-EMM-97/25	CEMP INDICES 1997: SECTIONS 1 TO 3 Secretariat

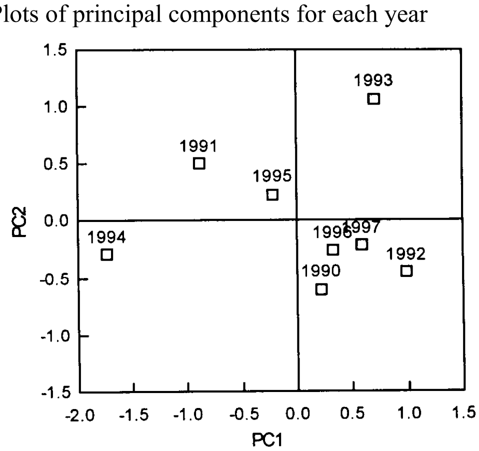
RESULTS OF A PRINCIPAL COMPONENTS ANALYSIS ON BIRD ISLAND DATA 1990–97

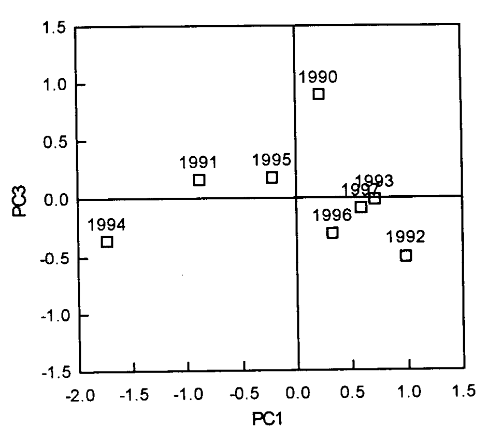
The variables are in the order shown in Table 2, with obvious abbreviations for names.

Bird Island data (all untransformed)

PCA axis	1	2	3	4	5	6	7
Eigenvalue	5.83	2.19	1.36	0.82	0.47	0.20	0.13
% of Total	53.02	19.92	12.32	7.46	4.27	1.78	1.22
Cumulative %	53.02	72.94	85.26	92.72	96.99	98.78	100.00
Eigenvectors (component loadings)							
SEALFD (C1)	0.36	0.02	0.27	-0.02	-0.49	0.26	-0.33
SEALPG-F (C2b)	-0.16	0.51	-0.28	0.45	0.03	-0.12	0.35
SEALPG-M (C2b)	0.02	0.65	-0.04	-0.13	-0.20	-0.25	-0.35
MACBS (A6a)	-0.06	0.29	0.73	0.26	0.04	-0.06	0.17
GENBS (A6a)	0.34	0.15	-0.16	-0.47	-0.13	0.13	0.65
MACFW (A7)	0.37	-0.05	-0.10	0.37	0.34	0.16	-0.17
GENFW (A7)	0.34	-0.29	0.10	0.10	0.17	-0.74	0.08
MACPK (A8)	0.36	-0.09	0.17	0.34	-0.34	0.09	0.33
GENPK (A8)	0.27	0.27	0.31	-0.36	0.61	0.13	-0.02
SEALWT-F	0.35	0.14	-0.31	0.28	0.19	0.31	-0.12
SEALW-M	0.38	0.14	-0.21	-0.12	-0.16	-0.38	-0.17
Principal component scores							
1990	0.22	-0.60	0.90	0.03	0.15	0.04	0.08
1991	-0.88	0.50	0.17	0.60	-0.19	0.10	-0.08
1992	0.99	-0.44	-0.50	0.16	0.24	0.18	-0.13
1993	0.71	1.07	-0.00	-0.09	0.26	-0.03	0.12
1994	-1.74	-0.29	-0.36	-0.14	0.26	-0.07	0.07
1995	-0.21	0.23	0.18	-0.61	-0.17	0.05	-0.19
1996	0.32	-0.25	-0.30	-0.10	-0.42	0.10	0.21
1997	0.59	-0.21	-0.08	0.16	-0.12	-0.37	-0.07

Plots of principal components for each year





EXECUTIVE SUMMARY
WORKSHOP ON INTERNATIONAL COORDINATION

(La Jolla, USA, 14 to 18 July 1997)

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The 1997 Workshop on International Coordination was convened by Suam Kim (Republic of Korea) at 0900 on 14 July 1997 at the Southwest Fisheries Science Center, La Jolla, USA. In attendance were Sung-Ho Kang (Republic of Korea), Hyungmoh Yih (Republic of Korea), Mikio Naganobu, So Kawaguchi (Japan), Volker Siegel (Germany), Anthony Amos, David Demer, Christopher Hewes, Roger Hewitt, Osmund Holm-Hansen and Valerie Loeb (USA). Attendees and addresses are listed in Table 1.1 of WG-EMM-97/44.

2. During the 1996/97 field season Germany, Republic of Korea and USA conducted surveys in the Elephant Island area. It was agreed during a planning session at the 1996 meeting of WG-EMM to conduct observations at a common set of stations along the 55°W meridian north and south of Elephant Island. These stations correspond to stations 60–67 on the US AMLR grid which has been occupied twice each austral summer since 1991. Table 1.2 of WG-EMM-97/44 lists the cruise dates, the dates that the common stations along 55°W were occupied, the survey areas, the types of observations conducted and the equipment used by each Member country.

3. Of particular note were the following conclusions:

(i) surface waters were extremely warm throughout the spring and summer of 1996/97 with surface temperatures exceeding 4°C in February 1997;

(ii) as the season progressed the upper mixed layer deepened, the thermocline intensified, the cold winter water layer diminished, Bransfield Strait waters warmed, and the intrusion of the Circumpolar Deep Water varied. Freshening of surface waters due to the processes of ice melting, precipitation and advection was also noted;

(iii) a dramatic change in the biomass and geographic distribution of phytoplankton was observed at the five stations north of Elephant Island through December to February time period. However, the chlorophyll-*a* (Chl) concentrations at the three stations to the south of Elephant Island did not change dramatically with time from late spring 1996 (German data), through early summer 1996 (Korean data), to late summer 1997 (USA data);

(iv) diversity of the phytoplankton species was low. Only seven species accounted for more than 84% of the total phytoplankton carbon biomass. The increased Chl and phytoplankton carbon were mainly due to the dominance of an autotrophic nanoflagellate (*Cryptomonas* spp., <10 micrometer in length);

(v) on average, 81% of the integrated Chl (0–100 m) was dominated by nanoplankton (<20 micrometer), which compares to the previous surveys;

(vi) a prolonged krill spawning season and delayed spawning peak and massive salp population bloom in 1997 followed below average sea-ice conditions in winter 1996. Low larval krill densities observed during this year suggest poor reproductive success and poor recruitment of the 1996/97 year class is to be expected;

(vii) conditions during 1996/97 contrasted strongly with 1994/95 when high larval krill densities and low salp densities occurred after above average sea-ice conditions;

(viii) dominant acoustic scattering in the Elephant Island area generally followed a band, just north of the archipelago, extending from the southwest to the northeast. This feature is coincident with both the shelf break and a persistent but variable frontal zone;

(ix) krill tended to reside in the upper 50 m, frequently near the thermocline and above water ~ 0°C; and

(x) myctophids may be associated with circumpolar deep water and their residence in the Elephant Island area may be influenced by the advance and retreat of the warm-water dome.

4. In addition the group made the following recommendations:

(i) all cooperating national research programs should standardise, or at least inter-calibrate, the methodologies used in their analyses;

(ii) closer spaced CTD casts extending to the ocean bottom are necessary to resolve the frontal boundary north of Elephant Island;

(iii) CTD stations should extend to the ice edge early in the season in order to investigate the thermohaline properties of water near the ice edge;

(iv) moored current meters and Acoustic Doppler Current Profiler (ADCP) instruments should be deployed to investigate water transport relative to krill movement along the north side of the South Shetland Islands;

(v) shipboard ADCP should be used to provide continuous data on current structure and scattering layer velocities. The use of shipboard ADCP data to evaluate geostrophic calculations of circulation patterns should be investigated;

(vi) collection of underway environmental data, including meteorological measurements, along transects between stations is encouraged;

(vii) seasonally extensive temporal sampling of microbial plankton is necessary to assess variability of food sources for krill and salps;

(viii) future phytoplankton work should incorporate increased size-fraction ranges for measurement of particles and methodologies for differentiation of phytoplankton sub-populations;

(ix) substantially greater spatial sampling effort than a single transect across the Elephant Island area is necessary in order to obtain a more representative sample of krill length/maturity stages and abundance in the Antarctic Peninsula area;

(x) seasonally extensive temporal sampling coverage is necessary to assess the timing and success of krill and salp reproduction. This information, along with winter sea-ice data, is essential for the prediction of krill year class success;

(xi) improved net sampling techniques should be used for validation of sound scatterer identification, especially regarding mesopelagic fish; and

(xii) enhanced multifrequency acoustic methods should be used for remotely identifying and delineating species of sound scatterers.

EXAMPLE FORMAT FOR ECOSYSTEM ASSESSMENT SUMMARY

Ecosystem Assessment Summary: Krill-centred System in Subareas 48.1, 48.2 and 48.3.

Component	Subarea 48.1	Subarea 48.2	Subarea 48.3
Krill			
Reported catch (tonnes)			
1991/92	78 385	123 186	101 310
1992/93	37 716	12 670	30 040
1993/94	45 085	19 259	18 648
1994/95	35 025	48 833	33 590
1995/96	62 384	2 734	36 590
Largest reported annual catch (tonnes)			
Standing stock			
Recruitment			
Status of CEMP dependent species			
Conservation measures in force			

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 13 to 22 October 1997)

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REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 13 to 22 October 1997)

INTRODUCTION

1.1 The meeting of WG-FSA was held at CCAMLR Headquarters, Hobart, Australia, from 13 to 22 October 1997. The Convener, Dr W. de la Mare (Australia), chaired the meeting.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The Convener welcomed participants to the meeting and introduced the Provisional Agenda which had been circulated prior to the meeting. With the addition of sub-item 3.6 'Consideration of Management Areas and Stock Boundaries' the Agenda was adopted.

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 Drs A. Constable (Australia), E. Balguerías (Spain), J. Croxall and I. Everson (UK), R. Holt (USA), G. Kirkwood (UK), K.-H. Kock (Germany), E. Marschoff (Argentina), D. Miller (South Africa), G. Parkes (UK), G. Watters (USA), Mr R. Williams (Australia) and the Secretariat.

REVIEW OF AVAILABLE INFORMATION

Data Requirements

Inventory and User's Guide

3.1 An inventory of CCAMLR databases (SC-CAMLR-XVI/BG/11) was developed at the request of WG-FSA-96. The inventory lists all datasets currently in use within the Secretariat. This is the first stage in developing dataset users' guides for each dataset maintained by the Secretariat. The Working Group agreed that the inventory should include the assessment summaries produced by WG-FSA, and details on the data fields within each dataset. It was noted that some users' guides already existed for some datasets maintained by other agencies, and these should be referenced. The Secretariat was requested to revise the paper and this was completed at the meeting.

3.2 A draft dataset user's guide was presented (WG-FSA-97/32), outlining a proposed general structure and format for this type of document, and an example was developed for the catch and effort data from longline fisheries (C2). Members were encouraged to provide comments and additions during the meeting. The Working Group discussed the need for a staged approach to developing users' guides. The C2 user's guide drafted by the Secretariat was comprehensive, and considerable time would be required to develop similar guides for other major fisheries and research datasets. The Working Group felt that it would be preferable, in the short term, to develop guides covering the essential data elements of each dataset, including data fields, constraints and usage. Later, as resources allow, each dataset user guide could be developed further.

3.3 The Secretariat was encouraged to explore the development of interactive, web-based users' guides. Rules governing access to, and usage of, CCAMLR datasets should be clearly stated in the users' guides. In addition, the maintenance of a record of usage of datasets would provide useful information when the Working Group allocated priorities for further development of datasets, and analytical tools.

Database Data Entry and Validation

3.4 The Secretariat reported on its actions in response to data requirements endorsed by the Scientific Committee in 1996 (SC-CAMLR-XVI/BG/21 and related papers). The state of requests specified by WG-FSA-96 (SC-CAMLR-XV, Annex 5, paragraph 9.2) are as follows:

(i) haul-by-haul data from longline fisheries for *Dissostichus eleginoides* in Subarea 48.3 (SC-CAMLR-XV, Annex 5, Table 16) – the data problems listed were identified, and where feasible, corrected as part of data validation and improvement to the data-entry process. The single largest problem in this dataset remains: data on the end position of hauls were not submitted until 1996, when data form C2 Version 5 was introduced (SC-CAMLR-XVI/BG/18);

(ii) haul-by-haul length-frequency data for *D. eleginoides* from earlier bottom trawl surveys in Subarea 48.3 – the Secretariat corresponded with Germany and Russia, and data were submitted by Germany, and the results of the 1990 survey of the RV *Akademic Knipovich* are represented in WG-FSA-97/12;

(iii) catch data from fisheries for *D. eleginoides* in areas adjacent to the Convention Area – a request was sent to Members and the UK submitted data;

(iv) haul-by-haul, catch and age data from earlier *Champsocephalus gunnari* fisheries in Subarea 48.3 – the Secretariat corresponded with Russia, Germany and Poland, and data were submitted by Germany;

(v) a comprehensive list of bottom trawl surveys – the Secretariat compiled a list of bottom trawl surveys conducted within the Convention Area (SC-CAMLR-XVI/BG/22), covering surveys for which data have been submitted to the Secretariat, and others notified by Members. At the request of the Working Group, the Secretariat circulated a detailed listing of research and exploratory cruises (SC-CAMLR-XVI/BG/22 addendum), and Members were invited to provide annotations and corrections; and

(vi) haul-by-haul data from the Ukrainian fishery for *D. eleginoides* in Division 58.5.1 – the Secretariat was advised by Ukraine that further work would be required to prepare historical data for submission and that this could not be done due to resource limitations. Longline fishery data for the 1996/97 fishing season were submitted.

3.5 The Working Group also requested that the Secretariat review CCAMLR databases and determine which datasets are incomplete (SC-CAMLR-XV, Annex 5, paragraph 9.3). This has proved a lengthy problem to address as the Secretariat can only identify missing datasets if there is a record of those sets. Identification of other datasets require input from Members to be resolved satisfactorily. The Working Group proposed that the Secretariat provide each technical coordinator with a full inventory of data held by the Secretariat and invite Members to identify missing datasets and submitted data, as appropriate. The Working Group recommended that, in order to cover the full spectrum of datasets maintained by the Secretariat, the role of coordination through technical coordinators would need to be broadened to encompass catch and effort data and CEMP data.

3.6 The state of requests specified by WG-FSA-96 (SC-CAMLR-XV, Annex 5, paragraph 9.4) are as follows:

(i) preparation of an inventory of, and users' guides for, the CCAMLR databases – see paragraphs 3.1 to 3.3;

(ii) development and application of methods for validation of data entries into the databases – the Secretariat has begun a review of database structure and routines, and has implemented an inventory of data and submissions (see paragraphs 3.1 to 3.3);

(iii) preparation of data files for length-density analyses of *D. eleginoides* – all length-frequency data available to the Secretariat have been compiled. Further work may be required;

(iv) completion and validation of the entry of observer data for 1995/96 – Argentina have submitted remaining data and these have been processed;

(v) request information on fisheries activities by non-Members – some information was reported by Members in their activities reports and this information will be collated during the meeting; and

(vi) revision of catch and effort and biological data forms for the squid jigging fishery – the data forms and instructions were revised in consultation with Dr P. Rodhouse (UK) in December 1996. The revised fine-scale catch and effort data reporting form (C3 Version 3) and its instructions was distributed to all Members in December 1996. An advance copy of the scientific observer squid logbook forms (S1, S2 and S3) was sent to all Members and technical coordinators in December 1996, and later published in the *Scientific Observers Manual* in June 1997.

3.7 The Working Group recognised that the quantity and diversity of data requested from Members was high and likely to increase during 1997/98 and subsequent years. A list of data requirements and submission deadlines was circulated during the meeting (SC-CAMLR-XVI/BG/21 addendum). Data processing priorities should be identified so as to guide the work of the Secretariat during the intersessional periods. The Secretariat was advised that data from the most recent split-year should be afforded top priority when preparing data for analyses by WG-FSA.

3.8 UK survey data for a number of surveys conducted around the South Georgia area were re-submitted to the Secretariat at WG-FSA-96 following problems in the formatting of previous submissions within the CCAMLR database. The structure of the UK survey data was more detailed than the model for commercial (C1) data, which is used by the Secretariat for survey datasets. During 1997, the UK re-submitted the data in a format compatible with the CCAMLR commercial trawl fisheries database. These data are presently held by the Secretariat in a separate database and will be transferred to the primary database by the end of 1997. The Working Group thanked Dr Parkes and Mr C. Jones as well as the Secretariat for resolving this issue.

3.9 The Working Group recommended that the Secretariat be asked to develop a data format and procedure for handling research survey data submitted to CCAMLR, which ensures that all of the complexity of the data is preserved and the data are readily available for analysis during future meetings.

3.10 The timing of, and responsibility for, submissions of catch and effort data, biological data and observer data were also discussed. The Working Group recognised that the current schedule for submitting data may result in expensive data transmissions or delays in cases where vessels undertook prolonged fishing trips. The Working Group discussed the requirements for vessels carrying observers to report biological data and the possibility that observers collect these data as part of their own observations and submissions. The role of observers in reporting these data should be stated in the bilateral observer agreements. The Working Group agreed to review the types of data needed to monitor fisheries and conduct stock assessments, and to identify critical data and ways that would ensure their timely submission to the Secretariat. Changes in data requirements would need to take into account the responsibility of flag states for reporting data, existing conservation measures, the absence of any measures of port control and the duties of observers.

3.11 The Working Group discussed the Secretariat's request for regular reporting of vessel names during the fishing season to facilitate the reconciliation of catch and effort data and observer data. The Working Group recommended that Members advise the Secretariat of the names of vessels engaged in fishing whenever they submitted five-day, 10-day or monthly catch reports. Data forms would be modified to include this requirement.

3.12 The Working Group discussed the results of a study comparing longline fishery data submitted to CCAMLR, and those acquired by the UK (WG-FSA-97/37). Both sets of data were collected independently from the fishery from 1994 to 1996. Comparisons were made at two levels: between hauls and within hauls. Reported problems included data for multiple hauls submitted to CCAMLR as a single record, some zero catches not reported to CCAMLR, inconsistencies in the reporting of by-catch and incidental bird mortality. The number of discrepancies between the two datasets declined from 1994 to 1996. The Working Group took these findings into consideration when assessing stocks during the meeting.

Other

3.13 New calculations of seabed area by depth strata were presented (SC-CAMLR-XVI/BG/17), using a newly-released topographic dataset of Sandwell and Smith. The Secretariat was asked to compare the output of this new method with estimates of seabed area published by Kock and Harm (1995) and Everson (1990). Overall, there was reasonable agreement between these estimates.

3.14 At South Georgia, the new dataset appears to overestimate the areas closest inshore although there was good agreement with the total area down to 500 m. The Working Group was unable to assess the quality of the areas for depths between 500 and 1 500 m at the meeting.

Fisheries Information

Catch, Effort, Length and Age Data

3.15 The Secretariat presented summaries of reported catches within the Convention Area for the 1997 split-year (Table 1). Catches for the split-year were derived from STATLANT data, if available, or estimates based on data in the fine-scale databases (SC-CAMLR-XVI/BG/1). Catches for the fishing season were obtained from five-day, 10-day or monthly catch and effort reports (CCAMLR-XVI/BG/17).

3.16 The Working Group examined annual catches in the proposed revision of the *Statistical Bulletin*, Volume 1 (SC-CAMLR-XVI/BG/19). The revision was based on the latest version of STATLANT data which included reworked Ukrainian data (WG-FSA-96/7). There were few changes between the revised and original dataset, except for catches reported by Ukraine for *C. gunnari* from 1971 to 1979. The total reported catch from 1970 to 1979 in the revised dataset was 76 774 tonnes less than the total based on that published in Volume 1. The Working Group expressed concern that the revised dataset may be incomplete. Further investigation during the meeting revealed that revised annual catches from 1979 to 1996 matched those published (SC-CAMLR-XVI/BG/19 addendum).

Dissostichus eleginoides

Commercial Catch

3.17 Catches taken under conservation measures regulating fishing for this species in various statistical areas are reported in CCAMLR-XVI/BG/17. In addition, catches have been reported by France from French EEZs. These are summarised in Table 2.

Unreported Catches

3.18 It is crucial for the purposes of stock assessment to have as complete information as possible on removals of fish from a stock. A large number of Commission circulars (COMM CIRCs 96/71, 97/4, 97/26, 97/27, 97/38, 97/40, 97/43, 97/48 and 97/50) drew attention to high levels of unregulated fishing on *D. eleginoides*, in particular, in the Indian Ocean sector (Area 58). Of the 90 vessels which were implicated as taking part in the unregulated fishery on *D. eleginoides*, 46 (51.1%) were flagged to CCAMLR Members. Forty-four longliners (49.9%) were either from non-Member states with the majority flagged to Panama and Belize or their flag state could not be identified with certainty. As in previous years (SC-CAMLR-XIV, Annex

5, paragraph 5.11; SC-CAMLR-XV, Annex 5, paragraphs 4.46 and 4.47), the Working Group considered information from various sources in order to be able to estimate the magnitude of catches in the authorised and in the unregulated fishery on *D. eleginoides* during the 1996/97 season.

3.19 Information was drawn from reports of landings in ports of Members and non-Members, reports on sightings of fishing vessels in various subareas and divisions available from COMM CIRCs and national authorities, estimated fishing capacities of these vessels, and catch and effort data from licensed vessels fishing in the same subareas and divisions for purpose of estimating of catches of sighted vessels. This information is more detailed in Appendix D.

3.20 The total reported catch of *D. eleginoides* from EEZs outside the CCAMLR Convention Area and from inside the CCAMLR Convention Area was 32 991 tonnes in the 1996/97 split-year (Table 3). In addition, the unreported catch derived from landings in ports of southern Africa and Mauritius (Appendix D, Table D.2) was estimated to be 74 000 to 82 200 tonnes (Table 3). The total catch of 107 000 to 115 000 tonnes was similar to information received by the Working Group that about 130 000 tonnes of *D. eleginoides* were available on the world market in the past 12 months.

3.21 Landings in southern African ports and Mauritius mostly, if not all, originated from catches taken in the Indian Ocean sector (Area 58). Most of this catch was apparently taken between August 1996 and April 1997 (Figure 1). Based on sightings of longliners, their known fishing capacities, and catch and effort data from the licensed fishery in this area (Appendix D, Table D.3), the Working Group made an attempt to estimate the unreported catch in each subarea and division. However, estimates for the various subareas and divisions (Appendix D, Table D.4) add up to only 38 000 to 42 800 tonnes (Table 3), i.e. approximately 50% of the landings. Some of the landings could have been from catches on banks in international waters north of the CCAMLR Convention Area. However, given the small dimensions of these seamounts and their location at the northernmost limit of the geographical range of *D. eleginoides*, it is unclear to what extent catches from such areas contributed to the landings. The Working Group was unable to reconcile the two estimates of the amount of unreported catches at the present stage.

3.22 Information from recent landings, in particular in the port of Mauritius (Appendix D, Table D.2) and sightings of vessels in Divisions 58.5.1 and 58.5.2 provided strong evidence that the unregulated fishing in the current 1997/98 season continues at a similar level to 1996/97. Until the end of September 1997, landings of 17 500 to 28 500 tonnes were reported (Table 4). Again, catch estimates using catch and effort data from vessels known to have fished in the area were much lower than the reported landings (Table 4). Information from commercial sources suggests that the unregulated fishing had been extended to the Ob and Lena Banks (Division 58.4.4), but no firm evidence was available to the Working Group.

Scientific Observer Information

3.23 Conservation Measures 101/XV, 102/XV and 112/XV required the placement of international scientific observers on board each longline vessel fishing for *D. eleginoides* in Subareas 48.3, 48.4, 48.6, 58.6, 58.7, 88.1 and 88.2, as well as Divisions 58.4.3 and 58.4.4 during the 1996/97 season. During the 1996/97 split-year, 12 vessels (16 cruises) took part in the fisheries in Subareas 48.3, 88.1 and 88.2, and all cruises carried international scientific observers. Nine vessels undertook fishing within the South African EEZ at the Prince Edward Islands (Subareas 58.6 and 58.7) and national scientific observers were deployed on 11 out of 14 cruises in the EEZ during the 1996/97 split-year.

3.24 The UK provided catch and biological data (see Table 5) for scientific observations on board the Korean squid jigging vessel *Ihn Sung 101* which undertook two fishing trips for *M. hyadesi* in Subarea 48.3 (WG-FSA-97/10). Results of this fishery are also considered in paragraphs 3.63, 4.2 to 4.6.

3.25 The information supplied by the observers in their reports is summarised in Table 6. Note that the data in this table are for the 1996/97 split-year, and the period 1 July 1997 to 31 August 1997.

3.26 The attention of Members is drawn to a number of observer narrative reports and observer logbook data not yet submitted to the Secretariat.

Observer Logbooks

3.27 Overall, the introduction of technical coordinators has improved the coordination and submission of information by scientific observers and the submission of observer logbook data. The Working Group noted with appreciation the much-improved promptness of submission of reports of scientific observers and the major improvement in the quality and relevance of the information presented in these reports. WG-FSA requested the Scientific Committee write to the technical coordinators, and commend all the scientific observers who had submitted reports to CCAMLR, as well as thanking technical coordinators for their efforts.

3.28 This year, the main difficulties encountered with processing and validating observer logbook data were related to the timing of submissions and data formats. About 60% of the observer data collected during the fishing season of 1996/97 were submitted to the Secretariat prior to the start of WG-FSA-97, and a further 35% of the data were submitted at the start of the meeting. Delays in submitting the data were largely attributed to the late closure of longline fisheries.

3.29 The Secretariat only received copies of about 45% of the bilateral scientific observer arrangements as required under CCAMLR's Scheme of International Scientific Observation and, consequently, had difficulty tracking scientific observers and their data. Approximately 25% of the observer data were submitted in non-CCAMLR formats, and some of these did not contain all the data required under the scheme. It appears that some scientific observers were unfamiliar with the procedures and requirements for data collection, including the collection of data on incidental catches of seabirds.

Observer Reports

3.30 At its 1996 meeting, WG-FSA recommended ways of improving data recording and submission procedures (SC-CAMLR-XV, Annex 5, paragraphs 3.7 to 3.19, 7.81 and 7.82) by scientific observers.

Feedback in Reports of Scientific Observers

3.31 In reviewing the observer reports and WG-FSA-97/25, the Working Group noted a number of difficulties experienced by observers in fulfilling or reporting their tasks. The following suggestions were made in relation to the logbook forms:

(i) add an illustration of the Beaufort scale of wind force (form L4);

(ii) add more explicit descriptions of differences between sea and swell height (L4);

(iii) reduce the size of the seabird by-catch field once CCAMLR measures are being used effectively (L5);

(iv) although WG-FSA has set a target of 60 fish per line to be measured, extra space taken from fields L5(iv) and (v) for 100 data points is likely to prove useful (as discussed in WG-FSA-97/4); and

(v) the maps in the *Scientific Observers Manual* (Part IV) are difficult to read and should be printed using larger print.

3.32 The Working Group agreed that these issues could be readily resolved would enhance data recording. It tasked the Secretariat with addressing these during the intersessional period.

3.33 The Working noted other matters and comments relating to the utility and feasibility of data recording (WG-FSA-97/25):

(i) the vessel speed during setting (form L4(ii)) varies so a single datum may be misleading. Also, the line course setting varies continuously and the observer cannot record bird interactions if involved in the recording of course changes. The latter requires alternating observations between the setting point and bridge;

(ii) the visibility index field (L4(v)) needs to include space for comments on factors limiting visibility;

(iii) the bird-hook interactions (L4(vii)) are difficult to observe completely at night due to poor visibility and during the day due to high levels of activity;

(iv) hook loss (L5(ii)) is difficult to estimate independently and there needs to be more definition of what information to include so avoiding possible errors in interpretation of information; and

(v) stage classification of gonads appears very subjective; the literature supplied should relate directly to *D. eleginoides*, rather than combining information from orange roughy and icefish (Anderson, *Zambezi*, second cruise).

3.34 The Working Group agreed that a task group be formed to address such matters during the intersessional period, and appointed the Science Officer as coordinator.

Observer Duties

3.35 The Working Group noted that reports of scientific observers refer to several matters relating to time constraints, sampling priorities and difficulties in fulfilling observer duties.

(i) The recording of by-catch numbers (L5(viii)) is straight forward, but recording of weight constitutes a large task which may detract from other higher-priority activities.

(ii) General difficulties were noted with form L5(v). A number of observers noted that the need for safe working conditions sometimes prevented observations during longline setting. Similarly, it was difficult at times to communicate with vessel crews on matters of detail.

(iii) Some tasks were hindered, or prevented by, safety considerations, captain/fishing master/crew, or communication difficulties (either within vessel or respect of radio communications with home stations or local locations.

3.36 The Working Group agreed that these matters should be referred to the task group for consideration during the intersessional period. In the longer term, changes and additions should be included in a revised edition of the *Scientific Observers Manual*. Scientific observers and technical coordinators were encouraged to continue to seek feedback from other observers on their experiences in carrying out duties under the Scheme of International Scientific Observation and to consider the suggested changes to operating procedures. Such feedback and suggestions should be regularly reviewed with a view to improving the scheme's efficiency.

Additional Information in Observer Reports

3.37 The Working Group noted the information provided by scientific observers on vessel awareness of CCAMLR conservation measures (see Table 7). The crews of several vessels appeared unaware of CCAMLR conservation measures. For example:

Aquatic Pioneer, cruise 1: crew unaware of Conservation Measure 29/XV until 20 November;

Aquatic Pioneer, cruise 3: crew unaware of Conservation Measure 29/XV until 7 May;

Garoya: crew believed that day setting of longlines was not prohibited;

Garoya: crew refused to deploy the streamer line required by Conservation Measure 29/XV.

3.38 The Working Group also noted that several reports of scientific observers indicated that some vessels (e.g. *Aquatic Pioneer, Garoya*) operating in the Convention Area had plastic packaging bands on board. In addition, there was a report of an oil spill involving

Zambezi and *Garoya*, and several reports of discarding of damaged fishing gear and plastics and other packaging at sea (e.g. *Aquatic Pioneer, Koryo Maru*). There were also records of good practice, and the Working Group noted this especially in relation to the *Garoya*.

3.39 The Working Group agreed that the issues of awareness of CCAMLR conservation measures and marine pollution should be drawn to the attention of the Scientific Committee and Commission, as appropriate. The observations above indicate the need for enhanced efficiency in ensuring the crews of fishing vessels are aware of CCAMLR conservation measures and of the regulations governing waste disposal in the Convention Area.

3.40 The Working Group congratulated the many observers who were able to assist vessels in awareness of, and compliance with, CCAMLR conservation measures and Southern Ocean/Antarctic waste disposal regulations.

Research Surveys

3.41 Results from research cruises undertaken during 1996/97 were noted. Germany re-surveyed Subarea 48.1 around Elephant Island during November/December 1996, and the results and changes in biomass are reported in WG-FSA-97/27. Australia conducted a survey for *C. gunnari* in Division 58.5.2 on Shell Bank and Heard Plateau in August 1997, and the results are presented in WG-FSA-97/29. The UK conducted a repeat survey for *C. gunnari* and *D. eleginoides* in Subarea 48.3 around South Georgia in September 1997 (WG-FSA-97/39). Argentina conducted a survey for *C. gunnari* in Subarea 48.3 around South Georgia in March 1997 (WG-FSA-97/44 and 97/47). In addition, Prof. G. Duhamel advised that France had conducted a survey in Division 58.5.1 and that the resulting data were available to the Working Group. Dr Balguerías advised that the Spanish longline survey proposed for August 1997 had been postponed until November 1997.

Mesh/Hook Selectivity and Related Experiments Affecting Catchability

3.42 Two papers were considered, one reporting trawl mesh selectivity for *C. gunnari* (WG-FSA-97/29), the other reporting information of hook selectivity for *D. eleginoides* (WG-FSA-97/49).

Fish and Squid Biology and Demography

Champsocephalus gunnari

3.43 An analysis of data from South Georgia (Subarea 48.3) in WG-FSA-97/44, indicated that there had been increases in standing stock from the low level found in 1994 through to 1995 and 1996 but that, for some unexplained reason, this had not been sustained through to 1997. The distribution of size classes, analysis presented in WG-FSA-97/45, indicated that larger fish tended to be found in deeper water near to the shelf break.

3.44 Research surveys in the vicinity of Heard Island (Division 58.5.2), reported in

WG-FSA-97/29, indicated that there were important ecological differences between the fish present on the Heard plateau from those on the Shell Bank. Spawning occurs in August/September on the plateau and Gunnari Ridge whereas on the Shell Bank the fish spawn in April. The size at first spawning is about the same at both locations. Differences were detected in the parameters of the von Bertalanffy growth equation. On the plateau k = 0.41, L_{inf} = 411 mm and t_0 = 0.57, whereas on the Shell Bank k = 0.45, L_{inf} = 392 mm and t_0 = 0.17. Prof. Duhamel noted that similar differences in spawning season were also to be found between fish from the Kerguelen Shelf and Skif Bank.

3.45 Several papers included information on natural mortality rates. WG-FSA-97/5 presented a re-examination of data from the 1950s and 1960s, the period prior to large-scale commercial fishing. Following correction of an error in the paper, it was concluded that during that early period, the Heincke method, which provided the best estimates of M, 0.42 (for 1955) and 0.46 (for 1966) for this pre-exploitation period, was realistic. The same study indicated that there had been an increase in mortality rate after 1966 which may have been due to fishing prior to 1970, the first year for which CCAMLR statistics are available.

3.46 Recent studies at different localities had indicated large interannual variations in natural mortality coefficients. At South Georgia from 1995 to 1996, M was 0.49 but trebled for the year 1996 to 1997 (WG-FSA-97/44).

3.47 It was noted that, in general, fish from the Atlantic sector attain a greater size than those from the Indian Ocean sector; with such a difference it was to be expected that there would be differences between these areas in growth and mortality rates.

3.48 The sizes of fish taken in the surveys in Subarea 48.3 followed the pattern of previous surveys with few fish greater than 40 cm total length. At Shag Rocks no large fish, greater than 40 cm length, were present. Dr Kock noted that in a survey in 1975/76 around the South Orkneys (Subarea 48.2) size classes of 40 to 52 cm predominated in the stock (Kock, 1991); these size classes were absent two years later at the commencement of commercial fishing.

3.49 There was some discussion regarding whether the variability in standing stock in specific areas might be caused by *C. gunnari* migrating between regions where concentrations have been found in the past. Genetic studies had been inconclusive in determining whether different stocks existed in the Atlantic sector. There were noticeable differences in size frequency distributions, from for example, Shag Rocks and South Georgia, and also, Heard Island, Shell Bank, Kerguelen and Skif Banks, which might indicate that such groups are, for management purposes, geographically isolated.

3.50 Analysis of stomach contents of *C. gunnari* reported in WG-FSA-97/48 sampled in four surveys over the period from 1994 to 1997 in Subarea 48.3, confirmed the importance of krill in the diet of this species. In 1994, a year when krill were scarce in the region, krill were replaced in importance in the diet by the amphipod hyperiid *Themisto gaudichaudii*. In 1996 and 1997, krill were abundant and were the dominant component in the diet. The krill abundance index in 1995 was intermediate between 1994 and 1996 and this is reflected in the diet composition. Dr E. Barrera-Oro (Argentina) noted that these results provided a good link to acoustic survey data and CEMP indices for the area.

Dissostichus spp.

3.51 Around Kerguelen (Division 58.5.1), the region of greatest catch rates of *D. eleginoides* by Ukrainian longliners was on the northwestern shelf in 1995/96, whereas during the 1996/97 season the higher catch rates were obtained along the western and southwestern slope regions (WG-FSA-97/7). This change may possibly be associated with the period of strong westerly winds in 1996/97 and the incursion of warm sub-Antarctic waters to the south (WG-FSA-97/8).

3.52 A review of biological information for *D. eleginoides* was presented in WG-FSA-97/42. Spawning within the CCAMLR Convention Area takes place during the period from June to September at Crozet, Kerguelen, Shag Rocks and South Georgia, whereas on the Falkland/Malvinas shelf it is slightly earlier, from March to June. *D. eleginoides* is typical of many nototheniids in that it produces large yolky oocytes. Male fish tend to reach sexual maturity at an earlier age (7–11 years and 72–90 cm total length) than females (9–12 years and 90–100 cm). Off the coast of southern Chile maturity occurs at a larger size, 105 cm in the case of males and 117 cm for females.

3.53 WG-FSA-97/41 provided further evidence for differences between the size at sexual maturity of male and female *D. eleginoides*. Results from a commercial longliner operating during the spawning season around South Georgia indicated that L_{m50} for males was 76 cm whereas for females it was approximately 99 cm. This had meant that 76% of the female fish taken in the commercial catch were immature; 23% of the male fish in the commercial catches were immature.

3.54 Information from outside the CCAMLR region (WG-FSA-97/41), on the Argentinian slope, indicated that male *D. eleginoides* matured at a smaller size than females L_{m50} (male) = 78.3 and L_{m50} (female) = 87.1 cm; these values are much lower than those reported in WG-FSA-97/42. In discussion it was suggested that there is probably a geographical and seasonal progression in maturation with spawning in northern regions taking place in the fall and in the Antarctic zone in the latter part of the winter. Within these areas spawning appears to be prolonged with the result that the maturity ogive may depend on the time of year during which the observations are made. In addition, fish in spawning condition have been taken outside this extended season, which indicates that the spawning season may be even more extended than previously reported.

3.55 The Working Group agreed that further work was needed on this topic and noted a suggestion that spawning occurs at a low level throughout much of the year. Prof. C. Moreno (Chile) and Dr Everson agreed to investigate this matter during the intersessional period.

3.56 The current assessment models for *D. eleginoides* do not take account of sexual differences in biological parameters. In view of the differences in size at sexual maturity of males and females it was agreed that this should be undertaken as a matter of priority.

3.57 Two papers (WG-FSA-97/7 and 97/8) were tabled which provided information on the distribution and ecology of *Dissostichus mawsoni* which had been abstracted from the records of various YugNIRO research and commercial fishing. A third paper (WG-FSA-97/19), provided various other general observational notes on meteorological information and its possible relationship to *Dissostichus* distribution.

3.58 In the Indian Ocean sector, WG-FSA-97/19 indicates that *D. mawsoni* were found from 63°57' to 69°30'S and from 11°50' to 144°34'E. Juveniles of 9 to 75 cm standard length were reported from all the continental Antarctic seas as a by-catch during target fishing for *Chaenodraco wilsoni*. Juveniles less than 150 mm had been reported regularly in near-surface midwater trawls targeting krill and *Pleuragramma* in oceanic areas 3 to 4 000 m deep.

3.59 Results from an extensive series of observations of *Dissostichus* found in sperm whale (*Physeter macrocephalus*) stomachs were summarised in WG-FSA-97/19 and from trawl fishing in WG-FSA-97/20.

3.60 Both species, *D. mawsoni* and *D. eleginoides*, are found in the Atlantic sector but there did not appear to be any overlap in distribution. *D. mawsoni* were only found south of about 56°S. *D. eleginoides* were only found in the northern and western part of the sector; they were not found very far to the east of the South Georgia area. The gap between the observed limits of the two species in the Bouvet Island area is between three and four degrees of latitude and with a temperature difference of about three degrees Centigrade.

3.61 In the Indian Ocean sector, *D. mawsoni* were found close to the continent and in deep water to the north. *D. eleginoides* appeared to be restricted to the shelf and slope regions of sub-Antarctic islands and Ob and Lena Banks but rarely extended into deep oceanic water. It was also noted that generally *D. mawsoni* tends to be more pelagic than *D. eleginoides*.

3.62 *D. mawsoni* were found over much of the Pacific sector and appear to make extensive migrations as far north as the Antarctic Polar Frontal Zone. This distribution and assumed migration pattern are thought to be related to the presence of squid, its principal food.

3.63 The Working Group agreed with this general view of the distribution of the two species although it was suggested that the differences in distribution may not be quite so clearly defined as the papers indicated and that there may be some significant overlap in some regions.

Martialia hyadesi

3.64 Catches of *M. hyadesi* were reported from near-surface waters on the northern slope of South Georgia (WG-FSA-97/10) in waters of depths from 500 to 1 500 m. The mantle length of males ranged from 236 to 332 mm (mode 270 mm) and females 235 to 361 mm (mode 300 mm). Most of the males were maturing (stages IV and V) whereas most of the females were immature (stage II). The squid appeared to be feeding on krill.

Review of Biological Reference Points for Decision Criteria

3.65 The current decision rules used to assess long-term annual yields identify two criteria based on the status of the spawning stock: (i) the critical level of spawning stock relative to the pre-exploitation median level below which recruitment may be impaired; and (ii) the long-term escapement of the stock relative to the pre-exploitation median level (SC-CAMLR-XIII, paragraphs 5.18 to 5.26). These decision rules provide a practical means of implementing important elements of Article II. The exact form of the two criteria is not solely a scientific consideration. At its 1996 meeting, WG-FSA explored the implications of varying elements of the criteria (e.g. the probability of depletion and the critical level of depletion) to *D. eleginoides* and to the fishery in Subarea 48.3 (SC-CAMLR-XV, Annex 5, paragraphs 4.75 to 4.80). This analysis was seen as a first step to providing the Scientific Committee with advice on the nature of suitable biological reference points for the stocks considered by CCAMLR. In continuing this work, the Working Group asked the Secretariat to undertake a general review of the nature and use of biological reference points in other fisheries organisations in order to be able to compare those with reference points used in CCAMLR (SC-CAMLR-XV, Annex 5, paragraph 9.5).

3.66 WG-FSA-97/35 provided an overview of reference points and their use in NAFO and FAO. The Working Group thanked the Science Officer for producing this review and agreed this was a useful foundation for identifying practices in other fisheries agencies which could be considered in the implementation of Article II. The paper described many types of reference points, which can be divided into those pertaining to a constant fishing mortality and those pertaining to critical spawning biomasses (in relation to stock-recruitment relationships). Few examples were available as to the methodologies used to identify critical reference points and none were available for helping identify critical biological reference points on the status of populations required under Article II.

3.67 The Working Group noted that the current decision rules used by CCAMLR encapsulate biological reference points that are as advanced as any currently in use in fisheries management. This is because they identify critical levels of spawning biomass and take account of uncertainties in specifying these levels as well as the inherent inability to state such levels precisely. Nonetheless, the Working Group also recognised that further work needs to be undertaken to examine the properties of these reference points in relation to fish stocks with different life history characteristics.

3.68 To date, the decision rules have been applied to krill and *D. eleginoides*. Intersessional work on *C. gunnari* (WG-FSA-97/29 and 97/38) has revealed that the decision rules may not be appropriate for this species in their current form. WG-FSA-97/29 identified substantial levels of recruitment variability for *C. gunnari* at Heard Island, which results in the probability of the population falling to below 20% of median spawning stock biomass being naturally high when fishing is absent. In the case of icefish on the Heard Plateau, the generalised yield model (GYM) predicts that, even in the absence of fishing, the probability of falling below 20% of the median unexploited spawning stock biomass is about 0.5. The current decision criterion used in formulating catch limits requires that this probability be held at 0.1. Clearly, this is not possible for this fish population, and application of this decision rule would prevent any fishing on it. This suggests that the existing form of the rule is not appropriate for such cases. WG-FSA-97/29 proposes an alternative form of the decision rule for application in such cases designed to ensure that the probability of falling below the 20% reference level is not substantially increased by the effects of fishing. In this case, the authors proposed that the probability of depletion should not be increased by more than 0.05. Combining this with the existing decision criteria leads to a composite form of the decision rule where the decision probability level (p_{dec}) is set to 0.1 when the probability of depletion with no fishing ($p_{F=0}$) is less than 0.05 and $p_{dec} = p_{F=0} + 0.05$ when $p_{F=0}$ is greater or equal to 0.05, i.e.:

$$0.10 \quad ; p_{F=0} < 0.05$$

$$p_{dec} =$$

$p_{F=0} + 0.05$; *otherwise*

3.69 The Working Group agreed that such a rule has merit but its implications need to be explored further. The relationship between this rule and the overall dynamics of the stock needs to be examined, including the length of the projection over which the rule is evaluated, the magnitude of change in the probability of depletion and the real relationship between spawning stock biomass and recruitment.

3.70 WG-FSA-97/38 highlights the need to review the decision rule regarding the level of escapement. *C. gunnari* is a prey species of fur seals, which may increase consumption of icefish when krill abundance is low. For this reason, the level of escapement would be considered to be 75% of median pre-exploitation spawning biomass (compared to 50% escapement in a single-species assessment). The Working Group noted that, in evaluating long-term annual yields using the GYM, this paper explicitly factors in interannual variation in mortality of *C. gunnari* that might arise from the prey switching by fur seals when krill abundance is low. In this case, the 75% escapement rule may be able to be relaxed to 50% because escapement for predators has been accounted for in the mortality function. The implications of such a change for both predators and the prey species need to be explored further. Notably, a revision of this rule will depend on the ability to apportion natural mortality to the various sources, such as that arising from predation compared to other sources, as well as including covariation in other parameters arising from changes in M, such as growth and recruitment.

3.71 Similarly, different parts of a stock may be subject to different levels of predation. For example, at Heard Island, juvenile *D. eleginoides* may be prey of elephant seals while the larger fish escape such predation (WG-EMM-97/31). Consequently, decision rules need to be sufficiently robust to cater for variation in predator–prey interactions ontogenetically as well as spatially and temporally.

3.72 The Working Group also recognised that pre-exploitation stock levels may be unable to be estimated for some species. As a consequence, work needs to be undertaken to identify appropriate biological reference points in these cases.

3.73 The Working Group considered the appropriateness of having target levels of fishing mortality as biological reference points in the decision rules. Previous work has shown that a strategy of fishing at $F_{0.1}$ can overexploit the stock in short lived species such as *Electrona carlsbergi* (SC-CAMLR-X, Annex 6, paragraphs 7.136 to 7.140 and 7.144; SC-CAMLR-X, paragraph 4.80). WG-FSA-97/43 shows that such a strategy may lead to overexploitation in the long-lived species *D. eleginoides* as well. The Working Group agreed that target levels of F, including $F_{0.1}$, are inappropriate for implementing Article II. However, further evaluation of target fishing mortalities such as $F_{0.1}$ as a reference point in a long-term management strategy for *C. gunnari* remains to be undertaken.

Developments in Assessment Methods

Sampling Method for Longline Observations

3.74 WG-FSA-97/4 provides a methodology for sampling fish from longlines by observers in order to obtain an unbiased random sample of fish from the whole longline. These methodologies are developed for Japanese and Spanish systems comprising series of several hundred baskets of hooks joined together to form a continuous line as well as the Norwegian system of a single continuous line. The paper outlines the statistical rationale, the methods to be followed by observers and some worked examples. In addition, an addendum provides a report of direct application of the system by an observer of a Spanish longline system.

3.75 The Working Group commended the authors for their work and encouraged them to put together a document with general instructions for observers, bearing in mind that observers may not have statistical training. This can then be circulated to technical coordinators in each country for trials and subsequent feedback as to its general application. The Working Group noted that refinements to sampling of continuous longlines may need to be developed to avoid observers having to attend the longline at all times. Nevertheless, the Working Group recognised that this work is very useful for establishing a standard methodology for sampling fish caught using longlines.

Determination of Stock Structure and Movement of *Dissostichus eleginoides*

3.76 WG-FSA-97/40 reports on progress on the determination of stock structure and movement-at-age in *D. eleginoides* through laser-based analysis of otoliths. Samples have been obtained from Macquarie Island, Kerguelen Island and South Georgia Island. Work is progressing well as a result of a well coordinated program of sampling and supply of otoliths from CCAMLR Members.

3.77 The Working Group was also informed of three other studies currently working on the stock structure of *D. eleginoides*: a DNA study being coordinated by New Zealand, a C_{14} study by Australia and a cruise being undertaken by the UK to examine stock structure of toothfish, icefish and krill. Similarly, Spain is intending to conduct a longline survey (see paragraph 6.8), the objective of which is to study the stock structure of *Dissostichus* in Subarea 48.6 and Division 58.4.4.

Developments in the Generalised Yield Model

3.78 The GYM has had two additions to its structure since last meeting. The first concerns the option of using a table of recruits in place of a lognormal recruitment function. This enables estimates of recruitment from observations of year class strength in mixture analyses to be used directly in a bootstrap function. In addition, uncertainty in these estimates can be incorporated in the model. A parametric bootstrap procedure has been added to the program so that the recruitment selected from the table of recruits is randomly modified according to a lognormal distribution with a coefficient of variation derived from the uncertainty in that recruitment estimate. This procedure is illustrated in WG-FSA-97/29.

3.79 The second enhancement of the model is the incorporation of a function allowing M to vary from year to year in a projection run. Such a function requires that the initial age structure be established sequentially from oldest to youngest ages. As a consequence, the correct formulation of the pre-exploitation median spawning biomass requires considerably more time to run than the case where M does not vary between years. Two interannual variations in M are possible. The first is where M is randomly modified according to a lognormal distribution with a coefficient of variation derived for the estimate of M. The second case is for M to be multiplied by a specified amount, with a probability of this occurrence in any year being specified also. This case is illustrated for *C. gunnari* in WG-FSA-97/38 where M may be multiplied by 4 with a probability of this occurring in any year of 0.2.

3.80 The Working Group agreed that validation of the GYM should be given a high priority by the Secretariat in the intersessional period. The Working Group also requested that an improved user interface be developed and made available at the next meeting.

Consideration of Management Areas and Stock Boundaries

3.81 WG-FSA-97/50 proposes a change of the boundary between Subareas 58.6 and 58.7 (see Figure 2) to avoid transecting the South African EEZ around the Prince Edward Islands and to clearly separate the reporting from fishing grounds around these islands from those around Crozet Island.

3.82 The Working Group noted that, in principle, management units should have a biological justification and agreed that management advice should be based on stocks rather than statistical areas. To this end, management areas may need to be identified for individual stocks based on small scale areas, as was undertaken in the crab fishery and as has been considered in the past in distinguishing Shag Rocks from South Georgia in the myctophid fishery. This distinction is also necessary for two stocks of *C. gunnari* in the Heard Island area (WG-FSA-97/29). If this recommendation is adopted then adjustments, although likely to be minor, will need to be made to the existing database and reports for statistical subareas.

3.83 The Working Group agreed that the proposed change of the boundary between Subareas 58.6 and 58.7 be undertaken because the proposed boundary is likely to coincide with a natural boundary between stocks in the shelf area of Prince Edward Islands and stocks in the shelf area around Crozet Island.

ASSESSMENTS AND MANAGEMENT ADVICE

New and Exploratory Fisheries

New Fisheries in 1996/97

4.1 There were seven new fisheries operating in 1996/97. Summary information on these is given in Table 8, and a summary of data received by the Secretariat is given in Table 9.

New Fishery for *Martialia hyadesi* in Subarea 48.3

4.2 A total catch of 81 tonnes was reported for the Republic of Korea/UK new fishery for *M. hyadesi* in Subarea 48.3 in 1996/97 (Conservation Measure 99/XV). This was taken by a single vessel in 14 days during June/July 1997; fishing operations by this vessel for six days in January 1997 had failed to locate squid. The observer's report for the June/July operations is given in WG-FSA-97/10. All fishery and observer data have been submitted to CCAMLR.

4.3 The failure to locate squid to the north and west of South Georgia during January is in line with the results of previous squid fishing trials and groundfish surveys, which have never revealed the presence of squid in this area during the austral summer. However, the winter operations did provide new information about the biology of *M. hyadesi* (SC-CAMLR-XVI/BG/10).

4.4 CCAMLR-XVI/21 cites an unusually good and extended season for *Illex argentinus* in the southwest Atlantic (February to June 1997) and a desire to join the *Dosidicus gigas* fishery off Peru at the end of July as the reason for the low fishing effort directed towards *M. hyadesi* this year.

4.5 A new fishery notification for *M. hyadesi* in Subarea 48.3 in 1997/98 by the UK and the Republic of Korea is given in CCAMLR-XVI/21. This is discussed in paragraphs 4.59 to 4.62.

4.6 Revised data forms for the squid jig fishery were developed in consultation with Dr P. Rodhouse (British Antarctic Survey) by the Secretariat as requested by the Working Group last year (SC-CAMLR-XV, Annex 5, paragraph 4.14) and used for recording and submitting data for this new fishery.

New Fisheries for *Dissostichus* spp. in Subarea 48.6 and Division 58.4.4

4.7 For administrative reasons, no fishing took place in the new fisheries for *D. eleginoides* and *D. mawsoni* notified by South Africa for Subarea 48.6 and Division 58.4.4 (Conservation Measure 114/XV and 116/XV). A new fishery notification for these two fisheries for 1997/98 is discussed in paragraphs 4.27 to 4.29.

New Fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7

4.8 A total of 2 521 tonnes of *D. eleginoides* was taken between October 1996 and 31 August 1997 in Subareas 58.6 and 58.7. This comprised 1 200 tonnes taken in the South African EEZ around Prince Edward Islands up to late January 1997 (CCAMLR-XVI/8 Rev. 1), a further 1 320 tonnes taken in the South African EEZ around Prince Edward Islands between 1 March and 31 August 1997, and around 400 kg taken outside the EEZ in Subareas 58.6 and 58.7. Approximately half the catches in the South African EEZ were taken in Subarea 58.7.

4.9 All observer data have been submitted to CCAMLR, as have STATLANT data for the fisheries up to 30 June 1997. Additional length-at-age data, CPUE by month and set and summary VMS data were made available to the Working Group during the meeting.

4.10 It was agreed that, at least in respect of the fishery within the Prince Edward Islands EEZ, the results of fishing operations reported in CCAMLR-XVI/8 Rev. 1 had established that the fishery was commercially viable. Notifications for exploratory fisheries in Subareas 58.6 and 58.7 in 1997/98 outside EEZs are discussed in paragraphs 4.75 to 4.91.

New Fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2

4.11 CCAMLR-XVI/17 reports that, for a number of reasons, fishing operations in the new fisheries for *D. eleginoides* and *D. mawsoni* notified by New Zealand for Subareas 88.1 and 88.2 (Conservation Measure 115/XV) did not commence until May 1997. Only two sets were made, one each in Subareas 88.1 and 88.2, with a total catch of 128 kg of *D. eleginoides*. All data pertaining to these catches have been submitted to CCAMLR. The primary reason for the low fishing effort expended was that, given the late start to fishing, extensive sea-ice coverage greatly restricted fishing operations. A new fishery notification for these two fisheries for 1997/98 is discussed in paragraphs 4.30 to 4.34.

New Fishery for *Dissostichus* spp. in Division 58.4.3

4.12 New fishery notifications had been made in 1996 for Division 58.4.3 to take *D. eleginoides* and *D. mawsoni* by Australia and South Africa. In the Australian notification, the fish were to be taken by bottom trawl; in the South African notification, longlines were to be used. For 1996/97, this new fishery was covered by Conservation Measure 113/XV.

4.13 For the same administrative reasons cited earlier, no fishing was undertaken in Division 58.4.3 by South African vessels. An Australian vessel fished for four days on BANZARE Bank in March 1997, but no *Dissostichus* spp. were caught. Fishing for one day in April on Elan Bank resulted in a catch of 7 kg of *D. eleginoides* (WG-FSA-97/31). A VMS trial was successfully carried out. The low fishing effort was a result of poor weather conditions and a preference by the vessel to fish in Division 58.5.2.

New Fishery for Deepwater Species in Division 58.5.2

4.14 A new fishery for deepwater species not covered by Conservation Measures 109/XV and 110/XV had been notified by Australia in Division 58.5.2 (Conservation Measure 111/XV). No catches of the target species were made and the total catch of less than 24 tonnes consisted of known fish species taken as a by-catch in the *D. eleginoides* fishery. There is no current interest by Australia in progressing further with this fishery.

New Fisheries Notified for 1997/98

4.15 When reviewing notifications for new fisheries and for exploratory fisheries in 1997/98, the Working Group noted that in a number of cases, these fisheries had been new fisheries in 1996/97.

4.16 In two cases (South Africa: Subarea 48.6, Divisions 58.4.3 and 58.4.4 – CCAMLR-XVI/7; and Norway: Subarea 48.6 – CCAMLR-XVI/10), no fishing took place and new fishery notifications have been submitted for these for 1997/98.

4.17 In three other cases, however (Australia, Division 58.4.3; New Zealand, Subareas 88.1 and 88.2 – CCAMLR-XVI/17; UK/Republic of Korea, Subarea 48.3 – CCAMLR-XVI/21), only very small catches had been taken during 1996/97. In these cases, Members had taken different approaches to notifications for these fisheries in 1997/98; Australia submitted a notification for an exploratory fishery, while the New Zealand and UK/Republic of Korea notifications were for new fisheries. The Working Group agreed to consider these notifications under the categories nominated by the notifying Member. Where possible, however, additional advice is given in case the Scientific Committee or Commission should consider an alternative categorisation would be more appropriate.

4.18 To aid its discussions of new fishery notifications for 1997/98, the Working Group developed a check list of information required by Conservation Measure 31/X and, particularly in the case of fisheries for *Dissostichus* spp., the additional points in SC-CAMLR-XV paragraph 8.17. Summaries in tabular form were then developed for each notification and these are given below.

4.19 The Working Group observed that in some of the notifications for new and exploratory fisheries for 1997/98, it had not been specifically indicated that all the data collection and submission requirements of Conservation Measures 117/XV and 112/XV had been met. While these omissions were no doubt inadvertent, the Working Group recommended that all Members undertaking new or exploratory fisheries operations be reminded of the need to comply fully with these conservation measures.

4.20 In respect of Conservation Measure 112/XV, experience had been gained in the application of this in the South African fishery in Subareas 58.6 and 58.7. Compliance with those aspects of this conservation measure that related to fine scale rectangles was found to be feasible, but only if very good positional information was available, such as from VMS.

New Fishery for *D. eleginoides* in Division 58.4.4

4.21 Ukraine submitted a notification (CCAMLR-XVI/6) for a new fishery for *D. eleginoides* in Division 58.4.4. A summary is given in the following table.

New Fishery – Information Required	Information Supplied
Member	Ukraine
Reference	CCAMLR-XVI/6
Area	Division 58.4.4
Species	*D. eleginoides*
1997/98 notification by 28 July 1997	Yes
Catch level (tonnes) for viable fishery	Expect to catch about 500 tonnes in first year

Table (continued)

New Fishery – Information Required	Information Supplied
Fishery plan	Target fishing using Mustad longlines One fishing vessel during September 1997 to May 1998
Biological information	Research data since 1971
Effect on dependent species	Expect by-catch species to include *Bathyraja* spp., *Macrourus whitsoni* (*M. holotrachys*), *Muraenolepis marmoratus*. Catches of these species will not exceed those in Subarea 48.3 and Division 58.5.1. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	Biomass estimates from trawl survey (to 300 m)
Data collection plan	Haul-by-haul data as required by CCAMLR
Observer coverage	One national observer (biologist) and one CCAMLR observer
Position verification	Not mentioned
Other information/comment	Limit of 100 tonnes/fine-scale grid (Conservation Measure 112/XV) will not allow viable fishing due to bathymetry of region.

4.22 The Working Group noted that commercial catches of *D. eleginoides* have not been reported to date from this division and very little information is available to CCAMLR about the abundance and status of fish stocks in the division. It noted further, however, that CCAMLR-XVI/6 reveals the existence of data from a long series of trawl surveys conducted by Ukraine since 1971, which are apparently sufficient, *inter alia*, to allow biomass estimates for *D. eleginoides* to be calculated.

4.23 None of these data, however, have been submitted to CCAMLR, and the Working Group recommended that Ukraine be requested to submit these data as soon as possible. Had these data been available in the CCAMLR database, the Working Group believed that a thorough assessment of stock status similar to those undertaken in Subarea 48.3 and Division 58.4.2 could have been conducted and sound advice provided.

4.24 Biomass estimates of 1 500 tonnes and 3 000 tonnes for *D. eleginoides* are reported in CCAMLR-XVI/6 for the Ob and Lena Bank areas respectively. These estimates stem from surveys conducted within the 300 m isobath. The proposed catches of 500 tonnes may seem large in comparison with these biomass estimates, but such comparisons are very difficult to make, because the estimates are likely to relate only to juvenile fish at 300 m and less. It was unclear to the Working Group how catches would be restricted mainly to mature fish.

4.25 The Working Group agreed that, as suggested in CCAMLR-XVI/6, by-catches of *Bathyraja* spp., *Macrourus whitsoni* and *Muraenolepis marmoratus* were likely. It noted, however, that at shallower depths in the range proposed to be fished, it was also possible that *Lepidonotothen squamifrons* and *Notothenia rossii* may also be taken.

4.26 The Working Group noted that fishing was planned to take place throughout the summer. If this occurs, at times it will be very difficult to set longlines only at night and there may be a problem with bird by-catches (see also section 7).

New Fisheries for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.3 and 58.4.4

4.27 South Africa submitted a notification (CCAMLR-XVI/6) for new fisheries for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.3 and 58.4.4. A summary is given in the following table.

New Fishery – Information Required	Information Supplied
Member	South Africa
Reference	CCAMLR-XVI/7
Area	Subarea 48.6, Divisions 58.4.3 and 58.4.4
Species	*Dissostichus* spp.
1997/98 notification by 28 July 1997	Yes. Subarea 48.6 and Division 58.4.4 were new fisheries in 1996/97 (not fished).
Catch level (tonnes) for viable fishery	
Fishery plan	South African flagged longline vessels Limit of 100 tonnes/fine-scale grid (Conservation Measure 112/XV) 1 March to 31 August 1998, or earlier
Biological information	WG-FSA-96 for Subarea 48.6
Effect on dependent species	By-catch of any species other than *Dissostichus* shall not exceed 50 tonnes for each species. Jellymeat *Dissostichus* will be reported. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	WG-FSA-96 for Subarea 48.6
Data collection plan	Catch, effort and biological as stipulated in Conservation Measure 117/XV Five-day catch and effort reports
Observer coverage	CCAMLR observers on all trips
Position verification	VMS on all vessels
Other information/comment	Collection of environmental data

4.28 In 1996/97, there were new fisheries notified by South Africa for Subarea 48.6 and Division 58.4.4, but these were not fished. The notification for Division 58.4.4 is for a fishery in the same area as the Ukrainian notification discussed above. Australia has notified an exploratory fishery for Division 58.4.3 in 1997/98.

4.29 The South African notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

New Fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2

4.30 New Zealand submitted a notification (CCAMLR-XVI/17) for new fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2. A summary is given in the following table.

New fishery – Information required	Information supplied
Member	New Zealand
Reference	CCAMLR-XVI/17
Area	Subareas 88.1 and 88.2
Species	*Dissostichus* spp.
1997/98 notification by 28 July 1997	Yes. New fishery in 1996/97 (128 kg)
Catch level (tonnes) for viable fishery	Re-apply the 1980 tonnes catch limit
Fishery plan	Limit of 100 tonnes/fine-scale grid (Conservation Measure 112/XV), longline 15 February to 31 August 1998
Biological information	WG-FSA-96
Effect on dependent species	By-catch of any species other than *Dissostichus* shall not exceed 50 tonnes for each species. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	WG-FSA-96
Data collection plan	As required by CCAMLR
Observer coverage	CCAMLR observers on all trips
Position verification	VMS on all vessels, required to leave area on malfunction

4.31 A very small catch (128 kg) was taken in Subareas 88.1 and 88.2 in a new fishery undertaken by New Zealand in 1996/97 (see paragraph 4.11).

4.32 The New Zealand notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

4.33 The Working Group noted that extensive tagging of *D. mawsoni* had been carried out by US scientists at McMurdo and of *D. eleginoides* by Australian scientists at Macquarie Island. It is possible that tagged fish from both sources may be taken in this new fishery.

4.34 The Working Group noted that for this fishery, no further development of the Data Collection Plan (Conservation Measure 65/XII) by the Scientific Committee would be required in the coming year, should it be considered to be an exploratory fishery (see paragraph 4.67 and Appendix E).

New Fishery for *D. eleginoides* in Subarea 48.6

4.35 Norway submitted a notification (CCAMLR-XVI/10) for a new fishery for *D. eleginoides* in Subarea 48.6. A summary is given in the following table.

New Fishery – Information Required	Information Supplied
Member	Norway
Reference	CCAMLR-XVI/10
Area	Subarea 48.6
Species	*D. eleginoides*
1997/98 notification by 28 July 1997	Yes. New fishery in 1996/97 (permits not issued for fishing).
Catch level (tonnes) for viable fishery	Maximum catch of 1 500 tonnes
Fishery plan	Mainly in waters around Bouvet Island One vessel, longline
Biological information	
Effect on dependent species	All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	
Data collection plan	As required by CCAMLR
Observer coverage	As required by CCAMLR
Position verification	VMS

4.36 A new fishery had been notified by Norway for this subarea for 1996/97, but it was not fished.

4.37 As was the case with the notification submitted by Norway last year, the Working Group was unable to comment on the current notification, because of the lack of information provided in it. The Working Group did query the restriction of the notification to *D. eleginoides* only, since if fishing operations took place towards the southern part of Subarea 48.6, it is likely that *D. mawsoni* may also be taken.

New Fisheries for *Dissostichus* spp. in Subareas 48.1, 48.2 and 88.3

4.38 Chile submitted a notification (CCAMLR-XVI/9) for new fisheries for *Dissostichus* spp. in Subareas 48.1, 48.2 and 88.3. The document submitted is a summary of a much longer document (in Spanish only) which provided a comprehensive review of the proposed fishery and data collection plan. This document was made available to the Working Group. A summary of the notification is given in the following table.

New Fishery – Information Required	Information Supplied

Member	Chile
Reference	CCAMLR-XVI/9
Area	Subareas 48.1*, 48.2* and 88.3 (*see current conservation measures)
Species	*Dissostichus* spp.
1997/98 notification by 28 July 1997	Yes
Catch level (tonnes) for viable fishery	Suggest a catch limit of 1 980 tonnes in each subarea
Fishery plan	Research and commercial fishing Three longline vessels Limit of 100 tonnes/fine-scale grid (Conservation Measure 112/XV) 1 January to 31 October 1998
Biological information	No
Effect on dependent species	By-catch of any species other than toothfish shall not exceed 50 tonnes for each species. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	As per Conservation Measure 112/XV
Data collection plan	Catch, effort and biological as stipulated in 117/XV Five-day catch and effort reports
Observer coverage	CCAMLR observers on all trips
Position verification	VMS
Other information/comment	Collection of environmental data

4.39 The Working Group noted that, for Subareas 48.1 and 48.2, there were conservation measures in force that prohibited the directed fishing for finfish, at least until such time as a survey of stock biomass has been carried out, its results have been analysed, and a decision to reopen the fishery has been made by the Commission based on the advice of the Scientific Committee (Conservation Measure 72/XII and 73/XII).

4.40 WG-FSA-97/27 reports the results of a survey conducted around Elephant Island (Subarea 48.1) in 1996 and a comparison of the results of that survey with previous surveys (see paragraph 4.136). The conclusion was reached that the fish standing stock biomass has continued to decline since closure of the area and that there is little prospect of reopening the multispecies trawl fishery around Elephant Island. Dr Kock advised the Working Group that an estimate of the biomass of juvenile *D. mawsoni* around Elephant Island from the 1996 survey was approximately 57 tonnes (calculated from a catch of 26 individuals of lengths from 18 to 65 cm).

4.41 Dr Balguerías advised that no *Dissostichus* spp. were taken during the most recent Spanish survey (1991) carried out in Subarea 48.2 at depths less than 500 m.

4.42 Reviewing the background to Conservation Measures 72/XII and 73/XII, the Working Group observed that their imposition had arisen from concerns about the status of finfish species vulnerable to capture in trawl fisheries in relatively shallow waters. The new fishery proposal was for longlining in deeper waters using the Spanish system.

4.43 Reported by-catches by longline system in the *D. eleginoides* longline fishery in Subarea 48.3 are shown in Table 10.

4.44 The Working Group agreed that the by-catch rates in this table may be underestimated, because they are based on reported by-catches from the commercial fishery, rather than scientific observation. However, it agreed that if the Spanish system is used and longlining is restricted to depths greater than 600 m, it is unlikely that there would be any threat to the species of concern in Conservation Measures 72/XII and 73/XII.

4.45 The most likely by-catch species from the proposed longline fishery using the Spanish system are *Rajiformes* and *Macrourus* species. On the evidence from the table above, it appears that the by-catch rate of these species may also be low, but attention was again drawn to the likelihood that these estimates of by-catch rates are biased downwards.

4.46 CCAMLR-XVI/9 indicates that the intended fishing operations will comply with the by-catch provisions of Conservation Measure 112/XV. The Working Group recommended that, in addition to this, a by-catch provision similar to that in Conservation Measures 109/XV, 110/XV and 111/XV be adopted, under which vessels move to another fishing location if the by-catch in any one longline set of species other than *D. eleginoides* or *D. mawsoni* exceeds 5%, subject to the modification suggested in CCAMLR-XVI/12.

4.47 The principal concern raised by members of the Working Group regarding Subareas 48.1 and 48.2 was that the little existing information suggested that the abundance of *D. eleginoides* or *D. mawsoni* in these areas may be very low. In this context, attention was drawn to the very low abundances of juvenile *D. mawsoni* in research surveys in Subareas 48.1 and 48.2 in comparison with juvenile abundance estimates for *D. eleginoides* from surveys in Subarea 48.3. It was also noted that *D. mawsoni* may be more pelagic in its habits (WG-FSA-97/19 and 97/20), thus making it less vulnerable to capture in a bottom trawl survey.

4.48 In view of the possibility that very low catches may be achieved, the need for three vessels was queried. Prof. P. Arana (Chile) clarified that the fishing operation plan called for an initial cruise of 45 days by one vessel systematically exploring three regions within the areas. The results of this exploratory cruise will be used to prepare fishing plans for a later period using up to three vessels. If the initial exploratory cruise failed to locate sufficient fish, the later fishing operations would be abandoned.

4.49 Dr Kock observed that, as so little is known about the deepwater fish species to be found in these areas, it was very pleasing to see that an expert in taxonomy would be participating in the cruises. He offered further assistance in this area should it be needed.

4.50 The Working Group also noted that, because of the extensive sea-ice coverage in these subareas, only a restricted period of months would be available for fishing. During the summer months, there is a high risk of by-catch of giant petrels and albatrosses (see section 7). It was explained that the proposed fishing season of 1 January to 31 October allowed two potential periods of sea-ice-free fishing activities.

4.51 In relation to the proposed fishing activities in Subarea 88.3, it was noted that there was a low risk of seabird by-catch (see paragraph 7.126(xii)).

4.52 Attention was drawn to the extensive tagging of *D. mawsoni* by US scientists at McMurdo. A close watch should be kept for the presence of external tags.

New Fisheries for *D. eleginoides* in Subareas 48.1, 48.2 and 48.4

4.53 Uruguay submitted a preliminary notification by letter for new fisheries for *D. eleginoides* in Subareas 48.1, 48.2 and 48.4. No accompanying document has been submitted to CCAMLR. A summary of the information contained in the preliminary notification is given in the following table.

New Fishery – Information Required	Information Supplied
Member	Uruguay
Reference	Preliminary notification by letter (4 August 97)
Area	Subareas 48.1*, 48.2* and 48.4*. (*see current conservation measures)
Species	*D. eleginoides*
1997/98 notification by 28 July 1997	No
Catch level (tonnes) for viable fishery	-
Fishery plan	Up to six vessels?
Biological information	-
Effect on dependent species	-
Information for calculation of potential yield	WG-FSA-97
Data collection plan	-
Observer coverage	-
Position verification	-

4.54 The new fisheries proposed for Subareas 48.1 and 48.2 are for the same areas notified by Chile in CCAMLR-XVI/9. Existing conservation measures for these areas are discussed in paragraphs 4.39 to 4.44.

4.55 Insufficient information is provided in this preliminary notification for the Working Group to comment. Concern was expressed, however, that apparently up to six vessels may be involved in this fishery. This may be rather excessive, given the notification submitted by Chile for up to three vessels in these subareas and the doubts expressed by the Working Group as to the likely levels of abundance of *Dissostichus* spp. in these areas (see paragraphs 4.47 and 4.48).

4.56 Under these circumstances, if fishing does take place the Working Group recommended that consideration should be given to imposition of restrictions on the level of fishing effort, as well as existing limitations on catches in fine-scale rectangles and overall precautionary catch limits for these areas. Dr Holt noted that there was a precedent for such restrictions in the measures adopted for the crab fishery in Subarea 48.3.

4.57 The Working Group noted that Conservation Measure 101/XV sets a catch limit of 28 tonnes for *D. eleginoides* in Subarea 48.4 for 1996/97, and that catches of *D. eleginoides* (but not *D. mawsoni*) have previously been reported (see paragraph 4.115; SC-CAMLR-XV, paragraph 4.79).

4.58 The Working Group was also concerned that the preliminary notification was for *D. eleginoides* only. It is highly likely that *D. mawsoni* will also be taken.

New Fishery for *Martialia hyadesi* in Subarea 48.3

4.59 The UK and the Republic of Korea submitted a notification (CCAMLR-XVI/21) for a new fishery for *M. hyadesi* in Subarea 48.3. A summary is given in the following table.

New Fishery – Information Required	Information Supplied
Member	UK and Republic of Korea
Reference	CCAMLR-XVI/21
Area	Subarea 48.3
Species	*M. hyadesi*
1997/98 notification by 28 July 1997	No. New fishery in 1996/97 (81 tonnes)
Catch level (tonnes) for viable fishery	800 to 1 200 tonnes per vessel. Overall catch limit 2 500 tonnes. Prospects discussed in SC-CAMLR-XVI/BG/10.
Fishery plan	Joint venture UK/Republic of Korea Jig fishery
Biological information	Research and 1997 fishery data
Effect on dependent species	Limited by-catch, potential threat to squid predators
Information for calculation of potential yield	Research and WG-FSA-96
Data collection plan	As required by CCAMLR
Observer coverage	Scientific observers on all trips
Position verification	Not mentioned

4.60 As with the notification by New Zealand (CCAMLR-XVI/17), this fishery had been notified as a new fishery for 1996/97, but only a very small catch (81 tonnes) was taken (see paragraphs 4.2 to 4.5).

4.61 The UK/Republic of Korea notification addresses all the information requirements Conservation Measure 31/X. An analysis of future prospects for the fishery is given in SC-CAMLR-XVI/BG/10.

4.62 The Working Group noted that for this fishery, no further development of a Data Collection Plan (Conservation Measure 65/XII) by the Scientific Committee would be required in the coming year, should it be considered to be an exploratory fishery (see paragraph 4.67 and Appendix E).

Exploratory Fisheries Notified for 1997/98

4.63 Notifications of exploratory fisheries for 1997/98 were submitted by Australia (Division 58.4.3) and South Africa (Subareas 58.6 and 58.7), and notifications by Ukraine and Russia for Subareas 58.6 and 58.7 were also considered to be for exploratory fisheries.

4.64 As with new fishery notifications for 1997/98, the Working Group developed a check list of information required by Conservation Measure 65/XII to aid it in its discussions and summaries in tabular form were prepared for each notification.

4.65 This is the first time that the Working Group has had to provide advice on notifications for exploratory fisheries under Conservation Measure 65/XII. One of the requirements of Conservation Measure 65/XII is that the Scientific Committee shall develop a Data Collection Plan for each exploratory fishery.

4.66 Each of the notifications to be considered at this meeting are for fisheries that were new fisheries in 1996/97. Although data for these fisheries have been submitted to CCAMLR, there has not been sufficient time for the Working Group to analyse these data or to develop detailed specific Data Collection Plans.

4.67 Both the Australian and South African notifications for *Dissostichus* spp. contained comprehensive data collection plans that were quite similar. Based on these and on the UK/Republic of Korea notification for a new fishery for squid, an outline Data Collection Plan was developed by the Working Group. This is included as Appendix E. The status of scientific observers is referred to the Scientific Committee for further consideration.

4.68 The Working Group noted that in the preamble to Conservation Measure 65/XII, the Commission had agreed that exploratory fishing should not be allowed to expand faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles set forth in Article II. A vital element in ensuring this is the ability of the Scientific Committee to conduct stock assessments.

4.69 For *Dissostichus* spp., the assessment methods currently available to the Scientific Committee all require research survey estimates of biomasses. For longline fisheries for *Dissostichus*, the Working Group has been unable to assess the status of the stocks using data from longline fishing only. The Working Group agreed that the conducting of research surveys was an essential element of the precautionary development of exploratory fisheries. It therefore recommended that research trawl surveys be included at the very early stages of the development of new and exploratory fisheries for *Dissostichus*. In this context, the

Working Group welcomed the inclusion of plans for the early conducting of research surveys in the notifications by South Africa and Australia.

Exploratory Fishery for *Dissostichus* spp. in Division 58.4.3

4.70 Australia submitted a notification by letter for an exploratory fishery for *Dissostichus* spp. in Division 58.4.3. A summary of the information provided is given in the following table.

Exploratory Fishery – Information Required	Information Supplied
Member	Australia
Reference	Letter
Area	Division 58.4.3
Species	*Dissostichus* spp.
1997/98 notification date	Received by Secretariat on 19 September 1997 New fishery in 1996/97
Catch level (tonnes) for viable fishery	800 tonnes
Fishery plan	One vessel Trawl fishery
Biological information	Research data
Effect on dependent species	As for 1996/97 new fishery and WG-FSA-97/31
Information for calculation of potential yield	WG-FSA-96
Research plan	WG-FSA-97/31
Observer coverage	CCAMLR observers on all trips
Registration of vessel details	Yes
Position verification	VMS

4.71 As discussed in paragraphs 4.12 and 4.13, a new fishery had been notified for this division by Australia for 1996/97. Only 7 kg of *D. eleginoides* had been taken.

4.72 A detailed research and data collection plan for this fishery is given in WG-FSA-97/31. Random stratified trawl surveys are planned for both BANZARE and Elan Banks, though surveys of both banks will not necessarily be completed in the first year. When these surveys have been completed, it should be possible for the Working Group to conduct stock assessments using the methods employed currently for Subarea 48.3 and Division 58.5.2.

4.73 Mr Williams advised that past observations have shown no lethal interactions of the fishing gear and fishing activities with seabirds and marine mammals. Australian regulations require that there be no overboard discharge of offal or waste.

4.74 The Working Group noted that a new fishery proposal for a longline fishery for *Dissostichus* spp. in Division 58.4.3 was discussed in paragraphs 4.27 to 4.29.

Exploratory Fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 outside EEZs

4.75 Notifications have been submitted for exploratory fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 outside EEZs by South Africa (CCAMLR-XVI/8), Ukraine (CCAMLR-XVI/6) and Russia (by letter).

4.76 A summary of the information provided in the South African notification is given in the following table.

Exploratory Fishery – Information Required	Information Supplied
Member	South Africa
Reference	CCAMLR-XVI/8 Rev. 1
Area	Subareas 58.6 and 58.7, outside EEZs
Species	*Dissostichus* spp.
1997/98 notification date	Received by Secretariat on 15 July 1997
Catch level (tonnes) for viable fishery	Up to 3 200 tonnes in each subarea
Fishery plan	South African flagged longline vessels Catch rate decision rule (CCAMLR-XVI/8 Rev. 1) Year round Haul-by-haul data as required by CCAMLR
Biological information	WG-FSA-96
Effect on dependent species	By-catch of any species other than toothfish shall not exceed 50 tonnes for each species. Jellymeat *Dissostichus* will be reported. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	WG-FSA-96
Research plan	Experimental fishing, two-stage decision rule Research survey in each subarea within two years
Observer coverage	CCAMLR observers on all trips
Registration of vessel details	?
Position verification	VMS on all vessels
Other information/comment	Collection of environmental data

4.77 As discussed in paragraphs 4.8 to 4.10, a new fishery had been notified for these subareas by South Africa for 1996/97. A total of 2 521 tonnes of *D. eleginoides* had been taken by 31 August 1997, almost all within the EEZ around Prince Edward Islands. In addition, very large unreported catches were estimated to have been taken in these subareas.

4.78 The notification by South Africa is intended to cover longline fishing only outside the Prince Edward Islands EEZ. No notification had been submitted in respect of fishing activities within the Prince Edward Islands EEZ for 1997/98.

4.79 Detailed research, data collection and fishing plans are included in CCAMLR-XVI/8 Rev. 1. A three stage research plan involving both normal and experimental fishing is proposed, with a two-stage decision rule based on catch rates in fine-scale rectangles being used to set tiered catch levels. The research plan also envisages that a research survey will be completed in the two subareas within the first two years. This should enable the Working Group to conduct stock assessments using the methods employed currently for Subarea 48.3 and Division 58.5.2.

4.80 The decision rule proposed in the South African notification for setting tiered catch levels based on catch rates in fine-scale rectangles was similar to proposals made last year by South Africa and New Zealand. The Working Group recalled its previous discussions on fine-scale rectangle catch limits and its agreement that a uniform approach should be taken across all new and exploratory fisheries. It had consequently recommended that there should be a 100-tonne limit imposed on the catches taken in each 0.5 by 1 degree rectangle (SC-CAMLR-XV, Annex 5, paragraphs 4.22 to 4.27).

4.81 It was further observed that one of the reasons it had preferred the 100-tonne limit to the adaptive approach using a more complex decision rule was that the properties of that decision rule had not yet been elaborated. The Working Group agreed that it could consider the adaptive approach further if a paper considering further development of it were submitted for the Working Group's consideration at its next meeting.

4.82 Several members commented, however, that practical experience with application of the fine-scale rectangle catch limit had indicated that there were some problems in its application, both for trawl and longline fisheries. These occurred particularly in circumstances where there were limited fishable grounds or fishable aggregations within the area being fished, or where the overall catch limit for the area was low. In some of these cases, strict adherence to the 100-tonne limit could make the fishery unviable.

4.83 The Working Group recalled that the primary aim of this conservation measure was to ensure that fishing effort was spread around the area. In very large areas, such as Subarea 48.6, the measure should not cause problems. However, it did appear that problems could arise in smaller areas with low overall catch limits. It therefore believed that consideration might be given to some relaxation of the fine scale limit in appropriate areas.

4.84 The fishing season proposed envisaged no closed seasons other than those agreed by CCAMLR for mitigating seabird mortality or for other reasons. In this respect, CCAMLR-XVI/8 Rev. 1 comments on the likely efficacy of closed seasons for mitigating seabird mortality, for improving knowledge of *Dissostichus* dynamics year round and in relation to the need for maintaining a legitimate presence. The Working Group felt it was not appropriate for it to discuss these points, other than to note that these subareas appear to be some of the highest risk areas for seabird mortality (paragraphs 7.126(viii) and (ix)).

4.85 Dr Miller noted that the 3 200 tonnes maximum catch limits for each area proposed in CCAMLR-XVI/8 Rev. 1 was based on extrapolation of catch rates from Subarea 48.3 and that the limits were presented for the purpose of provoking discussion. He also noted that, while the effect of the very large estimated unreported catches on the stocks in these areas was uncertain, they did demonstrate the likelihood of substantial abundances of *D. eleginoides* in the general region, possibly also including adjacent areas close to the northern boundary of CCAMLR.

4.86 When calculating estimates of precautionary catch levels using extrapolations based on seabed areas or numbers of fine-scale rectangles, the Working Group noted that it would not be excluding the areas contained within EEZs in the subareas or divisions (see paragraphs 4.94 to 4.96). Should fishing within EEZs be restricted, with the precautionary catch limits being taken only outside of EEZs, then higher removals from the stocks than intended may occur.

4.87 A summary of the information provided in the Ukrainian notification (CCAMLR-XVI/6) is given in the following table.

Exploratory Fishery – Information Required	Information Supplied
Member	Ukraine
Reference	CCAMLR-XVI/6

Table (continued)

Exploratory Fishery – Information Required	Information Supplied
Area	Subareas 58.6 and 58.7, outside EEZs
Species	*Dissostichus* spp.
1997/98 notification date	Received by Secretariat on 11 June 1997
Catch level (tonnes) for viable fishery	Expect to catch about 500 tonnes in first year
Fishery plan	Target fishing using Mustad longlines One fishing vessel from September 1997 to May 1998
Biological information	-
Effect on dependent species	Expect by-catch species to include *Bathyraja* spp, *Macrourus whitsoni* (*M. holotrachys*), *Muraenolepis marmoratus*. Catches of these species will not exceed those in Subarea 48.3 and Division 58.5.1. All CCAMLR measures will be taken to minimise incidental catches.
Information for calculation of potential yield	-
Research plan	Haul-by-haul data as required by CCAMLR
Observer coverage	One national observer (biologist) and one CCAMLR observer

Registration of vessel details	-
Position verification	-
Other information/comment	Notified as new fishery. Limit of 100 tonnes/fine-scale grid (Conservation Measure 112/XV) will not allow viable fishing due to bathymetry of region.

4.88 In the original notification, this proposal had been treated as for a new fishery, but on the advice of the Secretariat it has been treated here as for an exploratory fishery.

4.89 There was insufficient information provided to allow the Working Group to evaluate what is intended.

4.90 A summary of the information provided in the Russian letter of notification is given in the following table.

Exploratory Fishery – Information Required	Information Supplied
Member	Russia
Reference	Letter
Area	Subareas 58.6 and 58.7, outside EEZs
Species	*Dissostichus* spp.
1997/98 notification date	Received by Secretariat on 20 August 1997
Catch level (tonnes) for viable fishery	

Table (continued)

Exploratory Fishery – Information Required	Information Supplied
Fishery plan	Longline fishery Same plan as for South Africa
Biological information	WG-FSA-96
Effect on dependent species	Same plan as for South Africa
Information for calculation of potential yield	WG-FSA-96
Research plan	
Observer coverage	Same plan as for South Africa
Registration of vessel details	
Position verification	

4.91 As with the Ukrainian notification, insufficient information had been provided for the Working Group to comment on the Russian notification. Dr K. Shust (Russia) advised that all CCAMLR regulations and conservation measures will be strictly adhered to in this fishery, and as far as possible the research and data collection plans proposed by South Africa will be followed.

Calculation of Precautionary Catch Levels

4.92 Last year, the Working Group had agreed that a conservative approach to advising on precautionary catch limits for new fisheries would be to extrapolate from estimated yields for *D. eleginoides* in Subarea 48.3 and Division 58.5.2 in a manner that is discounted to take implicit account of incomplete knowledge of previously unexploited areas and/or adjusted for the relative areas of fishable seabed (SC-CAMLR-XV, Annex 5, paragraph 4.28).

4.93 In its 1996 report (SC-CAMLR-XV, Annex 5, paragraph 4.29), the Working Group presented an example calculation involving multiplying the yield estimate by 0.5. Subsequently, the Commission agreed to precautionary catch limits equal to the yield estimates multiplied by 0.45.

4.94 It was not possible last year to make an adjustment of precautionary catch limits based on proportional seabed areas, and the Secretariat was asked to undertake such calculations during the intersessional period. Estimates were tabled at this meeting in SC-CAMLR-XVI/BG/17. Also available was a computer program that allowed calculations for any range of depths required.

4.95 During the meeting, at the request of the Working Group, the Secretariat calculated, for each subarea and division, the estimated seabed areas in three depth ranges: 0 to 600 m (possibly representative of juvenile habitat), 600 to 1 800 m (longline fishing depths) and 500 to 1 500 m (trawl fishing depths).

4.96 It was noted that the estimates of seabed areas in high latitudes were more uncertain than those in lower latitudes, and it had been necessary to perform these calculations only as far as 70°S. This may result in a considerable underestimation of seabed area if there are substantial areas of shallow water in high latitudes. For this reason, the degree of underestimation may be quite large in Subareas 88.1 and 88.2 (Ross Sea), for example. Also, it is likely that seabed areas in regions with numbers of isolated seamounts are underestimated.

4.97 Dr Miller observed that the seabed area calculations also ignored the areas to the north of the northern boundary of the Convention Area. At least in the case of Subareas 58.6 and 58.7, there were undoubtedly *D. eleginoides* present to the north. It was important to recognise that conservation of *D. eleginoides* involved consideration of areas and fisheries both inside and outside the Convention Area.

4.98 Seabed areas above 600 m may provide some indication of the area of juvenile habitat, but the Working Group emphasised that interpretation of these was difficult, because of uncertainties in the extent of migratory movement of *Dissostichus* spp.

4.99 The Working Group agreed that at this meeting it would carry out calculations of precautionary catch limits that involved:

(i) proportional adjustments for areas of fishable seabed. For longline fisheries the adjustment used the relative areas of seabed between 600 and 1 800 m in Subarea 48.3 and in the area under consideration. For trawl fisheries, the depth range used was 500 to 1 500 m;

(ii) calculations using the GYM with biological and fishery parameters set at the values most appropriate for the area under consideration. For most areas, this meant using parameters from assessments for Subarea 48.3 for longline fisheries (see Tables 20 and 33), or those for Division 58.5.2 for trawl fisheries. Information from observer reports for Subareas 58.6 and 58.7 on maturity at length (range 50–80 cm, LM_{50} = 65 cm) and selectivity (knife-edge at 55 cm) were used in calculations for those two subareas;

(iii) use of the GYM to incorporate the potential effects of the recent catch history on the long-term status of the spawning stocks in each area for which calculations were made; and

(iv) yield levels calculated in this way were then multiplied by a factor less than 1.0 to account for the uncertainty of extrapolation to previously unfished or lightly fished areas.

4.100 The Working Group noted that the catches in the 1996/97 season, including unreported catches, are unlikely to substantially affect the precautionary long-term annual yields (see paragraph 4.270 for consideration of this issue). However, these catches were substantially greater than the crude estimates of yield presented here. The Working Group agreed that sustained catches substantially above estimates of the long-term annual yield could cause the spawning stocks to collapse.

4.101 The proportional adjustments for seabed area were made by adjusting the mean recruitment in the GYM for either Subarea 48.3 or Division 58.5.2 by the relative seabed areas in the appropriate fishable depth ranges.

4.102 The Working Group noted that last year precautionary catch limit calculations for new fisheries had used average catches in Subarea 48.3 and Division 58.5.2 as an indicator of yield. This year estimates from the GYM were used. In addition to providing a more consistent estimator of yield, use of the GYM allowed use of absolute estimates of recruitment and accounting for the different recent catch histories in each area.

4.103 For Subareas 58.6 and 58.7, two separate sets of calculations were done. The first set involved calculation of seabed areas and allocation of catches according to the existing boundaries of the two subareas. These are labelled ‘current’ in Table 11. The second set of calculations involved use of the new boundaries for the two subareas as proposed in WG-FSA-97/50. These areas are labelled ‘proposed’ in Table 11.

4.104 Initially, precautionary catch limit calculations were done for the whole of the areas under consideration, regardless of the *Dissostichus* species involved. However, several members expressed concern that the available knowledge about *D. mawsoni* was much less than that for *D. eleginoides*. This implied that precautionary catch levels calculated in the manner proposed would be much more uncertain for *D. mawsoni* than for *D. eleginoides*. In these circumstances, it may be appropriate for a greater discount factor for uncertainty to be applied for *D. mawsoni*.

4.105 Accordingly, the calculations (including the proportional seabed area calculations) were repeated separately for those parts of each subarea or division that were believed to be occupied by the two species. The discount factor used for *D. eleginoides* was 0.45, matching the factor used by the Commission for calculating precautionary catch limits for new fisheries last year. The discount factor used for *D. mawsoni* was 0.3. The Working Group emphasised that there is no scientific basis for selecting particular values for these discount factors.

4.106 The results of these calculations are shown in the Table 11.

4.107 In view of the restricted and scattered nature of information on *D. mawsoni*, the Working Group recommended that the Secretariat compile all available information on this species for presentation to the Working Group at its next meeting.

4.108 Mr Williams observed that if the proposed new fisheries were to encounter both *D. eleginoides* and *D. mawsoni*, there would be a need for observers to identify them positively. He agreed to prepare an addendum to the *Scientific Observers Manual* to cover this.

4.109 Before considering the individual precautionary catch limit calculations in detail, the Working Group discussed the strengths and limitations of the calculation procedure used. On the one hand, the Working Group agreed that the procedure used was, scientifically, the best available given the existing information. In particular, the procedure was essentially the one it had wanted to use last year, but had been unable to because of the lack of estimates of areas of fishable seabed. On the other hand, however, there were a number of intrinsic uncertainties in the procedure that meant the results must be interpreted with considerable caution.

(i) First, as was noted last year (SC-CAMLR-XV, Annex 5, paragraph 4.30), the values calculated for precautionary limits should not be taken to imply that such quantities of fish would actually be available for capture.

(ii) The calculation procedure relies explicitly on extrapolation from assessments of existing fisheries to new and exploratory fisheries in previously unfished or lightly fished areas. In particular, it makes the assumption that the recruitment rate per unit area of fishable seabed is the same across all areas. This assumption may not hold, but there was evidence from some areas (e.g. Crozet Islands) that the approach produced precautionary catch limits that were consistent with independent information of yield levels.

(iii) There is much greater uncertainty associated with the calculations for *D. mawsoni*. This is reflected in part in the greater discount factor used for uncertainty, but it must be emphasised that the factors used in the calculations are to a large extent arbitrary.

(iv) Estimates of unreported catches are also uncertain.

4.110 In reviewing the precautionary catch limits calculated for individual areas, several members reiterated their concerns (see paragraphs 4.96 and 4.97) that the fishable seabed areas listed may not for some subareas (e.g. Subareas 58.6, 58.7 and 88.2) be fully representative.

4.111 Subareas 48.1 and 48.2 are covered by existing conservation measures (72/XII and 73/XII) prohibiting the directed fishing for finfish. As discussed in paragraphs 4.42 to 4.44, the Working Group agreed that, provided longline fishing using the Spanish system is restricted to depths greater than 600 m, it was unlikely that the undertaking of new fisheries for *Dissostichus* spp. in these subareas would threaten the species that these conservation measures were designed to protect.

4.112 In a number of cases, the precautionary catch limits for either *D. eleginoides* or *D. mawsoni* calculated using the agreed procedure are zero or very low. The Working Group acknowledged that the method used to split catch limits between the two species was only approximate and based on rather imperfect knowledge of the distribution of the two species. On these grounds, and in view of the need to gain as much new information as possible, it would be quite inappropriate to insist, for example, that fishing should cease if a zero or low precautionary catch limit on one species was inadvertently exceeded.

4.113 Rather, the Working Group agreed that some flexibility was needed. This might be achieved, for example, by allowing a limited proportion of the catch limit for each *Dissostichus* species to be transferred to the other species.

4.114 With the exception of *D. eleginoides* in Subarea 48.4, and subject to the above points, the Working Group recommended that the precautionary catch limits given in Table 11 for *D. eleginoides* and *D. mawsoni* be applied for the new and exploratory fisheries in the subareas and divisions for which they were notified.

4.115 A catch limit of 28 tonnes was set for *D. eleginoides* in Subarea 48.4 during 1996/97 (Conservation Measure 101/XV). This was discussed in relation to the notification for a new fishery in Subarea 48.4 by Uruguay in paragraph 4.57. Management advice for *D. eleginoides* on a recommended catch limit in this subarea is given in paragraphs 4.233.

General Comments

4.116 The large number of notifications for new and exploratory fisheries for 1997/98, along with the need to review the results of new fisheries notified for 1996/97, meant that a large part of the time available to the Working Group was devoted to discussing this topic.

4.117 The Working Group was disappointed by the large variation in the amount of information contained in the notifications. In many cases, there was insufficient information provided for the Working Group to develop useful advice and in some cases the notifications referred to data and analyses not available to the Working Group. In other cases, there were varying interpretations as to what constituted new or exploratory fisheries (see paragraph 4.17).

4.118 In a number of cases, the notifications indicated that the data collection and/or research and fishery plans adopted would be as required by CCAMLR. It was not clear that these statements of intent would always result in practice in the requisite data being collected successfully or the plans being fully followed.

4.119 For example, the experience in the South African fisheries in Subareas 58.6 and 58.7 indicates that compliance with Conservation Measure 112/XV requires that each vessel has very accurate positioning information. This experience has been mirrored in other new fisheries carried out by Australia and New Zealand. In each case, the method used to ensure accurate positioning information was installation of a VMS on each vessel.

Management Advice

4.120 Seven new fisheries operated in 1996/97. Information and comments on these are in paragraphs 4.1 to 4.14. Seven notifications for new fisheries in 1997/98 had been received by the Secretariat by the start of the meeting. Information and Working Group comments on these are given in paragraphs 4.15 to 4.62. In addition, four notifications had been received for exploratory fisheries in 1997/98. Information and Working Group comments on these are in paragraphs 4.63 to 4.91.

4.121 In Subareas 48.1 and 48.2, there are conservation measures in force which prohibit the directed fishing for finfish, at least until such time as a survey of stock biomass has been carried out, its results have been analysed, and a decision to reopen the fishery has been made by the Commission based on the advice of the Scientific Committee (Conservation Measures 72/XII and 73/XII). These conservation measures had been imposed as a result of concerns about the status of finfish species vulnerable to capture in trawl fisheries in relatively shallow waters.

4.122 Notifications for new fisheries in Subareas 48.1 and 48.2 have been received from both Chile (CCAMLR-XVI/9) and Uruguay (by letter). These were for longlining for *Dissostichus* spp. in deeper waters using the Spanish system.

4.123 Recent surveys around Elephant Island (Subarea 48.1) in 1996 and the results of a 1991 Spanish survey in Subarea 48.4 both suggested that the species of concern in Conservation Measures 72/XII and 73/XII continued to have low abundance. However, examination of by-catch rates for the longline fisheries in Subarea 48.3 (paragraphs 4.42 to 4.44) indicated that if the Spanish system is used and longlining is restricted to depths greater than 600 m, it is unlikely that there would be any threat to the species of concern in Conservation Measures 72/XII and 73/XII.

4.124 The Working Group was concerned, however, that the surveys in these subareas had revealed very low abundances of juvenile *D. mawsoni* (paragraphs 4.40 and 4.41). It is therefore possible that the new fisheries may catch very few fish. The Working Group was pleased to receive confirmation that the Chilean fishing operation plan called for an initial exploratory cruise of 45 days by one vessel and that the results of this cruise will be used by Chile to prepare fishing plans for a later period using up to three vessels. If the initial exploratory cruise failed to locate sufficient fish, the later fishing operations would be abandoned.

4.125 It was noted, however, that there was, in addition, a notification for a new fishery in this area by Uruguay, which involves up to six vessels. The Working Group recommended that if fishing does take place, consideration should be given to imposition of restrictions on the level of fishing effort, as well as on fine-scale rectangle and overall precautionary catch limits for these areas (paragraph 4.56).

4.126 The Chilean notification for a new fishery in Subareas 48.1 and 48.2 (CCAMLR-XVI/9) indicates that the intended fishing operations will comply with the by-catch provisions of Conservation Measure 112/XV. The Working Group recommended that, in addition to this, a by-catch provision similar to that in Conservation Measures 109/XV, 110/XV and 111/XV be adopted, under which vessels move to another fishing location if the by-catch in any one longline set of species other than *D. eleginoides* or *D. mawsoni* exceeds 5%, subject to the modification suggested in CCAMLR-XVI/12 (paragraphs 4.43 to 4.46).

4.127 The Working Group was able this year to complete calculations of precautionary catch limits for new and exploratory fisheries in 1997/98 using methods similar to those it had wished to use last year. These methods are described in paragraph 4.99. The Working Group agreed that the procedure used was, scientifically, the best available given the existing information. However, there were still significant uncertainties that imply a need to take account of the points discussed in paragraphs 4.109 and 4.110.

4.128 Separate precautionary catch limits were calculated for *D. eleginoides* and *D. mawsoni.* The final step in the calculation involved multiplying by a factor that allowed for the uncertainty in extrapolation from known fisheries (Subarea 48.3 for longlines and Division 58.5.2 for trawl fisheries) to previously unfished or lightly fished areas. A factor of 0.45 (as used by the Commission last year) was used for *D. eleginoides* and 0.3 (making a greater allowance for uncertainty) was used for *D. mawsoni.* While it believed the factor should be less for *D. mawsoni* than for *D. eleginoides,* the Working Group emphasised that there was no scientific basis for selecting appropriate values for these factors.

4.129 The results of the calculations are shown in Table 11 by area, species and fishing gear for each of the new and exploratory fisheries notified for 1997/98.

4.130 In a number of cases, the precautionary catch limits for either *D. eleginoides* or *D. mawsoni* calculated using the agreed procedure are zero or very low. The method used to split catch limits between the two species is only approximate and it is based on imperfect knowledge of the distribution of the two species. In view of the need to gain as much new information as possible, the Working Group believed that it would be quite inappropriate to insist, for example, that fishing should cease if a zero or low precautionary catch limit on one species was inadvertently exceeded. Rather, the Working Group agreed that some flexibility was needed. This might be achieved, for example, by allowing a limited proportion of the catch limit for each *Dissostichus* species to be transferred to the other species.

4.131 With the exception of *D. eleginoides* in Subarea 48.4, and subject to the above points, the Working Group recommended that the precautionary catch limits given in Table 11 for *D. eleginoides* and *D. mawsoni* be applied for the new and exploratory fisheries in the subareas and divisions for which they were notified.

4.132 In addition to the conservation measures for Subareas 48.1 and 48.2 discussed above, a catch limit of 28 tonnes was set for *D. eleginoides* in Subarea 48.4 during 1996/97 (Conservation Measure 101/XV). This was discussed in relation to the notification for a new fishery in Subarea 48.4 by Uruguay in paragraph 4.57. Management advice for *D. eleginoides* on a recommended catch limit in this subarea is given in paragraph 4.233.

4.133 The primary aim of those aspects of Conservation Measure 112/XV that imposed a 100-tonne limit on catches of *Dissostichus* spp. in fine-scale rectangles was to ensure that fishing effort was spread around the area. In very large areas, such as Subarea 48.6, the measure should not cause problems. However, it did appear that problems could arise in smaller areas with low overall catch limits (see paragraphs 4.82 and 4.83). The Working Group therefore believed that consideration might be given to some relaxation of the fine-scale limit in appropriate areas.

4.134 Management advice stemming from consideration of seabird by-catches in new and exploratory fisheries is given in paragraphs 7.148(xxi) and (xxii).

Antarctic Peninsula (Subarea 48.1)

Notothenia rossii, Gobionotothen gibberifrons, Chaenocephalus aceratus, Chionodraco rastrospinosus, Lepidonotothen larseni, Lepidonotothen squamifrons and *Champsocephalus gunnari*

4.135 Finfish stocks in the Antarctic Peninsula region (Subarea 48.1) have been exploited from 1978/79 to 1988/89 with most of the commercial harvesting taking place in the first two years of the fishery. Given the substantial decline in biomass of the target species in the fishery, mackerel icefish (*C. gunnari*) and marbled notothenia (*N. rossii*) by the mid-1980s, Subarea 48.1 was closed for finfishing from the 1989/90 season onwards.

4.136 A bottom trawl survey within the 500 m isobaths was carried out by Germany in the vicinity of Elephant Island, one of the most important fishing grounds in the area, in November/December 1996 (paragraphs 3.35 and 4.40). Results from this survey (WG-FSA-97/27) provided the Working Group with the first opportunity to assess the status of most of the abundant fish stocks (*C. gunnari*, *C. aceratus*, *G. gibberifrons*, *L. squamifrons*, *C. rastrospinosus* and *L. larseni*) after the closure of the area for finfishing (Table 12). No new information could be obtained during the survey on the status of *N. rossii*.

4.137 Biomass estimates (Table 13) using CCAMLR standard methodology (de la Mare, 1994) suggested that, despite a closure of the area for finfishing, the fish standing stock biomass had declined compared to the previous survey in 1987. The causes for this decline are unclear, but are likely to be sought in natural variability. Unauthorised fishing which might have taken place after the closure of the area for fishing in 1989 could be a possible explanation for the decline in fish standing stock biomass. However, the size distribution of the most abundant species appears to have changed little.

4.138 Given the current low abundance of *C. gunnari* and the other species and the difficulties which CCAMLR had experienced previously in managing fisheries which exploit mixed-species assemblages, the Working Group did not attempt to calculate precautionary catch limits using the GYM during the meeting.

Management Advice

4.139 There appears to be little prospect for a substantial fishery given the low biomass estimates for the 1996/97 season and some of the uncertainties associated with decline in biomass compared to 1987. The Working Group therefore recommended that Conservation Measure 72/XII should remain in force for the species considered in this section until future surveys indicate an increase in fish biomass in the subarea.

4.140 Further advice concerning the new longline fisheries for *Dissostichus* spp. in this subarea is contained in paragraphs 4.120 to 4.134.

South Orkney Islands (Subarea 48.2)

4.141 No new information was available to the Working Group on stocks in this subarea.

Management Advice

4.142 In the absence of new information on stocks in this subarea, the Working Group noted that fisheries in Subarea 48.2 should remain closed in accordance with Conservation Measure 73/XII. Advice relating to the new longline fisheries for *Dissostichus* spp. in this subarea is contained in paragraphs 4.120 to 4.134.

South Georgia (Subarea 48.3)

Dissostichus eleginoides (Subarea 48.3)

Standardisation of CPUE Indices

4.143 Following on the work conducted at its last meeting, the Working Group used generalised linear models (GLMs) to standardise CPUE data from the *D. eleginoides* fishery in Subarea 48.3. The aim of this analysis was to determine whether there are any annual trends in CPUE after controlling for the effects of any other factors/covariates that add to the variability in observed CPUE.

4.144 During the intersessional period, it was determined that the CPUE standardisations conducted at the Working Group's 1996 meeting were in error. As such, the results in Table 17 and Figures 5 and 6 of last year's report (SC-CAMLR-XV, Annex 5) are incorrect and should be disregarded.

4.145 The GLM analyses presented below do not contain the errors made at the 1996 meeting and have been updated to include revised information from previous fishing seasons (see paragraph 4.148 below) as well as new information from the 1996/97 fishing season. It should not be surprising, therefore, that the following results are quite different from those presented in last year's report. Note that the basic approach used to fit the GLMs was the same as that used last year and at the 1995 meeting of the Working Group; details of the methodology are provided in SC-CAMLR-XIV, Annex 5, Appendix G.

4.146 The GLMs were fitted to haul-by-haul data with non-zero catches submitted on form C2 over the period 1992 to 1997. Data from years prior to 1992 were not available in haul-by-haul format so they could not be used in the analyses. Numbers per hook and kilogram per hook were used as response variables, and nationality, fishing season, month, area, depth and bait type were considered as predictor variables. Fishing seasons were defined as occurring from 1 October to 30 September; this definition was consistent with the approach used last year
(SC-CAMLR-XV, Annex 5, paragraph 4.100).

4.147 Last year the Working Group considered vessel identification number as a factor in the

GLM analyses. At this year's meeting, nationality was used instead of vessel because when vessel is used as a factor the design matrix is poorly crossed, i.e. there are large gaps in the overlap between vessel ID and other factors. Using nationality rather than vessel made the GLM parameters easier to estimate.

4.148 At its 1996 meeting, the Working Group noted that there were a number of data records that were spurious or incomplete (SC-CAMLR-XV, Annex 5, paragraph 4.102). One of the worst data problems in 1996 was a lack of position information for over 1 000 hauls. During the intersessional period, the Secretariat remedied many of the problems in the C2 database and the GLMs were easier to fit this year. The Working Group thanked the Secretariat for its work on revising and updating the C2 database, but noted that there are still a number of data omissions that are catalogued in SC-CAMLR-XVI/BG/11 Rev. 1.

4.149 Nationality, fishing season, month, area and bait type contributed significant sources of variation to haul-by-haul CPUE (Table 14). Nationality was the most significant component of variability in CPUE, and the fishing season effect was the next most significant component of variability in catch rates.

4.150 The time series effects of fishing season on kilogram per hook and numbers per hook are plotted in Figure 3. These time series are adjusted for the presence of hauls with zero catches. This adjustment was made by estimating the probability of a zero catch in each fishing season and multiplying this probability by standardised CPUEs predicted from the GLMs.

4.151 The probabilities of zero catches for each fishing season are provided in Table 15. These probabilities should be viewed with some caution since there have been very few vessels to actually report zero catches. The Working Group noted that the C2 database may be biased because hauls with zero catches may not always be reported to CCAMLR. In this regard, the Working Group encouraged Members to make every possible effort to assure that zero catches are also recorded on the form C2 and reported to CCAMLR.

4.152 Adjusted, standardised catch rates increased between the 1992 and 1993 fishing seasons, but declined after 1993 (Figure 3). The decline was faster for kilogram/hook than it was for numbers/hook, indicating that the average size of fish in the catch has decreased over time. The decline of both CPUE indices slowed between the 1996 and 1997 fishing seasons. Both CPUE indices were less variable at the end of the time series than they were at the beginning of the time series.

4.153 The Working Group noted the trends in Figure 3 with concern. Standardised catch per unit effort in kilogram/hook in 1997 is at the lowest level for the period from 1992 to 1997. It is important to note that the *D. eleginoides* fishery began before the 1992 fishing season, and the Working Group cannot comment on the standardised kilogram/hook for 1997 compared to years prior to 1992. Season-specific, unstandardised catch rates (calculated as the sum of catch divided by the sum of hooks fished in a season) are not reliable indicators of trends in CPUE (Figure 3).

4.154 The predicted effects of month on kilogram and numbers per hook are illustrated in Figure 4. The GLMs predicted that kilogram/hook were highest in the period from March through July of each fishing season. This trend was not as apparent for numbers/hook, but expected numbers/hook were slightly higher in March and April.

4.155 The Working Group noted that the results in Figure 4 suggest that delaying the start of the *D. eleginoides* fishing season until 1 May of each year would not have a negative impact of catch rates.

Maturity Ogive of *D. eleginoides*

4.156 *D. eleginoides* spawns in Subarea 48.3 between June and October (WG-FSA-97/49). Other studies (see SC-CAMLR-XI, Annex 5) have shown that in this same subarea spawning occurs between June and September, with a peak in August. Fish in the Cape Horn–Diego Ramirez Island area have a similar spawning period (WG-FSA-97/42). Given the difficulties to accurately determine maturity stages in *D. eleginoides* experienced by observers in previous seasons, the Working Group used information on the proportion of various maturity stages in the stock at the peak of the spawning season in August. Further studies of maturity ogives from observer data are to be examined (see paragraph 3.55).

4.157 In previous years the fishing season finished in July (1996) or even earlier (1992 to 1995), so data on reproductive condition were only available from before the spawning season. During 1996/97 the season ended on 31 August, and at least two vessels with scientific observers operated in the subarea in that month, the *Cisne Verde* and *Argos Helena*. Data on fish maturity collected by the observers consisted of 434 fish samples for females and 398 for males. The parameters to fit the observations (maturity stage I versus stages II–V) to the logistic model used in previous meetings of the Working Group are presented in Table 16.

4.158 Results in Table 16 confirm earlier observations by the Working Group (SC-CAMLR-XI, Annex 5) that males and females have different sizes when attaining sexual maturity. It is unclear at present whether the differences are due to different growth rates or different ages when attaining sexual maturity. The Working Group recommended that more emphasis should be given to age and growth studies of this species. Length compositions superimposed on the maturity ogive (Figure 5) demonstrate that a high proportion of the males in the exploited part of the population is sexually mature, while more than 60% of the females are immature when exploited. The high proportion of immature females in the catch indicates that this species may be vulnerable to recruitment overfishing.

4.159 No age/length keys separated by sex were available. Therefore the Working Group agreed to use a maturity ogive for both sexes combined, but recommended, that in order to make progress in the assessment of the population of *D. eleginoides* separated by sex, an effort should be made to prepare such age/length keys in time for the next meeting and also to improve the studies on maturity. The Working Group recommended that Members inform the Secretariat of the location and availability of the scales and otoliths collected by scientific observers to facilitate their use for this research.

Revised Estimates of Recruitment Parameters

4.160 An error was discovered in a procedure for calculating the swept area from some of the trawl surveys used to estimate the recruitment parameters used in the GYM assessments last year (SC-CAMLR-XV, Annex 5, paragraphs 4.69 to 4.73). Revised estimates of recruitment are given in Tables 17 to 19.

Generalised Yield Model

4.161 The assessment of the precautionary yield using the GYM was undertaken to incorporate the revised estimates of the parameters for recruitment as well as the revised maturity ogive and the catch for split-year 1996/97. The input parameters are shown in Table 20. In this case, the decision rule concerning the probability of depletion was binding. The yield at which there is a probability of 0.1 of falling below 0.2 of the median pre-exploitation spawning biomass level over 35 years was 3 540 tonnes. The median escapement for this catch level was 0.51.

4.162 The GYM was used to predict the status of the spawning stock biomass and fishable biomass prior to exploitation (1988/89) and during the period of catches from 1989/90 to the 1996/97. These biomasses were monitored during the runs described above. The respective median biomasses (and 95% confidence intervals) at 1 March over each of these years is shown in Figure 6. The trend in the median biomasses predicts that the current spawning biomass is 59% of the pre-exploitation median level with the fishable biomass potentially at 54% of the pre-exploitation median level.

Trends in Size at Capture

4.163 An attempt was made to analyse trends in the size of fish caught in the South Georgia fishery since 1990. Length-frequency data submitted on Form B2 were plotted for each year between 1990 and 1997. No consistent trend was evident. The Working Group felt that length-frequency data not corrected for size of catch and size of sample measured are unlikely to be of much use. Such datasets are only available from observers' reports for the 1996 and 1997 fishing seasons, and the Working Group stressed that the continued collection and appropriate recording in the database of these data remains a high priority. Routines should be developed by the Secretariat to extract length frequencies corrected for size of catch and sample size by next year's meeting.

Comparison of GLM and GYM Results

4.164 The Working Group summarised its assessment of the *D. eleginoides* stock in Subarea 48.3 by comparing results from GLM and GYM analyses.

4.165 The trend in median biomasses from the GYM predicts that the current median spawning biomass is 59% of the pre-exploitation median level (see Figure 7). This stock is therefore above, but approaching, one of the reference points used in CCAMLR decision rules which holds that the median spawning stock should not be allowed to fall below 50% of its unexploited median level.

4.166 The Working Group noted with concern a sustained decline in standardised CPUE from the GLM between 1993 and 1997 and that standardised CPUEs have fallen more rapidly than the median fishable biomasses predicted by the GYM. This may be due to the total removals of *D. eleginoides* in a number of years being greater than estimated. If this is so, these underestimates will result in a decline in stock size greater than that indicated by the time series of median fishable biomasses predicted from the GYM using the current input data.

4.167 The Working Group did note, however, that it is very difficult to interpret time series of CPUE data. The relationship between CPUE and stock size is unknown (and needs to be better understood), and there are many mechanisms that are not related to stock size but can still explain trends in CPUE. The Working Group discussed a number of such mechanisms but agreed that there was no information available to weigh the relative merits of the various, proposed alternatives. As such, the Working Group considered that it would still be appropriate (and more risk-averse) to view the trend of declining CPUE as an indication that stock size has declined substantially.

Management Advice

4.168 The estimate of yield from the GYM was 3 540 tonnes.

4.169 The Working Group considered that the TAC for 1997/98 should be less than the 3 540 tonnes in order to maintain a degree of caution appropriate to the uncertainty indicated by the results above.

4.170 The Working Group was unable, however, to advise on what lower TAC is appropriate. This was because there are no elements in the decision rules to reconcile conflicting indicators such as in this case, where the GYM suggests the stock is approaching a decision rule reference point, whereas the CPUE trend suggests it may already have exceeded it. A high priority task is to develop advice to deal with such situations.

Champsocephalus gunnari (Subarea 48.3)

Development of a Long-term Management Strategy

4.171 The Working Group recalled the high priority given to the development of a long-term management strategy for *C. gunnari* in Subarea 48.3 at previous meetings of the Scientific Committee (e.g. SC-CAMLR-XV, paragraph 4.75). Two papers discuss long-term approaches to the management of *C. gunnari* as well as suggesting interim measures during the development of the long-term strategies.

4.172 WG-FSA-97/38 presents the components to be considered in the long-term management of *C. gunnari* in Subarea 48.3. A management strategy in this subarea needs to take account of food chain interactions between *C. gunnari*, krill and fur seals, which have been discussed extensively at previous meetings (e.g. SC-CAMLR-XV, Annex 5, paragraphs 4.136 to 4.155). The paper proposes the use of the GYM (Constable and de la Mare, 1996) to estimate a precautionary yield, which takes into account the possibility of periodic increases in natural mortality associated with years of poor krill availability in the vicinity of South Georgia. The analysis undertaken in this paper was updated at the Working Group meeting with the following revisions:

(i) explicit use of the mortality function rather than an approximation (see paragraph 3.79);

(ii) correct evaluation of the status of the spawning stock when interannual variation in M is present;

(iii) use of the recruitment parameters estimated from VPA Run 5 in 1993 (SC-CAMLR-XII, Annex 5); and

(iv) assessment of real catches rather than an assessment of γ because the recruitment parameters were available.

4.173 The GYM analysis was rerun using the parameters listed in Table 23. In this run, the decision rule regarding the probability of depletion was binding. The results were similar to that for Heard Island (WG-FSA-97/29) where the probability of depletion with no fishing was greater than the critical probability of 0.1. When the decision rule is modified to that described in paragraph 3.68, the long-term annual yield was estimated to be 2 600 tonnes.

4.174 WG-FSA-97/38 suggested that further development of the management scheme could use information from studies on krill and predators undertaken as part of CEMP, to interpret or modify information from commercial fisheries and research surveys in an attempt to make informed predictions about future levels of M in the short term. This information could be used in association with estimates of long-term precautionary yield in a quasi-real-time management strategy. For example a precautionary catch limit could be augmented in years when there is evidence of abundant year classes in the stock and the likelihood of increased natural mortality is low. The authors recognised that this scheme would require greater quantitative knowledge of food web dynamics within the South Georgia ecosystem than presently available, but that an interim approach for setting catch limits is required.

4.175 WG-FSA-97/29 also presented assessments of precautionary catch limits developed using the GYM for Division 58.5.2 as well as a method for adjusting catch limits according to results of recent surveys. The parameters used in this assessment were all obtained from the stock at Heard Island. Recruitment was found to have substantial variability, which was not well modelled by a lognormal distribution. Consequently, the GYM assessment used a parametric bootstrap procedure to model the recruitments.

4.176 The Working Group noted the substantial probabilities of the spawning stock declining to below 20% of the unexploited median even in the absence of fishing for *C. gunnari* both in Subarea 48.3 and Division 58.5.2. Consequently the Working Group agreed that the appropriate form of decision rule to apply in such cases needs further consideration. Some further tests on the properties of this type of decision criterion are described in paragraphs 3.68 and 3.69.

4.177 The Working Group welcomed these useful contributions to the development of a long-term management strategy for *C. gunnari*. The Working Group encouraged further work on assessments of long-term annual yield in line with the development of biological reference points. For Subarea 48.3 these assessments will benefit from further analysis of survey data to examine the magnitude and frequency of previous periodic increases in M and the development of recruitment estimates from survey results rather than VPA analyses.

4.178 In addition the Working Group agreed that the following components should be evaluated for their inclusion in an integrated long-term management procedure:

(i) appropriate biological reference points for *C. gunnari* in Subarea 48.3 and Division 58.5.2;

(ii) the level of catch appropriate as a long-term precautionary yield when no recent surveys are available;

(iii) methods for adjusting catch levels based on recent survey results to take advantage of strong year classes recruiting to the fishery;

(iv) use of CEMP data and other knowledge of predator/prey interactions to predict adjustments in natural mortality, recruitment and growth parameters for use in assessments; and

(v) methods for achieving target levels of fishing mortality.

Short-term Assessment Methodology

4.179 The Working Group agreed that at present it could not recommend precautionary catch limits for *C. gunnari* on the basis of current applications of the GYM, until further studies on the properties of possible decision criteria have been considered (see paragraphs 3.68
and 3.69).

4.180 WG-FSA-97/29, for example reported that the precautionary catch limit, based on decision rules discussed in paragraph 3.68, is dominated by the periods in which the stock has naturally fallen to a low level. Consequently, the opportunity to increase catches is foregone when the stock is abundant due to the presence of one or more strong year classes. The authors suggested that this is currently the case on the plateau at Heard Island where the recent trawl survey gives a biomass estimate of about 50 000 tonnes, with two strong year classes in the spawning stock. This suggests that a form of management strategy based on recent abundance estimates would allow an increase in yield over the precautionary level. However, the development of such a strategy is a substantial task requiring further study and evaluation.

4.181 Nonetheless, WG-FSA-97/29 proposed an interim step in this direction, where catch limits are calculated which allow for higher catches in the next two seasons without any substantial risk of depleting the spawning stock. The criterion applied was to calculate the fishing mortality which would result in a probability of no more than 0.05 that the spawning stock after fishing would be less than 75% of the level which would have occurred in the absence of any fishing. This was achieved by using the bootstrap one-sided lower 95% confidence bound on the trawl survey estimate as the current stock biomass. The numbers of fish in the cohorts are calculated using the following formula:

$$\tilde{N}_a = \frac{\hat{N}_a}{\sum_i \hat{N}_i} \cdot \frac{\tilde{B}}{\overline{w}} \tag{1}$$

where $\tilde{N}_a$ is the number of fish of age a, given the current age structure and a population biomass at the lower 95% confidence bound $\tilde{B}$, $\hat{N}_a$ is the estimated abundance of fish aged a in the current population and $\overline{w}$ is the average weight of a fish in the current population. The average weight is given by:

$$\overline{w} = \frac{w_a \hat{N}_a}{\sum_i \hat{N}_i} \tag{2}$$

where w_a is the average weight of fish of age a, calculated from the growth curve and weight-length relationship. The fishing mortality was found numerically by solving the usual fisheries differential equations with an initial age structure derived from equation (1):

$$\begin{aligned}
\frac{dN}{dt} &= -zN \\
\frac{dB}{dt} &= NaL_\infty{}^b\left(bk\left(1-\mathrm{e}^{-k(t-t_0)}\right)^{b-1}\mathrm{e}^{-k(t-t_0)} - z\left(1-\mathrm{e}^{-k(t-t_0)}\right)^b\right) \\
\frac{dC}{dt} &= FB
\end{aligned} \tag{3}$$

where N is the number of fish, $z = M+F$ where M and F are the natural and fishing mortality rates respectively, B is the biomass of fish, L_∞, k and t_0 are the von Bertalanffy growth parameters, a and b are the weight – length parameters and C is the catch.

4.182 The Working Group agreed that the procedure set out in WG-FSA-97/29 was useful first step in developing assessments of *C. gunnari* based on current biomass estimates and recommended that such procedures should be further developed as a component of the long-term management strategy for this species.

General Management Advice on *C. gunnari*

4.183 The Working Group welcomed the progress made at this year's meeting on the development of an assessment methodology which could form the basis of an approach to the long-term management of *C. gunnari*. Several ways in which this approach could be developed in the future were identified (paragraph 4.178), and the Working Group recommended that these be given a high priority at the next meeting.

4.184 In the future it is expected that the strategy will enable calculation of long-term precautionary yields which may be adjusted in years when up-to-date information on the stocks is available, for example from research surveys. Given that this is a strategy under development, the Working Group recommended that surveys be undertaken during the 1997/98 season in all areas where fisheries for this species occur.

Assessment of *C. gunnari* in Subarea 48.3

Commercial Catch

4.185 There was no commercial catch of *C. gunnari* in Subarea 48.3 during the 1996/97 season, although there was a TAC of 1 300 tonnes in accordance with Conservation Measure 107/XV. There has now been no substantial reported commercial catch since March 1990.

Research Surveys

4.186 The survey conducted on board RV *Dr Eduardo Holmberg* during March and April 1997 was summarised in WG-FSA-97/47. The position of the trawl stations closely followed those sampled during previous surveys by Argentina. The proportion of young fish in the samples remained high: 95% of the fish at South Georgia and 84% of the fish at Shag Rocks were age class three and below.

4.187 A brief summary of the recent UK survey on the *Argos Galicia* was presented in WG-FSA-97/39, sampling for which had only finished around South Georgia on 29 September 1997. The Working Group congratulated Dr Everson and his team for completing the study and bringing the results to the meeting so quickly.

4.188 The survey had been undertaken in the same way as the previous UK surveys with randomly-located hauls allocated to the three depth strata, 50 to 150 m, 150 to 250 m and 250 to 500 m, in the ratio of approximately 1:2:1. All hauls were undertaken during the hours of daylight. Although it has been assumed that the fish concentrate close to the seabed during daylight, it was noted that experience at Heard Island had indicated that the fish did not disperse into the water column until about two hours after sunset and return to the seabed until about two hours after sunrise.

4.189 A summary of the results of these two surveys is provided in Table 21.

4.190 With respect to the acoustic survey by Russia using RV *Atlantida* in 1996, correspondence between Drs Everson, V. Vorobyov and K. Sushin (WG-FSA-97/11) was discussed. In his final letter, Dr Everson agreed that in the conduct of both the survey, and the results obtained from it, the most important possible sources of bias had been taken into account. The Working Group concluded that it would be useful to refer the report of the survey (WG-FSA-96/59) to acoustic experts for further consideration. If necessary, Drs Everson and P. Gasiukov agreed that data from the *Atlantida* survey could be re-analysed and re-submitted to WG-FSA. The Working Group noted with gratitude the work done to clarify the issues raised during WG-FSA-96, and agreed that the results from this survey could be considered in future assessments of *C. gunnari*.

Other Information

4.191 WG-FSA-97/5, presenting a review of the estimation of M for *C. gunnari* in Subarea

48.3, is reviewed in paragraph 3.45.

4.192 WG-FSA-97/45 demonstrated a significant relationship between size and age of *C. gunnari* and depth, with larger, older fish being found in deeper water.

4.193 WG-FSA-97/44 examined the series of density observations derived from the four Argentinian surveys conducted in Subarea 48.3 between 1994 and 1997. Density increased significantly from 1994 to 1996 and there was no significant difference between observations in 1997 and 1996. An analysis of numbers at age indicated that variations in observed density were closely related to changes in the numbers of fish at age 1 and less. A study of relative cohort abundance over time suggested that the results of the 1994 survey were anomalously low. The age structures of the samples from the 1995, 1996 and 1997 surveys were similar. The steep decline in relative abundance of the older age classes is indicative of higher mortality of older fish, but it might also be the result of a recovery in the stock.

4.194 WG-FSA-97/48 reported on an analysis of the diet of *C. gunnari* in Subarea 48.3 (see paragraph 3.50).

Recommendations from WG-FSA-96

4.195 The Working Group recalled several recommendations made at last year's meeting with respect to the development of a long-term management approach for this fishery. These included a review of previous assessments (SC-CAMLR-XV, Annex 5, paragraph 4.137), submission of any outstanding historical commercial fisheries data and research surveys to the Secretariat (SC-CAMLR-XV, Annex 5, paragraphs 4.138 and 4.142), compilation of a comprehensive list of surveys (SC-CAMLR-XV, Annex 5, paragraph 4.124), and standardisation of trawl surveys using GLMs.

4.196 Data from research trawl surveys undertaken by the UK were re-submitted to the Secretariat during the intersessional period. At the time of the meeting, these data were being incorporated into the CCAMLR database and were at various stages of availability for analysis at the meeting. However, the Working Group noted that these data were being handled within the database using the commercial fisheries data format (C1) and that this tended to result in some loss of detailed information due to the relative complexity of the survey data (see paragraphs 3.8 and 3.9).

4.197 A comprehensive list of surveys in all subareas is provided in Table 22.

4.198 The Working Group reiterated its recommendation made at last year's meeting that a standardisation of the trawl survey time series using GLMs should be undertaken. No papers were presented and no further analysis was undertaken at this year's meeting. This was partly due to problems with the processing of survey data submitted to CCAMLR and availability of these data for analysis by Members during the intersessional period (see also paragraph 4.196).

Analyses Undertaken at this Year's Meeting

Short-term Assessment

4.199 The Working Group noted that the recent UK and Argentinian surveys reported in WG-FSA-97/39 and 97/47 respectively show that the population has recovered from recent low levels after the recruitment of two cohorts above the mean recruitment estimated from the VPA run 5 in 1993 (see Table 21). The Working Group developed an assessment using the approach described in paragraph 4.181 and WG-FSA-97/29 for Division 58.5.2. Length-density estimates of age class strength were derived from the two surveys using the maximum likelihood method (de la Mare, 1994).

4.200 Recalling discussions at last year's meeting (SC-CAMLR-XV, Annex 5, paragraph 4.139), the Working Group agreed to assess the population in Subarea 48.3 as one stock, although it was noted that, among other things, marked differences in age structure between South Georgia and Shag Rocks warranted further examination with a view to resolving the question of stock structure in the region.

4.201 The estimates of year class strength are given in Table 24.

4.202 A lower one-sided 95% confidence bound for the abundance estimate was calculated using a bootstrap procedure with the UK survey results. This was equivalent to the procedure used for Heard Island (Division 58.5.2) (WG-FSA-97/29), although in this case the result using the bootstrap procedure was very similar to that produced by the TRAWLCI program (Table 25). Because the Argentinian survey was designed for examining aspects of stock distribution, it was not used for abundance estimation (WG-FSA-97/47). The lower confidence bound from the UK survey was estimated to be 31 563 tonnes.

4.203 The number of fish in each age class for this biomass was calculated using equations (1) and (2) given above. The calculations use a von Bertalanffy growth function with parameters derived from UK surveys between 1989 and 1992 (Parkes, 1993) and a weight-length relationship derived from samples collected during the UK survey in 1997. The parameters for these functions are shown in Table 26.

4.204 The Working Group noted that the fluctuating ecosystem interactions believed to be responsible for periodic increases in the natural mortality of *C. gunnari* might also result in changes in growth. It was agreed that the sensitivity of the short-term projections to variations in growth parameters should be investigated in the future.

4.205 The numbers of fish in each age class for a biomass at the level of the lower 95% confidence bound are shown in Table 27.

4.206 The Working Group recalled previous discussions of the possible values of catchability of trawl surveys, based principally on the results of VPAs tuned to survey abundance indices (SC-CAMLR-XII, Annex 5, paragraphs 6.34 to 6.46). There were indications from these analyses that catchability could be substantially less than 1, but in view of the fact that M was constant in the VPA, which was now considered to be an unacceptable assumption, these results could not be considered reliable. In the absence of other quantitative information about catchability of the survey trawl, for the purposes of this analysis, it was assumed to be 1.

4.207 Catch limits were calculated by solving the usual fishing differential equations to find the fishing mortality that, if fished over a projected two-year period, would result in a biomass at 75% of the level which would occur without fishing. This was calculated using two values of M, one which would apply in a 'normal' year, M = 0.42 (paragraph 3.45), and one which would be four times this value. The latter was derived from comparisons between surveys using deterministic cohort analysis, and has been suggested as being consistent with the declines observed for *C. gunnari* in Subarea 48.3 in those years when krill, a major food item for *C. gunnari*, are scarce (WG-FSA-97/38). However, the Working Group recognised that this estimate was highly uncertain and that further investigation would be necessary before such a value could be used reliably in an assessment. The value was used in the present analysis only as a means of investigating the sensitivity of the projection results to such a large increase in M.

4.208 The fishing mortality and catches in each of the two projected years are shown in Table 28.

Future Work

4.209 The Working Group recommended several areas of future work for the development of the assessment and management strategy for *C. gunnari* in Subarea 48.3, in particular:

(i) analyse all available survey data to investigate the possible magnitude and frequency of periodic increases in M at South Georgia;

(ii) examine the potential for deriving recruitment estimates directly from trawl survey results, rather than using the VPA results; and

(iii) examine the sensitivity of assessments of yield to variations in growth parameters.

Management Advice

4.210 The Working Group noted that recent surveys show that the population of *C. gunnari* in Subarea 48.3 has recovered from recent low levels (paragraph 4.199), however, given the continued uncertainty about the potential yield of *C. gunnari* in Subarea 48.3, the Working Group considered that a conservative approach to management is appropriate in the immediate future.

4.211 The Working Group noted that the yield estimated from the short-term projections undertaken at this year's meeting were based on the lower 95% confidence bound of the survey undertaken by the UK in September 1997 and that this constituted a conservative estimate of yield. Accordingly, the Working Group recommended that fishing in the 1997/98 season should be limited to a total catch of 4 520 tonnes.

4.212 Dr Marschoff noted that the abundance of fish in the older age classes estimated from the UK survey, when compared with the median biomass derived from the application of the GYM (paragraph 4.161) showed that a probability of 0.05 exists that the spawning biomass is below 0.2 of B_0.

4.213 Other members noted the difficulties, identified at this meeting, of applying the decision rule relating to depletion of the spawning stock biomass to less than 20% of B_0 for *C. gunnari* (see paragraph 4.176).

4.214 The Working Group recalled its consideration at the 1992 meeting (SC-CAMLR-XI, Annex 5, paragraphs 6.67 to 6.74) of the proportion of by-catch of other finfish in the *C. gunnari* fishery and the implied ceiling on the catch of the target species. No new information was presented to the Working Group on the proportion of by-catch species in the commercial catch. The recommended catch limit given in paragraph 4.211 is substantially below the implied ceilings on both a bottom trawl and pelagic trawl fishery (8 800 and 9 200 tonnes respectively).

4.215 The Working Group also recalled its conclusion from previous meetings that a pelagic trawl fishery would result in a lower proportion of by-catch and would avoid the possible adverse effects of bottom trawling on the benthic community (e.g. SC-CAMLR-XII, Annex 5, paragraph 6.61). Accordingly it is recommended that the fishery in 1997/98 be undertaken by pelagic trawling only.

4.216 The fishing season set for 1996/97 by Conservation Measure 107/XV closed on 1 May 1997. The Working Group noted that this represented a one-month extension of the season applied in previous seasons and was adopted by the Commission on the understanding that it would apply for the 1996/97 season only. In accordance with earlier seasons, the Working Group recommended that the fishing season in the 1997/98 season be closed on 1 April to reduce fishing directed at spawning concentrations.

4.217 In order to provide the information required for assessment of the fishery, the Working Group recommended that reporting requirements for the commercial fishery should include the submission of haul-by-haul data in accordance with standard CCAMLR formats and that an international scientific observer be on board every vessel participating in the fishery in the 1997/98 season.

Chaenocephalus aceratus, Pseudochaenichthys georgianus, Gobionotothen gibberifrons, Notothenia rossii, Patagonotothen brevicauda guntheri, Lepidonotothen larseni and *Lepidonotothen squamifrons* (Subarea 48.3)

4.218 New biomass estimates of *Chaenocephalus aceratus, Pseudochaenichthys georgianus, Gobionotothen gibberifrons, Notothenia rossii, Patagonotothen brevicauda guntheri, Lepidonotothen larseni* and *Lepidonotothen squamifrons* were available to the Working Group from Argentinian and UK biomass surveys conducted around Shag Rocks and South Georgia (WG-FSA-97/47 and 97/39).

4.219 The surveys were conducted in March/April (Argentinian survey) and September 1997 (UK survey) according to the methodologies described in paragraph 3.41. The estimated standing stocks of each of these species on the Shag Rocks and the South Georgia shelf, (i.e. effectively the whole of Subarea 48.3), calculated from each of the surveys are shown in Table 29.

4.220 Biomass estimates from both surveys are quite similar for *N. rossii* and *G. gibberifrons* but differ in several orders of magnitude for all other species, being greater for Nototheniids (*L. squamifrons* and *P. guntheri*) in the Argentinian survey and for Channichthyds (*C. aceratus* and *P. georgianus*) in the UK survey. These differences in the distribution of the fish are difficult to explain since they could be due to the concurrence of several factors such as the period of the cruise, the sampling design and the gear used.

4.221 Despite these differences, biomass estimates of both cruises seem to confirm a degree of stability in most of the stocks compared to results obtained in previous cruises conducted in the Subarea using a similar methodology. Only *G. gibberifrons* has experienced an apparent biomass decrease from 1994 to 1997 in the UK surveys series, which is not apparent in the Argentinian series.

4.222 The Working Group did not make any attempt to calculate precautionary catch limits from these estimates using the GYM, but given the apparently low abundances of most of these stocks and the difficulties in managing fisheries which exploit mixed-species assemblages, there seems to be little prospect for a fishery targeted on them.

Management Advice

4.223 Taking into account the considerations which arose during its deliberations, the Working Group reiterated its advice from previous years concerning these species and therefore recommended that Conservation Measures 2/III, 3/IV and 95/XIV remain in force and that Conservation Measure 100/XV be extended to the 1997/98 season.

Electrona carlsbergi (Subarea 48.3)

4.224 No new data were available.

Management Advice

4.225 The Working Group reiterated its advice from 1995 and 1996 concerning this stock (SC-CAMLR-XIV, Annex 5, paragraphs 5.116 and 5.117; SC-CAMLR-XV, Annex 5, paragraph 4.168). In the absence of any new information the Working Group recommended that Conservation Measure 103/XV be carried forward for the 1997/98 season.

Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)

4.226 There has not been any fishing activity on these stocks since the last operations of the US fishing vessel *American Champion* conducted in January 1996 according to the Experimental Harvest Regime set up in Conservation Measure 90/XV.

4.227 Noting that this fishery does not appear to be commercially viable and that no information had been received on vessels intending to enter the fishery, the Working Group determined that it was not necessary to conduct an assessment of the crab stocks in Subarea 48.3.

Management Advice

4.228 The Working Group, recognising the great utility of the experimental harvest regime set out in Conservation Measure 90/XV in providing useful information for developing an assessment of the target species, reiterated the view expressed at its 1996 meeting that Conservation Measure 90/XV should remain in force, but that, if new vessels were to enter the fishery, the Commission might wish to revise Phase 2 in the light of the comments made in paragraph 4.183 of the 1996 report (SC-CAMLR-XV, Annex 5).

4.229 The Working Group also stated that since the crab stocks were not assessed, a conservative management scheme as contained in Conservation Measure 104/XV is still appropriate for this fishery.

Squid (*Martialia hyadesi*) (Subarea 48.3)

4.230 A notification of the intent to conduct a new fishery for the squid *M. hyadesi* in Subarea 48.3 during the 1996/97 season was lodged jointly by the Republic of Korea and the UK (SC-CAMLR-XV, Annex 5, paragraphs 4.7 and 4.188). Discussions on this fishery are contained in paragraphs 4.2 to 4.6.

South Sandwich Islands (Subarea 48.4)

4.231 Although a small fishery for *D. eleginoides* was open in this area, no catches were reported.

4.232 A proposal for a new longline fishery for *D. eleginoides* in Subarea 48.4 has been lodged by Uruguay. In considering the proposal, the Working Group noted the possibility of *D. mawsoni* also being caught (paragraph 4.58).

Management Advice

4.233 In the absence of any new information on this species, the Working Group recommended that Conservation Measure 101/XV for this stock be carried forward for the 1997/98 season. Additional advice concerning *D. mawsoni* is provided in paragraphs 4.120 to 4.134.

Bouvet Island (Subarea 48.6)

4.234 Notifications of the intention to conduct new fisheries for *D. eleginoides* in Subarea 48.6 during the 1996/97 season were lodged by Norway and South Africa (SC-CAMLR-XV, Annex 5, paragraphs 4.7 and 4.192). Details on their development are provided in paragraphs 4.7 and 4.27 to 4.29.

4.235 No information was available to make any assessment on other stocks occurring in this subarea.

Statistical Area 58

4.236 Total reported catches by species and subarea in Area 58 for the 1997 season are shown in Table 30.

Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)

4.237 No new information was available to the Working Group to undertake any assessment on the stocks in these divisions.

BANZARE and Elan Banks (Division 58.4.3)

Dissostichus spp. (Division 58.4.3)

4.238 Notifications of the intention to conduct new fisheries for *D. eleginoides* and *D. mawsoni* in Division 58.4.3 during the 1996/97 season were respectively lodged by Australia and South Africa (SC-CAMLR-XV, Annex 5, paragraphs 4.7 and 4.195). Details on the development of these fisheries are given in paragraphs 4.27 to 4.29 and the corresponding management advice is provided in paragraphs 4.120 to 4.134.

Ob and Lena Banks (Division 58.4.4)

Dissostichus eleginoides (Division 58.4.4)

4.239 South Africa notified its intention to initiate a new fishery for *D. eleginoides* in Division 58.4.4 during the 1996/97 season (SC-CAMLR-XV, Annex 5, paragraphs 4.7 and 4.197). No fishing took place by South African vessels in this division and a new fishery notification has been received from this Member for 1997/98 (paragraph 4.16). Management advice on this new fishery is provided in paragraphs 4.120 to 4.134.

Lepidonotothen squamifrons (Division 58.4.4)

4.240 A conservation measure to allow a commercial catch of 1 150 tonnes of *L. squamifrons* to be caught over a two-year period (Conservation Measure 87/XIII) was approved and extended over three consecutive seasons at the successive requests made by Ukraine, provided a biomass survey was undertaken. Apparently no biomass surveys were carried out during the 1994/95, 1995/96 and 1996/97 seasons, and therefore no data were available to the Working Group to assess the state of this stock.

Management Advice

4.241 Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks provided an approved biomass survey is undertaken, was extended until the end of the 1996/97 season (Conservation Measure 105/XV). The Working Group noted that the survey proposed by Ukraine did not take place and therefore recommended that the fishery should be closed until a biomass survey of the design approved by the Scientific Committee shows that the stock could support a sustainable fishery.

Kerguelen Islands (Division 58.5.1)

Dissostichus eleginoides (Division 58.5.1)

Standardisation of CPUE Indices

4.242 The Working Group also used a GLM to standardise an updated series of CPUE data from the trawl fishery for *D. eleginoides* in Division 58.5.1. This GLM analysis followed the approach used for *D. eleginoides* in Subarea 48.3 (paragraphs 4.143 to 4.155).

4.243 As was the case for Subarea 48.3, the results from last year's meeting of the Working Group were found to be in error for this division, and Table 22 and Figure 7 of SC-CAMLR-XV, Annex 5 are not correct.

4.244 The GLM was fitted to haul-by-haul data from the French and Ukrainian trawl fisheries operating off the western, northern, and eastern coasts of Kerguelen during the period 1990 to 1997. Kilograms per hour towed was used as the response variable, and nationality, year, month, area, and depth were considered as predictor variables. Year was defined as split-year.

4.245 Last year the Working Group considered vessel identification number as a factor in the GLM analysis. At this year's meeting, nationality was used instead of vessel.

4.246 Nationality, year, month and area contributed significant sources of variation to haul-by-haul CPUEs from the trawl fishery (Table 31). The year effect was the most significant component of variability in CPUE, and the month effect was the next most significant component of variability in catch rates.

4.247 Figure 8 illustrates the effects of year and month on standardised catch rates from the trawl fishery. The time series is adjusted for the presence of hauls with zero catches. This adjustment was made by estimating the probability of a zero catch in each fishing season and multiplying this probability by standardised CPUEs predicted from the GLMs.

4.248 The probabilities of zero catches for each fishing season are provided in Table 32. These probabilities should be viewed with some caution since very few vessels have actually reported zero catches.

4.249 Adjusted, standardised catch per unit effort has decreased over the course of the time series, and CPUEs in the 1997 split-year were the lowest on record (Figure 8, upper panel). Standardised CPUE was also less variable at the end of the time series than it was at the beginning of the time series.

4.250 The Working Group viewed the declining trend in adjusted, standardised catch rates with concern and noted that the trend in unstandardised catch rates mirrored that of standardised catch rates (Figure 8).

4.251 Although month explained a significant amount of variation in trawl CPUE (Table 31), there was no clear pattern in standardised CPUE by month (Figure 8, lower panel).

Management Advice

4.252 The declining trend in CPUE in the trawl fishery demonstrated by the GLM analysis confirms previous studies of this stock (WG-FSA-93/15). Annual reductions of the French TAC (3 800 tonnes for the 1996 season, 3 500 tonnes for the 1997 season and 3 000 tonnes for the 1998 season) shows the concern in the management of the fishery in the French EEZ.

4.253 The French authorities have allocated a TAC for trawling for the 1997/98 season. A maximum of 3 000 tonnes applies for the whole area, including a 1 000-tonne limit in the eastern sector.

4.254 The longlining catch limit in the western sector has already been established up to the end of 1997 (October–December). A TAC of 500 tonnes applies for two vessels only. The total value for 1997/98 season in this sector will not exceed the value of the long-term sustainable yield estimated at the 1994 meeting (1 400 tonnes).

4.255 A TAC of 600 tonnes will apply for 1997/98 season for one French longliner in the eastern sector outside the area used by trawlers.

4.256 The Working Group considered that the GLM analysis of factors affecting CPUE in the trawl fishery is a useful technique to improve its assessments and recommended the continued reporting of catch and effort data on a haul-by-haul basis. In addition, efforts should continue to acquire haul-by-haul data collected on board Ukrainian longline vessels from the Ukrainian authorities, and to ensure that such data are also collected from the longliner working in the eastern sector.

4.257 Management of this fishery, in common with other subareas in the Indian Ocean sector, will be severely compromised as long as illegal catches continue.

Champsocephalus gunnari (Division 58.5.1)

4.258 As recommended by the Scientific Committee at last year's meeting (SC-CAMLR-XV, paragraph 4.96), there were no commercial catches on the shelf stock during the 1996/97 season. This was intended to allow the expected abundant new cohort born in 1994 to have a first spawning before being fished.

4.259 As requested by the Scientific Committee (SC-CAMLR-XV, paragraph 4.96), two pre-recruit biomass surveys were conducted during the summer/autumn of 1996/97 to evaluate the abundance of age 3 fish. Standardised hauls were undertaken during daylight (due to vertical migration of fish at night) at randomly allocated locations within a monostratified (100–200 m depth) area. Two different French trawlers were used for the surveys. The first survey, during late March 1997 (35 hauls) covered a shelf area of 18 318 km^2. The second survey, early in May (29 hauls), concentrated on a smaller area of the shelf break (5 246 km^2) within the area of the first survey, which was identified as having a higher density of fish.

4.260 As expected, three-year-old fish of the cohort born in 1994 were present in nearly all the catches. They grew from 27.2 cm to 28.1 cm (mean TL) between the two surveys. However, no aggregations of fish were detected despite indications from the previous year of a strong cohort entering the fishable stock. The abundance of other age classes was low.

4.261 The standing stock estimate of icefish in the areas covered by the surveys was calculated using the TRAWLCI program (de la Mare, 1994) and the results are given in Table 25.

4.262 The difference observed in the density between the two surveys is related to the position of the area in which the second survey was carried out, i.e. close to the shelf break where the concentrations are normally reported. Even if the distribution of the cohort over the whole shelf (48 965 km^2 in the normal bathymetric range of the stock) is assumed to be homogenous, as has been observed for the previous abundant cohorts, the standing stock estimate would be about 10 500 tonnes.

4.263 The Working Group noted that the unexpectedly low biomass was as yet not explained. Several possible explanations were briefly considered, including, early migration for spawning, change in the position of the fish aggregations to other places on the shelf, increase in predation by fur seals or *Channichthys rhinoceratus*, another predatory icefish, for which a high level of catches was reported during the survey. The French authorities have indicated that they plan to continue to monitor the stock with the help of the French trawlers on the basis of an allocation of very limited catches (not more than 1–5% of the present standing stock), and the use of scientific observation or other data collection opportunities.

Management Advice

4.264 The Working Group recalled its advice from the 1995 meeting (SC-CAMLR-XIV, Annex 5, paragraphs 5.151 and 5.152) that the fishery for *C. gunnari* in Division 58.5.1 should be closed until at least the 1997/98 season when the cohort born in 1994 would have had an opportunity to spawn. The recommended pre-recruit biomass survey conducted this season has shown that the strength of this cohort (age 3) is lower than expected and no conclusive explanation for this situation is presently available.

4.265 The Working Group supported the plan of action proposed by the French Authorities as outlined in paragraph 4.263 above.

Notothenia rossii (Division 58.5.1)

4.266 No new data on the stocks of this species in the Division were made available to the Working Group.

Management Advice

4.267 The Working Group reiterated its advice from previous meetings (SC-CAMLR-XV, Annex 5, paragraph 4.223) that the fishery for *N. rossii* in Division 58.5.1 remain closed until new information demonstrating the recovery of the stock to a level that allows for its exploitation is submitted for analysis.

Lepidonotothen squamifrons (Division 58.5.1)

4.268 No data were reported to the Working Group to allow the assessment of this stock.

Management Advice

4.269 In the absence of a new assessment the Working Group recommended that the Kerguelen fishery for *L. squamifrons* should remain closed.

Heard and McDonald Islands (Division 58.5.2)

Dissostichus eleginoides (Division 58.5.2)

Impact of Illegal Catches on TAC

4.270 The 1996/97 season was the first one in which commercial fishing for *D. eleginoides* was conducted in this division. As the reported catch of 1861 tonnes was less than half the TAC of 3 800 tonnes, and no new biological data are yet available, it was not considered necessary to re-evaluate the TAC. Because of the high estimates of unreported catches from this division, however, the assessment of the precautionary yield using the GYM from 1996 was re-run to examine the effect on the long-term annual yield of the estimates of unreported catches from this division in the last fishing season. The inputs to the model are given in Table 33. Two catch levels were used in these runs, being the reported catch (1 861 tonnes) plus the lower and higher estimates of unreported catches respectively (10 200 and 18 400) (Appendix D). In both cases, the decision rule concerning the escapement of spawning stock after 35 years was binding. The future long-term annual yield at which median escapement is 0.5 was 3 720 tonnes for the lower estimate of catch and 3 700 tonnes for the upper estimate, provided that high levels of unreported catches do not continue. The respective probabilities of depletion below the 0.2 median pre-exploitation biomass over 35 years were 0.039 and 0.045.

Management Advice

4.271 In view of the large illegal catches estimated to have been taken from this Division, the Working Group recommends that the TAC should be revised to 3 700 tonnes, the yield estimated by the GYM with the higher estimate of illegal catches used as input.

4.272 This TAC should be used on the assumption that total catches are reduced to 3 700 tonnes or less in the near future. If total catches continue at levels similar to those estimated by the Working Group for the 1996/97 season, there will be a much greater affect on TAC than has been estimated at this meeting.

Champsocephalus gunnari (Division 58.5.2)

Commercial Catch

4.273 A commercial catch of 216 tonnes was taken by one vessel from Australia in Division 58.5.2 during the 1996/97 season, which was less than the precautionary TAC of 311 tonnes set by Conservation Measure 110/XV.

Research Surveys

4.274 Three research surveys were conducted around Heard Island in the years 1990, 1992 and 1993 (Williams and de la Mare, 1995). In August 1997 a further survey was carried out on Shell Bank and the Heard Plateau. The results of this paper were presented in WG-FSA-97/29. This survey covered a smaller area of the plateau than previous surveys and may therefore represent an underestimate by comparison. However, most of the area not covered in this survey had a very low biomass in the previous surveys, so the underestimate is probably not very great. Biomass estimates were calculated using both the Delta-lognormal maximum likelihood estimator (Pennington, 1983; de la Mare, 1994) and the sample means with bootstrap variance and confidence intervals. Biomass estimates are given in Table 25.

Assessment of Short-term Yield

4.275 WG-FSA-97/29 presented an assessment of the potential yield of *C. gunnari* over the next two years, using the method described in paragraph 3.68. The assessment used growth curves, maturation ogives and weight-length relationships derived from the survey data collected at Heard Island.

4.276 The assessment was carried out for the populations of *C. gunnari* in two regions:

(i) the plateau of Heard Island, including the locality known as Gunnari Ridge; and

(ii) Shell Bank, which is separated from the plateau by water of depths greater than 500 m.

4.277 The *C. gunnari* populations in these two regions have different spawning seasons, and as indicated in WG-FSA-97/29, have different age structures in the same year and appear to have differences in their growth curves. For these reasons the two populations are treated separately.

4.278 The bootstrap lower 95% confidence interval was used to estimate the initial age structure for the projection. The resulting fishing mortality was F = 0.095. This resulted in a combined catch over two years from the two abundant cohorts of 1500 tonnes. This comprises 900 tonnes in the first year and 600 tonnes in the second year.

Management Advice

4.279 The Working Group recommended a catch limit of 900 tonnes for *C. gunnari* on the plateau at Heard Island for the 1997/98 season.

4.280 The Working Group noted that the lower 95% confidence limit for the abundance estimate of *C. gunnari* on Shell Bank reported in WG-FSA-97/29 was only 592 tonnes. Accordingly, the Working Group recommended that commercial fishing on this bank should be avoided in the 1997/98 season.

4.281 The Working Group noted the value of having up-to-date surveys on which to base assessments of a species such as *C. gunnari* which has widely fluctuating abundance. The Working Group recommended that such surveys should be conducted regularly.

4.282 The Working Group further noted the conclusion presented in WG-FSA-97/29 that there appears to be no compelling requirement to protect juvenile fish from the effects of fishing at the levels proposed for precautionary catch limits. However, this has not been established for the higher catch limits from the interim procedure for estimating catch limits for abundant cohorts. For this reason, the Working Group agreed that it would be advisable to continue a procedure for limiting the proportion of small fish taken by the fishery. It recommended that a fishing vessel should move to another location when the proportion of small fish exceeds 10% of the total (provided the catch of *C. gunnari* is above a minimum threshold such as 100 kg). Small fish should be defined as those of less than 240 mm total length (paragraphs 4.312 to 4.319).

Channichthys rhinoceratus, Lepidonotothen squamifrons and Skates (*Bathyraja* spp.) (Division 58.5.2)

4.283 WG-FSA-97/30 provides an assessment on the long-term annual yield for two species, and a group of species, caught as by-catch in the commercial trawl fishery in the Heard Island area: *C. rhinoceratus*, *L. squamifrons* and skates (*Bathyraja* spp.). Two analyses were undertaken. First, the long-term annual yield for each of the stocks was estimated using the GYM developed for WG-FSA. The second analysis examined the amount of each species and group of species caught in the commercial operations, the nature of the trawl operations in which they were caught and the effectiveness of current by-catch provisions in CCAMLR to ensure the status of these stocks is not affected by these fisheries (paragraphs 4.312 to 4.319).

4.284 The assessment of yield for each stock was based on the determination of γ, as used for determining precautionary catch limits for krill and *E. carlsbergi*, where γ is the proportion of a biomass estimate that can be taken as a long-term annual yield. In the case of these three stocks, three biomass estimates were available. The decision rules used to assess the precautionary limits were those used for prey species (i.e. that median escapement of the spawning stock at the end of 20 years of exploitation should be 75% of the pre-exploitation spawning biomass and the probability of depletion below 0.2 of the median pre-exploitation spawning biomass be no greater than 10%). Where possible, biological characteristics of the stocks used as inputs for the GYM were obtained from data of research surveys conducted in the division. However, when not available these data were extracted from information contained in the literature on related species occurring in other geographical areas (sometimes in very distant waters). Consequently, the yields derived from these results are uncertain, especially for skates for which very little information is available.

4.285 The range of estimates of long-term annual yields meet the 75% escapement rule. The precautionary catch limits for *C. rhinoceratus, L. squamifrons* and skates were 69 to 97 tonnes (average 80 tonnes), 7 to 911 tonnes (average 325 tonnes) and 50 to 210 tonnes (average 120 tonnes) respectively. The Working Group noted that the by-catch of these species in the Heard Island trawl fishery did not exceed the lowest estimates of yield for each species and therefore it does not seem to be negatively affecting their stocks. It also stated that while further work is needed to refine the estimates of long-term annual yields, especially for skates, these results could be used as a basis to set precautionary catch limits for these stocks in Division 58.5.2.

4.286 The Working Group welcomed the assessments of these stocks using the GYM and noted a number of further refinements which could be undertaken in the future.

Management Advice

4.287 The Working Group recommended that the estimates of yield using the GYM should be the basis for setting the by-catch limits for these species in Division 58.5.2 during the 1997/98 season: 69–97 tonnes for *C. rhinoceratus*, 7–911 tonnes for *L. squamifrons* and 50–210 tonnes for skates (*Bathyraja* spp.).

Crozet Islands (Subarea 58.6)

Dissostichus eleginoides (Subarea 58.6)

Standardisation of CPUE Indices

4.288 A generalised additive model (GAM) (Hastie and Tibshirani, 1990) was used to standardise CPUE data from the joint French-Japanese longline survey conducted around Crozet Island. GAMs are similar to GLMs in that one does not need to assume that residuals are normally distributed, but GAMs are more flexible than GLMs because the former model uses nonparametric smoothing techniques to model the effects that continuous predictor variables have on the response.

4.289 Kilograms per hook was used as the response variable, and month and depth were considered as predictor variables (note that the model did not include a year effect because the data were collected during the period December 1996 through April 1997). The effect of depth was modelled with a smoothing spline. A chi-square test was used to determine whether the smoothing spline explained significantly more variation in kilogram/hook than a simple linear model. Details about fitting GAMs to data, using smoothing splines, and making inferences from chi-square tests can be found in Hastie and Tibshirani (1990).

4.290 Depth explained a significant amount of variation in kilogram/hook (Table 34). The depth effect was modelled with a smoothing spline that approximated a quadratic function, and CPUE was predicted to have a shallow, U-shaped relationship with depth (Figure 9, upper panel). The smoothing spline was significantly different from a simple linear fit ($p = 0.02$), so the Working Group considered what mechanisms might explain the U-shaped relationship.

4.291 Prof. Duhamel provided the Working Group with information on the by-catch of grenadiers captured during the toothfish survey, and the Working Group considered whether grenadiers outcompete *D. eleginoides* for hooks. A GAM was used to model grenadier CPUE as a function of depth. Grenadier CPUE was calculated as numbers per hook because grenadiers might be seen to outcompete toothfish for hooks if the catch was measured in weight rather than numbers.

4.292 Depth explained a significant amount of variation in grenadier CPUE ($p < 0.01$), and the depth effect was modelled with a smoothing spline that had a bell-shaped curve (Figure 4, upper panel). The smoothing spline for grenadier CPUE was significantly different from a simple linear fit ($p < 0.01$).

4.293 The predicted trends in *D. eleginoides* and grenadier CPUE peaked at different depths (Figure 9, upper panel), and the Working Group agreed that there was some evidence that these two species compete for hooks around Crozet Island. Grenadiers may have the strongest effect on toothfish CPUE at depths between about 800 and 1 000 m.

4.294 Month was a statistically significant ($p = 0.1$) source of variation in the CPUE of *D. eleginoides* (Table 34). Standardised catch rates of toothfish were highest in December 1996 and declined through April 1997 (Figure 9, lower panel).

4.295 The Working Group noted that the declining trend illustrated in Figure 9 (lower panel) was different from that estimated for Subarea 48.3 (Figure 4) where CPUE was higher in March and April than in January and February. The Working Group speculated that the declining trend illustrated in Figure 9 may have resulted from the substantial unreported catches taken from Subarea 58.6 since its last meeting in October 1996 (see Table 3). In this regard, the Working Group noted that the median unexploited spawning biomass estimated from the GYM for Subarea 58.6 (according to proposed new boundaries) was 52 290 tonnes and the total estimated catch from this subarea was 23 943 tonnes (see section 4). The Working Group further noted that the total estimated catch from Subarea 58.6 was thus about 45% of the predicted median unexploited spawning biomass. The Working Group considered that such a large proportion of the estimated spawning stock biomass being taken in a single year is a very serious situation. It is even more disturbing considering that last season was the first known occasion of a significant level of exploitation, and that very little is known of the fish stock in this region.

4.296 The Working Group agreed that since the declining trend illustrated Figure 9 is likely to be a result of the substantial catches taken from Subarea 58.6, the information in this figure could not be used to assess how delaying the start of the fishing season until the beginning of May (as a means of reducing incidental mortality to seabirds) would affect the fishery.

Management Advice

4.297 The Working Group viewed with concern the estimate that 23 943 tonnes have been taken from this area (based on the proposed new boundaries of Subarea 58.6), which represents 45% of the median unexploited spawning biomass estimated from the GYM.

4.298 In the assessment of new fisheries, the Working Group determined that a precautionary catch limit for Subarea 58.6 should be 817 tonnes based on area of seabed and taking 0.45 of the calculated yield (paragraphs 4.92 to 4.115 and Table 11).

4.299 The decline in CPUE observed in the GLM analysis, together with the very high level of catches compared with estimated unexploited spawning biomass and precautionary catch limits is cause for concern. There will be a severe effect on the stock if the high level of illegal catches continues.

4.300 Further work is urgently needed to determine the biological parameters of *D. eleginoides* in this subarea.

Crozet and Prince Edward Islands (Subareas 58.6 and 58.7)

4.301 Notification of the intention to conduct a new fishery for *D. eleginoides* in Subareas 58.6 and 58.7 during the 1996/97 season was lodged by South Africa (SC-CAMLR-XV, Annex 5, paragraphs 4.7 and 4.244). South Africa, Ukraine and Russia have expressed their intentions to continue the fishery in a exploratory phase during the 1997/98 season. Information relating to this fishery is contained in paragraphs 4.8 to 4.10 and 4.63. Management advice is provided in paragraphs 4.120 to 4.134.

4.302 No information was available on other stocks occurring in these subareas.

Prince Edward Islands (Subarea 58.7)

Dissostichus eleginoides (Subarea 58.7)

Standardisation of CPUE Indices

4.303 The Working Group used a GLM to standardise CPUE data from the longline fishery for *D. eleginoides* in Subarea 58.7 around the Prince Edward Islands. The analysis was conducted with the same techniques used to analyse haul-by-haul CPUEs from the longline and trawl fisheries in Subarea 48.3 and Division 58.5.1 respectively.

4.304 CPUEs were calculated as kg per hook, and month, vessel ID, and depth were used as predictor variables. The haul-by-haul data were provided by Dr Miller (South Africa) and covered the period from October 1996 through June 1997. Dr Miller provided data on over 1 000 hauls, but the Working Group was not able to use all of this information in the analysis because of problems joining various fields in the data set. Just over 500 hauls were used in the analysis, so the Working Group considered the results to be preliminary. The Working Group noted that it would be able to undertake a more thorough analysis of the Prince Edward Islands data at its next meeting if the haul-by-haul data are be entered into the CCAMLR database by that time.

4.305 Month and vessel ID were statistically significant ($p < 0.01$) sources of variability to kg/hook (Table 35). The effect of month is illustrated in Figure 10. The Working Group noted that there was not a clear pattern to the standardised series of CPUE by month. Dr Miller further commented that the GLM results presented in Figure 10 were similar to results separately obtained by South African scientists who were able to analyse the full dataset.

4.306 The Working Group noted that for this subarea, as in Subarea 58.6, the estimated total of reported and illegal catches is a high proportion of the median unexploited spawning biomass estimated from the GYM (according to proposed new boundaries). For this Subarea the predicted median unexploited total biomass was 102 210 tonnes and the total estimated catch was 18 839 tonnes (Appendix D), or 18.4% of the median unexploited total biomass. The Working Group considered that the situation in Subarea 58.7 was equally serious to that in Subarea 58.6 because such a considerable proportion of the estimated spawning stock biomass has been taken in a single year. Again, it is particularly disturbing that last season was the first known occasion of a significant level of exploitation, and that very little is known of the fish stock in this region.

Management Advice

4.307 In the assessment of new fisheries, the Working Group determined that a precautionary catch limit for Subarea 58.7 should be 1 685 tonnes based on area of seabed and taking 0.45 of the calculated yield (paragraphs 4.93 to 4.115 and Table 11).

4.308 The Working Group viewed with concern the estimated catch of 18 839 tonnes taken from this area (based on the proposed new boundaries of Subarea 58.7), 87% of which was taken in the unregulated fishery. This was 17 154 tonnes greater than the estimated precautionary yield and represents 18.4% of the median unexploited spawning biomass estimated from the GYM. The high level of catches compared with estimated unexploited spawning biomass and precautionary catch limits is cause for great concern. There will be a severe effect on the stock if the high level of illegal catches continues.

4.309 Further work is urgently needed to determine the biological parameters of *D. eleginoides* in this subarea. The Working Group also recommended that a bottom trawl survey be carried out during the forthcoming season.

Pacific Ocean Sector (Area 88)

4.310 Notification of the intention to conduct a new fishery for *D. eleginoides* and *D. mawsoni* in Subareas 88.1 and 88.2 during the 1996/97 season was lodged by New Zealand (SC-CAMLR-XV, Annex 5, paragraph 4.17). Details on its development are given in paragraphs 4.11 and 4.30 to 4.34.

4.311 No information was available on other stocks occurring in this sector.

General By-catch Provisions

4.312 The Working Group considered issues associated with the by-catch of fish in this section of the report. Information on the by-catch (incidental mortality) of seabirds can be found under section 7 ‘Incidental Mortality Arising from Longline Fishing’.

4.313 Two papers that related to fish by-catch were presented to the Working Group: WG-FSA-97/30 and CCAMLR-XVI/12.

4.314 WG-FSA-97/30 presented results from Division 58.5.2 where *C. rhinoceratus*, *L. squamifrons* and skates (*Bathyraja* spp.) are caught as by-catch in the trawl fishery around Heard Island. In the paper, the GYM was used to estimate precautionary yields for each of these species (parameter estimates for running the model were taken from research survey results and from the literature). Species-specific, total by-catches taken during 1997 were then compared to the lowest estimates of precautionary yield. In all three cases, the actual by-catch was less than the estimated precautionary yield.

4.315 The Working Group noted that WG-FSA-97/30 was an important step forward in dealing with by-catch species and agreed that in general it is better to evaluate levels of by-catch in relation to stock productivity. Evaluating potential yield of by-catch species is preferable to arbitrary rules that restrict the level of by-catch.

4.316 The Working Group did acknowledge, however, that there will often be instances where information is not available to estimate yield for by-catch species.

4.317 WG-FSA-97/30 also outlined a practical problem with the by-catch provisions outlined in Conservation Measures 109/XV, 110/XV, and 111/XV; the same problem was discussed in CCAMLR-XVI/12. The provisions of these three conservation measures have made it difficult for fishermen to prospect for suitable trawling grounds because the fishermen were frequently forced to leave local areas when catches of by-catch species were less than 100 kg. Both WG-FSA-97/30 and CCAMLR-XVI/12 forwarded the proposal that the by-catch provisions in the three conservation measures be modified so that vessels are not forced to move if catches of any single by-catch species are less than 100 kg in any single haul.

4.318 The Working Group agreed that the 100 kg threshold for by-catch in a single haul would probably not cause stocks of by-catch species to become overexploited but agreed that there should also be an upper limit to the number of 100 kg by-catches that could occur in a single year. Ideally, this upper limit should be determined by the potential yield of each by-catch species.

4.319 The Working Group summarised its discussions on by-catch provisions by acknowledging that a mixed strategy of dealing with by-catch is probably most appropriate for all fisheries where there are fish by-catches. The mixed strategy has two components:
(i) total removals of each by-catch species are limited by estimates of potential yield; and
(ii) haul-specific by-catch limits are set at levels that permit prospecting but are not likely to cause the potential yield from Component 1 to be exceeded. The Working Group further noted that haul-specific by-catch limits in Component 2 of the mixed strategy should be set on a case-by-case basis and acknowledged that such a strategy has already been implemented in the *C. gunnari* fishery in Subarea 48.3 (Conservation Measure 107/XV).

Resumption of Closed or Lapsed Fisheries

4.320 At its last meeting, the Working Group recommended that the Commission maintain a register of lapsed fisheries (SC-CAMLR-XV, Annex 5, paragraph 4.251). In response to this recommendation the Secretariat prepared SC-CAMLR-XIV/BG/16 Rev. 1 and presented it to the Working Group. The paper identified five types of fisheries: new, exploratory, established, closed and lapsed. The paper further noted that formal definitions only exist for new, exploratory and closed fisheries. The Working Group noted that there were some errors and omissions in the document which should be revised and presented in a Rev. 2.

4.321 The Working Group agreed that SC-CAMLR-XIV/BG/16 Rev. 1 was a useful and important step forward in developing a framework for classifying fisheries in the CCAMLR Convention Area. The Working Group further commented that such a framework could provide the basis of a general means for guiding the Scientific Committee's and Commission's policies in reference to dealing with fisheries in the Convention Area. For instance, the Scientific Committee could direct the Working Group to conduct specific types of assessments for each type of fishery, and the Commission could adopt a standard data collection and reporting strategy for each type of fishery.

4.322 The Working Group further noted that the lack of consistent quality between the various notifications of new and exploratory fisheries received at this year's meeting (paragraph 4.17) indicated that Members applied different interpretations to the various requirements in the current conservation measures on new and exploratory fisheries (Conservation Measures 31/X and 65/XII). The Working Group agreed that a standard framework for dealing with various types of fisheries would make it easier for Members to provide the information necessary to evaluate new and exploratory fishery notifications.

4.323 As a final note on this topic, the Working Group reiterated the recommendation that information and procedures similar to those required for the initiation of a new fishery and/or for the execution of an exploratory fishery should be required during the resumption of a closed fishery (SC-CAMLR-XV, Annex 5, paragraph 4.249).

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

5.1 Dr Everson (Convener, WG-EMM) outlined those aspects of the ecosystem assessment conducted by WG-EMM at its meeting this year (Annex 4) which related directly to the work of WG-FSA.

5.2 The Working Group noted with appreciation that WG-EMM had continued to investigate the by-catch of fish in the krill fishery (Annex 4, paragraphs 6.1 to 6.4 and WG-EMM-97/72). It was also noted that this information could be used in conjunction with information on the distribution of juvenile and larval phases of fish species to determine the effect of the krill fishery on finfish populations. Therefore, in 1995 WG-FSA established a correspondence group to analyse all available material on fish by-catch in krill fisheries for the entire Convention Area.

5.3 To date, the Working Group (WG-FSA-97/46 Rev. 1) has:

(i) identified all datasets reported to CCAMLR and/or published elsewhere;
(ii) agreed on data requirements and analytical procedures;
(iii) requested authors/owners of data to submit them in a specified format;
(iv) developed a database; and
(v) processed the data received and input them into the CCAMLR database.

5.4 The Working Group noted that not all data identified and requested for inclusion in the database has been made available. It agreed that the Secretariat should once again request these data.

5.5 In addition, some deficiencies were noted in a number of datasets received. The Working Group agreed that the Secretariat should request originators of the data to correct deficiencies where possible.

5.6 However, irrespective of whether or not additional data and/or corrections of deficiencies identified in existing datasets have been received, after three months from the end of the Commission meeting (1 March 1998), a final database should be established and circulated to members of the Working Group for subsequent data analyses and review of methodology during the next intersessional period.

5.7 The Working Group noted that an analysis of data reporting stomach contents of fish specimens incidentally taken by a Japanese krill fishing vessel in January/February 1995 which was to be submitted to WG-FSA this year (Annex 4, paragraph 6.3) has not been received. The Working Group agreed that this analysis would be a valuable contribution to its work and would welcome its availability in the near future.

5.8 As demonstrated in papers submitted to previous meetings of WG-EMM and in WG-EMM-97/61, Antarctic blue-eyed shags (*Phalacrocorax bransfieldensis*) rely heavily on a range of inshore fish species. WG-EMM considered that, if a reliable method could be developed, it may be appropriate to adopt the Antarctic blue-eyed shag as a CEMP monitoring species (Annex 4, paragraph 6.82). At this year's meeting, Members of WG-EMM felt enough new information was now available to justify preparing a revised version of the draft standard method for consideration by WG-EMM and WG-FSA (Annex 4, paragraph 8.75).

5.9 The Working Group welcomed the development of this new monitoring method by Lic. R. Casaux (Argentina) and his colleagues and agreed with WG-EMM (Annex 4, paragraph 10.24) that a revised version of the draft standard method should be completed during the next intersessional period which could then be considered by both working groups.

5.10 The Working Group appreciated advice provided by WG-EMM concerning the potential impact of a fishery for squid (*M. hyadesi*) on predators (Annex 4, paragraphs 6.83 to 6.87). It noted that WG-EMM considered that there was generally insufficient information to conclude how the development of such a fishery was likely to influence predators. It appeared that most predators were taking one-year-old squid and there was little indication that they were feeding on spent squid. The most accurate information about squid consumption comes from the predator species which accounted for the smallest proportion of the estimated predation of squid in Area 48 (Annex 4, paragraph 6.83).

5.11 The Working Group thanked WG-EMM for its advice concerning the need for more information on the estimates of the natural mortality rate of squids, on variability in recruitment, on the appropriate level of squid escapement, and on the timing of the fishery (Annex 4, paragraphs 6.85 to 6.87). These concerns will be incorporated in the Working Group's advice to the Scientific Committee.

5.12 WG-EMM reviewed an analysis pertinent to the determination of the appropriate level for the median biomass of *D. eleginoides* after fishing (escapement) in the commercial fishery at Heard Island (Annex 4, paragraphs 6.88 and 6.89; WG-EMM-97/42). The analysis considered the age classes of *D. eleginoides* taken by elephant seals, based on seven otoliths from probably four *D. eleginoides* found in one of 65 sampled stomachs. The analysis indicated that the level of escapement in the age classes likely to be eaten by elephant seals was of the order of 87%, and the assessment developed by WG-FSA would not require adjustment to account for predator requirements on this species.

5.13 The Working Group accepted this conclusion, but noted that larger samples of otoliths from elephant seal stomachs at Heard Island would be useful. Dr Croxall indicated that preliminary data from South Georgia on diet composition estimated from lipid composition of milk suggested that *D. eleginoides* could form a substantial fraction of the elephant seal diet at this site.

5.14 The Working Group was encouraged that WG-EMM compared the GYM used to determine fish stock assessments to its krill yield model and found that it provided duplicate results (Annex 4, paragraph 7.3). WG-EMM also found that the generalised model used by WG-FSA is more readily extended to incorporate new features. After the Secretariat has validated the generalised model, it will replace the existing krill yield model for future krill-related computations.

5.15 The Working Group recognised that WG-EMM's plan to conduct a synoptic survey to determine krill biomass in the 1999/2000 season (Annex 4, paragraph 8.109) could be an opportunity to collect ancillary information which might further the Working Group's goals. For example, squid might be detected and delineated in the acoustic data and net sampling protocols might be developed to allow information on larvae and juvenile fish to be obtained. The Working Group agreed that Members should develop data collection plans which could utilise this opportunity and present them to its next meeting.

5.16 The Working Group expressed interest in an approach initiated by WG-EMM's Subgroup on Statistics. They recognised that an approach for the proper treatment of anomalies in data from non-normal distributions should be developed. In addition, they noted that some observations which are 'anomalies' from a biological perspective may not be statistically significant (Annex 4, Appendix D, paragraphs 2.5 to 2.23). The detection and treatment of these values were examined by investigating a proposal for combining CEMP variables to produce a smaller number of summary indices. The Working Group agreed that this work may have application for WG-FSA's work.

5.17 It was noted that WG-EMM is developing ecosystem assessments in a standardised form (Annex 4, paragraphs 7.29 and 7.30). An illustrative example developed by WG-EMM (Annex 4, Appendix F) was based on that used to present assessment summaries by WG-FSA. The Working Group encouraged this development and hoped further collaborative work along this line would be possible.

5.18 Finally, the Working Group noted WG-EMM's advice that revised calculations of precautionary catch limits for the krill fishery in Area 48 should be deferred until additional pertinent information (such as the results of the synoptic krill survey planned for 1999/2000) becomes available (Annex 4, paragraphs 7.1 to 7.3).

Ecological Interactions

5.19 The Working Group noted that several reports of scientific observers on board vessels participating in the *D. eleginoides* longline fisheries mentioned interactions between marine mammals and fish (Table 36). In Subarea 48.3 most observers reported that sperm whales were regularly associated with longline vessels during hauling operations. Killer whales and fur seals were occasionally seen in close proximity to the longline. Most observers in

Subarea 48.3 reported potential loss of fish to whales and/or fur seals. In four cases the observers estimated the number of fish lost, ranging from 6–7 grenadiers to 44–450 toothfish.

5.20 In Subareas 58.6 and 58.7 all observers noted the regular presence of marine mammals (Table 37), principally sperm whales with occasional observations of killer whales and fur seals. Only on two occasions were observers certain that fish had been removed from the longline, involving small numbers of *D. eleginoides*. There were two reports of entanglement with sperm whale and one with a minke whale which caused the loss of substantial portions of longline (and presumably the fish caught on these lines).

5.21 The Working Group endorsed results of the workshop on predator-prey-fisheries interactions reported by Australia (WG-EMM-97/27 and 97/31). The aim of the workshop was to report on:

(i) the current state of knowledge on those predator-prey relations in the Heard Island and McDonald Islands region and at Macquarie Island which may be affected by fisheries, particularly on *D. eleginoides* and *C. gunnari*;

(ii) future research requirements, including an outline of a research plan; and

(iii) interim advice on the implications of predator-prey interactions for the development of management plans for fisheries.

The Working Group was encouraged that the work will be continued intersessionally.

5.22 The management of *C. gunnari* at South Georgia is complicated by the likelihood of substantial periodic variation in natural mortality rates which may be associated with their increased consumption by fur seals in years of poor krill availability. A scheme that would use information from studies on krill and predators undertaken as part of CEMP to interpret or modify information from commercial fisheries and research surveys leading to estimates of stock biomass was developed (WG-FSA-97/38 and paragraph 4.174). The Working Group encouraged further development of this scheme.

RESEARCH SURVEYS

Simulation Studies

6.1 The Working Group noted that WG-EMM is undertaking a simulation study on the development of model-assisted assessments of biomass from krill acoustic surveys. It was agreed to closely follow these developments since the results could be applied in biomass estimates of fish surveys.

6.2 Drs Gasiukov and Marschoff reported on an intended simulation study aimed at the quantification of the influence of spatial correlation in the estimates of the stock of *C. gunnari*, attempting to define the minimum distance between stations allowing randomisation of the design.

Recent and Proposed Surveys

Recent Surveys

6.3 A list of all surveys undertaken in CCAMLR waters was compiled by the Secretariat and is given in Table 22.

6.4 Several members conducted surveys during the last season, which are discussed in the pertinent sections of this report.

6.5 Dr. Everson informed the Working Group that during the UK survey conducted in September 1997 on board *Argos Galicia* in Subarea 48.3, a baited camera was deployed to record the presence of *D. eleginoides* in order to provide estimates of density using a methodology that is independent of fishery methods.

Proposed Surveys

6.7 During the 1997/98 season, the USA intends to conduct a bottom trawl survey in Subarea 48.1 using a stratified random survey design and stations previously utilised by Spanish and German scientists (e.g. WG-FSA-97/27). The survey will be conducted between 9 March and 8 April using the chartered Russian RV *Yuzhmorgeologiya.* It is expected that 40 to 50 hauls each lasting approximately 30 minutes will be completed.

6.8 The Spanish longline survey to be conducted in Subarea 48.6 and Division 58.4.4, according to COMM CIRC 97/42 dated 22 July 1997, will take place during the coming season and will last for about 45 days operating in these subareas and outside CCAMLR waters on Meteor Bank. The mean number of hooks per set will be about 1 500 to allow a larger number of sites to be sampled.

6.9 A French survey on *C. gunnari* in Division 58.5.1 is expected to be conducted during the 1997/98 season if agreement is obtained from owners of French trawlers operating in the fishing grounds.

6.10 A survey on mesopelagic ichthyofauna is scheduled off the Kerguelen Islands (Polar Frontal Zone – Division 58.5.1) during January/February 1998 on board *La Curieuse* (see CCAMLR-XVI/MA/4). Myctophids are the targeted species of the scientific cruise. No high levels of catches are expected. A report will be available for the next meeting of WG-FSA.

6.11 The Argentinian research vessel *Dr Eduardo L. Holmberg* will be fitted with a deepwater winch. If available on time, a bottom trawl survey will be conducted in Subareas 48.3 and 48.2. It is planned that the design of the survey will make use of the results of the simulation exercise referred to in paragraph 6.2 above.

6.12 During the 1997/98 season, Australia is planning to repeat a random stratified trawl survey for *C. gunnari* on the Heard Island plateau and Shell Bank in Division 58.5.2. The conduct of this survey will depend on a suitable opportunity during the operations of an Australian trawler, but it is hoped to carry out the survey late in the season.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

7.1 Concern was expressed that only two members of the CCAMLR ad hoc Working Group on Incidental Mortality Arising from Longline Fishing (WG-IMALF) had been able to attend, as requested last year, to commence work on this topic from the start of the WG-FSA meeting. It was hoped that some members of WG-IMALF from Australia and New Zealand would be able to attend the whole meeting next year.

7.2 The Working Group approved the addition of Mr G. Benavides (Chile), Mr B. Baker (Australia) and Ms B. Dettmann (Australia) to WG-IMALF. Members were invited to review their nominees to this working group and to notify the Secretariat of any changes.

Intersessional Work

7.3 The Secretariat circulated the IMALF plan of intersessional work to members of the WG-IMALF in January 1997. WG-FSA-97/57 summarises the work requested (together with those responsible and deadlines), actions undertaken and responses received. The Science Officer was thanked for coordinating this work. It was noted that an earlier circulation of the intersessional work plan might assist scientists to undertake tasks prior to departure for Antarctic field work.

7.4 Background information on the work of IMALF was also circulated, including to the technical coordinators of scientific observer programs for them to forward to all scientific observers who had been scientific observers on board longline vessels in the Convention Area during the 1995/96 season.

7.5 The newly-revised *Scientific Observers Manual* (containing logbook forms for scientific observers on board longline vessels) was translated, published and distributed to all Members during the year.

7.6 Mr Benavides suggested that the list of bird species in Part IV, Section 5 of the manual should be updated and that the vernacular names of species in all languages of the Commission should be included. This was agreed.

7.7 During the year the Science Officer and the IMALF group were involved in extensive correspondence with non-governmental organisations, especially in the USA, on issues relating to incidental mortality of seabirds. Examples of some of this dialogue are included in WG-FSA-97/57.

7.8 The booklet *Fish the Sea Not the Sky* was widely circulated to Members, international governmental and non-governmental organisations (WG-FSA-97/57). Some publicity was sought from fishing publications and via Mustad, a company specialising in the production of longline fishing gear, in an article in *Fishing News International* (SC-CAMLR-XV/BG/23).

7.9 There was little indication that any feedback on this booklet had been provided by users. There were no comments in any of the reports of scientific observers to indicate whether the booklet was available on board vessels, whether it was used, or how useful it was. It was recommended that these questions be posed to observers via a footnote in the *Scientific Observers Manual.*

7.10 Mr Benavides indicated that Chilean observers/vessels had found the booklet useful.

He recommended that in any reprinting of this booklet the scientific names of bird species be included on the plates.

7.11 To assist in getting the messages contained in the CCAMLR booklet across to the fishing industry and fishermen, it was recommended that the Secretariat send copies to the main companies believed to be engaged in longline fishing in the Convention Area and adjacent areas. They should be requested to help ensure that copies are available on board all their vessels.

7.12 It was agreed that publicising on the worldwide web (see SC-CAMLR-XVI/BG/23) the CCAMLR booklet and CCAMLR activities and data concerning IMALF would be of considerable value.

7.13 The Science Officer had attended the second meeting of the Ecologically Related Species Working Group of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT-ERSWG) as the CCAMLR observer (SC-CAMLR-XVI/BG/13). His report noted:

(i) that the use of tori poles has become mandatory in the Australian, New Zealand and Japanese southern bluefin tuna fisheries. Data indicate that reductions in seabird by-catch of 69 to 87% have been achieved on Japanese vessels using appropriately designed and deployed tori poles and streamer lines;

(ii) that data suggest that a 70 to 96% reduction in incidental mortality of seabirds, especially albatrosses and giant petrels, is possible with night-time setting;

(iii) the recommendation from ERSWG to CCSBT to prepare plans for research priorities for mitigation measures;

(iv) that the CCAMLR proposal for a joint meeting of ERSWG and CCAMLR WG-IMALF has been referred to CCSBT; and

(v) the approval for information exchange between the two above groups – as evidenced by the provision to CCAMLR of several papers originally tabled at the ERSWG meeting (WG-FSA-97/13 to 97/17).

7.14 A request from CCSBT to CCAMLR for data on longline fishing effort in the Convention Area has been referred to WG-FSA, to provide advice to the Scientific Committee on establishing a data exchange between CCSBT and CCAMLR (SC-CAMLR-XVI/BG/13). It was noted that these data would contribute to analyses complementary to those being undertaken within CCAMLR. The Working Group recommended that the Scientific Committee agree to supply CCSBT with these data.

7.15 The Working Group welcomed the collaboration between CCSBT-ERSWG and CCAMLR and recommended that CCAMLR should request from CCSBT observer status for future meetings of ERSWG and that observers from CCSBT should continue to be invited to attend meetings of WG-FSA and/or WG-IMALF.

7.16 Last year CCAMLR requested other organisations regulating tuna fishing, especially ICCAT and IOTC, to establish groups to tackle the problem of seabird–longline fishing interactions. The report of the Coordinating Working Party on Fishery Statistics (CWP) had noted this recommendation (WG-FSA-97/51). However, there has so far been no further feedback from either of the above tuna commissions.

Research into Status of Albatrosses,
Giant Petrels and White-chinned Petrels

7.17 Before last year's meeting, CCAMLR had requested Members to provide information on their monitoring programs to assess the status and trends of breeding populations of albatrosses and petrels likely to be at risk through longline fishing in the Convention Area and adjacent regions. Reports from Australia, New Zealand and the UK had been made available last year.

7.18 A response from France had not yet been received; the Secretariat was requested to solicit a written report on relevant French programs.

7.19 It was noted that the projected Australian surveys at Heard Island (SC-CAMLR-XV, Annex 5, paragraph 7.18(iii)) had been postponed until 1998.

7.20 Further details of the New Zealand monitoring studies would be welcome (see SC-CAMLR-XV, paragraph 7.16) and should be requested intersessionally by the Secretariat.

7.21 South Africa had reported intersessionally that annual counts are made of wandering and grey-headed albatrosses at Marion Island. Recent information on sooty and light-mantled sooty albatrosses is lacking, principally because of the logistic difficulty of undertaking surveys. No data are available from Prince Edward Island so it is not known whether the population status of albatrosses and petrels there has changed since the 1970s (WG-FSA-97/57).

7.22 Dr Miller indicated that it was hoped to conduct surveys of seabird breeding populations at Prince Edward Island in the 1997 or 1998 summer.

7.23 Dr Robertson will also be conducting studies of albatross populations including satellite-tracking in collaboration with the Chilean Antarctic Institute in November 1997.

7.24 The additional information on monitoring studies was welcomed. It was requested that Members conducting such work provide CCAMLR with regular updates on their studies, particularly if population changes or trends are detected.

7.25 In response to intersessional requests for information on distribution and population size of albatrosses and petrels potentially at risk from new and exploratory longline fisheries, information had been supplied on giant petrels by SCAR (WG-FSA-97/22), on albatrosses worldwide by Dr R. Gales (Australia) (WG-FSA-97/28) and on bird communities at the Prince Edward Islands by South Africa (WG-FSA-97/23).

7.26 In addition, WG-FSA-97/59 reviews the conservation status of albatrosses, using the results of the latest taxonomic investigations – recommending the recognition of 10 new taxa at the species level – by applying the new IUCN criteria for the objective definition of threatened species. The conclusions of this review, in terms of categories of threat for albatrosses, have been reviewed by the appropriate IUCN Specialist Group and will be incorporated into the 1997 edition of the IUCN Red List.

7.27 The review indicates that of the albatross species breeding in the Convention Area, five are Threatened (at the Vulnerable level): wandering albatross (South Georgia, Prince Edward Islands, Crozet, Kerguelen, Macquarie), Salvin's albatross (Crozet), Indian yellow-nosed albatross (Prince Edward Islands, Crozet), grey-headed albatross (South Georgia, Prince Edward Islands, Crozet, Kerguelen, Macquarie), sooty albatross (Prince Edward Islands, Crozet, Kerguelen). In addition, one species is Near-threatened: black-browed albatross (South Georgia, Prince Edward Islands, Crozet, Kerguelen, Heard/McDonald Islands, Macquarie); and one is Data Deficient: light-mantled sooty albatross (South Georgia, Prince Edward Islands, Crozet, Kerguelen, Heard/McDonald Islands, Macquarie).

7.28 Those Members of CCAMLR with responsibilities for islands where these threatened species of albatross breed (Australia, France, South Africa, UK) may need to consider whether they have special responsibilities to protect globally threatened species. Australia is already giving effect to this responsibility in respect of wandering albatrosses at Macquarie Island.

7.29 At the fifth meeting of the Conference of the Parties of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) held in Geneva, Switzerland in April 1997, the Amsterdam albatross (which occurs in the northern part of the Indian Ocean region of the Convention Area) was placed on Appendix 1; 12 other species of albatross were placed on Appendix 2. Of the latter, six species breed in the Convention Area (wandering albatross, black-browed albatross, yellow-nosed albatross, grey-headed albatross, sooty albatross, light-mantled sooty albatross). The implications of these designations for CCAMLR and CCAMLR Members may need investigation.

7.30 Mr Baker noted that the listing of all albatross species to the CMS has now opened the way to develop an agreement under Article IV of the Convention. Australia believes that an agreement under the Convention is the most accessible mechanism to achieve global coordination of albatross conservation efforts. Australia will actively endeavour to develop an agreement in cooperation with other albatross range states.

7.31 Dr Kock suggested that the Secretariat should contact the CMS Secretariat in Bonn to inform it of CCAMLR's work in relation to albatross conservation. It was agreed to recommend this action to the Scientific Committee and that a copy of the information be sent to Dr Kock, to enable him to follow this up personally.

7.32 Dr Miller suggested that it might be appropriate for CCAMLR to draw the attention of the Convention on Biological Diversity (CBD) to the interactions between albatrosses and longline fisheries as an example of harmful biological consequences caused by anthropogenic effects. The Secretariat was requested to correspond with the CBD Secretariat to establish whether the Convention's clearing house mechanism and/or the UNEP Regional Seas Program would be interested in having further information on CCAMLR's work in this field.

Reports on Incidental Mortality of Seabirds during Longline Fishing in the Convention Area

1996 Data

7.33 Last year, analysis of the 1995/96 data could not be completed due to late and incomplete arrival of data and to the submission of data in non-standardised formats. Subsequent resubmission of data from scientific observers from Argentina was received in electronic format on 27 July 1997 but did not include data on seabird mortality (WG-FSA-97/36).

7.34 Consequently, it was not possible to improve the analysis of data on seabird incidental mortality from that presented in last year's report. Last year it was noted that extrapolating to the complete dataset based on four (of 16) sets of observer data was most unsatisfactory. Nevertheless, this still remains the best assessment possible with the available data.

7.35 Validation of data on incidental mortality from the C2 forms submitted in 1996 has resulted in a few minor changes being made to the data reported last year. These are as follows:

Antarctic III:	4, not 5, birds killed;
Vieirasa Doce:	41, not 42, birds killed;
Mar del Sur:	197, not 195, birds killed;
Frio Sur III:	48, not 49, birds killed.

This changes the overall total by only one bird; as a consequence it was not thought necessary to recalculate the complete tables from last year.

7.36 An additional set of 1996 data, submitted intersessionally by Japan, was from the *Anyo Maru No. 22* in Division 58.5.1 (Kerguelen). The C2 form records a total of 145 longline sets (696 000 hooks), between 17 February and 29 April 1996, when 246 white-chinned petrels were killed. This is a catch rate of 0.35 birds per thousand hooks.

1997 Data

Data Submission

7.37 The overall summary of data and reports from scientific observers on vessels engaged in longline fishing in the Convention Area is in Table 5.

7.38 It was recognised that the submission of data this year was a major improvement on last year and the Working Group thanked all observers and technical coordinators for contributing to this.

7.39 However, many data submissions and reports were received only on the first day of the WG-FSA meeting. A comprehensive (albeit still incomplete) set of data on incidental mortality of seabirds was not available for validation and analysis until the second week of the WG-FSA meeting. It was stressed that observer data and reports must be submitted to the Secretariat within one month of the observer returning to port. The Scientific Observer Data Analyst and the Data Entry Assistant were particularly thanked for their work before and during the meeting.

7.40 Information on data contained in scientific observer reports is summarised in Tables 38 and 39. Scientific observers were congratulated on the high standard of reports, which facilitated the extraction of this information. To assist this process in future years it was agreed to add to the *Scientific Observers Manual* a checklist of topics for which the observer should attempt to provide information (or indicate if no information/data are available) in the report. This checklist is attached as Appendix F. It was hoped that Items 4a, 4b and 5a on this checklist could be incorporated into the logbook forms at their next revision and thereby removed from the checklist.

7.41 During the meeting, priority in entering of incidental mortality data was accorded to data from Subarea 48.3. Data for all but four (of 21) cruises were entered before the end of the meeting (see Table 40) and therefore these data are used to estimate overall seabird by-catch rates.

7.42 There are, however, some discrepancies between these data and those recorded in the observer reports. High priority should be given to resolving these differences by discussion between the Scientific Observer Data Analyst and the Members and/or scientists responsible or knowledgeable about these data.

7.43 Entry of incidental mortality data from Subareas 58.6 and 58.7 was accorded a lower priority, particularly because most data were already summarised in WG-FSA-97/51 (see paragraphs 33 and 34). Only three sets of data could be entered before the end of the meeting (see Table 41). Consequently the data from the scientific observers' reports – which accord very closely with those in WG-FSA-97/51 – were used to estimate overall seabird by-catch and the species composition of this by-catch.

7.44 High priority should be given to completing data entry for the remaining cruises in Subareas 58.6 and 58.7 with a view to producing revised versions of Tables 41 to 43 as soon as possible (intersessionally) and resolving any discrepancies with appropriate Members/ scientists.

Results

Subarea 48.3

7.45 In addition to the information contained in Tables 38, 40 and 44 to 46, several reports relating to the seabird by-catch in Subarea 48.3 had been tabled.

7.46 WG-FSA-97/9 reports a study on the *Cisne Verde* of seabird by-catch associated with longline fishing around South Georgia in March to May 1997. All setting operations occurred at night; no offal was discharged during the haul. In response to last year's request by WG-FSA (SC-CAMLR-XV, Annex 5, paragraph 7.86) for research into the effectiveness of streamer lines, a randomised experiment (presence/absence of streamer lines) was carried out. With the precautions used, including appropriate weighting of the fishing line, seabird by-catch rates were very low, being 0.018 birds per thousand hooks. There was no significant difference in by-catch rates at night with or without streamer lines.

7.47 It was noted, however, that the number of sets used in the experiment was small and the result should be interpreted with caution.

7.48 WG-FSA-97/26 provides a preliminary analysis and summary of seabird by-catch data from nine cruises by four Chilean vessels between 1 March and 8 September 1997. The total seabird by-catch was 478 birds, comprising 196 black-browed albatross (41%) and 162 white-chinned petrels (34%) with small numbers of other species. The overall average seabird by-catch rate was 0.149 birds per thousand hooks compared with 0.077 in 1996 and 0.339 in 1995; none of these values was significantly different.

7.49 It was noted, however, that the above calculations on the Chilean data, based on the C2 format, assume that there was 100% observer coverage of all sets of all vessels. The logbook data submitted to the Secretariat indicate that, for some vessels, only 5–10% of the sets may have been observed (Table 40).

7.50 It was noted that the overall contribution of white-chinned petrels to the 1997 mortality estimates in WG-FSA-97/26 could be as great as 42% if the 60 sooty albatrosses (a very rare vagrant to Subarea 48.3) were white-chinned petrels (hereafter assumed to be the case) and 52% if the 48 unidentified petrels from the first *Isla Camila* cruise were also white-chinned petrels.

7.51 Table 40 indicates that about 89% of hooks were set at night, a marked improvement in compliance with Conservation Measure 29/XV compared with previous years.

7.52 However, of the 17 cruises in Table 40, streamer lines were apparently not (or hardly) used on nine cruises and only comprehensively used on four cruises. This is a very disappointing level of compliance with an important element of Conservation Measure 29/XV.

7.53 Table 39 indicates that some vessels are still discharging offal at the set – inevitably attracting large numbers of seabirds and substantially increasing the risk of incidental mortality and reduced fishing efficiency. Tables 39 and 40 suggest that a substantial proportion of vessels are still discharging offal during the haul on the same side as the vessel on which they hauling the longline. This practice is contrary to the intention of Conservation Measure 29/XV and is certainly responsible for the high level of bird entanglement observed during the haul by many vessels (though only 5% of the 360 birds entangled were killed) (Table 47).

7.54 Most seabird catch rates in Table 40 are broadly in line with previous experience (allowing for the poor use of streamer lines but noting the improved night setting performance), being in the range 0 to 0.72 birds per thousand hooks. It is notable that catch rates on summer cruises (1 March to 31 April) are an order of magnitude higher than on winter cruises (after 1 May). Night-time rates are consistently lower than daytime ones.

7.55 A notable exception to the by-catch rates above is the first cruise of the *Isla Isabel* where 276 birds were observed caught (99 – all white-chinned petrels – from a single set) an estimated overall rate of 9.31 birds per thousand hooks. The observation data suggest that only 10% of sets were observed, so this high catch rate is based on a relatively small sample, which is extrapolated to give the large estimate of the overall numbers of birds killed on this cruise (2 453 birds – see Table 45).

7.56 This example highlights the importance of ensuring that sampling of seabird by-catch is adequate to obtain a realistic estimate of the total mortality. It was recommended that Members investigate intersessionally the optimum levels of sampling of longline hauls to ensure coverage adequate to give robust overall estimates of seabird by-catch. Until this has been properly investigated, there is no reason to change the current procedures (recommending observations of as high a proportion as possible of the hooks hauled).

7.57 The species composition of the by-catch is summarised in Table 44. The main species killed are white-chinned petrels (48%, including the so-called sooty albatrosses (see paragraph 7.50)), black-browed albatross (40%), northern and southern giant petrels (2% combined) and grey-headed albatross (2%). If the unidentified petrels are white-chinned petrels (see paragraph 7.50) then their total becomes 55%.

7.58 Data from Table 40 are used to estimate the overall by-catch of seabirds per vessel (Table 45). Using the species composition data from Table 43, this estimate is converted into an estimate of total seabird mortality by species in Subarea 48.3 in the 1996/97 fishing season in Table 46.

7.59 Some concern was expressed that the method of analysis might not take account of biases due to disproportionate numbers of sets being in the periods of high or low seabird by-catch (e.g. summer or winter).

7.60 In response, it was noted that, provided the distribution of observer effort matches that of fishing effort, this should not be a problem. However, it was agreed that it might be useful to investigate this intersessionally. Members were also encouraged to propose other methods of analysis of the seabird by-catch data from scientific observers. Until such new proposals had been thoroughly investigated it was recommended that the existing approach be retained.

Division 58.5.1

7.61 No logbook data on seabird by-catch in this area have yet been received by the Secretariat.

7.62 WG-FSA-97/6 reports seabird by-catch for two Ukrainian longline vessels fishing in the Kerguelen Islands area between October 1996 and March 1997. The *N. Reshetnyak* made 540 sets (1 286 000 hooks) and caught 65 white-chinned petrels, an overall by-catch rate 0.051 birds per thousand hooks. The *Pantikapey* made 503 sets (1 201 500 hooks) and caught 39 white-chinned petrels, 1 black-browed albatross and 1 sooty albatross, an overall by-catch of 0.034 birds per thousand hooks.

7.63 From October to December, longlines were set both during the day and at night. The *N. Reshetnyak* caught 53 white-chinned petrels between 0400 and 2000 h. The *Pantikapey* caught 34 white-chinned petrels and both albatrosses between 0400 and 2000 h and 5 white-chinned petrels between 2000 and 0400 h. The peak by-catch was in November. After January, longlines were set only at night; only 12 white-chinned petrels were caught (all by *N. Reshetnyak*).

7.64 The Working Group noted that this was a good example of a change in fishing practice, to comply with Conservation Measure 29/XV, producing a considerable reduction in seabird by-catch and increase in fishing efficiency.

Subareas 58.6 and 58.7

7.65 In addition to the information contained in Tables 39 and 41 to 43, several reports relating to the seabird by-catch in Subareas 58.6 and 58.7 had been tabled.

7.66 WG-FSA-97/51 reports and summarises seabird by-catch data from 12 cruises of longline fishing vessels around the Prince Edward Islands. The cruises include *Alida Glacial* and *American Champion* (no observers on board and data not used in analysis), *Mr B* and *Aliza Glacial* (no observer reports yet received by CCAMLR). This paper does not include the last cruises of the *Aquatic Pioneer, Sudurhavid* and *Zambezi*. However, these cruises contributed only a total by-catch of two birds (both northern giant petrels).

7.67 The observer data included in WG-FSA-97/51 gave a total of 923 birds killed at an overall rate of 0.289 birds per thousand hooks. However, catch rates varied greatly both seasonally and between vessels and cruises. Thus the January to February cruise of the *Aquatic Pioneer* killed 417 birds (45% of all birds and 60% of all white-chinned petrels) at a by-catch rate of 1.468 birds per thousand hooks. For cruises only in winter (*Sudurhavid, Aquatic Pioneer* in May/June) the by-catch rate is 0.009 compared with a the summer rate (all other cruises) of 0.363 birds per thousand hooks, a 40-fold difference.

The main species caught were white-chinned petrels (73%), grey-headed and yellow-nosed albatrosses (23% combined) and giant petrels (4%). Catches of white-chinned petrels and albatrosses both peaked in February; few albatrosses or white-chinned petrels were caught after April.

About 55% of hooks were set during the day. Excluding white-chinned petrels, catch rates during the night were 0.012 birds per thousand hooks, an order of magnitude less than for daytime catches (0.138 birds per thousand hooks). On the January to February *Aquatic Pioneer* cruise, more white-chinned petrels were caught at night than during the day (0.231 and 0.190 birds per thousand hooks respectively). On the other cruises, however, white-chinned petrel by-catch during the day was higher than at night (0.131 and 0.043 birds per thousand hooks respectively).

7.68 The Working Group noted that further analysis of by-catch rates of white-chinned petrels in relation to phase of moon might prove illuminating, particularly by analogy with other studies of seabird by-catch in *Dissostichus* and tuna fisheries (see paragraph 7.113)

7.69 WG-FSA-97/51 also investigates by-catch rates as a function of distance from breeding site. Catch rates of seabirds were greater closer to the Prince Edward Islands. For all species except white-chinned petrel, six times as many birds were caught within 100 km of the islands as between 100 and 200 km (0.087 and 0.015 birds per thousand hooks respectively); however, the former zone was where most fishing effort occurred. In contrast, white-chinned petrels were present at similar catch rates within 100 km and between 100 and 200 km of the islands.

7.70 In response to a question, Dr Miller indicated that white-chinned petrel by-catch and fishing effort in relation to distance from the Prince Edward Islands could be compared by using haul-by-haul data. This analysis was encouraged by the Working Group.

7.71 WG-FSA-97/51 noted that not all vessels deployed streamer lines while setting gear and observers did not always report whether streamer lines were in use or not for particular sets. Therefore only for one vessel (*Garoya*) were there sufficient data to examine the effects of streamer lines. The use of streamer lines on the *Garoya* reduced by-catch by 41% during daytime sets and by 61% during night sets.

7.72 Estimates of the overall seabird by-catch in Subareas 58.6/58.7 in 1997, in both regulated and unregulated fisheries, were provided in WG-FSA-97/51. The authors estimated a total fishing effort 20 to 40 million hooks, equivalent to a total by-catch of 5 000 to 10 000 birds. Assuming a similar species composition of bird by-catch in both types of fishery, this represents 4 000 to 8 000 white-chinned petrels, 1 000 to 2 000 grey-headed albatrosses, 300 to 600 yellow-nosed albatrosses, 150 to 300 southern giant petrels and 100 to 200 northern giant petrels. As most birds caught were breeding adults this represents 8 to 16% of white-chinned petrel, 4 to 8% of grey-headed albatross and 2 to 4% of yellow-nosed albatross breeding populations at the Prince Edward Islands. The authors noted that these rates are unsustainable for the populations concerned.

7.73 The summarised observer data (together with the information in WG-FSA-97/51) indicate that setting only took place during the night on 45% of occasions. This represents a serious departure from compliance with Conservation Measure 29/XV.

7.74 Streamer lines of some description, perhaps one-half fairly similar to that specified by CCAMLR, were used on most vessels, though often not in all or part of earlier cruises, apparently because of misunderstandings concerning permit conditions.

7.75 On only one cruise was offal discharged at the set. However, while hauling the longline, about half the vessels discharged offal on the same side, undoubtedly contributing to the numerous entanglements of live birds recorded in observer reports (Table 39). These reports recorded entanglements of 21 black-browed albatrosses, 9 unspecified albatrosses, 13 giant petrels, 1 white-chinned petrel, 9 unspecified petrels and 1 gentoo penguin, with reference to a variety of other species (yellow-nosed albatross, macaroni and rockhopper penguins) also being entangled. Only 1 black-browed albatross, 1 giant petrel and 8 white-chinned petrels were recorded as killed during hauls.

7.76 The actual by-catch rates have already essentially been discussed in paragraphs 7.62 and 7.63. The main points to re-emphasise are the high rate for the January/February cruise of the *Aquatic Pioneer*, the much higher rates before 1 May compared with afterwards, the much lower catch rates at night compared to day and the substantial reduction in by-catch on sets when streamer lines were set, whether at day or night.

7.77 The data on species composition of the by-catch (Table 42) are very similar to those reported in WG-FSA-97/51 with white-chinned petrel (63%; 73% if combined with unidentified petrels), grey-headed albatross (15%), giant petrels (4%) and yellow-nosed albatross (1%) the main species involved. All albatrosses were caught during the day; white-chinned petrel by-catch was fairly evenly divided between day and night.

7.78 Because observer coverage was 100% on virtually all cruises it is straightforward to estimate the total seabird mortality by species for the subareas during the 1996/97 year (Table 43). This results in an estimated overall total of 879 seabirds killed, including 202 albatrosses (23%), 34 giant petrels (4%) and 551 white-chinned petrels (63%) (638 (73%) if unidentified petrels are included.

7.79 Prof. Duhamel reported on results from an experimental longline fishing cruise by the *Anyo Maru 22* within the Crozet Islands EEZ in Subarea 58.6 between December 1996 and April 1997. In 219 sets (865 260 hooks), all at night, all with 100% observation and all but one with CCAMLR streamer lines, only 27 seabirds (26 white-chinned petrels, 1 grey-headed albatross) were caught, a catch rate of 0.031 birds per thousand hooks (Table 39).

General

7.80 The catch rates recorded by observers are likely to underestimate the true seabird by-catch for at least two reasons. First, a proportion of birds caught during setting would not be recovered at the haul. In some tuna longline fisheries this difference has been estimated at

27% (WG-IMALF-94/6). The only value available to CCAMLR from this year's data is 11%, representing the failure to recover nine grey-headed albatrosses observed killed at one set on the *Garoya* (see Boix, observer report).

7.81 Second, especially where automatic baiting machines are in use, a proportion of hooks set are not baited and therefore are not 'available' to catch birds. In Subarea 48.3, because the Spanish method of longlining is prevalent, this would result in a less than 1% difference in overall seabird by-catch rates. In Subareas 58.6 and 58.7, however, where autoliners are used extensively, baiting efficiency was in the range 60 to 85%, depending on vessel (Table 39) and therefore the seabird by-catch rate would be underestimated by 15 to 40% for the vessels concerned.

7.82 The Working Group noted that extensive information was now available on the relationship between the presence and by-catch of seabirds in relation to time of year. The overall relationship between seabird by-catch and fishing effort in relation to data is shown for Subarea 48.3 in Figure 11 and for Subareas 58.6 and 58.7 in Figure 12. Typical data on abundance of albatrosses in the vicinity of longline vessels in relation to date for Subareas 48.3 and 58.6 and 58.7 are shown in Figures 13 and 14.

7.83 All of these data, and many comments and observer reports, testify to the scarcity of albatrosses (except wandering albatross) and white-chinned petrels after late April. Recalling the discussion last year (SC-CAMLR-XV, Annex 5, paragraph 7.71) on the merits of delaying the start of the longline fishing season for *D. eleginoides* until 1 May, the catch rates of seabirds in March/April and May to August were calculated (Table 48). These data indicate the major difference (of more than two and one orders of magnitude respectively) between night and day by-catch rates in the two periods.

7.84 The Working Group recommended delaying the start of the longline fishing season in the Convention Area until 1 May in order to achieve a significant reduction in incidental mortality of seabirds.

Estimated Seabird By-catch in Unregulated Fisheries

7.85 At the meeting, WG-FSA requested members of WG-IMALF to estimate the levels of seabird by-catch that might be associated with the unregulated longline fisheries in the Convention Area in 1996/97.

7.86 An estimate of total seabird by-catch for any fishery requires information on seabird by-catch rates from a sample of the particular fishery and an estimate of the total number of hooks deployed by the fishery. For unregulated fisheries information is not available either for seabird catch rate or for total hooks set. To estimate these parameters, information from the regulated fishery and estimates of total catch from the unregulated fishery have been used (Appendix D).

Seabird By-catch

7.87 As no information is available on seabird by-catch rates from the unregulated fishery, estimates have been made using both the average catch rate for all cruises from the appropriate period of the regulated fishery 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 are under no obligation to set at night, to use streamer lines or to use any other mitigation measure. Therefore catch rates, on average, are likely to be higher than in the regulated fishery. However, it should be noted that the worst case catch rate used is four times the average value and applies only to a single cruise in the regulated fishery. Using this catch rate to estimate the seabird catch rate of the whole unregulated fishery may produce a considerable overestimate.

Unregulated Effort

7.88 To estimate the number of hooks deployed by the unregulated fishery, it is assumed that the fish catch rate in the regulated and unregulated fisheries is the same. Estimates of fish catch rate from the regulated fishery and estimated total catch from the unregulated fishery can then be used to obtain an estimate for the total number of hooks using the following formula:

$$\text{Effort(U)} = \text{Catch(U)/CPUE(R)},$$

where U = unregulated and R = regulated.

Subarea 48.3

7.89 Appendix D identified no catch from unregulated fishing in this subarea this year, so no estimate of unregulated seabird by-catch is necessary.

Subareas 58.6 and 58.7

7.90 For this fishery, the year has been divided into two seasons, a summer season (September–April) and a winter season (May–August), corresponding to the periods with substantially different bird by-catch rates. Two sources of fish catch rates are available. The first is from the 'French survey' in Subarea 58.6 as used in the GLM and includes data from December 1996 to April 1997. The other is from South African data in SC-CAMLR-XVI/BG/28 and provides estimates from October 1996 to June 1997 inclusive (i.e. including two months of data for the winter period). The seabird catch rates used have been taken from Table 38 and Table 1 of WG-FSA-97/51. The results are shown in Table 49.

Divisions 58.5.1 and 58.5.2

7.91 For the fishery in these areas there is no breakdown available of the estimated distribution of the unregulated catch against time and very few data on seabird by-catch rates from the regulated fishery. If we assume that the fishery in these areas follows an identical pattern to those in Subareas 58.6 and 58.7 then, on the basis of the estimated unregulated catch of 9 200 to 14 000 tonnes (Appendix D, Table D.4), and using the data from SC-CAMLR-XVI/BG/28, the seabird by-catch totals would be as follows.

Unregulated Catch	Total Numbers of Seabirds in By-catch	
	Mean	Maximum
9 200 tonnes	8 006	19 727
14 200 tonnes	12 359	30 448

7.92 It was emphasised that the values in paragraph 7.91 are very rough estimates (with potentially large errors). A more thorough analysis should be conducted, including attempts to estimate error and confidence bounds. The present estimate should only be taken as indicative of the potential levels of seabird mortality prevailing in the area due to unregulated fishing and should be treated with caution.

General

7.93 The Working Group noted that the estimate of by-catch in unregulated fisheries around the Prince Edward Islands is, at a conservative view, more than double the estimate made in WG-FSA-97/51. This is probably because CCAMLR has been able to make more accurate estimates of the catch rates in the unregulated *D. eleginoides* fishery.

7.94 The total estimated by-catch of seabirds in the unregulated fishery is at least one order of magnitude greater than that estimated for the regulated fishery in the same areas.

7.95 The Working Group noted that, as already indicated in WG-FSA-97/51, these by-catch rates for albatrosses and petrels are totally unsustainable for the populations concerned.

7.96 These levels of seabird by-catch – including of several globally threatened species – were viewed with the greatest concern by the Working Group. It recommended that these concerns should form the basis of the strongest representation to the Members of CCAMLR and other countries responsible for the unregulated fishing.

7.97 Dr Miller indicated that, in his view, the maintenance of a regulated fishery in Subareas 58.6 and 58.7 offered a good way of minimising the activities and impact of unregulated fisheries. In response to a question, he indicated that there was good evidence of fewer observations of unregulated vessels in the Prince Edward Island EEZ when the regulated fishery was operating, than outside these times. He also indicated that other advantages of maintaining the regulated fishery included obtaining the best information on fished stocks and in obtaining data on by-catch levels of seabirds.

7.98 It was agreed that further discussion on this topic, at least under this agenda item, was probably inappropriate for WG-FSA, and would be more appropriately dealt with by the Scientific Committee and ultimately by the Commission.

Reports on Incidental Mortality of Seabirds during

Longline Fishing from Outside the Convention Area

7.99 In recognition of potential importance of incidental mortality outside the Convention Area of seabirds breeding within the area, CCAMLR has a standing request to Members for such information. The Working Group welcomed the data supplied below by the UK, South Africa and Australia.

7.100 WG-FSA-97/21 reports that during longline fishing (involving some 300 000 hooks set) by three vessels around the Falklands/Malvinas between August 1996 and May 1997, 103 cases of incidental mortality were observed. Two records relate to seals, one unidentified, one a southern elephant seal. Of the 101 seabirds, 93 (90%) were black-browed albatross, 4 (5%) white-chinned petrel, 2 (2%) Cape petrel and one each southern giant petrel and unidentified albatross. The overall rate of incidental mortality of seabirds was 0.34 birds per thousand hooks (maximum for any set 6.96 birds per thousand hooks). If the single set when 87 birds were caught (because of lack of appropriate mitigating measures) is excluded, the average catch rate was 0.05 birds per thousand hooks.

7.101 Previously unpublished data (many tabled at CCAMLR in WG-FSA-95/21) on seabird mortality associated with the experimental longline fishery for hake off South Africa have now been published (WG-FSA-97/55). The longlines observed were set at night between October and December 1994 and caught only white-chinned petrels (a species whose breeding distribution is virtually confined to the Convention Area). The overall catch rate was 0.44 birds per thousand hooks. The fishery was estimated to kill 8 000 ± 6 400 white-chinned petrels annually.

7.102 Dr Miller indicated that a decision would be made by the end of 1997 concerning the continuation of the South African experimental longline fishery for hake. This decision would address such matters as the level of fishing effort to be deployed, as well as consideration of mitigating measures to reduce incidental mortality consistent with new national fisheries regulations currently under negotiation.

7.103 Data provided by Australia, via CCSBT-ERSWG, in WG-FSA-97/13 updates WG-FSA-96/63 by providing information on:

(i) 113 sets (20 493 hooks) by eight vessels fishing for southern bluefin tuna in the Cairns area, Queensland, from May to August 1996, where no seabird by-catch was observed; and

(ii) five sets (9 082 hooks) by one vessel off the east coast of Tasmania, where no seabird by-catch was observed.

7.104 WG-FSA-97/14 provides data on seabird by-catch from 1995 cruises in the Real Time Monitoring Program conducted by the parties to the CCSBT in order to provide data for assessments of southern bluefin tuna. The complete set of relevant data for 1995 is set out in Table 50 (vessels 4 to 8 being supplementary to data summarised in WG-FSA-96/62; see SC-CAMLR-XV, Annex 5, paragraph 7.6). The high catch rate (1.52 birds per thousand hooks) in the absence of mitigating measures (tori poles/streamer lines) is evident.

7.105 WG-FSA-97/15 provides data on the seabird by-catch from Japanese tuna longline vessels in the Australian fishing zone between April 1995 and March 1997. For 1995 (3 599 sets with 11.373 million hooks) catch rates averaged 0.10 birds per thousand hooks (range 0.00–0.20) giving an estimated total of 1 085 birds caught. For 1996 (2 058 sets with 6.348 million hooks) catch rates averaged 0.30 birds per thousand hooks (range 0.00–1.65) giving an estimated total of 1 503 birds. The species identity of the birds caught is under investigation.

7.106 Dr Holt enquired about the reasons for the apparent increase in seabird by-catch in the 1996 season. Dr Tuck replied that the high value for 1996 was principally due to a single cruise in the southeast Indian Ocean, in winter, when 30 birds were observed caught from nine of
12 observed sets.

7.107 WG-FSA-97/17 provides a 1997 update (see WG-FSA-96/65 and SC-CAMLR-XV, Annex 5, paragraph 7.59 for a comprehensive review) of trends in tuna longline fisheries in the Southern Ocean and implications for seabird by-catch. The paper concludes that:

(i) there has been a marked reduction in Japanese longline effort in the Southern Ocean in recent years. The effort in 1995 is about 52% of the 1986 level. There have also been major contractions and shifts in the spatial extent of the Japanese fishery;

(ii) there has been a seasonal contraction in Japanese fishing effort to the second and third quarters (May–September). In 1994, 91% of the effort occurred in these two quarters;

(iii) the size of the Japanese longline fishery in relationship to other longline tuna fisheries (primarily Taiwanese) has been declining markedly, both in absolute and relative terms. Japanese effort in 1994 constituted less than 33% of the estimated tuna longline effort below 30°S; and

(iv) reported effort by Taiwanese vessels fishing south of 30°S has increased rapidly and markedly since 1990. The reliability of the reported effort needs to be assessed as the current levels of effort, if accurate, would be expected to result in substantial incidental takes of seabirds. However, there is no direct information on seabird by-catch rates for this fleet.

7.108 The paper also notes that in addition to the Japanese and Taiwanese longline fisheries, there are a number of other tuna longline fleets/fisheries in the southern oceans. These include:

(i) Korean longline vessels (traditionally targeting albacore);

(ii) Australian domestic vessels (traditionally targeting yellowfin tuna but recently expanding to include southern bluefin tuna, bigeye and swordfish);

(iii) New Zealand domestic vessels;

(iv) Spanish longline vessels (targeting swordfish);

(v) domestic longline fleets in South America (e.g. Brazil and Uruguay); and

(vi) Taiwanese and Japanese joint ventures with various South American countries.

For most of these fleets/fisheries, there is little readily accessible and reliable information on either fishing effort or seabird by-catch rates. Total by-catch from all of these sources, however, could be significant and by-catch from some sources may be important for specific populations of seabirds.

7.109 WG-FSA-97/17 concluded that, given the magnitude of the reported effort by Taiwanese vessels in the Southern Ocean in recent years, any assessment of the current and future impact of tuna longlining on seabird populations will need to account for the incidental takes by these vessels. Also, the by-catch from the other tuna longline fleets listed above will be important to take into account in any assessment, particularly since a number of these are expanding, because of the high catch rates that have been reported in some of them and because of the potential proximity to foraging areas of breeding seabirds. Improved information on fishing effort and direct observations on by-catch rates are needed from all of these fisheries.

7.110 WG-FSA-97/16 reports GLM analysis of the effects of environmental factors and the use of mitigating measures on the by-catch rate of seabirds by Japanese longline vessels fishing for tuna in the Australian region between April 1992 and March 1995. The variables included were year, time of capture (night, day), moon phase (full, new), area (southeast Australia, Tasmania, South Australia, southeast Indian Ocean), season (winter (April–September), summer (October–March)), wind, cloud, sea (all high, medium, low), use of tori pole during setting (yes, no), condition of bait (not, partly or well thawed), use of bait thrower during setting (yes, no). The overall dataset comprised 2 291 sets, involving 3.257 million hooks (32.5% set at night) and a by-catch of 577 birds (78% albatrosses) at an average rate of 0.18 birds per thousand hooks. The results from the GLM indicate that the environmental factors which most affect seabird catch rates are time of day (day/night sets), area fished and season fished. Of less importance but still significant is an interaction between time of day and moon phase. Effects which were not significant are year, moon phase alone, area/season interactions, wind, cloud, sea conditions and individual vessels. The strong interaction between day and moon phase would be expected if light levels were a primary factor affecting by-catch rates. The probability of capture of a bird is substantially greater in summer than in winter. Catch rates were highest in southern Australia and lowest in the southeast Indian Ocean (though data were fewest for this area). The lowest catch rate of seabirds is produced by a new moon at night, with higher catches at night during full moon and highest of all during the day, whether the moon is full or not. For hooks set at night there was a reduction of 91% in by-catch compared to hooks set during the day; during new moon the night by-catch was 98% less than the daytime rate. There were insufficient sets made without tori poles to investigate their effectiveness.

7.111 Overall, the most important factor affecting by-catch rates of seabirds in southern Australian waters is whether the longline is set during the night or day. If the prime objective of the fishing fleet was to avoid catching birds, then only setting lines at night would be the most effective strategy of the mitigation measures examined. However, maximising the value of the fish catches within operational and management constraints is most likely the highest priority for the vessels. From observer data, the average time to complete a set in winter at 43°S is 5 hours and 15 minutes. Therefore, with six hours of darkness at this time, it is possible to complete setting entirely at night in any stratum within the Australian region without adversely constraining the amount of time available for setting the longline.

7.112 The data on catch rates of southern bluefin tuna suggests that there is little difference between sets commenced at night, early in the morning or later in the day during winter. In summer there are indications that the catch rate decreased for sets which commence between 0300 and 0500 h local time (nautical twilight at 0300 h), and then increased until 0700 h. There were insufficient data to assess catch rates on sets wholly at night.

7.113 The Working Group noted that, although these results on seabird by-catch relate to a pelagic longline fishery for tuna in waters to the north of the Convention Area, it is probably not unrealistic to expect the results to have more general application. Indeed, these results are not dissimilar to those obtained by Moreno et al. (1996), who showed that distance from land, lunar phase, use of streamer lines and hook size were important sources of variation in seabird by-catch rates. It is not clear the extent to which diel variation in catch rates of tuna might be relevant to catch rates of *Dissostichus* spp.

7.114 Dr Kock enquired whether the data from *Dissostichus* spp. longline fisheries submitted to CCAMLR would enable similar analyses to be undertaken. In response it was indicated that at present there were probably insufficient data for a comprehensive analysis. However, in theory, the data from CCAMLR observers should include all appropriate information on environmental and biological variables. The greatest difficulty was likely to be whether records of the use of streamer had been made systematically on a per set basis (see paragraph 7.71). Scientific observers were encouraged to ensure that such records were always made in future.

7.115 It was recollected that New Zealand scientists had attempted to conduct similar analyses of data from longline fisheries in their area. The Working Group encouraged the submission to it of reports of the results of this analysis.

7.116 The Working Group thanked CCSBT-ERSWG for encouraging the preparation of these important papers and for allowing them to be tabled at WG-FSA.

7.117 In WG-FSA-97/52 the year-round foraging movements of shy albatrosses breeding at two sites off Tasmania were determined by satellite telemetry in order to assess potential levels of interaction with longline fisheries for tuna. It was concluded that the recent contraction of the Japanese southern bluefin tuna longline fishery to the south and east coasts of Tasmania has resulted in extensive overlap with adult shy albatrosses from Pedra Branca, but appears to pose a minimal threat to adult birds from Albatross Island. Coupled with the concomitant increase in the Australian domestic tuna longline fishing industry, adult shy albatrosses from southern Tasmania (Pedra Branca and the Mewstone) are vulnerable to incidental capture throughout their annual cycle.

Assessment of Incidental Mortality in Relation to New and Exploratory Fisheries

7.118 Last year, amongst the concerns raised relating to the numerous proposals for new fisheries and the potential rapid and widespread development of exploratory fisheries, was the potential for substantial increases in seabird incidental mortality.

7.119 The need was noted for data to provide advice on known and potential interactions with seabirds, relating to the:

(i) timing of fishing seasons;
(ii) need to restrict fishing to night time; and
(iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

7.120 Relevant information was solicited from Members intersessionally. At this meeting, in addition to basic general reference material on the breeding and at-sea distribution of Southern Ocean seabirds, more specific information was available on breeding, distribution and population sizes of albatrosses and petrels in WG-FSA-97/22, 97/23, 97/28 and on at-sea distribution from satellite-tracking studies in WG-FSA-97/8 and 97/56. The species particularly at risk were assumed to be all species of albatross, both species of giant petrel and *Procellaria* petrels (in the Convention Area white-chinned petrel, *P. aequinoctialis* and, in some areas, grey petrel, *P. cinerea*).

7.121 The estimates of site-specific breeding populations and of total world breeding populations are principally derived from WG-FSA-97/22 and 97/28, together with data summarised in Croxall et al. (1984) and Marchant and Higgins (1990).

7.122 In the assessments that follow, known potential for interaction was based exclusively on the known ranges of breeding birds determined by recent satellite-tracking studies. These are, therefore, minimum estimates of the home range of breeding populations. Within the Convention Area there have been no recent satellite-tracking studies of giant petrels. The only such data for white-chinned petrels are currently unpublished; there are no data for grey petrels.

Inferred potential for interaction is based on:

(i) ranges for breeding populations analogous to those determined by satellite-tracking at other breeding sites; and

(ii) at-sea distributions derived from seabird at-sea sightings during the breeding season as published in distribution atlases.

7.123 To assess distributions outside the breeding season, Tickell (1993) was used for albatrosses and Marchant and Higgins (1990) for giant petrels, white-chinned petrel and grey petrel. For the areas under review (see paragraph 7.124 below), the distributions are as follows:

wandering albatross	all, but only northern part of Subareas 88.1, 88.2, 88.3
royal albatross	Subareas 58.5, 58.7; northeastern part of Subarea 48.1; western part of Subarea 48.2
black-browed albatross	all, but only northeast part of Subareas 48.6, 88.1; rare in Division 58.4.4 and southern part of Subarea 88.3; virtually absent in Subarea 88.2

grey-headed albatross	all, but only northern part of Subarea 48.6; rare Subarea 88.2
yellow-nosed albatross	Subareas 58.5, 58.7
shy albatross	Division 58.4.3, Subarea 58.6
sooty albatross	Division 58.4.4, Subareas 58.6, 58.7
light-mantled sooty albatross	all, but only northern part of Subarea 88.2
Amsterdam albatross	no data
Antipodean albatross	no data
southern giant petrel	all
northern giant petrel	all, but only northern half of Subareas 48.1, 48.2, 48.6, 88.1, 88.2, 88.3
white-chinned petrel	all, but only northeast half of Subareas 88.1, 88.2; only extreme north of Subareas 48.1, 48.2, 48.6, 88.3
grey petrel	all except Subareas 48.1, 48.2, 48.4; but only northern part of Subareas 48.6, 88.1, 88.2, 88.3

7.124 Assessments were made against a five-point scale of potential risk of interaction between seabirds, especially albatrosses, and longline fisheries. The five levels are: low; average-to-low; average; average-to-high; high.

7.125 The advice section is based purely on consideration of reducing seabird by-catch by vessels operating under CCAMLR regulations.

7.126 The areas considered were those where proposals for new and exploratory fisheries were received by CCAMLR in 1996 and 1997: viz

Subarea 48.1	(Chile, Uruguay)
Subarea 48.2	(Chile, Uruguay)
Subarea 48.4	(Uruguay)
Subarea 48.6	(Norway, South Africa)
Subarea 58.6	(South Africa, Ukraine, Russia)
Subarea 58.7	(South Africa, Ukraine, Russia)
Division 58.4.3	(Australia, South Africa)
Division 58.4.4	(South Africa, Ukraine)
Division 58.5.2	(Australia)
Subarea 88.1	(New Zealand)
Subarea 88.2	(New Zealand)
Subarea 88.3	(Chile)

(i) Subarea 48.1:

Breeding species in area: southern giant petrel (c. 7 000 pairs; 20% world population)

Breeding species known to visit area: wandering albatross, grey-headed albatross from South Georgia

Breeding species inferred to visit area: black-browed albatross from South Georgia, Chile, Falklands/Malvinas; grey-headed albatross from Chile; southern giant petrel from Chile, Argentina, Falklands/Malvinas; white-chinned petrel from South Georgia.

Assessment: potential interactions with substantial fraction of southern giant petrel population and a small proportion of populations of three albatross species (two threatened, one near-threatened), most notably grey-headed albatross from both of its two main breeding sites, and white-chinned petrel.

Advice: average risk; prohibit longline fishing during the breeding season of black-browed and grey-headed albatrosses, southern giant petrel and white-chinned petrel (i.e. September–April); maintain all elements of Conservation Measure 29/XV.

(ii) Subarea 48.2:

Breeding species in area: southern giant petrel (c. 9 000 pairs; 26% world population).

Breeding species known to visit area: grey-headed albatross, black-browed albatross from South Georgia.

Breeding species inferred to visit area: white-chinned petrel from South Georgia.

Assessment: potential interactions with an important fraction of the southern giant petrel population and a small proportion of the population of two albatross species (one threatened, one near-threatened) and white-chinned petrel.

Advice: average-to-low risk; avoid longline fishing during the breeding season of southern giant petrel (October–March); maintain all elements of Conservation Measure 29/XV.

(iii) Subarea 48.4:

Breeding species in area: southern giant petrel (c. 800 pairs; 2% world population).

Breeding species known to visit area: none.

Breeding species inferred to visit area: wandering albatross, black-browed albatross, light-mantled sooty albatross, northern giant petrel, white-chinned petrel from South Georgia (see Ashford et al., 1994).

Assessment: little known/visited area so potential interactions probably underestimated. Nevertheless area, and especially shelf and shelf-slope, is small.

Advice: low risk (see also Ashford et al., 1994); avoid longline fishing during the breeding season of southern giant petrel (October–March); maintain all elements of Conservation Measure 29/XV.

(iv) Subarea 48.6:

Breeding species in area: southern giant petrel (until c. 1981).

Breeding species known to visit area: none.

Breeding species inferred to visit area: wandering albatross, light-mantled sooty albatross from Prince Edward Islands.

Assessment: relatively poorly-known area in terms of visiting species. Its very large area, however, suggests interaction potential is probably underestimated.

Advice: low risk; no obvious need for restriction of longline fishing season; applying Conservation Measure 29/XV would be sensible as a precautionary measure until better data are available.

(v) Division 58.4.3:

Breeding species in area: none.

Breeding species known to visit area: wandering albatross from Crozet Islands.

Breeding species inferred to visit area: black-browed albatross, light-mantled sooty albatross, southern giant petrel from Heard/Macdonald Islands; grey-headed albatross, black-browed albatross, light-mantled sooty albatross, northern giant petrel, white-chinned petrel, grey petrel from Kerguelen; white-chinned petrel, grey petrel from Crozet Islands.

Assessment: Although no breeding populations are within the area, this is a potentially important foraging area for four albatross species (two threatened, one near-threatened), southern giant petrel and white-chinned petrel from important breeding areas for the species concerned.

Advice: average (perhaps average-to-high) risk; prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September–April); maintain all elements of Conservation Measure 29/XV.

(vi) Division 58.4.4:

Breeding species in area: none.

Breeding species known to visit area: wandering albatross, light-mantled sooty albatross from Crozet.

Breeding species inferred to visit area: grey-headed albatross, yellow-nosed albatross, southern giant petrel, white-chinned petrel, grey petrel from Crozet; wandering albatross, grey-headed albatross, yellow-nosed albatross, light-mantled sooty albatross, southern giant petrel, white-chinned petrel, grey petrel from Prince Edward Islands.

Assessment: Although no breeding populations are within the area, this is a potentially important foraging area for four albatross species (three threatened, one near-threatened), southern giant petrel, white-chinned petrel and grey petrel from very important breeding areas for the species concerned.

Advice: average (perhaps average-to-high) risk; prohibit longline fishing during the main breeding season albatrosses and petrels (September–April); maintain all elements of Conservation Measure 29/XV.

(vii) Division 58.5.2:

Breeding species in area: black-browed albatross (750 pairs; 0.1% world population), light-mantled sooty albatross (c. 350 pairs; 1.5% world population), southern giant petrel (2 350 pairs; 7% world population) at Heard/McDonald Islands.

Breeding species known to visit area: wandering albatrosses from Crozet; black-browed albatrosses from Kerguelen; Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit area: all species breeding at Heard/McDonald Islands; wandering albatross, grey-headed albatross, yellow-nosed albatross, sooty albatross, light-mantled sooty albatross, northern giant petrel, white-chinned petrel from Kerguelen; yellow-nosed albatross from Amsterdam Island.

Assessment: important foraging area for six albatross species (four threatened, one near-threatened and including one of the only two albatross species which are critically endangered – Amsterdam albatross) and for both species of giant petrel and white-chinned petrels from globally important breeding sites at Kerguelen, Heard and Amsterdam Island.

Advice: average-to-high risk; prohibit longline fishing within the breeding season of the main albatross and petrel species (September–April). Ensure strict compliance with Conservation Measure 29/XV.

It was noted that longline fishing is currently prohibited within the EEZ around Heard/McDonald Islands.

(viii) Subarea 58.6:

Breeding species in area: wandering albatross (1 730 pairs; 20% world population), grey-headed albatross (5 950 pairs; 6% world population), black-browed albatross (1 000 pairs; 0.1% world population), Salvin's albatross (4 pairs), Indian yellow-nosed albatross (4 500 pairs; 12% world population), sooty albatross (1 200 pairs; 8% world population), light-mantled sooty albatross (2 200 pairs; 10% world population), southern giant petrel (1 000 pairs; 3% world population), northern giant petrel (1 300 pairs; 13% world population), white-chinned petrel (100 000+ pairs; world's second most important site), grey petrel (thousands of pairs) at Crozet Islands.

Breeding species known to visit area: wandering albatross, sooty albatross, light-mantled sooty albatross from Crozet Islands.

Breeding species inferred to visit area: in addition to all the Crozet Islands breeding species, wandering albatross from Prince Edward Islands and Kerguelen; black-browed, yellow-nosed, sooty, light-mantled sooty albatrosses, northern giant petrel, southern giant petrel, white-chinned petrel, grey petrel from the Prince Edward Islands; grey-headed albatross, white-chinned petrel, grey petrel from Kerguelen.

Assessment: known (see paragraphs 7.65 to 7.79) and potential interactions with seven species of albatross (five threatened, one near-threatened), for many of which Crozet is one of the most important world breeding sites, as it is for giant petrels and white-chinned and grey petrels. Also substantial potential for fishery interactions with albatrosses and petrels from the Prince Edward Islands and albatrosses from a variety of other breeding sites in their non-breeding season. Even outside the French EEZ (within which commercial longline fishing is presently prohibited), this is one of the highest risk areas in the Southern Ocean.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (i.e. September–April); ensure strict compliance with Conservation Measure 29/XV.

(ix) Subarea 58.7:

Breeding species in area: wandering albatross (3 070 pairs, 36% world population – most important site), grey-headed albatross (7 720 pairs; 8% world population), yellow-nosed albatross (7 000 pairs; 19% world population), sooty albatross (2 750 pairs; 18% world population), light-mantled sooty albatross (240 pairs; 1% world population), southern giant petrel (1 750 pairs; 5% world population), northern giant petrel (500 pairs; 5% world population), white-chinned petrel (10 000+ pairs), grey petrel (thousands of pairs) at Prince Edward Islands.

Breeding species known to visit area: wandering albatrosses from Crozet

Islands.

Breeding species inferred to visit area: all species breeding at the Prince Edward Islands; grey-headed albatross, black-browed albatross, yellow-nosed albatross, southern giant petrel, northern giant petrel, white-chinned petrel, grey petrel from Crozet Islands.

Assessment: known (see paragraphs 7.65 to 7.79) and potential interactions with five species of albatross (four threatened), for most of which the Prince Edward Islands is one of the most important world breeding sites, as it is for giant petrels. Also substantial potential for fishery interactions with albatrosses and petrels from the Crozet Islands and albatrosses from various other breeding sites in their non-breeding season. This small area is one of the highest risk areas in the Southern Ocean.
Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (September–April); ensure strict compliance with Conservation Measure 29/XV.

(x) Subarea 88.1:

Breeding species in area: none.

Breeding species known to visit area: Antipodean albatross from Antipodes Island, light-mantled sooty albatross from Macquarie Island.

Breeding species inferred to visit area: light-mantled sooty albatross from Auckland, Campbell and Antipodes Islands; grey-headed albatross from Campbell Island; wandering albatross from Macquarie Island.

Assessment: the northern part of this area lies within the foraging range of three albatross species (two threatened) and is probably used by other albatrosses and petrels to a greater extent than the limited available data indicate.

Advice: average risk; longline fishing season limits of uncertain advantage; the provisions of Conservation Measure 29/XV should be strictly adhered to.

It was noted that New Zealand had undertaken some longline fishing in this subarea in 1997, using a vessel with an underwater setting system (see paragraphs 7.143 to 7.146).

(xi) Subarea 88.2:

Breeding species in area: none.

Breeding species known to visit area: none.

Breeding species inferred to visit area: none.

Assessment: few relevant data but unlikely that many at-risk albatross and petrel species forage extensively in this area.

Advice: low risk; restrictions on timing of longline fishery probably inappropriate. Conservation Measure 29/XV should be applied as a precautionary measure, at least until better data have been acquired.

(xii) Subarea 88.3:

Breeding species in area: none.

Breeding species known to visit area: grey-headed albatross from South Georgia.

Breeding species inferred to visit area: grey-headed albatross from Chile.

Assessment: few relevant data from most of this large area. In the regions closer to the Antarctic Peninsula/South America there is considerable potential for interactions with albatrosses.

Advice: low risk; restrictions on timing of longline fishery probably inappropriate. Apply Conservation Measure 29/XV, at least until further data on seabird-fishery interactions are available.

7.127 For the purpose of comparison, similar assessments for the two areas with established longline fisheries for *D. eleginoides*, viz Subarea 48.3 (South Georgia) and Division 58.5.1 (Kerguelen) are presented below.

(i) Subarea 48.3:

Breeding species in area: wandering albatross (2 178 pairs; 26% world population – second most important site), grey-headed albatross (54 200 pairs; 59% world population), black-browed albatross (96 252 pairs; 14% world population – second most important site), light-mantled sooty albatross (c. 6 250 pairs; 29% world population – most important site), southern giant petrel (5 000 pairs; 15% world population), northern giant petrel (3 000 pairs; 28% world population – most important site), white-chinned petrel (c. 2 million pairs; perhaps 80% of world population) at South Georgia.

Breeding species known to visit area: wandering albatross, grey-headed albatross, black-browed albatross, light-mantled sooty albatross, white-chinned petrel from South Georgia.

Breeding species inferred to visit area: the remaining South Georgia breeding species.

Assessment: known interactions with four species of albatross (two threatened, one near-threatened), both species of giant petrel and white-chinned petrel, South Georgia being the world's most important breeding site for four of these.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (i.e. September–April); ensure strict compliance with Conservation Measure 29/XV.

(ii) Division 58.5.1:

Breeding species in area: wandering albatross (1 455 pairs; 17% world population), grey-headed albatross (7 900 pairs; 9% world population), black-browed albatross (3 115 pairs; 0.5% world population), yellow-nosed albatross (50 pairs; 0.1% world population), sooty albatross (c. 5 pairs), light-mantled sooty albatross (c. 4 000 pairs; 19% world population), northern giant petrel (1 800 pairs; 17% world population), white-chinned petrel (100 000+ pairs – second most important site), grey petrel (5 000–10 000 pairs) at Kerguelen.

Breeding species known to visit area: wandering albatross from Crozet Islands, black-browed albatross from Kerguelen, Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit area: all the remaining species breeding at Kerguelen; most, if not all, species breeding at Heard/McDonald Islands; many species breeding at Crozet Islands.

Assessment: important foraging area for six albatross species (four threatened, one near-threatened), southern giant petrel, white-chinned petrel and grey petrel, for several of which Kerguelen is a very important breeding site. Most albatross and petrel species breeding at Heard and McDonald Islands will also forage in this area, as will birds of many of the species breeding at Crozet.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (i.e. September–April); ensure strict compliance with Conservation Measure 29/XV.

7.128 It was re-emphasised that the advice presented relating to fishing season and to the application of Conservation Measure 29/XV was solely based on reducing by-catch of seabirds by vessels operating within the CCAMLR regulations. This advice did not, therefore, take into account other potential considerations, such as fishing operational considerations or measures to combat unregulated fishing.

7.129 Dr Miller noted that other mechanisms for protecting seabirds from longline by-catch should also be considered, such as no-fishing zones around breeding islands, following the example of the French EEZ around the Crozet Islands.

7.130 Dr Miller also noted that significant incidental mortality of seabirds breeding in the Convention Area is likely to be occurring in areas immediately to the north of the Convention Area, especially adjacent to Subareas 48.3 and 48.6, Division 58.5.1, and Subareas 58.6, 58.7 and 88.1. It was agreed that CCAMLR should urge those responsible for regulating longline fishing in these areas to adopt the provisions of Conservation Measure 29/XV and to consider restricting fishing to the time of year outside the main breeding season of albatross and petrels (September–April).

7.131 The Working Group advised the Scientific Committee that consideration of other elements relating to the management of new and exploratory fisheries is to be found in paragraphs 4.1 to 4.134. The Working Group had insufficient time to attempt to reconcile the management advice from these two sources.

Research into, and Experience with, Mitigating Measures

Tori Poles/Streamer Lines

7.132 Many reports of scientific observers in 1997 indicate difficulties in the use of streamer lines. These problems include:

(i) refusal of captain/fishing master to allow their deployment;

(ii) lack of materials to construct (or repair) appropriate streamer lines (especially line too short, no swivels);

(iii) entanglement of streamer line(s) with fishing line (especially with vessels using the Spanish double-line system);

(iv) loss of streamer lines in bad weather; and

(v) streamer lines ineffective when longline is set at an angle to the wind.

7.133 Many of the difficulties experienced probably resulted from the inappropriate construction and deployment of the streamer line. Most of these kinds of problems were discussed in detail in WG-FSA-95/58 which was the basis for much of the advice provided in the CCAMLR booklet *Fish the Sea Not the Sky*. The Working Group noted that it is essential that all scientific observers on longline vessels be familiar with the appropriate construction and deployment of streamer lines and associated mitigating measures. Members should also take all possible steps to ensure that fishing companies and especially fishing captains and masters are also fully familiar with the contents of this guide.

7.134 There was increasing evidence that streamer lines, if properly constructed and deployed and used in conjunction with other appropriate mitigating measures, provided significant reductions in seabird by-catch (e.g. paragraphs 7.71 and 7.78). Accordingly, the Working Group agreed that it was now a lower priority to test new or modified types of streamer line than to ensure that the existing design is deployed correctly.

7.135 In future, proposals to investigate the efficacy of existing or new types of streamer line should be accompanied by detailed research plans and submitted to the Working Group for comment in advance of the proposed field study. It may be appropriate to review footnote 6 of Conservation Measure 29/XV in the light of this advice.

Acoustic Scarers

7.136 Several scientific observers reported the use of sound cannons (e.g. Boix on *Garoya*) or other ad hoc sound scaring devices (e.g. Heinecken on *Koryo Maru No. 11*) especially during hauling operations. All reports indicated that albatrosses were either unaffected, or only briefly discouraged, by these devices but that they were much more effective in scaring giant and white-chinned petrels.

Bait

7.137 In response to the intersessional request from the Secretariat, Dr G. Robertson (Australia) reported (WG-FSA-97/57) that in June 1997 the Australian Antarctic Division conducted at-sea experiments on the sink rates of bait used in the Japanese longline tuna fishery off Tasmania. Factors tested were sea condition (two types), bait type (two types), bait thaw status (two types) and distance (lateral) bait was deployed from the ship propeller (three types). The experimental variable was sink rate. Among other things the experiment seeks to determine the optimal distance from the ship bait should be deployed to maximise sink rate (and hence where the bird scaring streamer line should be situated), whether it is necessary to thaw bait completely and whether or not bait thaw status is overridden by sea condition. Further experimental work will be conducted by the Division in a *Dissostichus* spp. longline fishery in December 1997. Results will be made available when time permits analysis of the data.

7.138 WG-FSA-97/24 describes recent experiences in the North Sea using artificial baits (based on waste fish and offal mixture). The advantages of these baits are deemed to include:

(i) higher percentage of hooks baited (because the cylindrical bait sausage passes perfectly through the baiting machine);

(ii) better selectivity in respect of target fish species; and

(iii) bait structure being excellent for long soak times.

7.139 Artificial bait had been supplied by Mustad to an autoliner targeting *D. eleginoides* (WG-FSA-97/57). The Secretariat was requested to contact Mustad to obtain further details.

7.140 The Working Group encouraged Members to carry out studies comparing the performance of artificial and natural baits especially in relation to their attractiveness to seabirds.

Weights

7.141 Many reports of scientific observers indicated or suggested that the fishing line carried insufficient weight to sink at an appropriate speed; therefore it was exposed to bait loss from seabirds (and the seabirds to incidental mortality) for much longer than necessary or desirable. In some cases observers reported that adding extra weights rectified the matter. It is vital that longlines carry enough weight to sink as quickly as possible, therefore avoiding bait loss and seabird by-catch and enhancing fishing efficiency.

Underwater Setting

7.142 Information on the Mustad underwater setting tube for longlines is contained in WG-FSA-97/24 (see also SC-CAMLR-XV, Annex 5, paragraph 7.24). A study of the performance of this device in relation to seabird by-catch is to be undertaken in the North Sea by a collaboration between the Norwegian Ornithological Society and the Royal Society for the Protection of Birds (UK) in October 1997. Results will be made available to CCAMLR in due course.

7.143 Two papers had been submitted on the developments in New Zealand of underwater setting devices designed to be suitable for use on domestic pelagic longline vessels (see SC-CAMLR-XV, Annex 5, paragraph 7.23). WG-FSA-97/53 gives details of trials of U-tube devices, the back-facing one of which successfully flushed baits to the required 3 m depth. Further study is deemed necessary to test the device under commercial operating conditions and to assess its effectiveness in avoiding by-catch of seabirds.

7.144 WG-FSA-97/54 reports trials of a towed depth-set paravane and of a capsule transporting the baited snood. Retrieval of the paravane and its associated endless cable proved too difficult and development was discontinued. Sea trials of the transporting capsule provided 100% successful bait release. The trials suggested various modifications which would further improve performance.

7.145 The Working Group thanked New Zealand for providing this information and for its initiative in commissioning this work. Further development of the two devices would seem highly worthwhile, in conjunction with observations to determine their efficacy in avoiding seabird by-catch and their performance under commercial operating conditions.

7.146 It was understood that the *Lord Auckland* (longline fishing in Subareas 88.1 and 88.2) and one Argentinian vessel had used underwater setting devices in the 1997 fishing season. No reports on experiences with these devices had yet been received. The Working Group strongly encouraged Members to supply appropriate information to CCAMLR as soon as possible.

Implications for Conservation Measure 29/XV

7.147 No submission had been received to indicate a need to revise any element of Conservation Measure 29/XV this year. However, it was felt that the footnote concerning the appropriate amount and spacing of weights might usefully be re-examined, in view of the problems experienced (see paragraph 7.137). Footnote 6 (concerning testing streamer lines) may also need reviewing (see paragraph 7.135).

Advice to the Scientific Committee

7.148 The Scientific Committee was requested to note the following recommendations/advice.

General

(i) Suggested revisions to the *Scientific Observers Manual* (paragraphs 7.6 and 7.9).

(ii) Circulation of the booklet *Fish the Sea Not the Sky* (paragraph 7.11), publicising its existence (paragraph 7.12) and the request for feedback from scientific observers on its availability and utility (paragraph 7.9).

(iii) Continuation of collaboration with CCSBT-ERSWG (paragraph 7.15) and the agreement to the request of CCSBT for access to data on longline fishing effort (paragraph 7.14).

(iv) Request for information on monitoring programs for seabirds particularly at risk from longline fishing from France (paragraph 7.18), further information from New Zealand (paragraph 7.20) and for regular updates on their studies from all Members (paragraph 7.24).

(v) Addition to CMS Appendices 1 and 2 of one and 12 species of albatross respectively, and the forthcoming classification on the IUCN Red List as Threatened, Near-threatened and Data Deficient of five, one and one species of albatross respectively, together with potential future obligations on and opportunities for Members of CCAMLR with range state responsibilities for these taxa (paragraphs 7.26 to 7.30).

(vi) Contact with Secretariats of CMS and CBD (paragraphs 7.31 and 7.32).

Data on Incidental Mortality of Seabirds during Longline Fishing in the Convention Area

(vii) Intersessional improvement to the analysis and conclusions from the 1996 data had been impossible because few additional relevant data had been submitted (paragraphs 7.33 to 7.36).

(viii) Substantial improvements in the quality and quantity of data submitted for 1997 and in the quality of the reports of scientific observers (paragraphs 7.38 and 7.40).

(ix) Late submission of data still causing major problems for analysis prior to and during WG-FSA (paragraphs 7.39, 7.41 to 7.43) and implications for intersessional work (paragraph 7.44).

(x) Results from 1997 data from Subarea 48.3 (paragraphs 7.45 to 7.58) indicate:

(a) in respect of compliance with Conservation Measure 29/XV:

- much improvement in night-time settings;
- poor compliance with requirement to use streamer lines;
- poor compliance with requirement on location of discharge of offal during haul;

(b) rates of seabird by-catch for most cruises/vessels are broadly similar to last year, but a few cruises gave higher values;

(c) some of this seabird mortality undoubtedly reflects lack of compliance with Conservation Measure 29/XV; other elements are less easy to explain; overall the result is a higher estimated total mortality of seabirds this year (5 755) than last year (1 618); and

(d) the species involved are principally black-browed albatross (40%; mainly caught during the day and twilight) and white-chinned petrel (48%; caught both during the day and at night), the latter when use of streamer lines was minimal throughout the fishery.

(xi) Results from Division 58.5.1 (paragraphs 7.62 to 7.64) indicate seabird by-catch rate was substantially reduced once night-time setting was implemented.

(xii) Results from Subareas 58.6 (outside the waters adjacent to the Crozet Islands) and 58.7 (paragraphs 7.65 to 7.71):

(a) in respect of compliance with Conservation Measure 29/XV indicate:

- low levels (45%) of setting at night;
- much less than comprehensive use of streamer lines;
- about half the vessels discharging offal on the same side as the haul;

(b) rates of seabird by-catch average 0.289 birds per thousand hooks, probably largely reflecting the lack of compliance with Conservation Measure 29/XV;

(c) catch rates:

- at night, were an order of magnitude less than during the day (0.012 and 0.138 birds per thousand hooks respectively);

- in October to April, were 40-fold greater than in May to June (0.363 and 0.009 birds per thousand hooks respectively);

- of species other than white-chinned petrel, within 100 km of the Prince Edward Islands were six times greater than between 100 and 200 km;

(d) species mainly affected are white-chinned petrels (73%) and grey-headed/yellow-nosed albatrosses (23%) – the two albatrosses both threatened species;

(e) total estimated seabird mortality was at least 879 birds.

(xiii) Requirements for intersessional work relating to the data from scientific observers on longline vessels (paragraphs 7.42, 7.44, 7.56 and 7.60).

(xiv) By-catch rates of seabirds estimated by the Working Group are underestimates due to birds killed at the set being unrecorded at the haul and because the proportion of baited hooks set on autoline vessels is substantially less than the total hooks set (paragraphs 7.80 and 7.81).

(xv) Delay the start of the longline fishing season in the Convention Area until 1 May in order to achieve significant reduction in seabird by-catch (paragraphs 7.83 and 7.84).

(xvi) The level of seabird by-catch in the unregulated fishery for *D. eleginoides* in the Convention Area is probably at least an order of magnitude greater than that of the regulated fishery (paragraphs 7.85 to 7.94). Its impact on white-chinned petrels and albatrosses is entirely unsustainable for the populations concerned – principally those at breeding sites in the Indian Ocean (Prince Edward Islands, Crozet, Kerguelen, Heard/McDonald Islands) (paragraph 7.95). The strongest possible action by the Commission is recommended (paragraph 7.96).

Incidental Mortality of Seabirds Outside the Convention Area

(xvii) Information concerning the nature and extent of longline fishing for various fish species in the Southern Ocean, including areas adjacent to the Convention Area (paragraphs 7.107 to 7.109).

(xviii) Information on seabird by-catch outside the Convention Area, indicating that in some areas there is substantial mortality of some seabird species breeding within the Convention Area (paragraphs 7.99 to 7.117).

(xix) Results of analyses of data on seabird by-catch in longline fishing for southern bluefin tuna in relation to environmental variables and the use of mitigating measures, which are of relevance to CCAMLR (paragraph 7.110).

(xx) Encourage New Zealand to report to CCAMLR results of similar analyses (paragraph 7.115).

Incidental Mortality of Seabirds in Relation to New and Exploratory Fisheries

(xxi) Advice on measures to minimise by-catch of seabirds in areas proposed for new and exploratory fishing (paragraph 7.126, noting also the comments in paragraphs 7.128, 7.129 and 7.131).

(xxii) The Commission should urge those responsible for regulating longline fishing in the areas immediately to the north of the Convention Area adjacent to Subareas 48.3 and 48.6, Division 58.5.1 and Subareas 58.6, 58.7 and 88.1 to adopt the provisions of Conservation Measure 29/XV and to consider restricting the fishing season (paragraph 7.130).

Research into, and Experience with, Mitigating Measures

(xxiii) Difficulties experienced by CCAMLR scientific observers in the use of streamer lines and recommendations that all scientific observers be fully familiar with the construction and deployment of streamer lines and other mitigating measures (paragraphs 7.132 and 7.133).

(xxiv) Efficacy of streamer lines (when correctly deployed), need for any future proposals to investigate streamer line performance to be based on research plans submitted beforehand to WG-FSA and possible need to review footnote 6 of Conservation Measure 29/XV (paragraphs 7.134, 7.135 and 7.147).

(xxv) Request Members to undertake studies of the performance of natural and artificial baits in relation to their attractiveness to seabirds (paragraph 7.140) and for Members using such baits to report information to CCAMLR (paragraph 7.139).

(xxvi) Importance of correct weighting of longlines (paragraph 7.141) and possible need to review footnote 3 of Conservation Measure 29/XV (paragraph 7.147).

(xxvii) Encourage New Zealand and Norway to undertake further work on the development of their devices for underwater setting of longlines (paragraphs 7.142 to 7.145) and for Members to report on their experiences in using these devices in the 1997 fishing season (paragraph 7.146).

OTHER INCIDENTAL MORTALITY

8.1 The reports of scientific observers (see Table 36) noted that three fur seals became entangled and drowned during the August cruise of the *Ercilla* in Subarea 48.3. Three other fur seals were entangled but were able to free themselves.

8.2 In Subareas 58.6 and 58.7, two sperm whales and one minke whale became entangled in longlines, but broke free (see paragraph 5.20 and Table 37).

FUTURE WORK

9.1 The Working Group identified a number of tasks which should be carried out by WG-FSA participants and the Secretariat. These tasks are summarised below. References are given to paragraphs in the report which contain details of these tasks.

9.2 The following tasks were identified for the Secretariat in general data management:

(i) include in the inventory of CCAMLR databases the assessment summaries produced by WG-FSA, and details on the data fields within each dataset (paragraph 3.1);

(ii) develop guides covering essential data elements of each dataset, including data fields, constraints and usage (paragraph 3.2);

(iii) explore the development of interactive, web-based user's guides (paragraph 3.3);

(iv) develop a data format and procedure for handling research survey data submitted to CCAMLR (paragraphs 3.8 and 10.13);

(v) compare the output of new calculations of seabed area by depth strata with published estimates (paragraph 3.13);

(vi) develop electronic forms and formats for the submission of data, reports and meeting documents (paragraph 10.11);

(vii) consolidate and validate methodology and datasets used by WG-FSA (paragraph 10.14);

(viii) prepare tables summarising the trips conducted by scientific observers, information from their reports (paragraph 10.8);

(ix) maintain observers logbook datasets (paragraph 10.8); and

(x) prepare and circulate by 1 March 1998 a database on fish by-catch in krill fisheries for analysis by members of the ad hoc group (paragraph 5.6).

9.3 The following tasks were identified for the work of the Secretariat in stock assessment analyses and modelling:

(i) arrange for data for WG-FSA analyses from the previous split-year to be prepared as a matter of priority (paragraphs 3.7 and 10.13) – Coordinator Dr Constable;

(ii) validate GYM and prepare documentation for the next meeting of WG-FSA (paragraph 3.80);

(iii) calculate an adjustment of precautionary catch limits for *D. eleginoides* based on proportional seabed areas (paragraph 4.94);

(iv) compile all available fisheries and biological information on *D. mawsoni* (paragraph 4.107);

(v) finalise the update of C2 database for *D. eleginoides* fisheries (paragraph 4.148);

(vi) prepare for next meeting age/length keys and register of holdings of the scales and otoliths of *D. eleginoides* collected by scientific observers (paragraph 4.159) - Coordinator Dr Williams;

(vii) develop routines to extract length frequencies for *D. eleginoides* corrected for size of catch and sample size (paragraph 4.163);

(viii) continue to acquire haul-by-haul data from *D. eleginoides* fishery by Ukraine in Division 58.5.1 (paragraph 4.256);

(ix) accomplish entry of haul-by-haul data for *D. eleginoides* fishery by South Africa in Subareas 58.6 and 58.7 (paragraph 4.304);

9.4 The following tasks were identified in the work of the Secretariat on the assessment of incidental mortality of seabirds and marine mammals in longline fisheries:

(i) insert a footnote in the Longline Observation Logbook on evaluation of the use of the book *Fish the Sea Not the Sky* on board longline vessels (paragraph 7.9);

(ii) send copies of the book to fishing companies believed to be engaged in longline fishing in the Convention Area and adjacent areas (paragraph 7.11);

(iii) contact the Secretariat of the CMS, with the assistance of Dr Kock, and inform it of CCAMLR work on albatross conservation (paragraphs 7.29 and 7.31);

(iv) draw attention of the Convention on Biological Diversity to the interactions between albatrosses and longline fisheries (paragraph 7.32);

(v) encourage the adoption of provisions of Conservation Measure 29/XV for regulating fisheries in areas adjacent to the CCAMLR Convention Area (paragraph 7.130);

(vi) identify discrepancies between observers logbooks and reports (paragraph 7.42);

(vii) complete data entry for remaining cruises in Subareas 58.6 and 58.7 (paragraph 7.44); and

(viii) add to the *Scientific Observers Manual* a list of topics for which the observer should attempt to provide information (paragraph 7.40).

9.5 The Working Group requested the Secretariat to correspond with appropriate scientists and authorities in Member countries and request them to do the following:

General:

(i) supply data from existing surveys of *D. eleginoides* in Division 58.4.4 (paragraph 4.23) – Ukraine;

(ii) submit papers and carry out simulations on an adaptive fishery management based on fine-scale rectangles catch limits (paragraph 4.81);

(iii) extend current technical coordination by Members in the provision scientific observers data to encompass catch and effort data and CEMP data (paragraph 3.5);

(iv) include names of vessels in five-day, 10-day and monthly catch reports (paragraph 3.11);

(v) review data needed to monitor fisheries and conduct stock assessment, and to identify critical data and ways that would ensure their timely submission to the Secretariat (paragraph 3.10);

(vi) prepare for the *Scientific Observers Manual* an identification guide for *Dissostichus* spp. (paragraph 4.106) – Mr Williams;

(vii) prepare general instructions for observers on sampling the fish from longlines (paragraph 3.75) – Dr J. Ashford and Prof. G. Duhamel (authors of WG-FSA-97/4); and

(viii) consider conducting bottom trawl surveys of *D. eleginoides* in Subareas 58.6 and 58.7 (in order to determine biological parameters) (paragraphs 4.300 and 4.309).

Stock assessment analyses and modelling:

(i) undertake standardisation of the trawl survey time series using GLMs (paragraph 4.198);

(ii) analyse all available survey data for *C. gunnari* to investigate the possible magnitude and frequency of periodic increases of M at South Georgia (paragraph 4.209(i));

(iii) examine the potential for deriving *C. gunnari* recruitment estimates directly from trawl survey results (paragraph 4.209(ii));

(iv) examine the sensitivity of assessments of yield variations in growth parameters for *C. gunnari* (paragraph 4.209(iii)); and

(v) investigate a possibility that spawning of *D. eleginoides* occurs at a low level throughout much of the year and that the maturity ogive may depend on the time of year during which observations are made (paragraph 3.55) – Prof. Moreno and Dr Everson.

Incidental mortality of seabirds in longline fisheries:

(i) provide to the Secretariat reports on national research programs into status of albatrosses, giant petrels and white-chinned petrels (paragraphs 7.18 and 7.20) – France and New Zealand;

(ii) provide to the Secretariat regular updates on population status of albatrosses and petrels (paragraph 7.24);

(iii) provide to WG-FSA results of GLM analysis of seabird interactions with longline fisheries (paragraph 7.115) – New Zealand;

(iv) provide information on the use of underwater longline setting devices in fisheries conditions (paragraph 7.116);

(v) investigate intersessionally the optimum levels of sampling of longline hauls to ensure coverage adequate to give robust overall estimates of seabirds by-catch (paragraph 7.56);

(vi) investigate intersessionally if the distribution of observer effort matches that of fishing effort (paragraphs 7.59 and 7.60); and

(vii) undertake studies of the performance of natural and artificial bait in relation to their attractiveness to seabirds and report to CCAMLR (paragraphs 7.139 and 7.140).

9.6 As was the practice in the past, a plan of work on the incidental mortality of marine animals in fisheries (discussed under Agenda Item 7) will be considered during CCAMLR-XVI by members of the IMALF Coordinating Group. The Secretariat will report on the work of the coordinating group to the next meeting of WG-FSA.

9.7 The Working Group also identified the following tasks in the Secretariat's general support to WG-FSA meetings:

(i) continue the practice of delivering meeting documents, on request, to participant's hotels prior to the start of the meeting (paragraph 10.5);

(ii) consider the provision of adequate resources to improve the scientific content of the library (paragraph 10.6); and

(iii) apply strategic planning and consultations with key participants of the Group in order to facilitate intersessional work (paragraph 10.10).

OTHER BUSINESS

10.1 The Working Group discussed the circulation of meeting documents and CCAMLR reports, the level of support required from the Secretariat prior to, and during, WG-FSA, and other issues related to the organisation of the meeting. The discussion was held with reference to a similar discussion held during WG-EMM-97.

Meeting Documents and CCAMLR Publications

10.2 The Working Group agreed that the rules pertaining to the submission and circulation for meeting documents should be strictly enforced, and endorsed the relevant points discussed during WG-EMM. Members were reminded that documents submitted to the Secretariat one month in advance of the meeting are circulated to all Members. Papers submitted by 0900 h of the first day of the meeting should be accompanied by 40 copies, and would be circulated to participants at the meeting. Ideally, Members should submit their papers at the earliest opportunity so as to allow participants adequate time to consider papers and issues for discussion, and alleviate the workload of the Secretariat in preparing for the Commission meetings. It was noted that papers submitted as little as one week in advance of the meeting may still be copied prior to WG-FSA, and were likely to be included in the bundles of papers.

10.3 WG-FSA supported WG-EMM's suggestion that Members and the Secretariat should be encouraged to move towards electronic submission and circulation of papers. This was seen as a logical step, and one which would eventually reduced the amount of paper used in producing the documents, and the volume of papers carried by Members to and from the meetings. Papers could be submitted electronically via email, or through the proposed CCAMLR web site. Alternatively, the Working Group discussed the possibility of circulating document abstracts prior to the meeting, and producing limited reference copies of complete papers, and agreed that this option would also reduce the volume of meeting papers copied by the Secretariat.

10.4 The Working Group noted that the current CCAMLR document distribution publication policy had resulted in a restricted circulation of CCAMLR reports and publications, with many of participants at WG-FSA no longer receiving copies of the Scientific Committee reports, and other relevant documents. The Working Group recommended that the Scientific Committee recommend to the Commission to review the current distribution policy to ensure that all participants at Working Group meetings receive, as a minimum, copies of the Working Group and Scientific Committee reports.

Secretariat Support

10.5 WG-FSA recognised that it operated under fewer constraints than WG-EMM. In particular, WG-FSA had fewer participants (about 30 participants) and enjoyed the Secretariat's home advantage with known equipment and regular facilities. WG-FSA encouraged the Secretariat to continue its practice of delivering meeting documents, on request, to participants' hotels prior to the start of the meeting. This was found to be useful, and the Secretariat was requested to extend this service to more participants, as requested.

10.6 The Working group found that the library resources in the Secretariat provided inadequate support to Members during the analyses of WG-FSA, and staff during the intersessional periods. The Working Group recommended that adequate resources be provided to improve the scientific contents of the library, particularly in the fields of stock assessment, ecosystem management and taxonomy.

Preparation of Data and Information Prior to WG-FSA

10.7 WG-FSA identified a number of tasks undertaken during the meeting which are becoming routine, and may now be undertaken by the Secretariat in the period leading up to meetings.

10.8 The Working Group spent a considerable time reading observer reports, and abstracting information. Following the format prepared this year, the Working Group recommended that the Secretariat prepare, if possible, tables summarising the trips conducted by scientific observers, and information in their reports, prior to future meetings. In addition, dataset inventories, of the type proposed in SC-CAMLR-XVI/BG/11 Rev. 1 be maintained for the observer logbook datasets. However, this year, the Working Group recognised that over 50% of the observer reports and logbooks had been submitted to the Secretariat during the first half of October, and that these could not have been summarised by the Secretariat prior to the meeting. Many of these reports were hand-delivered by Members. Some reports would have required translation.

10.9 The Working Group agreed that much of the initial preparation for new and exploratory fisheries assessments could now be performed by the Secretariat. For example, seabed areas for given depth intervals could be calculated using the program developed by the Secretariat (SC-CAMLR-XVI/BG/17).

10.10 The Working Group identified a number of tasks which had been requested during previous meetings and had not been entirely completed. It was recognised that some requests may not have been sufficiently clearly specified, and the Working Group suggested that key individuals be identified to facilitate inter-sessional work to be undertaken by the Secretariat and participants. The Working Group encouraged the development of a consultative process, and open communication between participants and the Secretariat so that ambiguities and problems can be easily and efficiently resolved. Dr Kock encouraged the Secretariat to take a more active role in strategic planning.

10.11 As part of this strategic planning, the Working Group encouraged the Secretariat to develop electronic forms and formats for the submission of data, reports and meeting documents. The Working Group agreed that clear specifications are required for each type of submission, and that these should be developed and provided by the Secretariat. This standard approach would ensure that submissions are made in the correct format, and using CCAMLR codes. The Secretariat should also consider developing simple stand-alone programs for data entry, primarily for use in the field, and providing Members with databases shells (e.g. SC-CAMLR-XVI/BG/21).

10.12 The Working Group reviewed the priorities for processing fisheries, research and observer data. It was agreed that the highest priority for processing and validating fishery and observer data should be given to data acquired during the previous split-year (to 30 June). Because of the importance of survey data in the assessments, these should be processed and validated on submission so that the latest results are available to WG-FSA. Finally, and as resources permit, data for the current fishing season should be processed and validated. These data are not considered essential to the analyses, and could be processed during the intersessional period following WG-FSA.

10.13 Recent problems with the submission of the UK survey data highlighted the need for the Secretariat to transfer survey data currently held in the catch and effort database (C1) to a purpose built research survey database. The Working Group agreed that the Secretariat should address this issue during the intersessional period. More generally, the Working Group recommended that the Secretariat review datasets, and develop databases for future needs. The Secretariat should work closely with Members involved in developing databases and data collection systems so as to avoid duplication. The Working Group agreed that a small data steering group should be formed under the coordination of Dr Constable.

10.14 The Working Group also encouraged the Secretariat to consolidate and validate the methodology and datasets used by WG-FSA. Some of this supporting analytical software should be packaged as a WG-FSA toolbox available in electronic format, preferably on the proposed CCAMLR web site.

Tasks During WG-FSA

10.15 WG-FSA identified a number of tasks and issues which should be addressed by the Secretariat during its meetings. As identified at WG-EMM, there was a need for a better system for circulating meeting papers (e.g. electronic submission and dissemination), and for keeping participants informed of progress during the meeting. It was suggested that the Secretariat should continue to maintain a whiteboard with up-to-date information on the state of rapporteur reports and other meeting papers. The possibility of using a numbering system for papers, and different coloured paper to distinguish the types of papers, was discussed. It was concluded that, at the very least, all working papers, reports and revisions prepared and distributed by subgroups should be clearly labelled with the name of the rapporteur, and the date and time of circulation.

Other Issues

10.16 WG-FSA recognised that some of its instructions to the Secretariat should be more thoroughly documented. It was agreed that some methods used during the meeting have evolved to a relatively final stage, and that these should be better documented.

10.17 The Working Group agreed that the appointment of a chief rapporteur should facilitate the compilation of the WG-FSA report in the future. In addition, the appointment of subgroup coordinators could be made in advance of the meeting so as to more clearly identify tasks and analyses likely to be undertaken by the Working Group.

10.18 The Working Group noted that it had proposed a number of analyses and data compilations which would require substantive use of the Secretariat's data management resources. Such requirements are likely to have budgetary implications.

10.19 The Working Group appreciated the work done by the Secretariat within the resources available, and was grateful for the Secretariat's work in support of WG-FSA. The Working Group thanked the Secretariat for the progress made, and agreed to assist the Secretariat in resolving problems identified above.

ADOPTION OF THE REPORT

11.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

12.1 The Convener thanked all participants for their hard work during a busy meeting and expressed his appreciation to the conveners of the subgroups and to the rapporteurs for their considerable efforts.

12.2 On behalf of the Working Group, Dr Parkes thanked the Convener for conducting a successful meeting.

12.3 The Convener then closed the meeting.

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Table 1: Reported catches (tonnes) by species and area for the split-year 1996/97 (1 July to 30 June). Source: STATLANT data.

Species	Subarea/Division										
	48.1	48.2	48.3	58.4.3	58.5.1	58.5.2	58.6	58.7	88.1	88.2	All Areas
A. rostrata			<1			<1					
C. gunnari					<1	216					216
C. rhinoceratus					4	1					5
D. eleginoides			2 389	<1	4 681	837	333[a]	2 386[a]	<1	<1	10 626
E. superba	51 286	98	31 124								82 508
L. nasus						2					2
L. squamifrons						4					4
Lithodidae			<1								
Macrourus spp.			15			<1					15
M. hyadesi			28								28
Myctophidae spp.						<1					
N. rossii					<1	<1					
Osteichthyes spp.						1					1
P. spinosissima			0								
Rajiformes spp.			29			3					32
Total	51 286	98	33 585		4 685	1 064	333	2 386			93 437

[a] From Annex D

Table 2: Catches of *D. eleginoides* from various statistical areas reported to the end of the 1996/97 fishing season on 31/8/97.

Conservation Measure	Subarea/ Division	Location	Method	Catch Limit (tonnes)	Reported Catch (tonnes)
109/XV	58.5.2	Heard Island	Trawl	3 800	1 861
102/XV	48.3	South Georgia	Longline	5 000	3 924
116/XV	58.6, 58.7	Prince Edward and Crozet Is	Longline	4 400[a]	2 096[b] 333[c]
	58.5.1	Kerguelen	Trawl		3 676
	58.5.1	Kerguelen	Longline		1 007
113/XV	58.4.3		Trawl	1 980	0.007
115/XV	88.1		Longline	1 980	0.114
115/XV	88.2		Longline	1 980	0.014

[a] Catch limit 2 200 tonnes for each of Statistical Areas 58.6 and 58.7
[b] Catch reported for South African EEZ around Prince Edward Islands
[c] Catch from joint French–Japanese experimental fishery in the French EEZ around Crozet Islands

Table 3: Estimates of unreported catches (in tonnes) of *D. eleginoides* in the 1996/97 split-year.

Reported Total Catch in EEZs outside CCAMLR Area	Reported Total Catch in CCAMLR Area	Estimated Unreported Catch in CCAMLR Area from Landings	Estimated Unreported Catch in CCAMLR Subareas/Divisions from Catch/Effort Data
22 365	10 626[1]	74 000 – 82 200	38 000 – 42 800

1 Includes catches in EEZs inside CCAMLR waters

Table 4: Estimates of unreported catches (in tonnes) of *D. eleginoides* from 1 July to 30 September 1997.

Reported Total Catch in EEZs outside CCAMLR Area	Reported Total Catch in CCAMLR Area	Estimated Unreported Catch in CCAMLR Area from Landings	Estimated Unreported Catch in CCAMLR Subareas/Divisions from Catch/Effort Data
2 048[3]	3 735[1]	17 580 – 28 580	5 500 – 8 900[2]

1 Includes catches in EEZs inside CCAMLR waters
2 Divisions 58.5.1 (2 500 tonnes) and 58.5.2 (3 000 to 6 400 tonnes) only
3 Argentinian EEZ only

Table 5: Data from observer reports from longline fishing vessels.

Vessel	Type	Date	Sets	Hooks				Fish Lost	Fish By-catch	Fish Speci-mens	CPUE	Length (L)	L/Wt	Sex			Catch Depth	Soak T/Catch	Pro-duct	Conv. Fact.	Fish Con-dition
				Set	Bait	Obs	Lost							Ratio	Mat / L						
Subareas 58.6 and 58.7:																					
American Champion	A	8–9/96	263	845.2	-	-	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y
Aquatic Pioneer	A	11–12/96	101	288.7	82.5 (238.2)	(100)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Aquatic Pioneer	A	1–2/97	82	287.0	82.5 (236.8)	(100)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Aquatic Pioneer	A	4–6/97	109	389.1	82.5 (321.0)	(100)	N	N	Y	N	Y	Y	N	N	N	N	N	N	Y	N	N
Aquatic Pioneer	A	7-8/97	54	207.5	60 (124.5)	47	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Garoya	S-1	4/97	62	251.6	67.5 (169.8)	(100)	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
Koryo Maru 11	S-2	11/96–1/97	48	248.2	100	(100)	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Koryo Maru 11	S-2	1–3/97	51	297.8	(100)	(100)	Y	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	N	N
Sudurhavid	S-1	5–6/97	66	247.1	100	(100)	Y	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	N	N
Sudurhavid	S-1	7/97	20	74.0	100	(100)	Y	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	N	N
Zambezi	A	3–5/97	190	699.0	85 (594.1)	(100)	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N
Zambezi	A	7–8/97	80	356.0	73 (259.9)	(100)	N	N	N	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N

Table 5 (continued)

Vessel	Type	Date	Sets	Hooks				Fish Lost	Fish By-catch	Fish Speci-mens	CPUE	Length (L)	L/Wt	Sex		Catch Depth	Soak T/Catch	Pro-duct	Conv. Fact.	Fish Con-dition
				Set	Bait	Obs	Lost							Ratio	Mat / L					
Division 58.5.1:																				
Anyo Maru 22	S-1	12/96–4/97	219	865.3		(100)														
Subarea 48.3:																				
Cisne Verde	S-2	3–5/97	61	654.4	100	20														
Koryo Maru 11	S-2	4–7/97	92	854.0	99 (845.5)	(100)	N	N	N	Y	N	Y	Y	N	Y Y	Y	N	N	N	N
Elqui	S-2	5-7/97	51	695	199	96	N	N	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N
Elqui	S-2	7-8/97	40	457	100	71	N	N	Y	Y	Y	N	N	N	N	Y	N	Y	Y	N
Ercilla	S-2	4-5/97	44	512	100	60	N	Y	Y	N	Y	Y	N	N	N	N	N	Y	Y	N
Ercilla	S-2	5-7/97	51	695	100	96	N	N	Y	N	Y	Y	N	N	N	N	N	Y	Y	N
Ercilla	S-2	8-8/97	50	244	100	62	Y	N	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	N
Ibsa Quinto	S-2	4-8/97	167	1184	100	60	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N
Isla Camila	S-2	3-4/97	45	365	100	18	N	N	N	Y	Y	N	N	N	N	N	N	Y	Y	N
Isla Camila	S-2	4-6/97	44	489	100	18	N	N	N	Y	Y	N	N	N	N	N	N	Y	Y	N
Isla Camila	S-2	7-8/97	44	489	100	18	N	N	N	N	Y	N	N	N	N	N	N	Y	Y	N
Isla Isabel	S-2	3-4/97	35	275	100	10	Y	N	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N
Isla Isabel	S-2	4-6/97	51	527	100	53	N	N	N	Y	Y	N	N	N	N	N	N	Y	Y	N
Isla Isabel	S-2	6-8/97	45	431	100	45	Y	N	Y	Y	Y	N	N	N	N	N	N	Y	Y	N

Table 6: Summary of scientific observer data and reports received by the Secretariat as of 18/10/97.

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report / Date Submitted	Data Reported
UK	*Argos Helena*	LLS Auto	Quintero Spain	48.3 *D. eleginoides*	1/3 – 11/8/97	Observer logbook 8/10/97	Cruise, vessel, catch and IMALF details
Chile	*Cisne Verde*	LLS Spanish	Ashford UK	48.3 *D. eleginoides*	24/3 – 24/5/97	Observer logbook 15/7/97, cruise report 14/10/97	Cruise, vessel, catch and IMALF details
Chile	*Cisne Verde*	LLS Spanish	Ovejero Spain	48.3 *D. eleginoides*	22/6 – 29/8/97	Observer logbook 2/10/97	Cruise, vessel, catch and IMALF details
Chile	*Elqui*	LLS Spanish	del Rio Spain	48.3 *D. eleginoides*	18/3 – 10/5/97	Observer logbook 29/7/97	Cruise, vessel, catch and IMALF details
Chile	*Elqui*	LLS Spanish	Raggio Argentina	48.3 *D. eleginoides*	20/5 – 21/7/97	Observer logbook and cruise report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Elqui*	LLS Spanish	Almeyda Argentina	48.3 *D. eleginoides*	24/7 – 7/9/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Ercilla*	LLS Spanish	Treves Argentina	48.3 *D. eleginoides*	9/4 – 17/7/97	Electronic submission 3/10/97 Observer logbooks (2) and report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Ercilla*	LLS Spanish	Marchetti Argentina	48.3 *D. eleginoides*	1/8 – 8/9/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
Spain	*Ibsa Quinto*	LLS Spanish	Alvarado Chile	48.3 *D. eleginoides*	17/4 – 31/8/97	Observer logbook and cruise report 13/10/97	Cruise, vessel, catch and IMALF details
Korea	*In Sung 66*	LLS Auto	Kozlov Russia	48.3 *D. eleginoides*	7/4 – 31/8/97	Observer logbook and cruise report 17/10/97	Cruise, vessel, catch and IMALF details
Korea	*In Sung 101*	Squid Jigger	Harding UK	48.3 *M. hyadesi*	1/1 – 6/1/97	Observer logbook and cruise report 17/2/97	Cruise, vessel, catch and biological details
Korea	*In Sung 101*	Squid Jigger	Harding UK	48.3 *M. hyadesi*	24/6 – 14/7/97	Observer Logbook and cruise report 23/9/97	Cruise, vessel, catch and biological details
Chile	*Isla Camila*	LLS Spanish	Sinconegui Argentina	48.3 *D. eleginoides*	20/2 – 12/6/97	Electronic submission 3/10/97 Observer logbooks (2) and report 11/10/97	Cruise, vessel, catch and IMALF details

Table 6 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report / Date Submitted	Data Reported
Chile	*Isla Camila*	LLS Spanish	Giangualano Argentina	48.3 *D. eleginoides*	29/6 – 23/8/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Isla Isabel*	LLS Spanish	Remaggi Argentina	48.3 *D. eleginoides*	1/3 – 9/4/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Isla Isabel*	LLS Spanish	Brachetta Argentina	48.3 *D. eleginoides*	18/4 – 16/6/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
Chile	*Isla Isabel*	LLS Spanish	Caballero Argentina	48.3 *D. eleginoides*	4/7 – 18/8/97	Electronic submission 3/10/97 Observer logbook and report 11/10/97	Cruise, vessel, catch and IMALF details
UK	*Jacqueline*	LLS Auto	Gyllen Chile	48.3 *D. eleginoides*	18/4 – 29/5/97	Observer logbook 13/10/97	Cruise, vessel, catch and IMALF details
UK	*Jacqueline*	LLS Auto	Gyllen Chile	48.3 *D. eleginoides*	5/7 – 31/8/97	Observer logbook 13/10/97	Cruise, vessel, catch and IMALF details
Japan	*Koryo Maru 11*	LLS Auto	Keith South Africa	48.3 *D. eleginoides*	30/3 – 11/8/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Spain	*Pescarosa Primero*	LLS Spanish	Arata Chile	48.3 *D. eleginoides*	2/5 – 11/9/97	Observer logbook 13/10/97	Cruise, vessel, catch and IMALF details
Australia	*Austral Leader*	Trawler	Williams Australia	58.5.2 *D. eleginoides*	6/3 – 7/5/97	Observer logbook 27/6/97	Cruise, vessel, catch and biological details
Australia	*Austral Leader*	Trawler	Saunders New Zealand	58.5.2 *D. eleginoides*	20/5 – 7/6/97	Observer logbook 23/7/97	Cruise, vessel, catch and biological details
Australia	*Austral Leader*	Trawler	Tucker Australia	58.5.2 *D. eleginoides*	10/7 – 2/9/97	Observer logbook 2/10/97	Cruise, vessel, catch and biological details
New Zealand	*Pakura*	Trawler	Brady New Zealand	58.5.2 *D. eleginoides*	5/4 – 18/5/97	Observer logbook 17/6/97	Cruise, vessel, catch and biological details
Argentina	*Alida Glacial*	LLS	No Observer	58.7 *D. eleginoides*	21/10 – 27/12	Logbook 15/10/97	Cruise, vessel, catch and IMALF details

Table 6 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report / Date Submitted	Data Reported
Argentina	*Aliza Glacial*	LLS	Stoffberg South Africa	58.7 *D. eleginoides*	7/12/96 – 7/1/97	Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
USA	*American Champion*	LLS	Koen South Africa	58.7 *D. eleginoides*	14/8 – 28/9/96	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
USA	*American Champion*	LLS	No Observer	58.7 *D. eleginoides*	24/10 – 21/11/96	Logbook 15/10/97	Cruise, vessel, catch and IMALF details
South Africa	*Aquatic Pioneer*	LLS	Purves South Africa	58.7 *D. eleginoides*	31/10 – 10/12/96	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
South Africa	*Aquatic Pioneer*	LLS	Purves South Africa	58.7 *D. eleginoides*	8/1 – 1/3/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
South Africa	*Aquatic Pioneer*	LLS	Wanless South Africa	58.7 *D. eleginoides*	20/4 – 18/6/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
South Africa	*Aquatic Pioneer*	LLS	Williams South Africa	58.7 *D. eleginoides*	1/7 – 29/8/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Namibia	*Garoya*	LLS	Boix ~~Spain~~[1]	58.7 *D. eleginoides*	5/4 – 10/5/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Japan	*Koryo Maru 11*	LLS	Enticott South Africa	58.7 *D. eleginoides*	10/11/96 – 5/1/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Japan	*Koryo Maru 11*	LLS	Heinecken South Africa	58.7 *D. eleginoides*	17/1 – 22/3/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
USA	*Mr B*	LLS	Le Roux South Africa	58.7 *D. eleginoides*	22/10 – 28/11/96	Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
USA	*Mr B*	LLS	Stoffberg South Africa	58.7 *D. eleginoides*	29/1 – 14/2/97	Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Namibia	*Sudurhavid*	LLS	Heinecken South Africa	58.7 *D. eleginoides*	15/5 – 16/6/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details

[1] South Africa – see SC-CAMLR-XVI, paragraph 3.8

Table 6 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report / Date Submitted	Data Reported
Namibia	*Sudurhavid*	LLS	Heinecken South Africa	58.7 *D. eleginoides*	4/7 – 24/7/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
Namibia	*Zambezi*	LLS	Stoffberg South Africa	58.7 *D. eleginoides*	19/3 – 16/5/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
South Africa	*Zambezi*	LLS	Anderson South Africa	58.7 *D. eleginoides*	25/7 – 29/8/97	Cruise report 9/10/97 Observer logbook 15/10/97	Cruise, vessel, catch and IMALF details
New Zealand	*Lord Auckland*	LLS Auto	Tucker Australia	88.1, 88.2 *D. eleginoides*	9/5 - 2/6/97	Observer logbook 24/6/97	Cruise, vessel, catch and IMALF details

Table 7: Information on packaging bands and marine debris from scientific observer reports from longline vessels fishing in Subareas 48.3, 58.6 and 58.7.

Vessel	Observer	Type	Date	Band	Oil	Debris	
						Gear	Garbage
Subarea 48.3:							
Elqui	Raggio, Argentina	S-2	5–7/97	Y		Y	Y
Elqui	Almeyda, Argentina	S-2	7–8/97	Y		Y	Y
Ercilla	Treves, Argentina	S-2	4–5/97				
Ercilla	Treves, Argentina	S-2	6–7/97				
Ercilla	Marchetti, Argentina	S-2	8/97	Y			Y
Ibsa Quinto	Alvarado, Chile	S-2	4–8/97	Y		Y	Y
Isla Camila	Sinconegui, Argentina	S-2	3–4/97	Y			
Isla Camila	Sinconegui, Argentina	S-2	4–6/97				
Isla Camila	Giangualano, Argentina	S-2	7–8/97				
Isla Isabel	Giangualano, Argentina	S-2	3–4/97	Y		Y	Y
Isla Isabel	Brachetta, Argentina	S-2	4–6/97				
Isla Isabel	Caballero, Argentina	S-2	6–8/97	Y		Y	Y
Cisne Verde	Ashford, UK	S-2	3–5/97				
Koryo Maru 11	Keith, South Africa	S-2	4–7/97				
Subareas 58.6, 58.7:							
American Champion	Koen, South Africa	A	8–9/96				
Aquatic Pioneer	Purves, South Africa	A	11–12/96				
Aquatic Pioneer	Purves, South Africa	A	1–2/97				
Aquatic Pioneer	Wanless, South Africa	A	4–6/97	Y		Y	Y
Aquatic Pioneer	Williams, South Africa	A	7-8/97				
Garoya	Boix, ~~Spain~~[1]	S-1	4/97	Y	Y		
Sudurhavid	Heinecken, South Africa	S-1	5–6/97				
Sudurhavid	Heinecken, South Africa	S-1	7/97				
Koryo Maru 11	Enticott, South Africa	S-2	11/96–1/97	Y		Y	
Koryo Maru 11	Heinecken, South Africa	S-2	1–3/97				
Zambezi	Stoffberg, South Africa	A	3–5/97				
Zambezi	Anderson, South Africa	A	7–8/97				

[1] South Africa – see SC-CAMLR-XVI, paragraph 3.8

Type A = Autoliner; S-1 = Spanish single line; S-2 = Spanish double line

Date Months only

Band Information available (Y = yes) on packaging bands (Conservation Measure 63/XV)

Oil Oil spillage observed (Y = yes)

Debris Information available (Y = yes) on marine pollution/waste disposal: Gear = disposal of fishing gear; Garbage = disposal of plastic, cardboard or other non-offal waste

Table 8: New fisheries in 1996/97.

Conservation Measure	Target Species	Subarea/ Division	Catch Limit (tonnes)	Season	Reported Catch (tonnes)	Closure Date 1997
99/XV	*M. hyadesi*	48.3	2 500	2 Nov 1996 – 7 Nov 1997	81	7 Nov
114/XV	*D. eleginoides* *D. mawsoni*	48.6	1 980	1 March – 31 Aug 1997	0	31 Aug
116/XV	*D. eleginoides* *D. mawsoni*	58.4.4	1 980	1 March – 31 Aug 1997	0	31 Aug
116/XV	*D. eleginoides* *D. mawsoni*	58.6, 58.7	2 200 in each	30 Oct 1996 – 31 Aug 1997	2 521	31 Aug
115/XV	*D. eleginoides* *D. mawsoni*	88.1, 88.2	1 980 in each	15 Feb – 31 Aug 1997	0.128	31 Aug
113/XV	*D. eleginoides* *D. mawsoni*	58.4.3	1 980	2 Nov 1996[a] or 1 Mar 1997[b] – 31 Aug 1997	0.007	31 Aug
111/XV	Deepwater species	58.5.2	50[c]	2 Nov 1996 – 31 Aug 1997	0	31 Aug

a For trawling
b For longlining
c For each species not covered by Conservation Measures 109/XV and 110/XV

Table 9: Summary of data submitted for new fisheries in 1996/97.
T – five-day or 10-day catch and effort reports, C – catch and effort data, B – biological data, S – STATLANT data (to 30 June 1997), R – report, L – logbook.

Target Species	Member	Subarea/ Division	Fishery Data	Observer Data	Other Data
M. hyadesi	Rep. of Korea	48.3	T, C, B	R, L	
D. eleginoides *D. mawsoni*	South Africa	48.6	Not fished		
D. eleginoides *D. mawsoni*	South Africa	58.4.4	Not fished		
D. eleginoides *D. mawsoni*	South Africa	58.6, 58.7	S T[1],C[1],B[1]	R, L	Length at age; CPUE by month and set; summary VMS data
D. eleginoides *D. mawsoni*	New Zealand	88.1, 88.2	T, C, B	L	VMS trial
D. eleginoides *D. mawsoni*	Australia South Africa	58.4.3	T, C, B	L	VMS trial
Deepwater species	Australia	58.5.2	not fished		VMS trial

1 Outside EEZ

Table 10: Reported by-catch of crabs, rays and fish in the longline fishery for *D. eleginoides* in Subarea 48.3. Catches are expressed as percentage of the reported annual catch, by weight, for *D. eleginoides*. Source: fine-scale catch and effort data (C2) for Spanish-style longlines (split-years 1995–98), autoliners (1995–96), and not specified (1990–96).

By-catch Taxon	Catch (%)		
	Spanish	Autoliner	Not Specified
Crabs:			
Paralomis spinosissima	<0.04		
Lithodidae	≤0.06	<0.01	<0.02
Rays:			
Rajiformes spp.	0.53 – 2.95	0.67 – 2.80	0.03 – 2.60
Raja georgiana	<0.01		
Fish:			
Macrourus spp.	0.25 – 0.98	0.94 – 4.00	≤0.84
Antimora rostrata	≤0.07		
Unknown / mixed spp.	<0.05	≤3.01	<0.01
Lepidonotothen squamifrons			<0.01
Muraenolepis microps			<0.01

Table 11: Precautionary catch limits for new and exploratory fisheries for *Dissostichus* spp. during 1997/98.

Target Species	Area		Reported Catch (tonnes) to 31 August 1997	Estimated Total Catch (tonnes) including Unreported	1996/97 Catch Limit (tonnes)	Seabed Area (km^2)		GY Unadjusted Catch Limit (tonnes) for Total Area	GY Unadjusted Catch Limit (tonnes) for Species	Precautionary Catch Limit (tonnes)	
						<600 m <500[d] m	600–1800 m 500–1500[d] m			0.45*GY	0.30*GY
Longline:											
D. eleginoides	48.3	(600–1800 m)	3 924	3 924	5 000	45 110	67 506				
D. eleginoides	48.1	north of 65°S				156 505	73 107	4 262	3 960	1 782	
D. mawsoni	48.1	south of 65°S				130 206	5 569		302		91
D. eleginoides	48.2	north of 60°S				198	16 847	4 013	912	410	
D. mawsoni	48.2	south of 60°S				35 465	57 308		3 101		930
D. eleginoides	48.4	north of 57°S	0	0	28	816	7 356	1 293	397	179	
D. mawsoni	48.4	south of 57°S				2 940	16 587		896		269
D. eleginoides	48.6	north of 65°S	0	0	1 980[b]	1 288	34 879	3 953	1 887	849	
D. mawsoni	48.6	65-70°S				32 963	38 205		2 066		620
D. eleginoides	58.4.3	north of 60°S				352	107 795	5 928	5 833	2 625	
D. mawsoni	58.4.3	south of 60°S				0	1 753		95		28
D. eleginoides	58.4.4	north of 60°S	0	?[c]	1 980[b]	8 783	22 848	1 234	1 234	555	
D. mawsoni	58.4.4	south of 60°S				0	0		0		0
D. eleginoides	58.6	current	2 521[a]	19 233	2 200[b]	19 933	69 158	4 648	4 648	2 092	
D. eleginoides	58.7	current		14 129	2 200[b]	1 988	15 618	996	996	448	
D. eleginoides	58.6	proposed		12 822		17 677	28 691	1 885	1 885	848	
D. eleginoides	58.7	proposed		18 839		4 244	56 085	3 745	3 745	1 685	
D. eleginoides	88.1	north of 65°S	0.114	0.114	1 980[b]	21	13 277	4 455	719	323	
D. mawsoni	88.1	65–70°S				57 087	69 045		3 736		1 121
D. eleginoides	88.2	north of 65°S	0.014	0.014	1 980[b]	17	1 012	178	55	25	
D. mawsoni	88.2	65–70°S				3	2 276		123		37
D. eleginoides	88.3	north of 65°S				0	20	1 454	1	0	
D. mawsoni	88.3	65–70°S				76 729	26 867		1 453		436
Trawl:											
D. eleginoides	58.5.2	(500–1500 m)	1 861	10 437	3 800	48 186	91 771				
D. eleginoides	58.4.3	north of 60°S	0.007	0.007	1 980[b]	107	49 550	2 047	2 047	921	
D. mawsoni	58.4.3	south of 60°S				0	0		0		0

[a] Subareas 58.6 and 58.7 combined [b] *Dissostichus* spp. [c] Evidence of substantial fishing (see Appendix D, Table D.3) [d] Trawl fisheries

Table 12: Biomass estimates of several fish stocks obtained in a German research cruise conducted in Subarea 48.1 during the 1996/97 season (WG-FSA-97/27).

Species	Biomass (tonnes)	Confidence Intervals (tonnes)
Champsocephalus gunnari	606	37 – 1 268
Chaenocephalus aceratus	2 124	1 169 – 13 015
Chionodraco rastrospinosus	282	135 – 856
Gobionotothen gibberifrons	5 157	2 679 – 212 193
Lepidonotothen squamifrons	312	65 – 5 564
Lepidonotothen larseni	182	131 – 269

Table 13: Biomass estimates (in tonnes) and their upper and lower 95% confidence intervals of finfish in the vicinity of Elephant Island in 1987 and 1996.

Species	1987		1996	
	Mean	CI	Mean	CI
Champsocephalus gunnari	2 059	929 – 8 406	606	374 – 1 268
Notothenia rossii	630	223 – 3 414	32	16 – 48
Gobionotothen gibberifrons	21 309	10 982 – 45 679	5 157	2 679 – 212 193
Chaenocephalus aceratus	5 530	3 234 – 12 251	2 124	1 169 – 13 015
Chionodraco rastrospinosus	475	285 – 985	282	135 – 856
Lepidonotothen larseni	533	317 – 944	182	131 – 269
Lepidonotothen squamifrons	139	48 – 809	312	65 – 5 564

Table 14: Analysis of deviance tables for GLMs fitted to time series of CPUE data for *D. eleginoides* from Subarea 48.3.

Effect	df	Deviance	Residual df	Residual Deviance	p
kg/hook					
NULL			4 160	2 087.70	
+ season	5	144.24	4 155	1 943.46	<0.01
+ month	9	64.50	4 146	1 878.96	<0.01
+ area	4	35.22	4 142	1 843.74	<0.01
+ nationality	8	277.11	4 134	1 566.63	<0.01
+ bait	4	30.88	4 130	1 535.75	<0.01
numbers/hook					
NULL			3 987	1 737.24	
+ season	5	121.93	3 982	1 615.31	<0.01
+ month	9	29.03	3 973	1 586.28	<0.01
+ area	4	31.09	3 969	1 555.20	<0.01
+ nationality	8	173.36	3 961	1 381.84	<0.01
+ bait	4	35.37	3 957	1 346.47	<0.01

Table 15: Percentage of longline hauls with zero catches for *D. eleginoides* from Subarea 48.3.

Season Ending 30 September	Number of Vessels	Mean % Hauls with Catch = 0
1992	3	8.42
1993	3	9.41
1994	2	3.12
1995	7	5.21
1996	2	3.20
1997	5	3.63

Table 16: Maturity ogive for *D. eleginoides* in Subarea 48.3 during August 1997.

Sex	am	bm	$L_{50\%}$
Males	-14.724876	0.194428	75.73
Females	-12.800288	0.1159154	110.43
Both*	-6.3819180	0.0686313	92.99

* Used in the assessment

Table 17: Estimated abundance at age (millions of fish) from a series of trawl surveys carried out at South Georgia.

Survey	N_3	Standard Error (N_3)	N_4	Standard Error (N_4)	N_5	Standard Error (N_5)
Argentina 1996	4.993	1.649	1.150	0.223	0.751	0.293
Argentina 1995 South Georgia	-	-	1.212	0.599	2.118	0.627
Argentina 1995 Shag Rocks	2.384	1.644	3.360	1.163	1.092	0.726
Total	2.384	1.644	4.572	1.308	3.210	0.959
UK 1994 depth 1	0.157	0.101	0.109	0.057	0.121	0.093
UK 1994 depth 2	0.764	0.537	0.678	0.153	-	-
UK 1994 depth 3	0.267	0.140	0.357	0.135	0.404	0.175
Total	1.188	0.778	1.144	0.345	0.526	0.268
UK 1992 depth 1	1.300	0.427	-	-	-	-
UK 1992 depth 2	5.523	1.970	0.092	0.512	0.115	0.129
UK 1992 depth 3	2.401	0.594	0.474	0.408	0.341	0.239
Total	9.225	2.102	0.567	0.655	0.457	0.271
UK 1991 depth 1	0.142	0.064	0.026	0.026	0.058	0.034
UK 1991 depth 2	0.056	0.037	0.026	0.013	0.057	0.029
UK 1991 depth 3	0.029	-	0.132	0.072	0.698	0.519
Total	0.229	0.073	0.185	0.076	0.813	0.521
UK 1990 depth 1	1.446	1.436	6.617	6.065	4.216	3.777
UK 1990 depth 2	0.058	0.035	0.081	0.063	0.165	0.103
UK 1990 depth 3	0.011	-	0.009	-	0.040	0.030
Total	1.515	1.437	6.707	6.065	4.422	3.779
US/Poland 1988	0.299	0.096	0.285	0.144	0.078	0.024
US/Poland 1986	1.000	0.288	1.051	0.805	0.045	0.026
USSR 1986	-	-	0.523	0.296	2.323	1.016

Table 18: Recruitment to the stock of *D. eleginoides* in Subarea 48.3 as numbers of fish by year class at age class 4, estimated from trawl surveys at South Georgia.

Cohort	Number of Fish at Age 4 (millions)
1993	4.255
1992	1.591
1991	2.155
1990	2.455
1989	4.239
1988	0.381
1987	0.671
1986	3.831
1985	2.722
1984	0.285
1983	0.315
1982	0.822
1981	1.389

Table 19: Parameters for the lognormal recruitment function.

Parameter	Value
Mean number of recruits at age 4	1 932 000
Standard deviation	2 187 000
Lognormal mean	14.243
Lognormal standard error	0.188
Lognormal standard deviation	0.679

Table 20: Parameters input to the GYM for evaluation of precautionary yield of *D. eleginoides* in Subarea 48.3.

Category	Parameter	*D. eleginoides*
Age composition	Recruitment age in simulation Number of age classes Plus class present – years in plus class in initial age structure	4 35 21
Resolution	Number of increments per year	360
Natural mortality	Mean annual M	0.16
Fishing mortality	Length of fish when 50% of individuals of that size are recruited to fishery (l_{r50}) Length range over which recruitment occurs (l_r) Reasonable upper bound for annual fishing mortality Tolerance (error) for determining fishing mortality in each year	70 cm 65–75 cm 5 1E-05
von Bertalanffy growth	Time 0 L_{∞} K	0 170.8 cm 0.088
Weight-length ($W = aL^b$)	a b	2.5E-05 2.8
Spawning biomass	Maturity ogive by length (m_m) - Lm_{50} Range over which maturity occurs Date when spawning begins Number of increments in spawning season	93 cm 78–108 cm 1 August 1 (knife edge)
Recruitment	Mean of $\log_e$ (Recruits) Standard error of the mean of $\log_e$ (Recruits) Standard deviation of $\log_e$ (Recruits)	14.219 0.194 0.698
Simulation characteristics	Number of runs in simulation for each catch Years to project stock to remove effects of initial age structure Vector of real catches for projecting over known catch period (tonnes) Number of years to project stock following known catch period Seed for random numbers	1 001 1 8 501, 4 206, 7 309, 5 589, 6 605, 6 171, 4 362, 2 619 35 -24189
Decision rules	Reference point for assessment of long-term annual yield	0.2.SB_0*median*

Table 21: Relative biomass estimates for *C. gunnari* in Subarea 48.3 from surveys undertaken by Argentina and the UK during the 1996/97 season.

Depth Stratum	Argentinian Survey		UK Survey (MVUE)		Lower CI	Upper CI
	Hauls	Mean	Hauls	Mean		
Shag Rocks:						
1	5	11 953	5	1 267	524	8 262
2	4	74 831	5	6 736	3 410	24 950
3	0	–	2	44.2	13.3	820
Total	9	86 784	12	8 047		
South Georgia:						
1	15	14 356	8	3 627	588	209 873
2	15	20 535	24	21 531	11 585	56 052
3	11	887	12	36 547	5 587	163 903
Total	41	35 777	44	61 705		
Overall Total	50	122 561	56	69 753	32 119	164 973

Table 22: List of bottom trawl surveys in the CCAMLR Convention Area compiled from information held by the Secretariat. ANI – *C. gunnari,* MZZ – Osteichthyes spp., NOX – Nototheniidae, TOP – *D. eleginoides.*

Year	Nationality	Area	Vessel	Survey Dates	Species	Sampling Design	Data Submitted
1997	Argentina	48.3	*Dr Eduardo L. Holmberg*	21/3 – 2//4/97	MZZ	Clustered survey	Yes
	Australia	58.5.2	*Austral Leader*	20/8 – 8/9/97	ANI	Random survey	No
	Spain	48.6, 58.4.4	*Ibsa Quinto*	20/9 – 20/10/97	TOP	Systematic, distribution and biology	Postponed
	UK	48.3	*Argos Galicia*	9/97	MZZ	Random survey	Yes
1996	Argentina	48.3	*Dr Eduardo L. Holmberg*	20/3 – 9/4/96	MZZ	Clustered survey	No
	Germany	48.1	*Polarstern*	14/11 – 30/12/96	MZZ	Random survey (37 tows)	Yes
	Russia	48.2, 48.3	*Atlantida*	3 – 4/96	MZZ		Yes
	USA	88.1	*Nathaniel B. Palmer*	5/12/96 – 5/1/97	NOX		No
	USA	48.1	*Polar Duke*	3/7 – 29/8/96	MZZ		No
1995	Argentina	48.2, 48.3	*Dr Eduardo L. Holmberg*	10 – 25/2/95	MZZ	Clustered survey	Yes
1994	Argentina	48.2, 48.3	*Dr Eduardo L. Holmberg*	12/2 – 23/3/94	MZZ	Clustered survey	Yes
	UK	48.3	*Cordella*	4/1 – 8/2/94	MZZ	Random survey	Yes
1993	Australia	58.5.2	*Aurora Australis*	2/9 – 24/9/93		Random survey	Yes
1992	Australia	58.5.2	*Aurora Australis*	23/1 – 12/2/92	MZZ	Random survey	Yes
	UK	48.3	*Falklands Protector*	5 – 14/1/92	MZZ	Random survey	Yes
1991	Spain	48.2	*Naroch*	19/1 – 10/2/91	MZZ	Random survey	Yes
	UK	48.3	*Falklands Protector*	22/1 – 11/2/91	MZZ	Random survey	Yes
	USSR	48.3	*Atlantida*	1/4 – 27/5/91	MZZ	Random survey	Yes
1990	Australia	58.5.2	*Aurora Australis*	23/5 – 21/6/90	MZZ	Random survey	Yes
	UK	48.3	*Hill Cove*	1/1 – 26/1/90	MZZ	Random survey	Yes
	USSR	48.3	*Pioner*	7/90	MZZ		Yes
	USSR	48.3	*Akademik Knipovich*	1/90 – 3/90	ANI		
	USSR	48.3	*Anchar*	4/90 – 6/90	MZZ	Distribution and biology	Yes
	USSR	58.4.2	*Professor Mesyatsev & Fiolent?*	21/1 – 1/4/90	MZZ	Distribution and biology	Yes
1989	Poland	48.3	Unknown	11/8 – 11/8/88	MZZ	Exploratory fishing?	Yes
	Poland/UK	48.1, 48.2, 48.3	*Professor Siedlecki*	1/1 – 14/2/89	MZZ	Random survey	Yes
	USSR	58.4.2	*Professor Mesyatsev*	1/2 – 21/3/89	MZZ		Yes
1988	Brazil	48.1	*Prof. W. Besnard*	11/1 – 11/1/88	MZZ	Histology	Yes
	Poland	48.1	Unknown	1 – 11/2/88	MZZ	Exploratory fishing?	Yes
	USSR	48.3	*Pioner Latvii*	12/88 – 1/89	MZZ	Biology	Yes
	USSR	48.3	*Evrika*	3 – 4/88	MZZ		Yes
1987	Brazil	48.1	*Prof. W. Besnard*	21/2 – 21/2/87	MZZ	Histology	Yes
	Germany	48.1	*Polarstern*	21/10 – 11/12/87	MZZ	Random survey (40 tows)	Yes
	Spain	48.1	*Pescapuerta Cuarto*	16/1 – 5/2/87	MZZ	Random survey	Yes
	GDR	48.3	Unknown		MZZ	Random survey	Yes
	Poland	48.3	Unknown	21/12/87 – 1/1/88	MZZ	Exploratory fishing?	Yes

Table 22 continued

Year	Nationality	Area	Vessel	Survey Dates	Species	Sampling Design	Data Submitted
1987	USSR	48.3	Unknown	1/8 – 21/9/87	ANI	Exploratory fishing?	Yes
	USSR	48.3	Unknown	21/7/87	NOG	Exploratory fishing?	Yes
	USSR	48.3	*Gizhiga*	7 – 8/87	MZZ		Yes
	USSR	48.3	*Gizhiga*	7 – 11/87	MZZ		Yes
	USSR/Australia	58.5.2	*Professor Mesyatsev*	10 – 27/5/87	MZZ	Biology	Yes
	USSR/Australia	58.5.2	*Professor Mesyatsev*	24/7 – 2/8/87	MZZ	Biology	Yes
	USA/Poland	48.3	*Professor Siedlecki*	11/12/87 – 1/1/88	MZZ	Random survey	Yes
1986	FRG	48.1	*Polarstern*	5 – 6/86	MZZ	Random survey (36 tows)	Yes
	Spain	48.2	*Pescapuerta Cuarto*	29/12/86 – 14/1/87	MZZ	Random survey	Yes
	Spain	48.4	*Pescapuerta Cuarto*	23 – 26/12/86	MZZ	Random survey	Yes
	Spain	48.3	*Pescapuerta Cuarto*	21/11 – 20/12/86	MZZ	Random survey	Yes
	USSR	48.3	*Gizhiga*	5 – 11/86	MZZ	Random survey	Yes
	USSR	58.4.2	Unknown	11/3 – 21/3/86	WIC	Exploratory fishing?	Yes
	USSR	58.4.2	Unknown	1/1/86	MZZ		Yes
	USA/Poland	48.3	*Professor Siedlecki*	21/11 – 11/12/86	MZZ	Random survey	Yes
1985	FRG	48.1, 48.2, 48.3	*Walter Herwig*	2/85	MZZ	Random survey (37 tows)	Yes
	USSR	48.3	*Gizhiga*	7 – 8/85	MZZ		Yes
	USSR	58.4.2	Unknown	1/1 – 1/4/85	MZZ		Yes
1984	USSR	48.3	*Gizhiga*	27/1 – 30/4/84	MZZ		Yes
1983	FRG	48.1	*Polarstern*	11/83	MZZ	Random survey (12 tows)	Yes
1981	FRG	48.1	*Walter Herwig*	3/81	MZZ	Random survey (13 tows)	Yes
1978	FRG	48.1, 48.2, 48.3	*Julius Fock*	1 – 3/78	MZZ	Non-random survey (20 tows)	Yes
1977	FRG	48.1, 48.2, 48.3	*Walter Herwig*	11/77, 1/78	MZZ	Random survey (7 tows)	Yes
1976	FRG	48.3	*Walter Herwig*		MZZ	Random survey	Yes
	FRG	48.1, 48.2, 48.3	*Weser*	1 – 2/76	MZZ	Non-random survey (18 tows)	Yes
1974	USSR	48.3	*Atlant*	12/74	MZZ		Yes
	USSR	48.3	*Salekhardt*	2 – 3/74	MZZ		Yes

Table 23: Parameters input to the GYM for evaluation of precautionary yield of *C. gunnari* in Subarea 48.3.

Category	Parameter	*C. gunnari*
Age composition	Recruitment age in simulation	1
	Number of age classes	6
	Plus class present – years in plus class in initial age structure	3
Resolution	Number of increments per year	360
Natural mortality	Mean annual M	0.42–0.55
	Interannual variability in M	0.2 probability of increase in M by 4
Fishing mortality	Length of fish when 50% of individuals of that size are recruited to fishery (l_{r50})	15–22 cm
	Length range over which recruitment occurs (l_r)	5 cm
	Fishing season	15 November – 31 March
	Reasonable upper bound for annual fishing mortality	5
	Tolerance (error) for determining fishing mortality in each year	1E-05
von Bertalanffy growth	Time 0	0
	$L_{\square}$	45.5 cm
	K	0.332
Weight-length ($W = aL^b$)	a	1.8E-06
	b	3.36
Spawning biomass	Maturity ogive by length (m_m) - Lm_{50}	21–28 cm
	Range over which maturity occurs	10 cm
	Spawning season	1 March – 30 April
Recruitment	Mean of $\log_e$ (Recruits)	20.1042
	Standard error of the mean of $\log_e$ (Recruits)	0.2397
	Standard deviation of $\log_e$ (Recruits)	0.8970
Evaluation of Gamma	Date of biomass survey	1 September
	CV of biomass survey estimate	0.3
	Coverage of survey	1.0
Simulation characteristics	Number of runs in simulation for each catch	1001
	Years to project stock to remove effects of initial age structure	1
	Vector of real catches for projecting over known catch period (tonnes)	
	Number of years to project stock following known catch period	10
	Seed for random numbers	Start (-24189) Not reset each time
Decision rules	Reference point for assessment of long-term annual yield	0.2.SB_0*median*

Table 24: Estimated year class strength from the Argentine and UK surveys showing the proportion of the population in each age class by number.

Age Class	Survey		Average	Proportion
	Argentina	UK		
	Number of fish (millions)			
2	776	562	669	0.426
3	936	503	720	0.458
4	18	243	131	0.083
5	40	63	52	0.033
6	2	9	5	0.003

Table 25: Abundance estimates and confidence intervals for *C. gunnari* from the 1997 Heard Island survey.

Stratum	Delta Lognormal Maximum Likelihood				Sample Statistics with Bootstrap			
	Abundance (tonnes)	Std. Error	95% Confidence Interval		Abundance (tonnes)	Std. Error	95% Confidence Interval	
			Lower	Upper			Lower	Upper
Shell 1	253.3	201.9	38.7	14 527.2	177.4	97.3	13.7	381.9
Shell 2	4 190.0	2 822.8	1 000.3	77 998.0	4 353.3	2 983.2	407.8	10 365.5
Plateau	110 825.0	91 849.1	14 420.5	$7.9^{*}10^{6}$	49 050.0	30 426.7	7 194.3	112 745.5
Gunnari R.	840.0	598.9	182.0	19 344.8	611.7	324.7	124.2	1 278.9
Shell 1+2					4 531.7	2 769.2	591.8	10 624.0
Gunn+Plat					49 661.7	28 946.1	7 810.9	113.2
Total	116 109.3	91 894.7	18 963.0	$7.9^{*}10^{6}$	54 193.4	29 071.7	11 765.6	118 235.2

Table 26: Parameters for von Bertalanffy growth curve and weight – length relation used for *C. gunnari* assessment in Subarea 48.3. The parameters *a* and *b* apply to a weight – length relationship $w = al^b$, where length l is measured in mm, the resultant weight w is given in kg.

Parameter	Value
von Bertalanffy t_0	0. (yrs)
von Bertalanffy k	0.332
von Bertalanffy L_∞	455.0 (mm)
Weight – length a	6.172×10^{-10}
Weight – length b	3.388

Table 27: Calculated numbers of fish in each age class for a biomass at the lower 95% confidence bound.

Age Class	Number of Fish (millions)
2	119.4
3	128.4
4	23.3
5	9.2
6	0.9

Table 28: Fishing mortality and catches for a two year projection of the *C. gunnari* stock in Subarea 48.3, assuming that the current biomass is at the lower 95% confidence bound of the UK survey carried out in September 1997. Two levels of natural mortality are used in the calculations.

Natural Mortality	Relative Change in Abundance without Fishing	Target Change in Abundance with Fishing	Fishing Mortality	Catch for the 1997/98 Season (tonnes)	Catch for the 1998/99 Season (tonnes)
0.42	1.088	0.816	0.145	4520	4140
1.68	0.090	0.068	0.144	2575	695

Table 29: Biomass estimates (in tonnes) of several fish stocks obtained from Argentinian and UK research cruises conducted in Subarea 48.3 during the 1996/97 season.

	Argentina			UK		
	South Georgia	Shag Rocks	Total	South Georgia	Shag Rocks	Total
N. rossii	10 074	0	10 074	12 398	0	12 398
G. gibberifrons	2 059	48	2 107	2 466	45	2 511
L. squamifrons	0	21 758	21 758	747	412	1 159
L. larseni	186	0	186	-	-	-
P. guntheri	0	23 907	23 907	0	4 244	4 244
C. aceratus	1 970	0	1 970	13 159	3	13 162
P. georgianus	1 921	0	1 921	8 315	0	8 315

Table 30: Total reported catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Lepidonotothen squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (Rajiformes spp.), WIC (*Chaenodraco wilsoni*).

Split-	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX
Year	58	58.5	58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.5	58	58.4	58	58.4	58.5	58.5.1
1971	10231				xx				63636			24545					679			
1972	53857				xx				104588			52912					8195			
1973	6512				xx				20361			2368					3444			
1974	7392				xx				20906			19977					1759			
1975	47784				xx				10248			10198					575			
1976	10424				xx			6	6061			12200					548			
1977	10450				xx			-	97			308					11			
1978	72643	250	82		196	-	2	370	46155			31582	6023	98	234		261			
1979				101	3	-	-	-				1307	2096				1218			
1980		1631	8	14		56	138	-			1742		3035	11308				239		
1981		1122	2			16	40	-		217	7924		4865	6239				375	21	
1982		16083				83	121	-		237	9812		1594	4038		50		364	7	
1983		25852				4	128	14			1829		733	1832		229		4	17	1
1984		7127				1	145	-		50	744		1175	3794					611[1]	17
1985		8253		279		8	6677	-		34	1707		570	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		11283	2464		692				3
1987		2625		1099		34	3144	-		2	482		1963	1641		28		22		
1988		159		1816		4	554	491		-	21		5002	41		66				

Split-	ANI		WIC	TOP			NOR	NOS		ANS	
Year	58.5.1	58.5.2	58.4.2	58.4.4	58.5.1	58.6	58.5.1	58.4.4	58.5.1	58.4.2	58.4.4
1989	23628	-	306	35	1630	21	245	4016	1553	30	17
1990	226	-	339	5	1062	-	155	1463	1262	-	-
1991	13283[2]	-	-	-	1944	-	287	1000	98	-	-
1992	44	3	-	-	7492[3]	13	-	-	4	-	-
1993	-	-	-	-	2722	-	2	-	-	-	-
1994	12	3	-	-	5083	56	-	-	-	-	-
1995	3936	-			5534	114					
1996	5	-	-	-	4911	3			15		
1997	-	215	-	-	4681	333	-	-	-	-	-

1 Mainly Rajiformes spp.

2 There are some discrepancies between the French statistics for the Soviet fishery under licence in Division 58.5.1 (12 644 tonnes) and the STATLANT A data provided by the USSR (13 268 tonnes). It may be explained by the inclusion of 826 tonnes of by-catch (mainly Rajiformes) in this total.

3 1 589 tonnes - France; 5 903 tonnes - Ukraine, of which 705 tonnes were caught by longline.

NB: Before 1979/80 catches reported in Statistical Area 58 mainly concern Division 58.5.1 (Kerguelen subarea). Catch reporting was not divided into Divisions 58.5.1 and 58.5.2 until the 1989 season.

Table 31: Analysis of deviance table for GLM fitted to time series of CPUE data (tonnes/hour) for *D. eleginoides* from Division 58.5.1.

Effect	df	Deviance	Residual df	Residual Deviance	p
NULL			5 445	4 699.29	
+ year	7	249.69	5 438	4 449.60	<0.01
+ month	11	215.34	5 427	4 234.26	<0.01
+ area	2	64.68	5 425	4 169.58	<0.01
+ nationality	1	10.19	5 424	4 159.39	0.01

Table 32: Percentage of trawl hauls with zero catches for *D. eleginoides* from Division 58.5.1.

Year	Number of Vessels	Mean % Hauls with Catch = 0
1990		
1991		
1992		
1993		
1994	2	0.47
1995	2	1.81
1996	3	3.00
1997	2	0.84

Table 33: Parameters input to the GYM for evaluation of precautionary yield of *D. eleginoides* in Division 58.5.2.

Category	Parameter	*D. eleginoides*
Age composition	Recruitment age in simulation Number of age classes Plus class present — years in plus class in initial age structure	4 35 21
Resolution	Number of increments per year	360
Natural mortality	Mean annual M	0.12–0.20
Fishing mortality	Age selectivity function: Age (Selectivity) Reasonable upper bound for annual fishing mortality Tolerance (error) for determining fishing mortality in each year	0. (0.) , 3. (0.), 3.5 (0.07), 4.5 (0.311), 5.5 (0.699), 6.5 (1.0), 7.5 (1.038), 8.5 (0.849), 9.5 (0.579), 10.5 (0.341), 11.5 (0.179), 12.5 (0.085), 13.5 (0.037), 14.5 (0.015), 15. (0.) 5 1E-05
von Bertalanffy Growth	Time 0 L_{∞} K	0 170.8 cm 0.088
Weight-length ($W = aL^b$)	a b	2.5E-05 2.8
Spawning biomass	Maturity-at-age function: age (proportion mature) Date when spawning begins Number of increments in spawning season	0. (0.), 1.39 (0.0002), 2.32 (0.0009), 3.10 (0.0027), 4.13 (0.0096), 4.82 (0.0213), 5.76 (0.0564), 6.56 (0.117), 7.67 (0.270), 8.45 (0.418), 9.49 (0.617), 10.70 (0.792), 11.59 (0.871), 12.58 (0.924), 14.07 (0.964), 16.08 (0.985), 18.90 (0.995), 21.48 (1.0) 1 July 1 (knife edge)
Recruitment	Mean of $\log_e$ (Recruits) Standard error of the mean of $\log_e$ (Recruits) Standard deviation of $\log_e$ (Recruits)	14.585 0.159 0.422
Simulation characteristics	Number of runs in simulation for each catch Years to project stock to remove effects of initial age structure Vector of real catches for projecting over known catch period (tonnes) Number of years to project stock following known catch period Seed for random numbers	1001 1 Run 1: 12061 Run 2: 20261 35 -24189
Decision rules	Reference point for assessment of long-term annual yield	0.2.SB_0*median*

Table 34: Analysis of deviance table for GAM fitted to haul-by-haul CPUE data (kg/hook) for *D. eleginoides* from Subarea 58.6 (Crozet Island).

Effect	df	Deviance	Residual df	Residual Deviance	p
NULL			219	93.46	
+ month	4	8.84	215	84.62	0.07
+ depth	2	8.83	213	75.79	0.01

Table 35: Analysis of deviance table for GLM fitted to haul-by-haul CPUE data (kg/hook) for *D. eleginoides* from Subarea 58.7 (Prince Edward Islands).

Effect	df	Deviance	Residual df	Residual Deviance	p
NULL			530	425.56	
+ month	8	144.02	522	281.54	<0.01
+ depth	8	76.12	514	205.41	<0.01

Table 36: Data on marine mammal incidental mortality from scientific observer reports from longline vessels fishing in Subarea 48.3.

Vessel	Observer	Type	Date	Mammals			
				K	E	O	F
Cisne Verde	Ashford, UK	S-2	3–5/97	0	0	Y	Y
Elqui	Raggio, Argentina	S-2	5–7/97	0	-	-	Y
Elqui	Almeyda, Argentina	S-2	7–8/97	0	0	Y	Y
Ercilla	Treves, Argentina	S-2	4–5/97	0	0	Y	TOP (450)
Ercilla	Treves, Argentina	S-2	6–7/97	0	0	Y	-
Ercilla	Marchetti, Argentina	S-2	8/97	SXX (3)	SXX (3)	Y	Y
Ibsa Quinto	Alvarado, Chile	S-2	4–8/97	0	0	Y	Y
Isla Camila	Sinconegui, Argentina	S-2	3–4/97	0	0	Y	Y
Isla Camila	Sinconegui, Argentina	S-2	4–6/97	0	0	N	Y
Isla Camila	Giangualano, Argentina	S-2	7–8/97	0	0	Y	TOP (44) GRV (6)
Isla Isabel	Giangualano, Argentina	S-2	3–4/97	0	0	Y	Y
Isla Isbel	Brachetta, Argentina	S-2	4–6/97	0	0	Y	TOP (47) GRV (7)
Isla Isabel	Caballero, Argentina	S-2	6–8/97	0	0	Y	TOP (10)
Koryo Maru 11	Keith, South Africa	S-2	4–7/97	0	0	Y	Y

Type A = Autoliner; S-1 = Spanish single line; S-2 = Spanish double line

Date Months only

Mammals K = killed; E = entangled; O = observations of frequency of occurrence of marine mammals
(Y = yes; N = no); F = fish loss observed (species, number estimated) or: Y = yes; N = no;
- = no information)

Table 37: Data on marine mammal incidental mortality from scientific observer reports from longline vessels fishing in Subareas 58.6 and 58.7.

Vessel	Observer	Type	Date	Mammals			
				K	E	O	F
American Champion	Koen, South Africa	A	8–9/96	-	-	-	-
Aquatic Pioneer	Purves, South Africa	A	11–12/96	0	SPW(1)	Y	N
Aquatic Pioneer	Purves, South Africa	A	1–2/97	0	SPW(1)	Y	N
Aquatic Pioneer	Wanless, South Africa	A	4–6/97	0	0	Y	Y
Aquatic Pioneer	Williams, South Africa	A	7-8/97	0	0	Y	N
Garoya	Boix, ~~Spain~~[1]	S-1	4/97	0	0	Y	N
Sudurhavid	Heinecken, South Africa	S-1	5–6/97	0	MIW(1)	Y	N
Sudurhavid	Heinecken, South Africa	S-1	7/97	0	0	Y	N
Koryo Maru 11	Enticott, South Africa	S-2	11/96–1/97	-	-	-	-
Koryo Maru 11	Heinecken, South Africa	S-2	1–3/97	-	-	-	-
Zambezi	Stoffberg, South Africa	A	3–5/97	0	0	Y	-
Zambezi	Anderson, South Africa	A	7–8/97	0	0	Y	Y

[1] South Africa – see SC-CAMLR-XVI, paragraph 3.8

Type A = Autoliner; S-1 = Spanish single line; S-2 = Spanish double line

Date Months only

Mammals K = killed; E = entangled; O = observations of frequency of occurrence of marine mammals (Y = yes; N = no); F = fish loss observed (species, number estimated) or: Y = yes; N = no; - = no information)

Table 38: Data on seabird incidental mortality from scientific observer reports from longline vessels fishing in Subarea 48.3.

Vessels	Observer	Type	Date	Sets			Hooks			Bait	Streamer			Offal		Seabirds Killed				Birds	Birds	Birds
				[No]	D	N	[Set]	[Bait]	[Obs]		Type	Time	Success	When	Where	Alb	GP	Pet	Total	at Set	Ent.	Band
Cisne Verde	Ashford UK	S-2	3–5/97	61			654.4	100	20	T	C	DN	H	H	S	2	0	9	12	Y	Y(24)	
Elqui	Raggio Argentina	S-2	5–7/97	(51)	0	100	(695)	100	(96)	(T)	-	No	-	S,H	S	0	0	0	0	N	Y(7)	Y(2)
Elqui	Almeyda Argentina	S-2	7–8/97	40	-	-	457	100	71	(T)	N	3%	-	S,H	S	0	0	0	0	Y		
Ercilla	Treves Argentina	S-2	4–5/97	44	10	90	512	100	60	(T)	C	D	-	-	-	34	3	0	38	Y	Y	
Ercilla	Treves Argentina	S-2	6–7/97	36	4	96	335	100	45	(T)	C	D	H	-	-	0	0	0	0	Y	Y	
Ercilla	Marchetti Argentina	S-2	8/97	50	20	80	244	100	62	(T)	-	No	-	-	-	0	0	0	0	Y	Y(8)	
Ibsa Quinto	Alvarado Chile	S-2	4–8/97	(167)	10	(90)	1184	(100)	60	-	C	N	-	-	O	33	8	0	41	Y	Y(1)	Y(1)
Isla Camila	Sinconegui Argentina	S-2	3–4/97	45	-	-	365	100	18	(T)	N	-	-	H	S	2	0	51	53	N		
Isla Camila	Sinconegui Argentina	S-2	4–6/97	44	-	-	489	100	18	(T)	N	-	-	-	-	4	0	6	10	N	Y(10)	
Isla Camila	Giangualano Argentina	S-2	7–8/97	53	-	-	460	100	9	(T)	-	No	-	H	S	0	0	0	0	Y		
Isla Isabel	Giangualano Argentina	S-2	3–4/97	35	3	97	275	100	10	T	C	N	-	H	S	126	6	148	280	Y	Y(23)	Y(3)
Isla Isabel	Brachetta Argentina	S-2	4–6/97	51	0	100	527	100	53	(T)	C	N	H	(H)	O	4	-	-	-	Y		
Isla Isabel	Caballero Argentina	S-2	6–8/97	45	0	100	431	100	45	T	C	N	H	(H)	O	0	0	0	0	Y		
Koryo Maru 11	Keith, Sth Africa	S-2	4–7/97	92			854.0	99 (845.5)	(100)	-	C	-	-	H	S	1	0	8	9	-	Y(9)	

[ ] = data entered by Secretariat
( ) = estimated data

Type	A = Autoliner; S-1 = Spanish single line; S-2 = Spanish double line
Date	Months only
Sets	D = daylight %; N = night %
Hooks	Set = thousands of hooks Bait = % baited Obs = % observed; values in parenthesis inferred
Bait	T = thawed; (T) = inferred thawed
Streamer	Type: C = CCAMLR design; ±C = similar to CCAMLR design; N = non-CCAMLR design; No = not used
	Time = proportion (%) of sets for which streamer line used, or whether streamer line used at night (N), day (D), day and moonlit nights (D+).
	Success: Observer opinion of success of using streamer line: H = high; M = medium; L = low
Offal	When: H = haul; S = set Where: O = opposite side to haul; S = same side as haul
Seabirds killed	Alb = albatrosses; GP = giant petrels; Pet = petrels (note that Other and Unidentified are not totalled separately)
Catch rate	Birds per thousand hooks
Birds band	Banded birds recovered and details recorded (Y = yes, number in parenthesis)
Birds at set	Data recorded on abundance of seabirds around the vessel during the set (Y = yes; N = no)
Birds ent.	Data on species and/or number of birds entangled during hauling (Y = yes, number in parenthesis; N = no)
-	No information

Table 39: Data on seabird incidental mortality from scientific observer reports from longline vessels fishing in Subareas 58.6 and 58.7.

Vessel	Observer	Type	Date	Sets				Hooks			Bait	Streamer			Offal		Seabirds Killed				Catch Rate		Birds	Birds	Birds
				No.	D	T	N	Set	Bait	Obs		Type	Time	Value	When	Where	Alb	GP	Pet	Total	All	Baited	at Set	Ent.	Band
American Champion	Koen, Sth Africa	A	8–9/96	263				845.2	-	-	-	-	-	-	-	-	0	0	0	0	0	-	Y	Y(1)	
Anyo Maru 22	-	S-1	12/96–4/97	219			100	865.3		(100)	-	C	DN	-	H	O	1	0	26	27	0.031	-	-	Y(1)	-
Aquatic Pioneer	Purves, Sth Africa	A	11–12/96	101	78*		22*	288.7	82.5 (238.2)	(100)	-	±C	most	M	-	-	25	4	108	138	0.478	0.579	N	Y	Y(1)
Aquatic Pioneer	Purves, Sth Africa	A	1–2/97	82	33*		67*	287.0	82.5 (236.8)	(100)	-	±C	D,N	M	H	-	3	8	403	415	1.446	1.753	N	Y	
Aquatic Pioneer	Wanless, Sth Africa	A	4–6/97	109	15 20*		85 80*	389.1	82.5 (321.0)	(100)	T	±C	23%	-	S,H	-	5	0	0	5	0.012	0.016	N	-	
Aquatic Pioneer	Williams, Sth Africa	A	7-8/97	54	17	13	70	207.5	60 (124.5)	47	-	±C	D	M	H	O	0	1	0	1	0.010	0.016	Y	N	
Garoya	Boix, ~~Spain~~[1]	S-1	4/97	62	50*		50*	251.6	67.5 (169.8)	(100)	T	C	part	M	H	O	67	10	4	82	0.326	0.483	Y	N	
Koryo Maru 11	Heinecken, Sth Africa	S-2	11/96–1/97	48	64 47*		36 53*	248.2	100	(100)	T	C	DN	H	H	O	15	7	22	44	0.177	0.177	N	N	
Koryo Maru 11	Heinecken, Sth Africa	S-2	1–3/97	51	72 94*	8	20 6*	297.8	(100)	(100)	T	C	DN	--	H	O,S	50	0	83	133	0.447	0.447	Y	Y(18)	
Sudur-havid	Enticott, Sth Africa	S-1	5–6/97	66	41*		59*	247.1	100	(100)	T	±C	D+	-	H	S	0	4	0	5	0.020	0.020	N	N	
Sudur-havid	Heinecken, Sth Africa	S-1	7/97	20	-		-	74.0	100	(100)	T	±C	D+	-	H	S	0	1	0	1	0.014	0.014	N	N	
Zambezi	Stoffberg, Sth Africa	A	3–5/97	190	48*		52*	699.0	85 (594.1)	(100)	-	N	part	-	H	O	38	2	15	55	0.079	0.093	N	Y(1+)	
Zambezi	Anderson, Sth Africa	A	7–8/97	80	1		99	356.0	73 (259.9)	(100)	-	C	49%	-	-	-	0	0	0	0	0	0	N	N	

[1] South Africa – see SC-CAMLR-XVI, paragraph 3.8

Type	A = Autoliner; S-1 = Spanish single line; S-2 = Spanish double line
Date	Months only
Sets	D = daylight %; T = twilight (dawn, dusk) %; N = night %; * = % of hooks set (as opposed to % of sets)
Hooks	Set = thousands of hooks Bait = % baited, with estimated number of hooks in parenthesis Obs = % observed; values in parenthesis inferred
Bait	T = thawed; (T) = inferred thawed
Streamer	Type: C = CCAMLR design; ±C = similar to CCAMLR design; N = non-CCAMLR design; No = not used
	Time = proportion (%) of sets for which streamer line used, or whether streamer line used at night (N), day (D), day and moonlit nights (D+).
	Success: Observer opinion of success of using streamer line: H = high; M = medium; L = low
Offal	When: H = haul; S = set Where: O = opposite side to haul; S = same side as haul
Seabirds killed	Alb = albatrosses; GP = giant petrels; Pet = petrels (note that Other and Unidentified are not totalled separately)
Catch rate	Birds per thousand hooks
Birds band	Banded birds recovered and details recorded (Y = yes, number in parenthesis)
Birds at set	Data recorded on abundance of seabirds around the vessel during the set (Y = yes; N = no)
Birds ent.	Data on species and/or number of birds entangled during hauling (Y = yes, number in parenthesis; N = no)
-	No information

Table 40: Summarised incidental mortality data of seabirds in longline fisheries for *D. eleginoides* in Subareas 48.3 and 88.1/88.2 during the 1996/97 season. Sp – Spanish method, Auto – Mustad autoliner, N – night-time setting, D – daytime setting (including nautical dawn and dusk), O – opposite side to hauling, S – same side as hauling, * – data obtained from observer cruise report. Shaded areas indicate extrapolated values.

Vessel	Dates of Fishing	Method	Streamer Line in Use (%)		Offal Discharge at Haul	Sets Deployed				Number of Hooks (1 000s)					Hooks Baited (%)	Number of Birds Caught			Observed Catch Rates of Dead Birds (birds/1 000 hooks)		
										Observed			Set	Percent		Dead		Total			
			N	D		N	D	Total	%N	N	D	Total	Total	Observed		N	D		N	D	Total
Subarea 88.1/88.2:																					
Lord Auckland	16–19/5/97	Auto	100	100	S	1	1	2	50	1.58	1.58	3.176	3.176	100	85	0	0		0	0	0
Subarea 48.3:																					
Argos Helena	2/3–11/8/97	Sp	0	0	S	150	15	165	91	284.0	45.4	329.4	1 392.9	23	95	128	62	190	0.45	1.37	0.58
Cisne Verde	24/3–23/5/97	Sp	66	60	S	56	5	61	92	119.6	13.3	132.9	654.4	20	100	10	2	12	0.08	0.15	0.09
Cisne Verde	22/6–29/8/97	Sp	2	0	S	93	6	99	94	417.3	29.4	446.7	951.9	46	100	0	0	0	0	0	0
Elqui	18/3–9/5/97	Sp	0	0	S	49	0	49	100	302.8	0	302.8	690	43	100	94	0	94	0.31	0	0.31
*Elqui**	20/5–21/7/97	Sp							89				695.4						0.18	0.93	0.23
Elqui	29/7–31/8/97	Sp	0	33	S	37	3	40	93	297.5	28.6	326.1	456.9	71	100	0	0	0	0	0	0
Ercilla	16/4–28/5/97	Sp	0	0	S	40	4	44	91	308.2	2.8	311.0	512.3	60	100	14	10	24	0.05	3.64	0.07
Ercilla	8/6–10/7/97	Sp	0	0	S	35	1	36	97	144.0	8.0	152.0	335.0	45	100	0	0	0	0	0	0
Ercilla	8/8–31/8/97	Sp	0	0	S	39	11	50	78	121.3	31.1	152.4	243.7	62	100	0	0	0	0	0	0
*Ibsa Quinto**	17/4–31/8/97	Sp							89			710.5	1 184.0	60		41		41	0.18	0.93	0.23
*Ihn Sung 66**	7/4–31/8/97	Auto				87	84	171	51			366.1	1 694.3	22					0.18	0.93	0.23
Isla Camila	5/3–7/4/97	Sp	98	0	S	41	4	45	91	64.0	4.5	68.5	364.7	18	100	43	6	49	0.67	1.32	0.72
Isla Camila	20/4–6/6/97	Sp	87	0	S	44	0	44	100	88.5	0	88.5	489.3	18	100	10	0	10	0.11	0	0.11
Isla Camila	4/7–18/8/97	Sp	2	0	S	53	0	53	100	44.3	0	44.3	459.8	9	100	0	0	0	0	0	0
Isla Isabel	13/3–9/4/97	Sp	67	100	S	30	5	35	86	24.6	5.0	29.6	274.6	11	100	175	101	276	7.11	20.14	9.31
Isla Isabel	23/4–10/6/97	Sp	100	100	S	50	1	51	98	276.0	6.9	282.9	527.3	53	100	4	0	4	0.01	0	0.01
Isla Isabel	24/6–10/8/97	Sp	100	100	S	44	1	45	98	194.2	2.5	196.7	431.0	45	100	0	0	0	0	0	0
Jacqueline	16/4–29/5/97	Auto	0	0	S	32	12	44	73	14.1	5.4	19.5	380.9	5	100	1	9	10	0.07	1.65	0.51
Jacqueline	5/7–31/8/97	Auto	0	0	S	69	21	90	77	31.3	10	41.3	683.0	6	100	0	6	6	0	0.60	0.15
*Koryo Maru 11**	30/3–11/8/97	Auto	100	0	S	92	0	92	100	854	0	854	854	100	99	9	0	9	0.01	0.01	0.02
*Pescarosa Primero**	2/5–11/9/97	Sp							89				277.6						0.18	0.93	0.23
Total									89			4855	13 553.0					725			

Table 41: Summarised incidental mortality data of seabirds in longline fisheries for *D. eleginoides* in Subareas 58.6 and 58.7 during the 1996/97 season. Sp – Spanish method, Auto – Mustad autoliner, N – night-time setting, D – daytime setting (including nautical dawn and dusk), O – opposite side to hauling, S – same side as hauling.

Vessel	Dates of Fishing	Method	Streamer Line in Use (%)		Offal Discharge at Haul	Sets Deployed				Number of Hooks (1 000s)					Hooks Baited (%)	Number of Birds Caught			Observed Catch Rates of Dead Birds (birds/1 000 hooks)		
										Observed			Set Total	Percent Observed		Dead		Total			
			N	D		N	D	Total	%N	N	D	Total				N	D		N	D	Total
Alida Glacial	21/10–27/12/96	Auto																			
Aliza Glacial	7/12/96–7/1/97	Auto																			
American Champion	14/8–28/9/96	Auto																			
American Champion	24/10–21/11/96	Auto																			
Aquatic Pioneer	31/10–10/12/96																				
Aquatic Pioneer	13/1–22/2/97	Auto	100	100	S	61	21	82	74	214	73	287	287	100		337	78	415	1.57	1.07	1.45
Aquatic Pioneer	26/4–11/697	Auto	9	71	S	88	21	109	81	313	75.5	388.5	388.5	100	80	0	4	4	0	0.05	0.01
Aquatic Pioneer	22/7–22/8/97	Auto	8	63	S	38	16	54	70	63.6	26.9	90.5	205.5	44	60	0	1	1	0	0.04	0.01
Garoya	5/4–10/5	Sp																			
Koryo Maru 11	10/11/96–5/1/97	Sp																			
Koryo Maru 11	17/1–22/3/97	Sp																			
Mr B	22/10–28/11/96	Auto																			
Mr B	29/1–14/2/97	Auto																			
Sudurhavid	15/5–16/6/97	Sp																			
Sudurhavid	4/7–24/7/97	Sp																			
Zambezi	19/3–16/5/97	Auto																			
Zambezi	25/6–29/9/97	Auto																			

Table 42: Summary of the species composition of birds killed in longline fisheries in Subarea 58.7 during the 1996/97 season. N – night setting, D – daylight setting (including nautical dawn and dusk), DIX – wandering albatross, DIM – black-browed albatross, DIC – grey-headed albatross, YNA – yellow-nosed albatross, PHE – light-mantled sooty albatross, ALZ – albatross unidentified, MAI – southern giant petrel, MAH – northern giant petrel, PRO – white-chinned petrel, PCI – grey petrel, PTZ – petrels unidentified, SKZ – skuas, UNK – unknown, * – data derived from scientific observer cruise reports.

Vessel	Dates of Fishing	Number of Birds Killed, by Group						Composition by Species												
		Petrels		Albatross		Total		DIX	DIM	DIC	YNA	PHE	ALZ	MAI	MAH	PRO	PCI	PTZ	SKZ	UNK
		N	D	N	D	N	D													
*American Champion**	24/10–21/11/96	1		0		1								1						
*Aquatic Pioneer**	31/10–10/12/96	112		25		137			2	15	8			3	1	108			1	
Aquatic Pioneer	13/1–22/2/97	336	75	0	3	336	78			2		1		6	2	403				1
Aquatic Pioneer	26/4–11/6/97	0	0	0	4	0	4			4										
Aquatic Pioneer	22/7–22/8/97	0	1	0	0	0	1							1						
*Garoya**	5/4–10/5/97	15		67		82		1		66				3	7	4	1			
Koryo Maru 11	10/11/96–5/1/97	29		15		44				11	4			7		22				
Koryo Maru 11	17/1–22/3/97	83		50		133							50					83		
*Sudurhavid**	15/5–16/6/97	4		0		4												4		1
*Sudurhavid**	4/7–24/7/97	1		0		1								1						
*Zambezi**	19/3–16/5/97	17		38		55			2	36				2		14	1			
Total (%)		674		202		876		1(0.1)	4(0.5)	134(15)	12(1)	1(0.1)	50(6)	24(3)	10(1)	551(63)	2(0.2)	87(10)	1(0.1)	2(0.2)

Table 43: Total seabird mortality by species for Subarea 58.7 during the 1996/97 fishing season.

Species	Total	Species	Total
Wandering albatross	1	Northern giant petrel	10
Black-browed albatross	4	White-chinned petrel	551
Grey-headed albatross	134	Grey petrel	2
Yellow-nosed albatross	12	Petrels unidentified	87
Light-mantled sooty albatross	1	Skuas	1
Albatross unidentified	50	Unidentified	2
Southern giant petrel	24		
		Total	879

Table 44: Summary of the species composition of birds killed in longline fisheries in Subarea 48.3 and adjacent areas during the 1996/97 season. N – night setting, D – daylight setting (including nautical dawn and dusk), DIX – wandering albatross, DIM – black-browed albatross, DIC – grey-headed albatross, PHE – light-mantled sooty albatross, MAI – southern giant petrel, MAH – northern giant petrel, PRO – white-chinned petrel, PTZ – petrels unidentified, UNK – unknown, * – data obtained from scientific observer cruise reports.

Vessel	Dates of Fishing	Number of Birds Killed by Group						Composition by Species								
		Petrels		Albatross		Total		DIX	DIM	DIC	PHE	MAI	MAH	PRO	PTZ	UNK
		N	D	N	D	N	D									
Argos Helena	2/3–11/8/97	114	3	14	59	128	62	2	68	3		3		114		
Cisne Verde	24/3–23/5/97	7	2	2	0	9	2		2					9		1
Elqui	18/3–9/5/97	60	0	34	0	94	0		31	1	2			60[1]		
Ercilla	16/4–25/5/97	0	3	14	7	14	10		21			3				
*Ibsa Quinto**	17/4–31/8/97	8		33		41			33					8		
Isla Camila	5/3–7/4/97	42	6	1	0	43	6		1						48	
Isla Camila	20/4–6/6/97	6	0	4	0	10	0		4					4	2	
Isla Isabel	13/3–9/4/97	120	30	55	71	175	101	1[2]	122	3			6	144		
Isla Isabel	23/4–10/6/97	0	0	4	0	4	0		3	1						
Jacqueline	16/4–29/5/97	0	0	1	9	1	9		3	7						
Jacqueline	5/7–31/8/97	0	5	0	1	0	6		1			5				
*Koryo Maru 11**	30/3–31/8/97	8	0	1	0	9	0		1					8		
Total (%)		414		310		724		3(0.4)	290(40)	15(2)	2(0.3)	11(1)	6(0.8)	347(48)	50(7)	1(0.1)

1 These birds were originally identified as sooty albatross (see paragraph 7.50)

2 This bird was originally identified as a royal albatross (see paragraph 7.50)

Table 45: Total estimated seabird mortality per vessel for Subarea 48.3 during the 1996/97 fishing season.

Vessel	Hooks Set (1 000s)	Night Sets (%)	Estimated Number of Birds Caught Dead		
			Night	Day	Total
Argos Helena	1 392.9	91.0	580.39	171.74	742.14
Cisne Verde	654.4	92.0	48.16	7.85	56.02
Cisne Verde	951.9	94.0	0	0	0
Elqui	690.0	100.0	213.9	0	213.9
Elqui	695.4	89.0	109.27	70.93	180.21
Elqui	456.9	93.0	0	0	0
Ercilla	512.3	91.0	20.98	167.83	188.81
Ercilla	335.0	97.0	0	0	0
Ercilla	243.7	78.0	0	0	0
Ibsa Quinto	1 184.0	89.0	186.05	121.12	307.17
In Sung 66	1 694.3	51.0	152.56	772.09	924.66
Isla Camila	364.7	91.0	222.36	43.33	265.68
Isla Camila	489.3	100.0	53.82	0	53.82
Isla Camila	459.8	100.0	0	0	0
Isla Isabel	274.6	86.0	1 679.07	774.26	2 453.33
Isla Isabel	527.3	98.0	5.17	0	5.17
Isla Isabel	431.0	98.0	0	0	0
Jacqueline	380.9	73.0	19.46	169.69	189.15
Jacqueline	683.0	77.0	0	94.25	94.25
Koryo Maru 11	854.0	100.0	8.54	0	8.54
Pescarosa Primero	277.6	89.0	43.62	28.4	72.02
Total	13 553.0		3 333.36	2 421.51	5 754.87

Table 46: Total estimated seabird mortality, by species, for Subarea 48.3 during the 1996/97 fishing season.

Species	Dead			Percent
	Night	Day	Total	
Wandering albatross	13.9	10.2	24.1	0.4
Black-browed albatross	1 348.2	979.4	2 327.6	40.4
Grey-headed albatross	69.7	50.7	120.4	2.1
Light-mantled sooty albatross	9.3	6.8	16.1	0.3
Southern giant petrel	51.1	37.2	88.3	1.5
Northern giant petrel	27.9	20.3	48.2	0.8
White-chinned petrel	1 576.0	1 144.9	2 720.9	47.3
Petrels unidentified	232.5	168.9	401.3	7.0
Unidentified	4.6	3.4	8.0	0.1
Total	3 333	2 422	5 755	100

Table 47: Total number of seabirds caught alive in Subarea 48.3 during the 1996/97 fishing season. N – night-time setting, D – daytime setting (including nautical dawn and dusk), * – data obtained from observer cruise reports.

<table>
<tr><th rowspan="2">Vessel</th><th colspan="3">Number of Birds Caught Alive</th></tr>
<tr><th>N</th><th>D</th><th>Total</th></tr>
<tr><td>Argos Helena</td><td>80</td><td>9</td><td>89</td></tr>
<tr><td>Cisne Verde</td><td>18</td><td>6</td><td>24</td></tr>
<tr><td>Cisne Verde</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Elqui</td><td>121</td><td>0</td><td>121</td></tr>
<tr><td>Elqui</td><td>6</td><td>0</td><td>6</td></tr>
<tr><td>Elqui*</td><td colspan="2">7</td><td>7</td></tr>
<tr><td>Ercilla</td><td>40</td><td>0</td><td>40</td></tr>
<tr><td>Ercilla</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td>Ercilla</td><td>8</td><td>0</td><td>8</td></tr>
<tr><td>Ibsa Quinto*</td><td colspan="2">0</td><td>0</td></tr>
<tr><td>In Sung 66*</td><td></td><td></td><td></td></tr>
<tr><td>Isla Camila</td><td>2</td><td>2</td><td>4</td></tr>
<tr><td>Isla Camila</td><td>9</td><td>0</td><td>9</td></tr>
<tr><td>Isla Camila</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Isla Isabel</td><td>23</td><td>0</td><td>23</td></tr>
<tr><td>Isla Isabel</td><td>10</td><td>0</td><td>10</td></tr>
<tr><td>Isla Isabel</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Jacqueline</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td>Jacqueline</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Koryo Maru 11*</td><td>9</td><td>0</td><td>9</td></tr>
<tr><td>Pescarosa Primero*</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td></td><td>360</td></tr>
</table>

Table 48: Seabird mortality catch rates for Subarea 48.3 during the 1996/97 fishing season.

Season	Seabird Catch Rates (birds/1 000 hooks)		
	Night	Day	Total
March – April	0.66	4.85	0.87
May – August	0.003	0.084	0.0083

Table 49: Estimate of seabird by-catch in the unregulated *Dissostichus* fishery in Subareas 58.6 and 58.7 in 1996/97.

Data Source for *Dissostichus* Catch Rate	Unregulated Catch (tonnes)		*Dissostichus* Catch Rate (kg/1 000 hooks)		Unregulated Effort (1 000 hooks)		Seabird By-catch Rate (birds/1 000 hooks)				Estimated Total Unregulated Seabird By-catch			
	Summer*	Winter*	Summer	Winter	Summer	Winter	Summer		Winter		Summer		Winter	
							Mean	Max	Mean	Max	Mean	Max	Mean	Max
GLM	28120.4	2679.6	380.8	-	73845.6	-	0.363	1.446	-	-	26806	106780	-	-
SC-CAMLR-XVI/BG/28	28120.4	2679.6	615.7	330	45672.2	8120.0	0.363	1.446	0.009	0.02	16572	66042	73	162

* Annex D, Table D.3 estimates total catch at 30 800 tonnes. It has been divided into summer and winter according to the table in SC-CAMLR-XVI/BG/28.

Table 50: Summary of observed seabird by-catch and by-catch rates for Real Time Monitoring Program observer cruise in 1995 for which seabird by-catch data are currently available. Identification of seabirds as albatrosses or petrels was made by the observers at the time of recovery.

Vessel	Cruise	Area of Operation	No. of Sets	Start Date	Finish Date	Pole Length (m)	Line Length (m)	Streamers	No. of Seabirds	No. of Albatross	No. of Petrels	Unknown	Obs. Hooks (1 000s)	Seabirds per 1 000 Hooks
1	1	S Atlantic	24	15/6/95	20/7/95	3.5	110	bait straps	16	10	5	0	43.6	0.37
	2 (total)	SE Indian	42	23/7/95	22/9/95				27	27	0	0	88.8	0.30
	2 (first 8 sets)					4	100	none	21	21	0	0	13.8	1.52
	2 (last 34 sets)					10	150	bait straps	6	6	0	0	75.0	0.08
	3	SE Indian	20	22/9/95	18/10/95	8.5	144	3–4 m	0	0	0	0	50.3	0.00
2	1	Sth Africa	28	16/6/95	24/7/95				14	8	2	4	77.9	0.18
3	1	SE Indian	69	21/8/95	16/10/95	8.9	48–70	6–10 m	45	42	0	3	114.8	0.39
4	1	Sth Africa	37	15/5/95	22/6/95				24	19	4	1	100.9	0.24
5	1	Tasman Sea	31	15/5/95	20/6/95				1	1	0	0	65.8	0.02
6	1	Tasman Sea	32	15/5/95	16/6/95				1	1	0	0	95.9	0.01
7	1	Sth Africa	42	13/5/95	24/6/95				106	89	17	0	101.4	1.05
8	1	Sth Africa	67	7/5/95	20/7/95				20	11	9	0	137.2	0.15

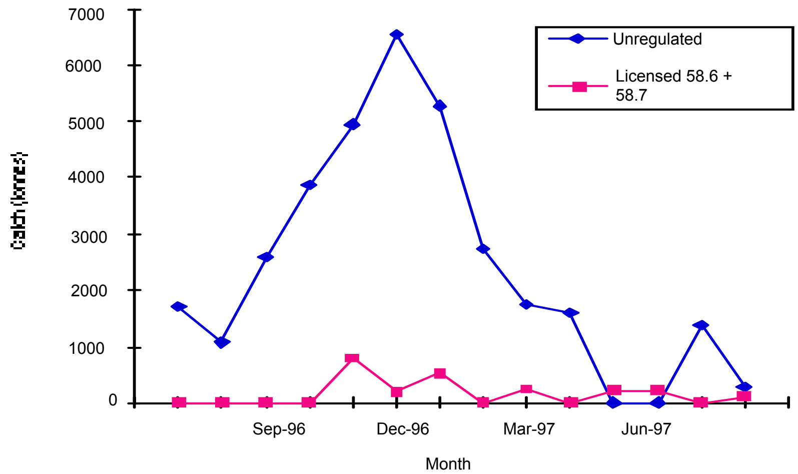


Figure 1: Catches estimated from landings in southern African ports from the unregulated fishery and catches from the licensed fishery in the South African EEZ in Subareas 58.6 and 58.7 by month from July 1996 to August 1997.

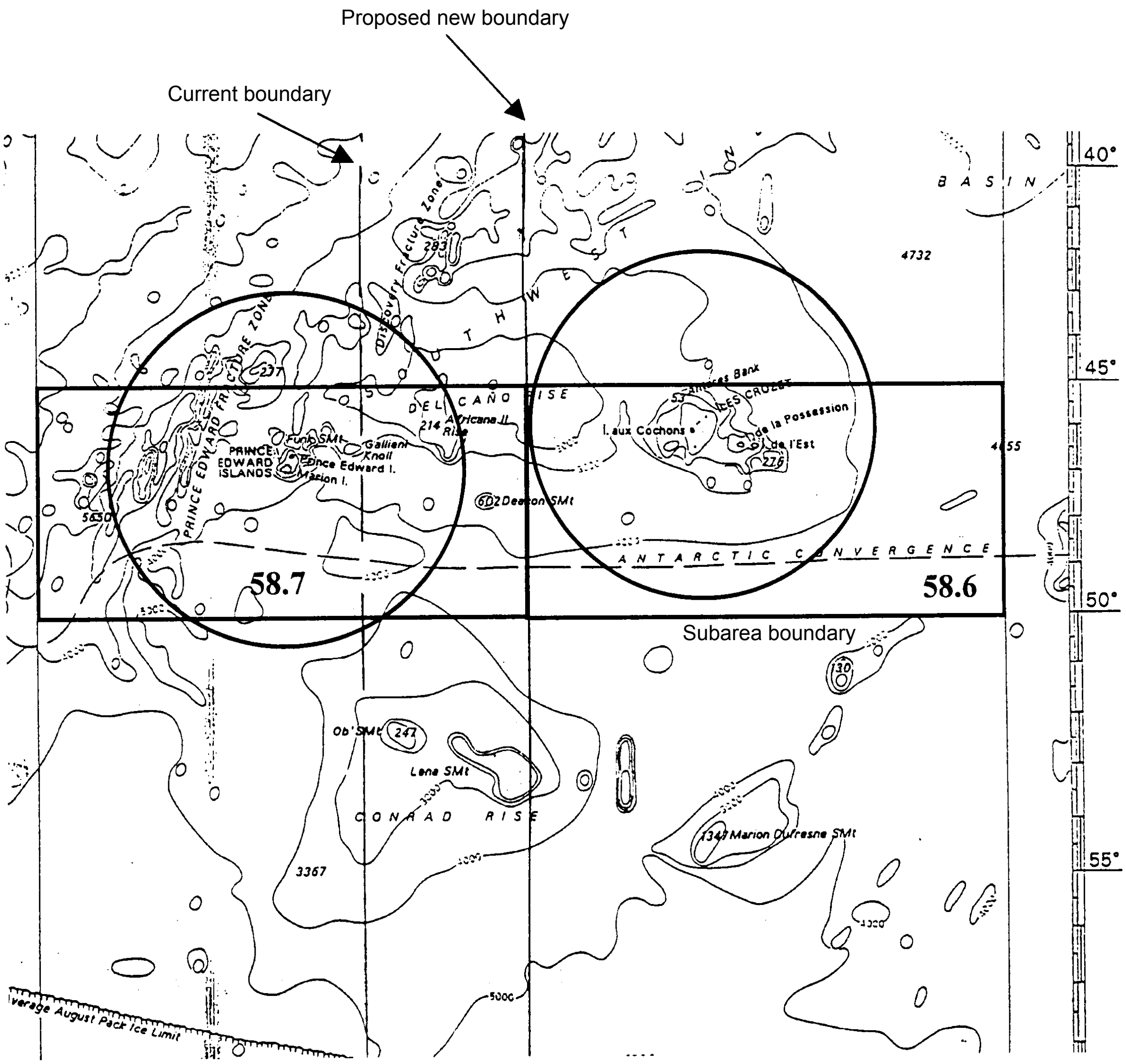


Figure 2:   Proposed change of boundary between Subareas 58.6 and 58.7.

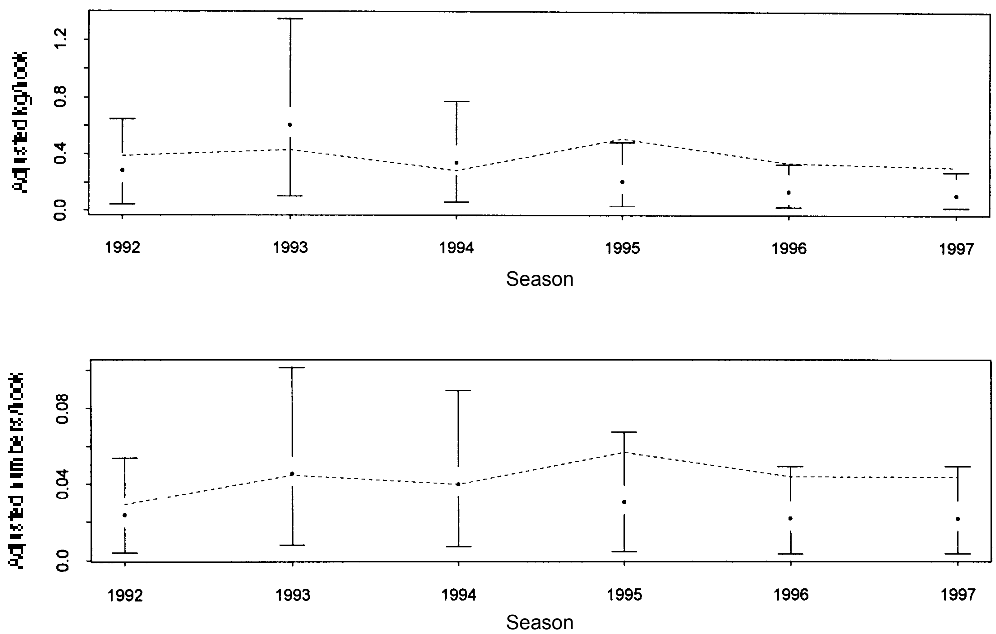


Figure 3: Time series of predicted fishing season effects on kilogram and numbers per hook of *D. eleginoides* from Subarea 48.3. The dashed lines are unstandardised catch rates; the whisker plots are standardised catch rates. All catch rates are adjusted for the presence of zero catches.

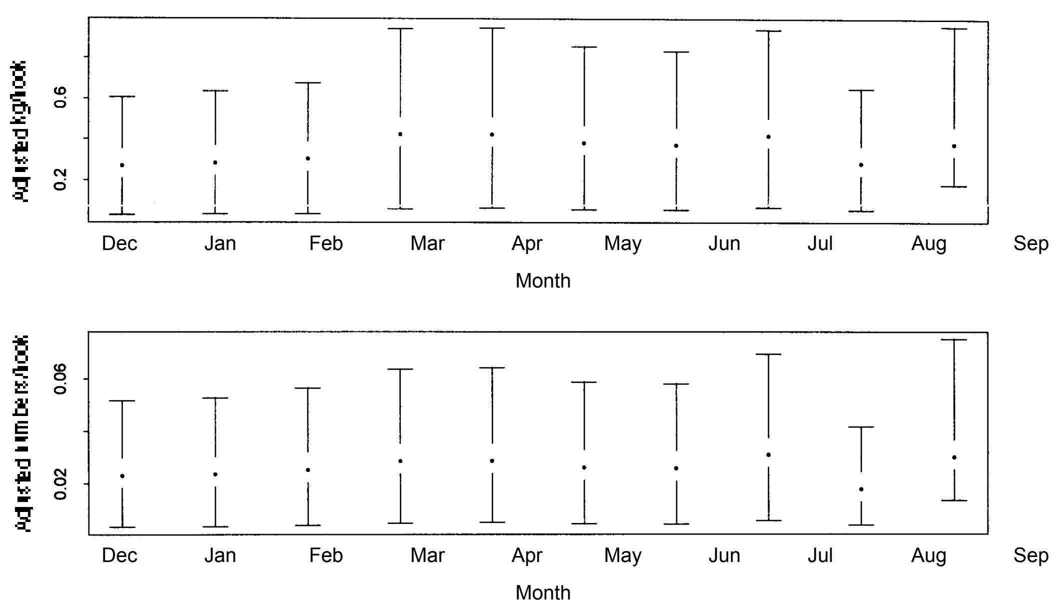
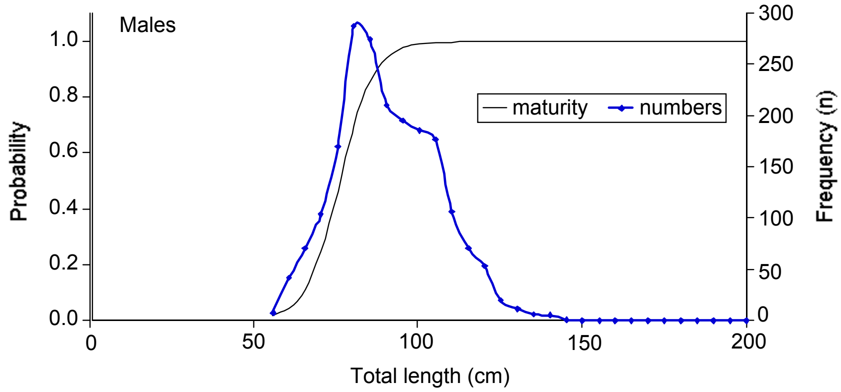


Figure 4: Predicted month effects on kilogram and numbers per hook of *D. eleginoides* in Subarea 48.3. The plots are standardised to the 1992 fishing season. Standardised catch rates for other fishing seasons would show the same monthly trends but would be scaled differently.



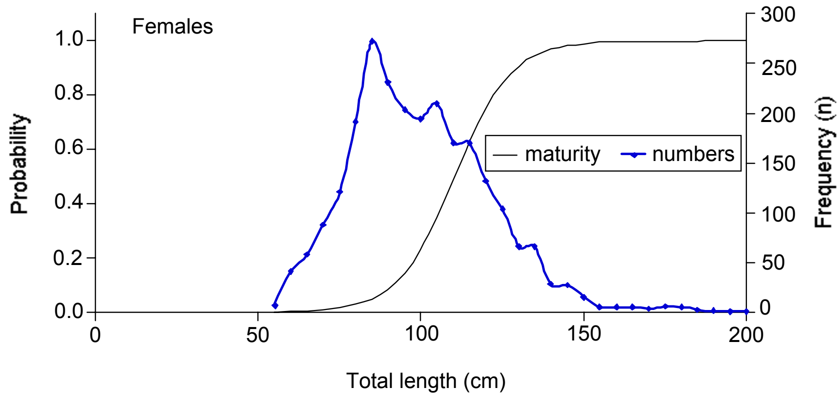


Figure 5: Size composition of the *D. eleginoides* catches in Subarea 48.3 during 1997 and the maturity ogive for males and females from August, the peak month of reproduction.

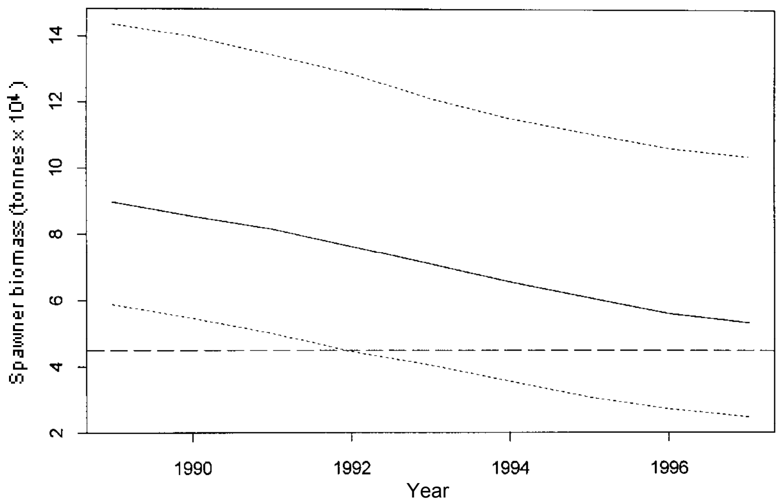


Figure 6: Annual trend in median spawning stock biomass predicted by the GYM. The dashed horizontal line drawn across the graph at approximately 4.5 x 10^4 tonnes is the level of spawning stock biomass that is equal to one half of the median unexploited spawning stock biomass.

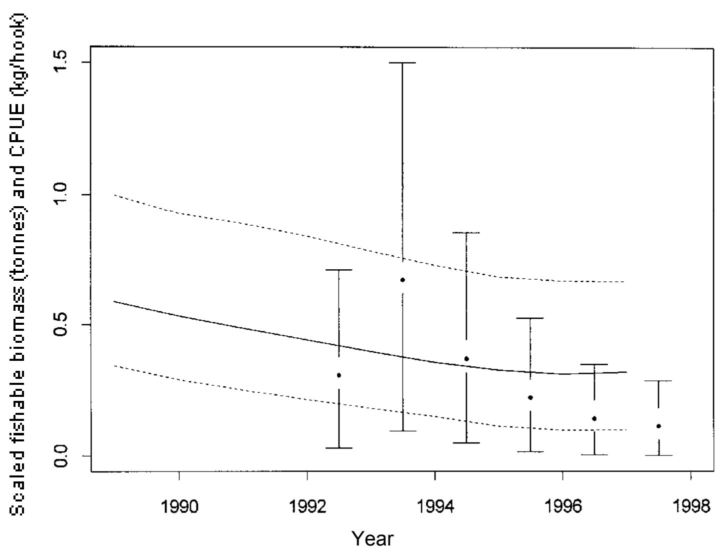


Figure 7: Predicted annual trends in median fishable biomass (solid line with 95% confidence bounds plotted as dashed lines) and standardised kg/hook (whisker plots) of *D. eleginoides* in Subarea 48.3. The two time series are scaled so that the areas under curves defined by median fishable biomass and expected standardised CPUE (solid dots) are appoximately equal. Median fishable biomasses are plotted on March 1 of each year, and standardised catch rates are plotted on September 30 of each year.

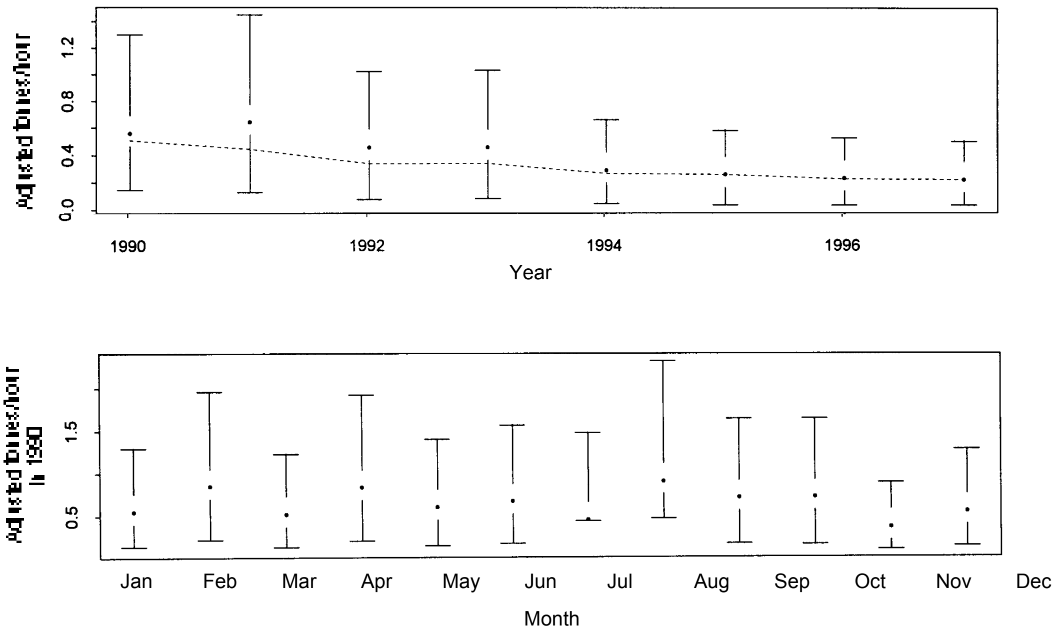


Figure 8: Predicted year (upper panel) and month (lower panel) effects on kg/hour of *D. eleginoides* from Division 58.5.1. The dashed line is the trend of unstandardised catch rates; the whisker plots are standardised catch rates. All catch rates in the upper panel are adjusted for the presence of zero catches.

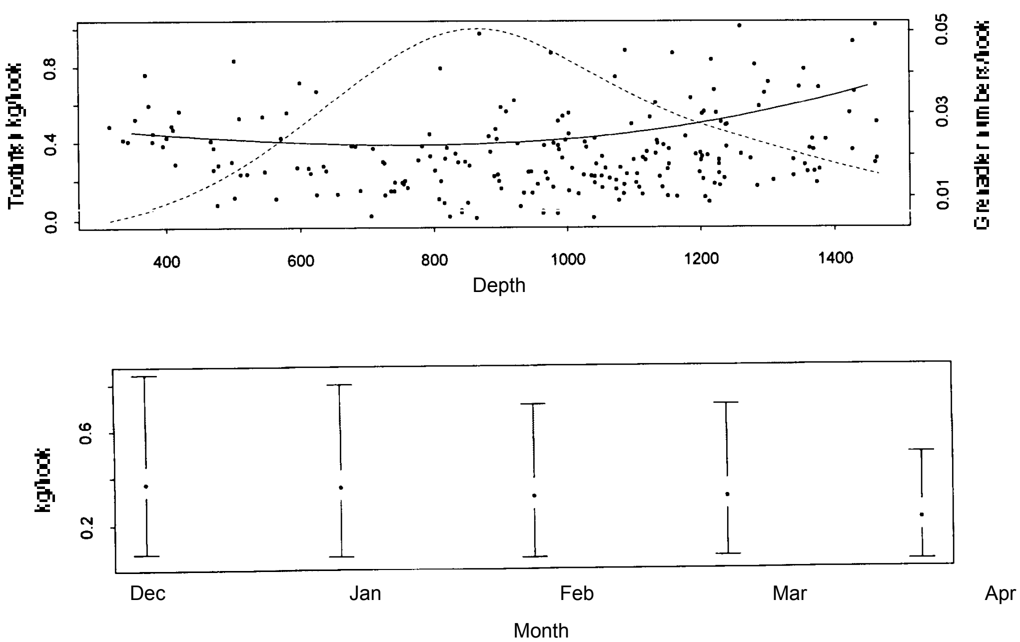


Figure 9: Depth (upper panel) and month (lower panel) effects on kg/hook of *D. eleginoides* from Subarea 58.6 (Crozet Island). In the upper panel, the data points are observed catch rates of *D. eleginoides* (kg/hook); the solid line is the predicted CPUE of *D. eleginoides* from the GAM described in Table 34; and the dashed line is the predicted CPUE of grenadiers (numbers/hook) from the GAM described in paragraphs 4.291 and 4.292.

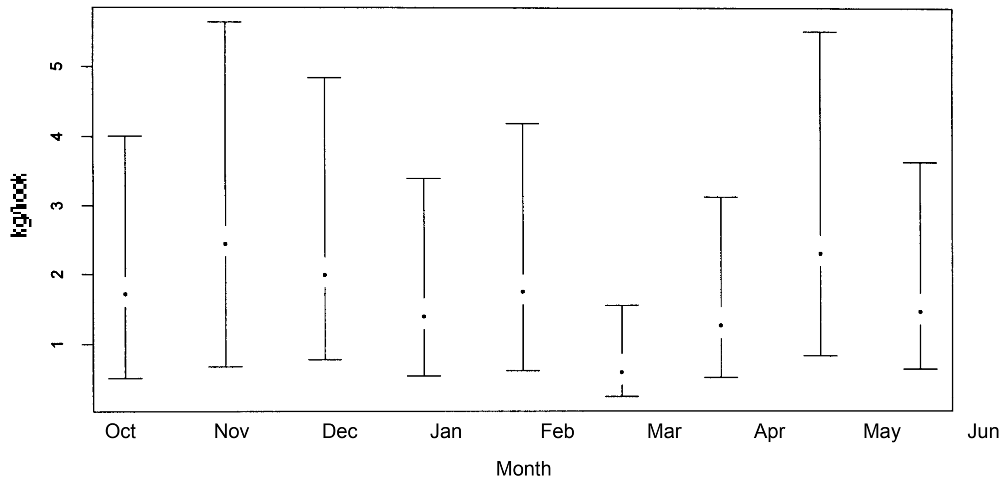


Figure 10: Effect of month on standardised CPUE of *D. eleginoides* from Subarea 58.7 (Prince Edward Islands).

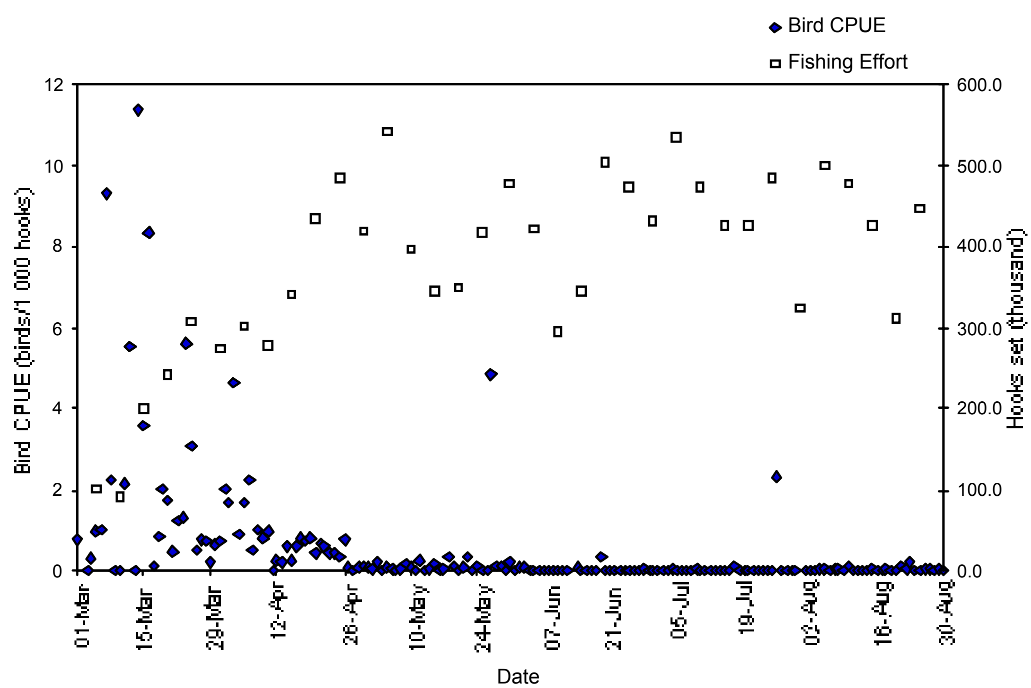


Figure 11: Daily catch-per-unit-effort values for seabird by-catch and fishing effort (hooks set) for Subarea 48.3 during the 1996/97 fishing season.

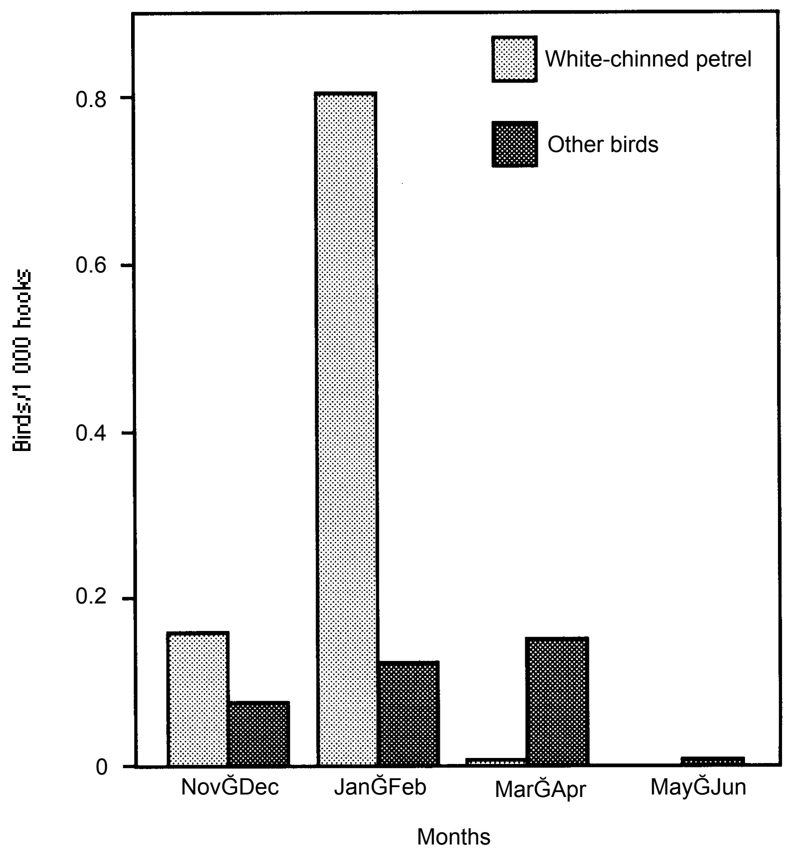
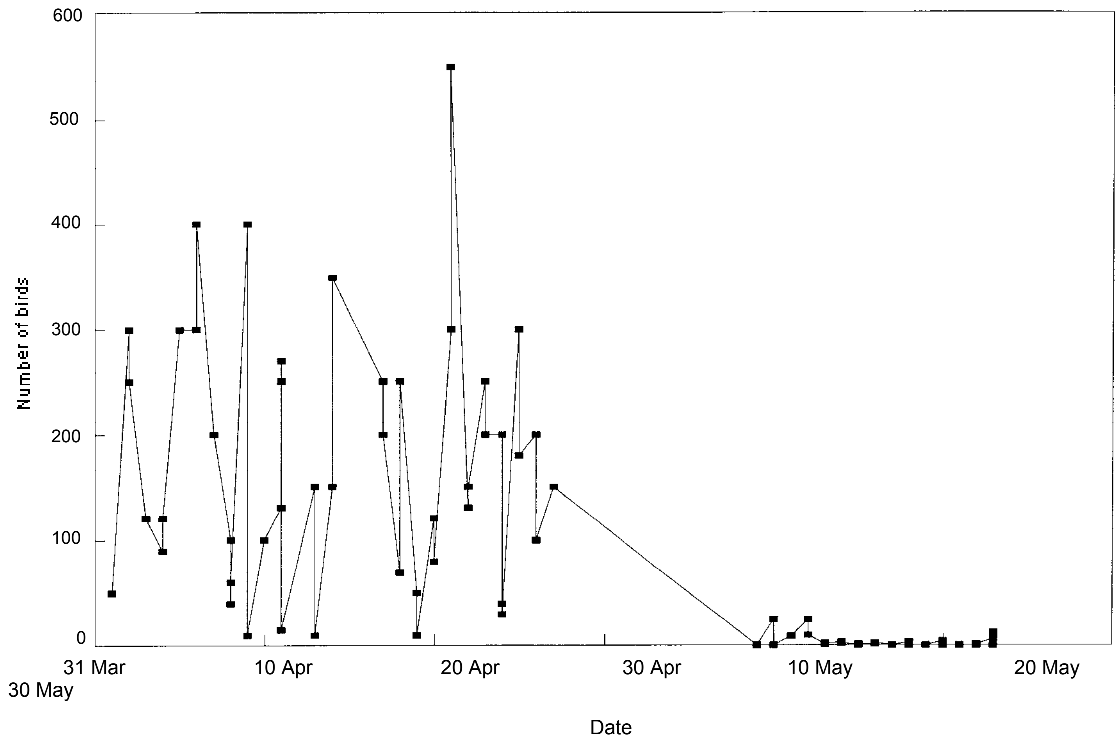


Figure 12: Seasonal differences in seabird by-catch mortality in the longline fishery for *D. eleginoides* at the Prince Edward Islands, from October 1996 to June 1997. Almost all 'other birds' are grey-headed albatrosses, yellow-nosed albatrosses and giant petrels (from WG-FSA-97/51).

(a)



(b)

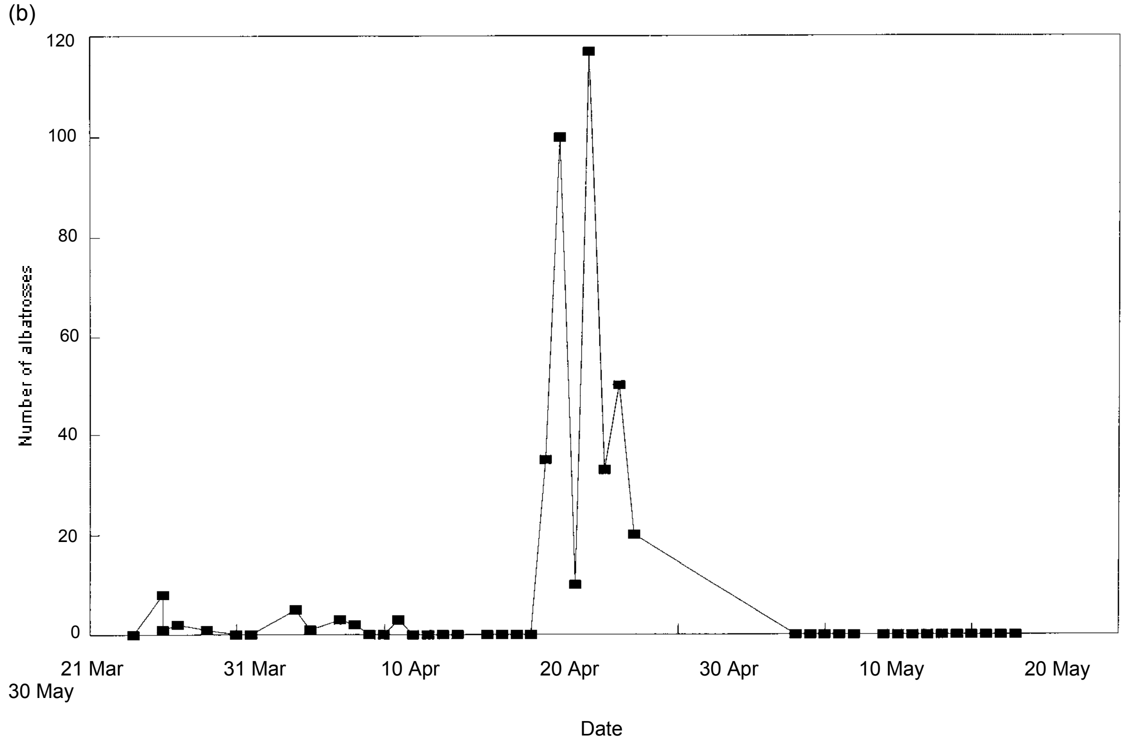


Figure 13: Daily abundance of seabirds in relation to date: (a) black-browed albatross at night; (b) all albatrosses during longline setting (from WG-FSA-97/9).

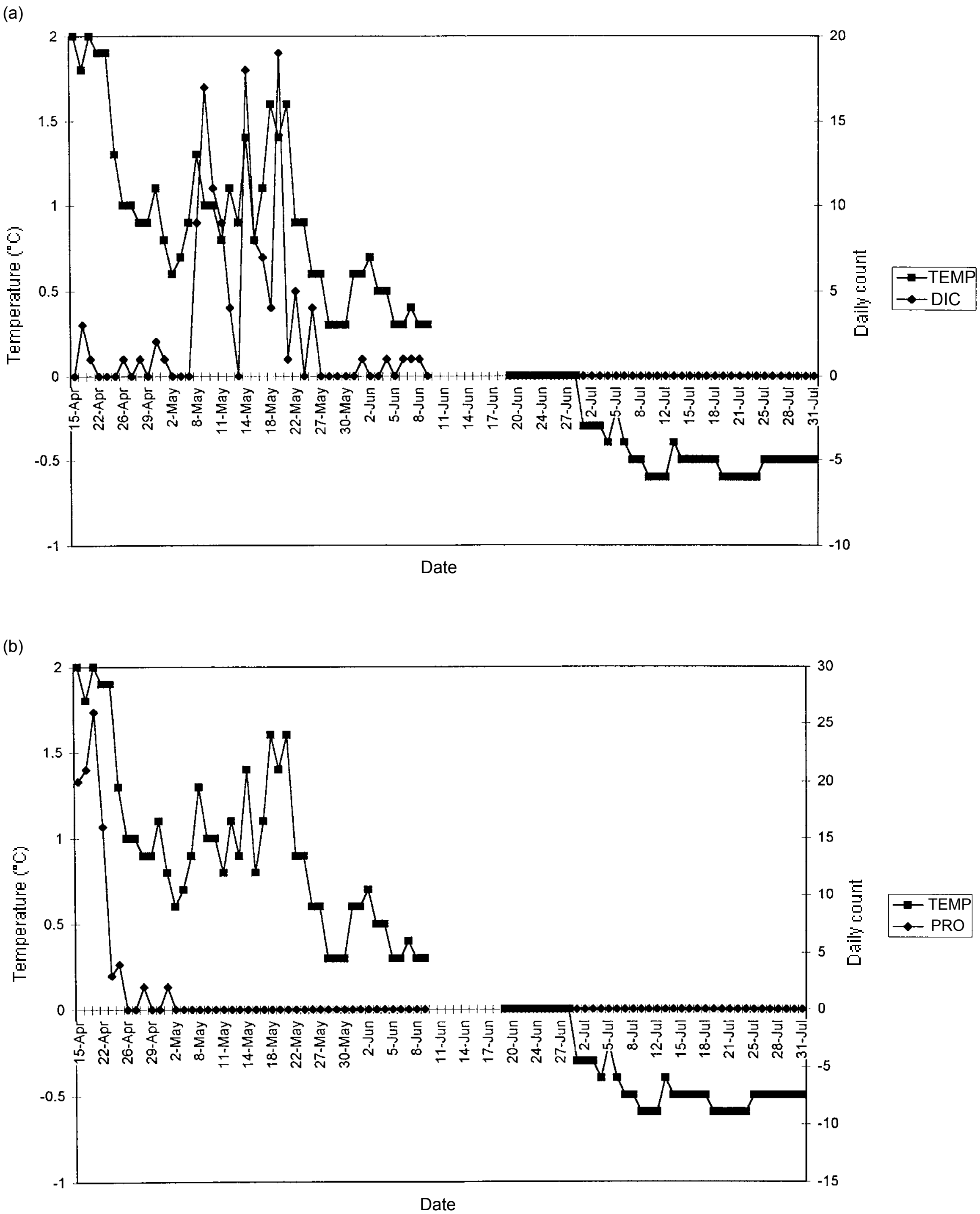


Figure 14: Daily abundance of seabirds in relation to date and sea-surface temperature: (a) grey-headed albatross (DIC); (b) white-chinned petrel (PRO) from Keith, D., scientific observer report, *Koryo Maru No. 11*, April to July 1997.

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1997)

1. Opening of the Meeting

2. Organisation of the Meeting and Adoption of the Agenda

3. Review of Available Information

    3.1 Data Requirements Endorsed by the Commission in 1996
        (a) Inventory and User's Guide to the CCAMLR Database
        (b) Database Data Entry and Validation
        (c) Other

    3.2 Fisheries Information
        (a) Catch, Effort, Length and Age Data
        (b) Scientific Observer Information
        (c) Research Surveys
        (d) Mesh/Hook Selectivity and Related Experiments Affecting Catchability

    3.3 Fish and Squid Biology/Demography/Ecology

    3.4 Review of Biological Reference Points for Decision Criteria

    3.5 Developments in Assessment Methods

    3.6 Consideration of Management Areas and Stock Boundaries

4. Assessments and Management Advice

    4.1 New and Exploratory Fisheries
    4.2 Antarctic Peninsula (Subarea 48.1)
    4.3 South Orkney Islands (Subarea 48.2)
    4.4 South Georgia (Subarea 48.3) – Finfish
    4.5 South Georgia (Subarea 48.3) – Crabs
    4.6 South Sandwich Islands (Subarea 48.4)
    4.7 Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)
    4.8 Ob and Lena Banks (Division 58.4.4)
    4.9 Kerguelen Islands (Division 58.5.1)
    4.10 Heard Island (Division 58.5.2)
    4.11 Pacific Ocean Sector (Area 88)
    4.12 General By-catch Provisions
    4.13 Resumption of Closed or Lapsed Fisheries

5. Considerations of Ecosystem Management

    5.1 Interactions with WG-EMM
    5.2 Ecological Interactions (e.g. multi-species, benthos, etc.)

6. Research Surveys

   6.1 Simulation Studies
   6.2 Recent and Proposed Surveys

7. Incidental Mortality Arising from Longline Fishing

8. Other Incidental Mortality

9. Future Work

   9.1 Data Requirements
   9.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting

10. Other Business

11. Adoption of Report

12. Close of Meeting.

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(Hobart, Australia, 13 to 22 October 1997)

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LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1997)

WG-FSA-97/1	PRELIMINARY AGENDA AND ANNOTATION TO THE PRELIMINARY AGENDA FOR THE 1997 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-97/2	LIST OF PARTICIPANTS
WG-FSA-97/3 Rev. 1	LIST OF DOCUMENTS
WG-FSA-97/4	INTERNATIONAL OBSERVER PROGRAM, CONVENTION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES J. Ashford (UK) and G. Duhamel (France)
WG-FSA-97/4 Addendum	ADDENDUM TO INTERNATIONAL OBSERVER PROGRAM, CONVENTION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES J. Ashford (UK)
WG-FSA-97/5	NATURAL MORTALITY RATE IN THE MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) AROUND SOUTH GEORGIA I. Everson (UK)
WG-FSA-97/6	REPORT ON EVALUATION OF DECREASED SIDE MORTALITY OF SEABIRDS INSIDE DIVISION 58.5.1 (KERGUELEN ISLANDS) DURING THE PERIOD OF 1996/97 FISHING CAMPAIGN A.S. Petrenko and A.M. Vertunov (Ukraine)
WG-FSA-97/7	REPORT ON OPERATION ACTIVITIES OF UKRAINIAN LONGLINERS INSIDE DIVISION 58.5.1 (KERGUELEN ISLANDS) DURING 1996/97 A.S. Petrenko and A.M. Vertunov (Ukraine)
WG-FSA-97/8	METEOROLOGICAL CONDITIONS DURING 1996/97 FISHING CAMPAIGN FOR TOOTHFISH INSIDE THE WATERS OF KERGUELEN ISLANDS A.S. Petrenko (Ukraine)
WG-FSA-97/9	AN ASSESSMENT OF SEABIRD INTERACTIONS WITH LONGLINING OPERATIONS FOR *DISSOSTICHUS ELEGINOIDES* AROUND SOUTH GEORGIA, MARCH–MAY 1997 J.R. Ashford and J.P. Croxall (UK)
WG-FSA-97/10	FISHERY FOR THE SQUID *MARTIALIA HYADESI* AT SOUTH GEORGIA CONDUCTED BY THE KOREAN REGISTERED VESSEL *IHN SUNG 101* (JUNE/JULY 1997): SCIENTIFIC OBSERVER'S REPORT S.P. Harding (UK)

WG-FSA-97/11	CORRESPONDENCE BETWEEN DRS EVERSON, VOROBYOV AND SUSHIN RELATED TO THE ACOUSTIC SURVEY CONDUCTED BY RV *ATLANTIDA* IN FEBRUARY 1996 (SC-CAMLR-XV, Annex 5, paragraph 4.131) I. Everson (UK)
WG-FSA-97/12	COMPARATIVE STUDY OF THE SIZE COMPOSITION OF CATCHES OF *D. ELEGINOIDES* TAKEN DURING THE 25TH EXPEDITION OF THE RV *AKADEMIC KNIPOVICH* IN JANUARY 1990 (SUBAREA 48.3) VNIRO (Russia)
WG-FSA-97/13	SOME OBSERVATIONS ON SEABIRD BY-CATCH FROM AUSTRALIAN LONGLINE FISHING VESSELS: 1994–1996 W. Whitelaw (Australia)
WG-FSA-97/14	RECENT INFORMATION RELATED TO SEABIRD BY-CATCH ON THE HIGH SEAS G. Tuck, A. Betlehem and T. Polacheck (Australia)
WG-FSA-97/15	JAPANESE LONGLINE SEABIRD BY-CATCH IN THE AUSTRALIAN FISHING ZONE: APRIL 1995 – MARCH 1997 N. Klaer and T. Polacheck (Australia)
WG-FSA-97/16	THE INFLUENCE OF ENVIRONMENTAL FACTORS AND MITIGATION MEASURES ON BY-CATCH RATES OF SEABIRDS BY JAPANESE LONGLINE FISHING VESSELS IN THE AUSTRALIAN REGION N. Klaer and T. Polacheck (Australia)
WG-FSA-97/17	TRENDS IN TUNA LONGLINE FISHERIES IN THE SOUTHERN OCEANS AND IMPLICATIONS FOR SEABIRD BY-CATCH: 1997 UPDATE G. Tuck and T. Polacheck (Australia)
WG-FSA-97/18	TOOTHFISHES OF THE GENUS *DISSOSTICHUS* – GEOGRAPHIC RANGE OF DISTRIBUTION V.L. Yukhov (Ukraine)
WG-FSA-97/19	SOME DATA PERTAINING TO THE DISTRIBUTION OF ANTARCTIC TOOTHFISH JUVENILES (*DISSOSTICHUS MAWSONI*) IN THE INDIAN SECTOR OF THE ANTARCTIC E.A. Roshchin (Ukraine)
WG-FSA-97/20	TO THE PROBLEM OF DISTRIBUTION OF DIFFERENT SPECIES OF TOOTHFISHES *DISSOSTICHUS* V.G. Prutko (Ukraine)
WG-FSA-97/21	INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS DURING LONGLINE FISHING AROUND THE FALKLAND/MALVINAS ISLANDS Z. Cielniaszek and J.P. Croxall (UK)
WG-FSA-97/22	BREEDING DISTRIBUTION AND POPULATION STATUS OF THE NORTHERN GIANT PETREL (*MACRONECTES HALLI*) AND THE SOUTHERN GIANT PETREL (*M. GIGANTEUS*) Submitted by SCAR

WG-FSA-97/23	BIRD COMMUNITIES – EXTRACT FROM A MANAGEMENT PLAN FOR THE PRINCE EDWARD ISLANDS, 1995 Delegation of South Africa
WG-FSA-97/24	UNDERWATER LONGLINE SETTING DEVICE AND ARTIFICIAL BAIT (from *Mustad Longlining News*, Summer 1997, Norway)
WG-FSA-97/25	COMMENTS ON THE SCIENTIFIC OBSERVERS MANUAL J. Ashford (UK-designated CCAMLR Scientific Observer)
WG-FSA-97/26	TENDENCIA DE LA MORTALIDAD INCIDENTAL DE AVES EN BUQUES DE LA FLOTA CHILENA DURANTE LA PESCA DE *DISSOSTICHUS ELEGINOIDES*, (SUBÁREA 48.3) A. Benavides, P.S. Rubilar and C.A. Moreno (Chile)
WG-FSA-97/27	CHANGES IN THE FISH BIOMASS AROUND ELEPHANT ISLAND (STATISTICAL SUBAREA 48.1) FROM 1976 TO 1996 K.-H. Kock (Germany)
WG-FSA-97/27 Addendum	CHANGES IN THE FISH BIOMASS AROUND ELEPHANT ISLAND (STATISTICAL SUBAREA 48.1) FROM 1976 TO 1996 K.-H. Kock (Germany)
WG-FSA-97/28	ALBATROSS POPULATIONS: STATUS AND THREATS R. Gales (Australia)
WG-FSA-97/29	AN ASSESSMENT OF THE MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) OFF HEARD ISLAND W.K. de la Mare, R. Williams and A. Constable (Australia)
WG-FSA-97/30	ASSESSMENTS OF BY-CATCH IN TRAWL FISHERIES AT HEARD AND MACDONALD ISLANDS A. Constable, R. Williams and W.K. de la Mare (Australia)
WG-FSA-97/30 Addendum	ASSESSMENTS OF BY-CATCH IN TRAWL FISHERIES AT HEARD AND MACDONALD ISLANDS A. Constable, R. Williams and W.K. de la Mare (Australia)
WG-FSA-97/31	A PROPOSED RESEARCH PLAN FOR AN EXPLORATORY FISHERY FOR *DISSOSTICHUS* SPP. IN DIVISION 58.4.3 R. Williams (Australia)
WG-FSA-97/32	DATASET USER GUIDE: FISHERIES C2 LONGLINE (DRAFT) Secretariat
WG-FSA-97/33	RESOURCES AVAILABLE TO WG-FSA-97 Secretariat
WG-FSA-97/34	SCIENTIFIC OBSERVATIONS OF TRAWL AND SQUID JIGGING OPERATIONS DURING 1997 Secretariat
WG-FSA-97/35	OVERVIEW OF BIOLOGICAL REFERENCE POINTS AND THEIR USE IN FISHERIES MANAGEMENT Secretariat

WG-FSA-97/36 Rev. 3	IMALF DATA ANALYSIS IN 1997 Secretariat
WG-FSA-97/37	CATCH AND EFFORT DATA FOR THE LONGLINE FISHERY IN SUBAREA 48.3 – COMPARISON OF DATA REPORTED TO CCAMLR AND DATA ACQUIRED BY THE UK BETWEEN 1994 AND 1996 D.J. Agnew, J. Pearce and G.B. Parkes (UK)
WG-FSA-97/38	MANAGEMENT OF *C. GUNNARI* IN SUBAREA 48.3 D.J. Agnew, I. Everson, G.P. Kirkwood and G.B. Parkes (UK)
WG-FSA-97/39	PRELIMINARY REPORTS OF UK FISH SURVEY: SUBAREA 48.3 I. Everson (UK)
WG-FSA-97/40	DETERMINATION OF STOCK STRUCTURE AND MOVEMENT-AT-AGE IN PATAGONIAN TOOTHFISH (*DISSOSTICHUS ELEGINOIDES*) THROUGH LASER-BASED ANALYSIS OF OTOLITHS: REPORT ON PROGRESS 1996–97 J. Ashford (UK), C. Jones (USA) and I. Everson (UK)
WG-FSA-97/41	AN ASSESSMENT OF LONGLINING OPERATIONS FOR *DISSOSTICHUS ELEGINOIDES* ON BOARD THE CHILEAN-REGISTERED LONGLINER BF *CISNE VERDE* DURING MARCH–MAY 1997 AROUND SOUTH GEORGIA (SUBAREA 48.3) J.R. Ashford and I. Everson (UK)
WG-FSA-97/42	FICHA TECNICA DEL BACALAO DE PROFUNDIDAD *DISSOSTICHUS ELEGINOIDES*, SMITT 1898 C.A. Moreno, P.S. Rubilar and A. Zuleta (Chile)
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WG-FSA-97/47 Addendum	RESULTS OF *E.L. HOLMBERG* 1997 FISH SURVEY IN SUBAREA 48.3 E.R. Marschoff, B. Gonzalez, J. Calcagno and B. Prenski (Argentina)

WG-FSA-97/48	ANALYSIS OF THE DIET OF *CHAMPSOCEPHALUS GUNNARI* IN SUBAREA 48.3, IN LATE SUMMER OF YEARS 1994–97, *DR E. HOLMBERG* SURVEYS E. Barrera Oro, R. Casaux and E. Marschoff (Argentina)
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WG-FSA-97/50	REDEFINING THE BOUNDARY BETWEEN CCAMLR STATISTICAL SUBAREAS 58.6 AND 58.7 Delegation of South Africa
WG-FSA-97/51	SEABIRD MORTALITY IN THE LONGLINE FISHERY FOR PATAGONIAN TOOTHFISH AT THE PRINCE EDWARD ISLANDS: 1996–1997 P.G. Ryan, C. Boix-Hinzen, J.W. Enticott, D.C. Nel, R. Wanless and M. Purves (South Africa)
WG-FSA-97/52	FORAGING MOVEMENTS OF THE SHY ALBATROSS *DIOMEDEA CAUTA* BREEDING IN AUSTRALIA; IMPLICATIONS FOR INTERACTIONS WITH LONGLINE FISHERIES N. Brothers, R. Gales, A. Hedd and G. Robertson (Australia)
WG-FSA-97/53	AN UNDERWATER SETTING METHOD FOR SURFACE LONGLINERS, TO MINIMISE THE ACCIDENTAL/INCIDENTAL CAPTURE OF SEABIRDS P. Barnes and K.A.R. Walshe (New Zealand)
WG-FSA-97/54	DEVELOPMENT OF AN UNDERWATER SETTING METHOD FOR SURFACE LONGLINERS, TO MINIMISE THE ACCIDENTAL CAPTURE OF SEABIRDS M. Smith and N. Bentley (New Zealand)
WG-FSA-97/55	THE IMPACT OF THE HAKE *MERLUCCUS* SPP. LONGLINE FISHERY OFF SOUTH AFRICA ON PROCELLARIIFORM SEABIRDS K.N. Barnes, P.G. Ryan and C. Boix-Hinzen (South Africa)
WG-FSA-97/56	RESEARCH AND CONSERVATION: A FUTURE FOR ALBATROSSES? J.P. Croxall (UK)
WG-FSA-97/57	INTERSESSIONAL WORK ON THE INCIDENTAL MORTALITY OF SEABIRDS IN LONGLINE FISHERIES IN THE 1996/97 INTERSESSIONAL PERIOD Secretariat
WG-FSA-97/58	REPORT ON MARINE DEBRIS AND ENTANGLEMENT AT PALMER STATION, ANTARCTIC PENINSULA, 1992–1997 W.R. Fraser (USA)
WG-FSA-97/59	AN ASSESSMENT OF THE CONSERVATION STATUS OF ALBATROSSES J.P. Croxall (UK) and R. Gales (Australia)

OTHER DOCUMENTS

CCAMLR-XVI/6	NOTIFICATION OF UKRAINE'S INTENTION TO INITIATE A NEW FISHERY Delegation of Ukraine
CCAMLR-XVI/7	NOTIFICATION OF SOUTH AFRICA'S INTENTION TO INITIATE A NEW FISHERY Delegation of South Africa
CCAMLR-XVI/8 Rev. 1	NOTIFICATION OF SOUTH AFRICA'S INTENTION TO INITIATE AN EXPLORATORY FISHERY Delegation of South Africa
CCAMLR-XVI/9	NOTIFICATION OF CHILE'S INTENTION TO INITIATE A NEW FISHERY Delegation of Chile
CCAMLR-XVI/10	NOTIFICATION OF NORWAY'S INTENTION TO INITIATE A NEW FISHERY Delegation of Norway
CCAMLR-XVI/12	REPORT ON THE PRACTICALITIES OF THE EXISTING CCAMLR 5% BY-CATCH RULE AND THE 10% SMALL *CHAMPSOCEPHALUS GUNNARI* RULE IN STATISTICAL DIVISION 58.5.2 AND SUGGESTIONS FOR POSSIBLE IMPROVEMENTS Delegation of Australia
CCAMLR-XVI/17	NOTIFICATION OF NEW ZEALAND'S INTENTION TO INITIATE A NEW FISHERY Delegation of New Zealand
CCAMLR-XVI/21	NOTIFICATION OF THE INTENTION OF THE UNITED KINGDOM AND THE REPUBLIC OF KOREA TO UNDERTAKE A NEW FISHERY FOR SQUID (*MARTIALIA HYADESI)* IN SUBAREA 48.3 Delegations of the United Kingdom and the Republic of Korea
CCAMLR-XVI/BG/17	IMPLEMENTATION OF CONSERVATION MEASURES IN 1996/97 Secretariat
SC-CAMLR-XVI/BG/8	REPORT FROM A SYMPOSIUM ON FISHERIES MANAGEMENT UNDER UNCERTAINTY Delegation of Norway
SC-CAMLR-XVI/BG/9	PLANS FOR A SCIENTIFIC RESEARCH CRUISE TO BE CONDUCTED BY UKRAINE IN THE 1997/98 SEASON Delegation of Ukraine
SC-CAMLR-XVI/BG/10	AN ANALYSIS OF FUTURE PROSPECTS FOR THE SQUID (*MARTIALIA HYADESI*) FISHERY IN SUBAREA 48.3 (SOUTH GEORGIA) Delegation of the United Kingdom
SC-CAMLR-XVI/BG/11 Rev. 1	INVENTORY OF CCAMLR DATABASES Secretariat
SC-CAMLR-XVI/BG/13	SECOND MEETING OF THE ECOLOGICALLY RELATED SPECIES WORKING GROUP OF CCSBT CCAMLR Observer

SC-CAMLR-XVI/BG/14	CCAMLR DATA MANAGEMENT – RESOURCES REQUIRED FOR MANAGING FISHERY, RESEARCH AND ENVIRONMENTAL DATA Secretariat
SC-CAMLR-XVI/BG/15	UNDERSTANDING CCAMLR'S APPROACH TO MANAGEMENT PART I: TEXT
SC-CAMLR-XVI/BG/15	UNDERSTANDING CCAMLR'S APPROACH TO MANAGEMENT PART II: FIGURES
SC-CAMLR-XVI/BG/16 Rev. 2	REGISTRY OF FISHERIES IN THE CCAMLR CONVENTION AREA Secretariat
SC-CAMLR-XVI/BG/17	ESTIMATES OF SEABED AREAS WITHIN SELECTED DEPTH RANGES USING THE SANDWELL/SMITH GLOBAL SEA FLOOR TOPOGRAPHY DATASET Secretariat
SC-CAMLR-XVI/BG/18	CONSIDERATION OF TABLE 16 IN WG-FSA-96 Secretariat
SC-CAMLR-XVI/BG/19	REVISION OF STATISTICAL BULLETIN VOLUME 1 (1970–1979) Secretariat
SC-CAMLR-XVI/BG/21 Rev. 1	DATA MANAGEMENT BY THE SECRETARIAT: TASKS, PROBLEMS AND ACTIONS DURING 1997 Secretariat
SC-CAMLR-XVI/BG/22 Rev. 2	BOTTOM TRAWL SURVEYS WITHIN THE CCAMLR CONVENTION AREA Secretariat
WG-EMM-97/61	ON THE ACCURACY OF THE PELLET ANALYSIS METHOD TO ESTIMATE THE FOOD INTAKE IN THE ANTARCTIC SHAG *PHALACROCORAX BRANSFIELDENSIS* R. Casaux (Argentina)

ESTIMATES OF CATCHES OF *DISSOSTICHUS ELEGINOIDES* INSIDE AND OUTSIDE THE CCAMLR AREA

The Working Group considered information from various sources in order to be able to estimate the magnitude of catches in the authorised and in the unregulated fishery on *D. eleginoides*. Information was drawn from:

(i) STATLANT 08A reports;

(ii) domestic fishery statistics provided by Members;

(iii) reports of landings in ports of southern Africa and Mauritius from June 1996 to September 1997;

(iv) reports on fishing vessels implicated as taking part in fishing in various subareas and divisions, available from Commission circulars and national authorities;

(v) known and estimated fishing capacities of these vessels; and

(vi) catch and effort data from fishing vessels taking part in authorised fishing in the same subareas and divisions.

The information was considered in two parts, the CCAMLR reporting year 1996/97 and the period from 1 July to 30 September 1997.

2. Reported catches of *D. eleginoides* and estimates of unreported catches by Member and Acceding State inside and outside the CCAMLR Convention Area are set out in Table D.1. Information on the total catch in EEZs outside the CCAMLR Convention Area were available for most countries with the exception of Uruguay (Table D.1). Estimates of unreported catches were only available for Argentina and Chile. Estimates for both countries are based on a crude estimate of the catch and effort of Chilean vessels in the Indian Ocean sector. They should therefore be treated with the necessary caution.

3. A number of vessels from other Members, such as Spain, Japan, Norway, Portugal (as a Member of the European Community), and the USA were implicated as taking part in the unauthorised fishery in the Indian Ocean sector. Among these vessels were longliners of the Norwegian 'Glacial' class which are among those with the highest fishing capacity in the Southern Ocean. The Working Group was unable to provide an estimate for the unreported catches of these Members.

Table D.1: Reported catches (in tonnes) of *D. eleginoides* by Member and Acceding State in EEZs and in the CCAMLR Convention Area, and estimates of unreported catches from the CCAMLR Convention Area in the 1996/97 split-year.

Member/ Acceding State	Outside CCAMLR Area Catch in EEZs	CCAMLR Area Reported Catch	CCAMLR Area Estimates of Unreported Catch	Estimated Total Catch All Areas
Argentina	9 395	0	19 670[5]	29 065
Chile	6 796	1 275	17 600[4]	25 671
Peru	4 000	0	0	4 000
Uruguay	?	0	0	
Republic of Korea	0	425	0	425
Spain	0	291	?[7]	291

Table D.1 (continued)

Member/ Acceding State	Outside CCAMLR Area Catch in EEZs	CCAMLR Area Reported Catch	CCAMLR Area Estimates of Unreported Catch	Estimated Total Catch All Areas
UK	1 164[6]	398	0	1 562
South Africa	0	2 386[8]	0	2 386
France	0	3 674	0	3 674
Australia	1 000[1]	837	0	1 837
New Zealand	10	<1	0	10
Ukraine	0	1 007[2]	0	1 007
Japan	0	333[3]	?[7]	333
Norway	0	0	?[7]	
Portugal (EC)	0	0	?[7]	
USA	0	0	?[7]	
All countries	22 365	10 626	37 270	70 261

1 From Macquarie Island
2 From French EEZ in Division 58.5.1
3 From joint venture in French EEZ in Subarea 58.6
4 Based on the following estimates: 18 vessels sighted of 22 vessels departing Chile, 14 vessels fishing at any time, effort: 2 104 days fishing, mean daily catch rate: 8.36 tonnes
5 Based on the same catch and effort data as [4], but pro-rated by the number of Argentinian vessels sighted
6 From Falkland/Malvinas Island
7 Vessels running the flag of the respective Member were sighted fishing in Area 58
8 From South African EEZ in Subareas 58.6 and 58.7

4. Information on landings by all countries (CCAMLR Members and non-Members) of *D. eleginoides* in ports of southern Africa (Walvis Bay, Cape Town, and possibly Mozambique) and Mauritius was available from South African authorities, commercial sources, and a Japanese seafood daily newspaper. Landings by port are shown in Table D.2. Main ports for landing in the first half of the season 1996/97 were Cape Town and Walvis Bay, while Mauritius became more and more important from April/May 1997 onwards.

Table D.2: Estimated landings (in tonnes) of *D. eleginoides* in southern African ports and Mauritius in the 1996/97 split-year and the beginning of the 1997/98 split-year.

Port	Product Weight 1996/97	Estimated Green Weight 1996/97	Product Weight July–Sept 1997	Estimated Green Weight July–Sept 1997
Walvis Bay	11 360[1]	18 403[1]	1 921[1]	3 106[1]
Cape Town	22 302[1]	36 129[1]		
Unknown	5 118[1]	8 291[1]		
Mauritius	6 900[2]	11 200[2]	9 200[2]	14 900[2]
Mauritius	9 000–12 000[3]	14 600–19 400	12 000–16 000[3]	19 400–25 900

1 Catches/landings reported to South African authorities conversion factor of product to green weight: 1.62
2 Information from Australian commercial sources. Catches mostly from Kerguelen Plateau
3 Information from Japanese Seafood Daily Newspaper, September 1997

5. Based on sightings of longliners in various subareas and divisions, their known fishing capacities in some instances, and estimates of their catch and effort, the Working Group attempted to estimate the magnitude of the unreported catch in these regions. The information on which these estimates are based is set out in Table D.3.

Table D.3: Estimated effort, mean catch rates/day and total catches by subarea/division in the unregulated fishery on *D. eleginoides* in the 1996/97 split-year.

Area/ Subarea/ Division	Estimated Start of Unregulated Fishery	No. of Vessels Sighted in Unregulated Fishery[1]	No. of Vessels Surveilling	Estimated No. of Vessels Fishing	No. of Days Fishing per Fishing Trip	Estimated Effort in Days Fishing (1)	Mean Catch Rate per Day (tonnes) (2)	Estimated Unreported Catch (1) x (2)	Estimated Total Catch by Subarea/ Division
48.3	No information but unlikely to be substantial								2 389
48.6	No information								
58.7	April/May 1996	23[2]	5	28[3]	32[4]	1 540	7.7[4,5]	11 900	14 129
58.6	April/May 1996	35	3	15 at any time	40	2 700	7-10	18 900[6]	19 233
58.5.1	Dec 1996	7	6	3	40	270	7-10	2 000	6 681
58.5.2	Feb/Mar 1997	10	2	10-15 at any time	35	825–1360	8-10 8-15	7 200 12 000	8 037[7] 12 837[7]
58.4.4	Possibly substantial unregulated fishing but no firm evidence								
58		90							

1 Double sightings in one zone not counted
2 Size of vessels ranging from 364 tonnes (39.7 m) to 1 103 tonnes (73.5 m)
3 Number of vessels actually seen fishing
4 Data from licensed operations
5 Some transhipment suspected, catch rates ranged from 2.8 to 23 tonnes/day
6 Minimum estimate based on vessels sighted and their landings
7 Based on lower and upper limit of the range of catch and effort estimates

Estimated Unreported Catches of *D. eleginoides*
in Division 58.5.2 in Split-year 1996/97

6. Estimates of total catches were required to update the current assessment for *D. eleginoides* in Division 58.5.2. Therefore, a more detailed analysis was undertaken to provide a range of catches for the Generalised Yield Model (GYM). This is set out in the following tables:

Minimum estimate:

Class	Period	Vessels	Days Fished	Catch/Day	Effort (vessel/days)	Estimated Catch (tonnes)
Autoliner	1 Apr – 30 Jun 97	5	60	10	300	3 000
Spanish style	1 Feb – 30 Jun 97	5	105	8	525	4 200
						7 200

Probable estimate:

Class	Period	Vessels	Days Fished	Catch/Day	Effort (vessel/days)	Estimated Catch (tonnes)
Autoliner	1 Apr – 31 May 97	5	42	10	210	2 100
Autoliner	1 – 30 Jun 97	5	20	15	100	1 500
Spanish style	1 Feb – 30 Jun 97	10	105	8	1 050	8 400
						12 000

Explanatory Notes

(i) Five autoliners confirmed from market information. Three of these observed in area during period. Reported catch rates in area began at 10 tonnes/day, rose to 20 tonnes/day, and recently reduced back to 10.

(ii) Five 'Spanish' style liners identified from January to June. Many more (23 named) observed in Subarea 58.6 during February 1997 and reported to be chased further east. One vessel observed in August.

(iii) Market information in Mauritius confirms four 'Glacial' vessels (four of five known Norwegian autoliners in region) landing 700 tonnes headed and gutted (HGT) fish per month, 14 'Spanish' style vessel landing 1 600 HGT tonnes per month. Landings began April/May. Total estimated landings over seven months is 16 100 tonnes HGT, or 26 100 tonnes green weight (GWT). Most catch likely from Kerguelen Plateau, and some from Crozet. Landings over split-year 6 900 HGT.

(iv) A recent Japanese seafood daily newspaper report noted:

'After an introduction of stricter regulations in South Africa a number of boats have switched to the Indian Ocean (10 Spanish vessels, 4–5 Norwegian vessels, Chilean and

Argentinian 5–10 vessels) with most boats averaging 200 tonnes of dressed product per six-week voyage. This average of 3 000–4 000 tonnes per month is predominantly discharged in Mauritius where the majority of catch is being purchased by US, HK, China, Taiwan'.

Total landings to October 1997 from this report would be 21 000 to 28 000 HGT (34 000–45 000 GWT).

(v) In total, 90 vessels in CCAMLR records present in Southern Africa/Indian Ocean region in the 1996/97 season. Twenty-four vessels identified within the French EEZ around Crozet (Subarea 58.6) January/February 1997.

Catches from Division 58.5.2 until 30 September 1997

Minimum estimate:

Class	Period	Vessels	Days Fished	Catch/Day	Effort (vessel/days)	Estimated Catch (tonnes)
Autoliner	1 Apr – 31 Sep 97	5	120	10	600	6 000
Spanish style	1 Feb – 30 Jun 97	5	105	8	525	4 200
						10 200

Note: Assumes 10 vessels fishing from April to June, five remaining until October.

Probable Estimate:

Class	Period	Vessels	Days Fished	Catch/Day	Effort vessel/days	Estimated Catch (tonnes)
Autoliner	1 Apr – 31 May 97	5	42	10	210	2 100
Autoliner	1 Jun 97 – 31 Aug 98	5	63	15	315	4 720
Autoliner	1 Sep – 1 Oct 97	5	30	10	150	1 500
Spanish style	1 Feb – 30 Jun 97	5	105	8	525	4 200
Spanish style	1 Feb – 30 Sep 97	5	147	8	735	5 880
						18 400

Note: Assumes 10 to 15 vessels fishing throughout year.

7. The estimated unreported catch by subarea/division derived from catch and effort data of sighted vessels is shown in Table D.4. In most subareas/divisions, unreported catches accounted for more than 80–90 % of the estimated total catch derived from catch and effort data. However, estimates derived from catch and effort information added up to only 38 000–42 800 tonnes (Table D.4), i.e. approximately 50% of the landings in southern African ports and Mauritius. If the landings are taken into account, unreported catches were likely to make up 90–95% of the total catch in most subareas/divisions. The Working Group was unable to reconcile these two estimates at the present stage.

Table D.4: Estimated total catch (in tonnes) by subarea/division of *D. eleginoides* in the CCAMLR Convention Area in the 1996/97 split-year.

Subarea/ Division	Estimated Total Catch	Reported Catch 1996/97	Estimated Unreported Catch from Catch/Effort Data	Unreported Catch in % of the Estimated Total Catch
48.3	2 389	2 389	probably low[1]	probably low
58.7	14 286	2 386	11 900	83.3
58.6	19 233	333	18 900	98.2
58.5.1	6 681	4 681	2 000	29.9
58.5.2	8 037–12 837	837	7 200–12 000	89.6–93.4
All subareas	48 856–53 656	10 856	38 000–42 800	77.8–79.8

[1] Two unauthorised vessels were sighted operating in the subarea

DATA COLLECTION PLANS FOR ALL EXPLORATORY FISHERIES OF *DISSOSTICHUS* SPP. AND *M. HYADESI*

In accordance with Conservation Measure 65/XII, paragraph 2(i), the Scientific Committee shall develop (and update annually as appropriate) a Data Collection Plan, which will identify the data needed and describe the actions necessary to obtain the relevant data from the exploratory fishery. The Data Collection Plan shall include (paragraph 3 of the same conservation measure), where appropriate:

(i) a description of the catch, effort, and related biological, ecological, and environmental data required to evaluate the distribution, abundance, and demography of the target species leading to an estimate of the fishery's potential yield and the date by which such data are to be reported annually to CCAMLR;

(ii) a plan for directing fishing effort during the exploratory phase to permit the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, dependent and related populations and the likelihood of adverse impacts; and

(iii) an evaluation of the time-scales involved in determining the responses of harvested, dependent and related populations to fishing activities.

Plan for Exploratory Bottom Trawl Fisheries for *D. eleginoides* in Division 58.4.3

2. Data proposed by Australia to be collected by its trawl fishery in Division 58.4.3 to fulfill requirements of the Data Collection Plan are provided in WG-FSA-97/31. These were reviewed and found to be suitable for the initial Data Collection Plan. Specifically:

(i) All vessels will comply with conditions set by CCAMLR. These include 120 mm minimum net size (Conservation Measure 2/III), no net monitor cables to be used (Conservation Measure 30/X), and five-day catch and effort reporting system (Conservation Measure 51/XII) and monthly fine-scale effort and biological data reporting system (Conservation Measure 117/XV) will be followed.

(ii) All data required by the CCAMLR *Scientific Observers Manual* for fin fisheries will be collected. These include:

(a) haul-by-haul catch and catch per effort by species;
(b) haul-by-haul length frequency of common species;
(c) sex and gonad state of common species;
(d) diet and stomach fullness;
(e) scales and/or otoliths for age determination;
(f) by-catch of fish and other organisms; and
(g) observation on occurrence and incidental mortality of seabirds and mammals in relation to fishing operations.

3. Each vessel participating in the fishery shall have at least one scientific observer, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities.

4. The likely ecological impact of the fishery on dependent and related species in Division 58.5.2 (Heard Island) has been addressed in WG-EMM-97/42. Results of this report are generally applicable to Division 58.4.3. The report identified a likely interaction between a *Dissostichus* fishery and elephant seals. The current limited information suggests that the level of escapement from the trawl fishery of *Dissostichus* in the size range taken by seals exceeds the 75% level accepted by CCAMLR for other species.

5. During the early stages of the exploratory fishery, vessels will conduct a random stratified trawl survey to assess the biomass of commercially important species. Details of the research and fishery operations plan are provided in WG-FSA-97/31.

Plan for Exploratory Longline Fisheries in all Areas
(Subareas 58.6, 58.7, 88.1, and 88.2)

6. Data proposed by South Africa to be collected by its exploratory longline fisheries in Subareas 58.6 and 58.7 to fulfill requirements of the Data Collection Plan are provided in CCAMLR-XV/18 Rev. 1. These were reviewed and found applicable for all proposed exploratory fisheries for *Dissostichus* longline fisheries in the Convention Area. Specifically:

(i) All vessels will comply with conditions set by CCAMLR. These include five-day catch and effort reporting system (Conservation Measure 51/XII) and monthly fine-scale effort and biological data reporting system (Conservation Measure 117/XV) will be followed.

(ii) All data required by the CCAMLR *Scientific Observers Manual* for fin fisheries will be collected. These include:

(a) haul-by-haul catch and catch per effort by species;
(b) haul-by-haul length frequency of common species;
(c) sex and gonad state of common species;
(d) diet and stomach fullness;
(e) scales and/or otoliths for age determination;
(f) by-catch of fish and other organisms; and
(g) observation on occurrence and incidental mortality of seabirds and mammals in relation to fishing operations.

(iii) Data specific to longline fisheries will be collected. These include:

(a) number of fish lost at surface;
(b) number of hooks set;
(c) bait type;
(d) baiting success (%);
(e) hook type;
(f) setting, soak, and hauling times;
(g) sea depth at each end of line on hauling; and
(h) bottom type.

7. Each vessel participating in the fishery shall have at least one scientific observer, including one appointed in accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities.

Plan for Exploratory Squid (*M. hyadesi*)
Fisheries in Subarea 48.3.

8. Last year, the Republic of Korea and the UK provided to the Scientific Committee, during their notification of the intention to start a new fishery for squid, specific data to be collected during the development of the proposed fishery (WG-FSA-96/21). This information was used to update data forms required by the Commission. Specifically:

(i) All vessels will comply with conditions set by CCAMLR. These include data required to complete the ten-day catch and effort reporting system, as specified by Conservation Measure 61/XII; and data required to complete the CCAMLR standard fine-scale catch and effort data form for a squid jig fishery (Form C3, version 3). This includes numbers of seabirds and marine mammals of each species caught and released or killed.

(ii) All data required by the CCAMLR *Scientific Observers Manual* for squid fisheries will be collected. These include:

(a) vessel and observer program details (Form S1);
(b) catch information (Form S2); and
(c) biological data (Form S3);

9. Each vessel participating in the fishery shall have a scientific observer on board, if possible appointed according to the CCAMLR Scheme of International Scientific Observation.

INFORMATION RELATING TO INCIDENTAL MORTALITY WHICH SHOULD BE MENTIONED IN OBSERVER REPORTS

1. Vessel awareness of CCAMLR conservation measures.

2. CCAMLR booklet (*Fish the Sea not the Sky*):
   (a) available on board; and
   (b) feedback.

3. Comments on *Scientific Observers Manual* / logbook data forms / observer duties.

4. Use of streamer line:
   (a) design (CCAMLR / other);
   (b) when used (or not) (e.g. day / night);
   (c) problems with use; and
   (d) other scaring devices/techniques used at set.

5. Offal discharge:
   (a) when (set, haul): and
   (b) scaring device/technique used at haul.

6. Seabird by-catch:
   (a) percentage of hooks observed;
   (b) birds caught at set not recovered at haul; and
   (c) other incidental mortality (e.g. birds killed by collision).

7. Observations of seabird abundance during set (yes / no).

8. Marine mammal interactions:
   (a) incidental mortality;
   (b) data on presence; and
   (c) data on fish loss.

APPENDIX G

1997 ASSESSMENT SUMMARIES

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This report

Year:	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]
Recommended TAC				-	4000	5000		
Agreed TAC	3500	3350	1300	2800	4000	5000		
Landings	3703	2990	604	6171[4]	3871[5]	3924[6]		
Survey Biomass	19315* 885+	3353* 2460+		14923*a 4831+a			2012*b 67259+b	
Surveyed by	UK		UK[a] Arg[b]					
Stock Biomass[3]		11000- 17000						
Recruitment (age...)								
Mean F (.....)[1]								

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 Estimated from cohort projections
4 Estimated by WS-MAD from various sources
5 For the period 1 March 1996 to 24 July 1996
6 For the period 1 March to 31 August 1997

* Shag Rocks
\+ South Georgia

Conservation Measures in Force: 102/XV and 117/XV

Catches: 3 924 tonnes in the 1996/97 fishing season (1 March to 31 August 1997).

Data and Assessment: Revised standardisation of CPUE using GLM model and revised prediction of median spawning stock biomass using GYM (paragraphs 4.143 to 4.162).

Fishing Mortality:

Recruitment:

State of Stock: Median spawning stock biomass predicted by GYM to be 59% of pre-exploitation median level (paragraph 4.165). Stock is therefore above, but approaching, one of the reference points used in CCAMLR decision rules.

Forecast for 1997/98: TAC derived from GYM is 3 385 tonnes. TAC may be less than this figure to allow for uncertainty resulting from sustained decline in standardised CPUEs being more rapid than median fishable biomass predicted by the GYM (paragraph 4.166).

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This report

Year:	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	7492	2722	5083	5534	4869	4683	7492	121	
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....
[1] ... weighted mean over ages (...)
[2] Over period 1982 to 1994
[3] From VPA using (..........)

Conservation Measures in Force: None. Recommendation not to exceed 1 400 tonnes in western fishing grounds (CCAMLR-XII, paragraph 4.21).

Catches: 3 676 tonnes taken by French trawlers in the northern and northeastern parts of the shelf. 1 007 tonnes taken by Ukrainian longliners in the western part of the shelf.

Data and Assessment: GLM analysis of trawl fishery 1990 to 1997. Standardised CPUE declining (paragraphs 4.249 and 4.250).

Fishing Mortality:

Recruitment:

State of Stock: Uncertain, but may be fully exploited.

Forecast for 1997/98: French authorities have set a TAC of 3 000 tonnes for the trawl fishery in the 1997/98 season. This is lower than in previous years (3 800 tonnes in the 1996 season, 3 500 tonnes in the 1997 season). Longlining TAC will not exceed 1 400 tonnes in the western sector and 600 tonnes in the eastern sector outside the area used by trawlers.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.2

Source of Information: This report

Year:	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]	Mean[2]
Recommended TAC			297	297	297	3800			
Agreed TAC					297	3800			
Landings	0	0	0	0	0	1861[4]			
Survey Biomass	3179		11880						
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 From VPA using (..........)
4 For fishing season ending 31 August 1997

Conservation Measures in Force: 109/XV – TAC 3 800 tonnes.

Catches: 1 861 tonnes caught by Australian trawlers. Estimated illegal catches 10 200 to 18 400 tonnes.

Data and Assessment: GYM re-run with lower and higher estimates of illegal catches as inputs. Revised predicted yields 3 700 to 3 720 tonnes (paragraph 4.270).

Fishing Mortality:

Recruitment:

State of Stock: First year of exploitation. Stock status satisfactory at the moment, but will be seriously affected if high levels of illegal catches continue (paragraph 4.272).

Forecast for 1997/98: TAC recommended at 3 700 tonnes.

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This report

Year:	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]
Recommended TAC	8400-61900	9200-15200	0			4520		
Agreed TAC	0	9200		1000	1300			
Landings	5	0	13	10	0			
Survey Biomass	43763[a]		16088[+a] 4870[*a] 2012[+b] 67259[*b]			122561[a] 69753[b]		
Surveyed by	UK[a]		UK[a] Arg[b]			Arg[a] UK[b]		
Stock Biomass[3]								
Recruitment (age 1)								
Mean F (.....)[1]	0							

Weights in '000 tonnes
[1] ... weighted mean over ages (...)
[2] Over period 1982 to 1992
[3] From VPA (2+)

* Shag Rocks
\+ South Georgia

Conservation Measures in Force: 19/IX and 107/XV

Catches: Only research vessel catches in 1996/97.

Data and Assessment: Survey biomass and age structure used as the basis for short-term projections.

Fishing Mortality: Nil.

Recruitment: Variable.

State of Stock: Survey results indicate recovery, but uncertainty over future long-term potential due to variable M year.

Forecast for 1997/98: Catches of 4 520 tonnes in 1997/98 and 4 140 tonnes in 1998/99 (F = 0.145) reduces spawning stock biomass to 81.6% of 1996/97 level at constant M of 0.42.

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

Source of Information: This report

Year:	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings (Kerguelen)	44	0	12	3936		<1	25852	0	
Landings (Combined)									
Survey Biomass						3890[a] 1837[b]			
Surveyed by						France			
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....
1 ... weighted mean over ages (...)
2 Over period 1982 to 1994
3 From VPA using (..........)

a Survey 1 18 318 km^2
b Survey 2 5 246 km^2

Conservation Measures in Force: CCAMLR: None. Recommendation that the fishery be closed until at least the 1997/98 season, and any fishing in that season to be preceded by a pre-recruit biomass survey in the 1996/97 season (SC-CAMLR-XIV, Annex 5, paragraph 5.152).

- French minimum legal size: 25 cm.

Catches: None. Fishery not opened for commercial catches.

Data and Assessment: Estimated 10 500 tonnes biomass for the 1994 cohort.

Fishing Mortality:

Recruitment:

State of Stock: Low biomass of the current cohort but not fully explained.

Forecast for 1997/98: Continue to monitor the shelf stock with survey.

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.2

Source of Information: This report

Year	1992	1993	1994	1995	1996	1997	Max[2]	Min[2]	Mean[2]
Recommended TAC			311						
Agreed TAC			311	311					
Landings	0	0	0		216				
Survey Biomass	3111		31701		7194-112745				
Surveyed by					Australia[4]				
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 From VPA using (..........)
4 August 1997

Conservation Measures in Force: 110/XV – TAC 311 tonnes.

Catches: 216 tonnes in 1996/97.

Data and Assessment: WG-FSA-97/29 – short-term projections based on results from recent survey in August 1997.

Fishing Mortality: Resulting F = 0.095 for 1997/98 fishing season from projections detailed in WG-FSA-97/29.

Recruitment:

State of Stock: Recent survey in August 1997 estimated biomass on the Heard Plateau at 49 050 tonnes (95% CI, 7 194–112 745 tonnes).

Forecast for 1997/98: Recommended TAC of 900 tonnes and other by-catch provisions.

ANNEX 6

TASK GROUP OF WG-FSA ON REPORTING FORMS AND INSTRUCTIONS FOR SCIENTIFIC OBSERVATION ON BOARD LONGLINE FISHING VESSELS

TASK GROUP OF WG-FSA ON REPORTING FORMS AND INSTRUCTIONS FOR SCIENTIFIC OBSERVATION ON BOARD LONGLINE FISHING VESSELS

The Scientific Committee has approved the recommendation of WG-FSA that a task group be formed to consider comments of scientific observers on the utility and feasibility of data recording forms and procedures currently in use for observations on board longline fishing vessels (Annex 5, paragraphs 3.33 and 3.34).

2. The task group will be carrying out its work intersessionally by correspondence. It should report back to WG-FSA at its 1998 meeting in October 1998.

3. The membership of the group comprises technical coordinators of national scientific observation programs, the Secretariat's Data Manager and Scientific Observer Data Analyst (SODA). The membership of the group is also open to any Member of the Scientific Committee who wishes to participate. The Science Officer was appointed as coordinator of this group.

4. It is intended that the group would first deal with a number of comments received from scientific observers at the 1997 meeting of WG-FSA (Annex 5, paragraphs 3.10, 3.31, 3.33, 3.35, 7.9 and 7.10). The work of the group will include the following:

(i) technical coordinators will consult, at a national level, with all scientific observers who took part in CCAMLR-related programs during the last two fishing seasons. Scientific observers will be asked whether they experienced similar problems to those reported to WG-FSA or any other problems in the conduct of observations, including the use of data reporting forms and instructions published in the *Scientific Observers Manual*;

(ii) technical coordinators will assess, first individually at a national level and then as a group, all comments and proposals received from scientific observers;

(iii) the Data Manager and Scientific Observer Data Analyst will consider any changes proposed to reporting forms and observer instructions in order to evaluate their potential impact on the structure and content of the existing Scientific Observer Database;

(iv) the group will advise on those revisions or proposals which call for immediate changes to existing reporting forms and instructions; and

(v) the group will revise and prepare drafts of the revised forms and instruction for consideration by WG-FSA at its next meeting.

5. The proposed timetable of the group's work is as follows:

Action	Deadline	Acting Members of the Group
Circulation to the group of all documents relevant to the formation of the group and its task	November 1997	Coordinator
Request comments from scientific observers	January 1998	National technical coordinators
Collate and analyse comments and proposals received from observers	February 1998	National technical coordinators
Submit collated comments and proposals to the Secretariat	March 1998	National technical coordinators
Analyse comments with respect to their potential impact on the structure and content of existing scientific observer database	April 1998	Data Manager and Scientific Observer Data Analyst
Consult with the group on changes required to existing forms and instructions	May 1998	Coordinator
Revise forms and instructions, as required	May 1998	Coordinator, Data Manager and Scientific Observer Data Analyst
Circulate revised draft forms and instructions to the group for approval.	May 1998	Coordinator
Prepare the group's report to WG-FSA	August 1998	Coordinator

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN CCAMLR REPORTS

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ACC	Antarctic Circumpolar Current
ADCP	Acoustic Doppler Current Profiler
AFZ	Australian Fishing Zone
AMD	Antarctic Master Directory
AMLR	Antarctic Marine Living Resources (USA)
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
ASIP	Antarctic Site Inventory Project
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
ASOC	Antarctic and Southern Ocean Coalition
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)
BPUE	Birds per unit effort
CBD	Convention on Biodiversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAS	Convention for the Conservation of Antarctic Seals
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CCSBT-ERSWG	CCSBT Ecosystem and Related Species Working Group
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection

CITES	Convention on International Trade in Endangered Species
CMS	Convention on the Conservation of Migratory Species of Wild Animals
COFI	Committee on Fisheries (FAO)
COMM CIRC	Commission circular (CCAMLR)
COMNAP	Council of Managers of National Antarctic Programs (SCAR)
CPD	Critical period-distance
CPUE	Catch per unit effort
CS-EASIZ	Coastal Shelf Sector of the Ecology of the Antarctic Sea-Ice Zone (SCAR)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CTD	Conductivity temperature depth probe
CV	Coefficient of variation
CWP	Coordinating Working Party on Fishery Statistics (FAO)
EASIZ	Ecology of the Antarctic Sea-Ice Zone
EEZ	Exclusive Economic Zone
EIV	Ecologically important value
EPOS	European *Polarstern* Study
FAO	Food and Agriculture Organisation
FFA	Forum Fisheries Agency
FFO	Foraging–fishery overlap
FIBEX	First International BIOMASS Experiment
FRAM	Fine Resolution Antarctic Model
FV	Fishing vessel
GAM	Generalised Additive Model
GEBCO	General Bathymetric Chart of the Oceans
GIS	Geographic Information System
GLM	Generalised Linear 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
GYM	Generalised Yield Model
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 (I-ATTC)	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
ICSEAF	International Commission for the Southeast Atlantic Fisheries
IDCR	International Decade of Cetacean Research
IGBP	International Geosphere Biosphere Programme
IHO	International Hydrographic Organisation
IKMT	Isaacs-Kidd midwater trawl
IMALF	Incidental mortality arising from longline fishing

IMO	International Maritime Organisation
IOC	Intergovernmental Oceanographic Commission
IOCSOC	IOC Regional Committee for the Southern Ocean
IOFC	Indian Ocean Fisheries Commission
IOTC	Indian Ocean Tuna Commission
IRCS	International radio call sign
ISCU	International Council of Scientific Unions
ISO	International Organisation of Standardisation
ISR	Integrated Study Region
IUCN	International Union for the Conservation of Nature and Natural Resources - the World Conservation Union
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
LMR	Living Marine Resources Module (GOOS)
LTER	Long-term Ecological Research (USA)
MARPOL Convention	the International Convention for the Prevention of Marine Pollution by Dumping of Wastes and other Matter
MBAL	Minimum biologically acceptable limits
MSY	Maximum sustainable yield
MV	Merchant vessel
MVBS	Mean volume backscattering strength
MVUE	Minimum variance unbiased estimate
NAFO	Northwest Atlantic Fisheries Organisation
NASA	National Aeronautical and Space Administration (USA)
NCAR	National Center for Atmospheric Research (USA)
NEAFC	Northeast Atlantic Fisheries Commission

NMFS	National Marine Fisheries Service (USA)
NMML	National Marine Mammal Laboratory (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NRT	Net registered tonnage
NSF	National Science Foundation (USA)
NSIDC	National Snow and Ice Data Center (USA)
OECD	Organisation for Economic Cooperation and Development
PCA	Principal Component Analysis
PTT	Platform Transmitter Terminals
RMT	Research midwater trawl
ROV	Remotely-operated vehicle
RTMP	Real-time monitoring program
RV	Research vessel
SACCF	Southern Antarctic Circumpolar Current Front
SCAF	CCAMLR Standing Committee on Administration and Finance
SCAR	Scientific Committee on Antarctic Research
SCAR-ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (SCAR Program)
SCAR-BBS	Bird Biology Subcommittee (SCAR)
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
SC-CAMLR	Scientific Committee for CCAMLR
SC CIRC	Scientific Committee circular (CCAMLR)

SC-CMS	Scientific Committee for CMS
SC-IWC	Scientific Committee for IWC
SCOI	CCAMLR Standing Committee on Observation and Inspection
SCOR	Scientific Committee on Oceanic Research
SD	Standard deviation
SeaWiFS	Sea-viewing wide field-of-view sensor
SIBEX	Second International BIOMASS Experiment
SO-GLOBEC	Southern Ocean GLOBEC
SO-JGOFS	Southern Ocean JGOFS
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Sequential population analysis
SPC	South Pacific Commission
SSSI	Site of special scientific interest
SST	Sea-surface temperature
TAC	Total allowable catch
TDR	Time depth recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TS	Target strength
TVG	Time varied gain
UN	United Nations
UNCED	UN Conference on Enviroment and Development
UNEP	UN Enviromental Program
UNCLOS	UN Convention on the Law of the Sea
US AMLR	United States Antarctic Marine Living Resources Program

US LTER	United States Long-term Ecological Research
UV	Ultra-violet
VMS	Vessel Monitoring System
VPA	Virtual population analysis
WG-CEMP	CCAMLR Working Group for the CCAMLR Ecosystem Monitoring Program
WG-EMM	CCAMLR Working Group on Ecosystem Monitoring and Management
WG-FSA	CCAMLR Working Group on Fish Stock Assessment
WG-IMALF	CCAMLR Working Group on Incidental Mortality Arising from Longline Fishing
WG-Krill	CCAMLR Working Group on Krill
WMO	World Meteorological Organisation
WOCE	World Ocean Circulation Experiment
WSC	Weddell-Scotia Confluence
WS-Flux	CCAMLR Workshop on Evluating Krill Flux Factors
WS-MAD	CCAMLR Workshop on Methods for the Assessment of *D. eleginoides*
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable bathythermograph